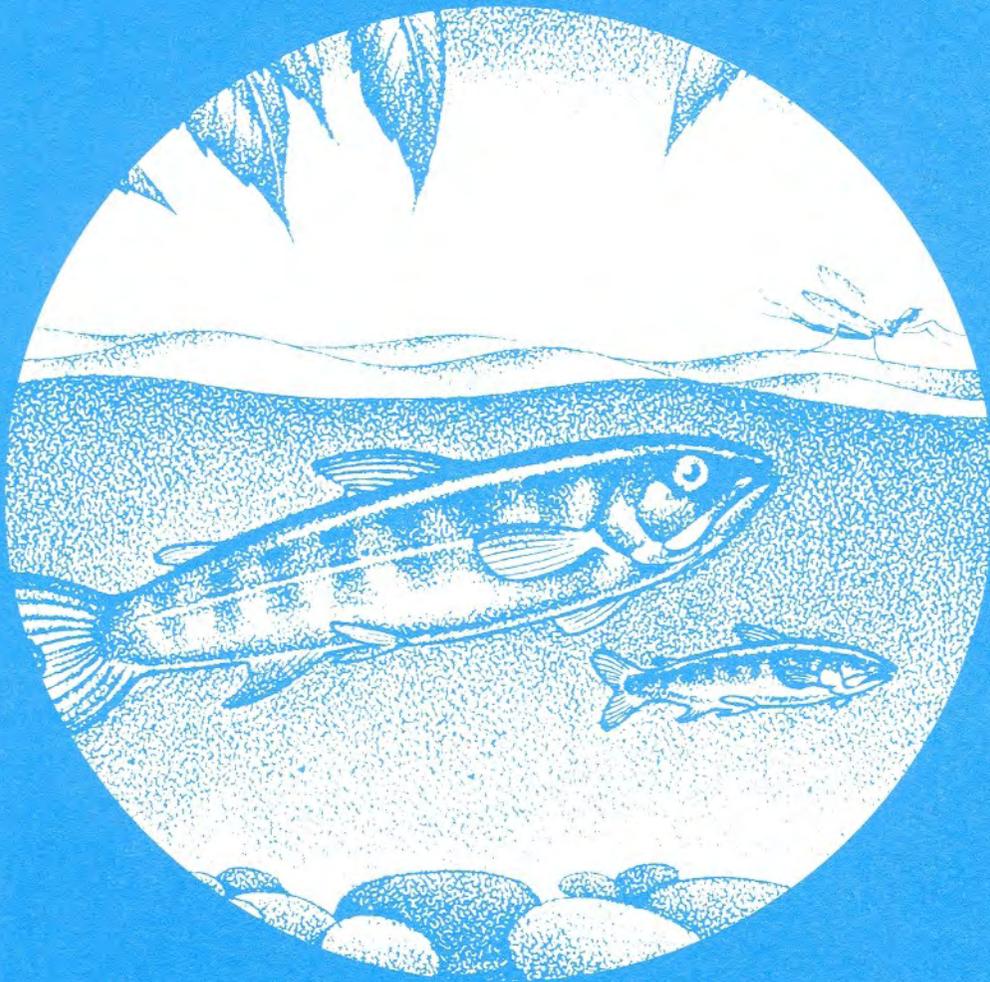


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# Smolt Monitoring at the Head of Lower Granite Reservoir and Lower Granite Dam



**Annual  
Report  
1993**

U.S. Department of Energy  
Bonneville Power Administration  
Division of Fish & Wildlife

Idaho Department of  
Fish and Game

March 1995

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

Annual Report  
for 1993 Operations

Prepared by:

Edwin W. Buettner

and

Arnold F. Brimmer

Idaho Department of Fish and Game  
Boise, ID 83707

Prepared for:

U.S. Department of Energy  
Bonneville Power Administration  
Environment, Fish and Wildlife  
P.O. Box 3621  
Portland, OR 97208-3621

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## ABSTRACT

This project monitored the daily passage of chinook salmon Oncorhynchus tshawytscha and steelhead trout O. mykiss smolts during the 1993 spring outmigration at migrant traps on the Snake River, Clearwater River, and Salmon River.

In 1993, for the first time, all hatchery chinook salmon released above Lower Granite Dam were marked. Total annual (hatchery + wild) Chinook salmon catch at the Snake River trap was nine times greater than in 1992. The trap captured 2,683 wild age 1 chinook salmon. Hatchery steelhead trout catch was the highest since trap operation began in 1984. Wild steelhead trout trap catch was the third highest since operation began and was 26% less than the high of 4,136 in 1991. For the third year, operations at the Snake River trap and an experimental screw trap were extended through the end of July to collect summer-migrating age 0 chinook. The differentiation of age 0 chinook from spring and (age 1) summer chinook, using physical characteristics, was again employed in 1993. The Snake River trap collected 58 age 0 chinook salmon. Overall total trap catch would have been greater, but the trap was out of operation for 32 days (d) in 1993 due to high flow and mechanical problems.

Chinook salmon catch at the Clearwater River trap was the second lowest since the drought started in 1987. Hatchery steelhead trout trap catch was the third highest since the drought. Wild steelhead trout trap catch was 25% of the highest catch, which was 3,507 in 1992. Due to the higher flows in 1993, the Clearwater River trap was out of operation after May 4 and was restarted on July 7 to collect age 0 chinook salmon. Age 0 chinook salmon catch was 27, which was about the same as the previous year.

The Salmon River trap was operated for the first time since 1987. A new scoop trap was used in 1993 allowing the trap to be fished at slightly higher flows. Chinook salmon catch was the second lowest of the five years the trap was operated between 1983-1993. One factor contributing to the low trap catch was about 30% fewer hatchery chinook were released into the Salmon River drainage than in 1987, and 1993 trap catch was 35% less. Hatchery releases account for the reduced trap catch. Wild chinook salmon were enumerated in 1993, and 5,147 fish were collected. Approximately 2.9 times more hatchery steelhead were collected in 1993 than the next highest year (1984), with 1.8 times more hatchery fish being released in 1993. The big difference between 1993 and 1984 was about one million more hatchery steelhead were released in the Riggins area in 1993. These fish would have the opportunity to pass the trap before operations were terminated due to high flows. Wild steelhead trout collection in 1993 was the highest (948 fish and 1.4 times higher than 1984) of the five years of operation.

Fish tagged with Passive Integrated Transponder (PIT) tags at the Snake River trap were interrogated at four dams with PIT tag detection systems (Lower Granite, Little Goose, Lower Monumental, and McNary dams). Because of the addition of the fourth interrogation site (Lower Monumental) in 1993, cumulative interrogation data are not comparable with previous years. Cumulative interrogations at the four dams for fish marked at the Snake River trap were 69% for hatchery chinook, 74% for wild chinook, 89% for hatchery steelhead, and 84% for wild steelhead. Cumulative interrogations at the four dams for fish PIT-tagged at the Clearwater River trap was 57% for hatchery chinook salmon, 74% for wild chinook salmon, 84% for hatchery steelhead trout, and 86% for wild steelhead trout. Cumulative interrogations at the four dams for fish marked at the Salmon River trap were 61% for hatchery chinook salmon, 74% for wild chinook salmon, 84% for hatchery steelhead trout, and 76% for wild steelhead trout.

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 five years of data showed that a two-fold increase in discharge increased migration rate by 2.5 times for hatchery chinook salmon, 2.9 times for hatchery steelhead trout, and 2.5 times for wild steelhead. In 1993, a two-fold increase in discharge increased migration rate by 4.1 times for wild chinook salmon.

Hatchery chinook salmon marked at the Clearwater River trap migrated 3.8 times faster with a two-fold increase in discharge. Not "enough wild chinook salmon were tagged at the Clearwater River. trap to do any analysis. The relation between migration rate and discharge was not significant for hatchery steelhead trout in 1993. A two-fold increase in discharge increased migration rate by two times for wild steelhead trout.

For fish marked at the Salmon River trap, a two-fold increase in discharge increased migration rate by 4.2 times, for hatchery chinook salmon, 5.2 times for wild chinook salmon, 5.1 times for hatchery steelhead trout, and 2.1 times for wild steelhead trout. Six hatchery chinook salmon, one wild chinook salmon, and one wild steelhead trout, marked and released at the Salmon River trap on May 12, were interrogated at the Snake River trap on May 13. These fish migrated 164 km in 24 to 30 hours, **OR** a rate of 5.5 to 6.8 km/hour, at a discharge of 25 to 35 thousand cubic feet/second (kcfs) in the Salmon River and slightly less than 90 kcfs in the Snake River.

Author:

Edwin W. Buettner  
Senior Fishery Research Biologist

Arnold F. Brimmer  
Senior Fishery Technician

## INTRODUCTION

The Pacific Northwest Electric Power Planning and Conservation Act of 1980 (P.L. 96-501) directed the Northwest Power Planning Council (NPPC) 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 smolt migration. In response to the fishery agencies and Indian Tribes' recommendations for migration flows, the NPPC Columbia River Basin Fish and Wildlife Program proposed a "water budget" for augmenting spring flows.

The NPPC's water budget in the Columbia's Snake River tributary is 1.19 million acre-feet of stored water for use between April 15 and June 15 to enhance the smolt migration. This is the third year since the establishment of the water budget that over a million acre-feet of water were made available. In the past, only about a third of the requested 1.19 million acre-feet has been provided.

To provide information to the Fish Passage Center (FPC) on smolt movement prior to arrival at the lower Snake River reservoirs, the Idaho Department of Fish and Game (IDFG) monitors the daily passage of smolts at the head of Lower Granite Reservoir. This information allows the FPC to request the limited Snake River water budget for optimal use to provide improved passage and migration conditions.

Smolt monitoring is beneficial for water budget management under all flow conditions and becomes critical when low flow conditions 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 the most timely use of the limited water budget resource. Five low-flow years (1987, 1988, 1990, 1991, 1992) have occurred during this smolt monitoring project. The indications are that judicious use of the water budget can greatly enhance the timing and migration rate of juvenile chinook salmon Oncorhynchus tshawytscha and steelhead O. mykiss trout.

The IDFG smolt monitoring project also collects other useful data on relative species composition, hatchery and wild steelhead trout ratios, travel time, and migration rate. All age 0 chinook are Passive Integrated Transponder (PIT)-tagged (Prentice et al. 1987) to determine migration rate through Lower Granite Reservoir and cumulative interrogation 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. 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. Monitoring sites on both the Snake and Clearwater arms of Lower Granite Reservoir and the Salmon River permit migration timing to be determined for smolts from each drainage. 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 NPPC-supported projects.

## OBJECTIVES

1. Provide daily trap catch data at the head of Lower Granite Reservoir for water budget and fish transportation management purposes.
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 freeze-branded and 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/summer chinook salmon, wild spring/summer chinook salmon, age 0 chinook salmon, hatchery steelhead trout, and wild steelhead trout from the head of Lower Granite Reservoir to Lower Granite Dam and to Little Goose 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/summer chinook salmon, age 0 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. Test the new screw trap to determine effectiveness of the trap to collect age 0 chinook salmon smolts.
9. PIT tag all age 0 chinook collected in the Snake River trap and screw trap and determine travel time and cumulative interrogation rate.
10. 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 1993 outmigration in the Snake River drainage, upstream of Lower Granite Dam. This information included species, number released, date, release location, number PIT-tagged, number freeze-branded, and associated brand.

### Smolt Monitoring Traps

During the 1993 outmigration, four smolt monitoring traps were employed to monitor the passage of juvenile chinook salmon and steelhead trout. A scoop trap (Raymond and Collins 1974) was located on the Clearwater River. A second scoop trap was located on the Salmon River, near White Bird, Idaho. The two other traps, a dipper trap (Mason 1966) and a screw trap (Murphy et al. in press), were

located on the Snake River (Figure 1). Smolts were captured and removed daily from the traps for examination, enumeration, and released back to the river. Up to 100 smolts of each species were measured (fork length to the nearest mm), and up to 2,000 fish were examined for hatchery brands. Smolts were anesthetized before handling with tricaine methanesulfonate (MS-222.) and allowed to recover before being returned to the river.

At each trap, water temperature (C) and turbidity (m) were recorded daily using a thermometer and a 20-cm secchi disk. The U.S. Weather Service provided daily information on river discharge (cfs). Snake River discharge was measured at the U.S. Geological Survey (USGS) Anatone gauge (#13334300), 44.4 km upstream from the dipper and screw traps. Clearwater River discharge was measured at the USGS Spalding gauge (#13342500), 8.8 km upstream from the Clearwater River trap. Salmon River discharge was measured at the USGS White Bird gauge (#13317000), 1.6 km upstream from the Salmon River trap.

### **Snake River Traps**

The Snake River trap was positioned approximately 40 m downstream from the Interstate Bridge between Lewiston, Idaho and Clarkston, Washington. The trap was attached to bridge piers just east of the drawbridge span by steel cables. This location is at the head of Lower Granite Reservoir, 0.5 km upstream from the confluence of the Snake and Clearwater rivers. River width and depth at this location are approximately 260 m and 12 m, respectively. The screw trap was attached to the Interstate Bridge piers west of the drawbridge span. These locations were chosen based on information from a radio telemetry study of juvenile steelhead (Liscom and Bartlett 1988) which suggests that 30% of the fish pass in this portion of the channel.

Snake River trap operation in 1993 began March 17 and continued until July 30. The Snake River Trap was not in operation for a total of 32 day (d) during the 1993 season due to mechanical failure **OR** heavy debris loads. Screw trap operation began on June 29 and continued until July 30. Screw trap operation was scheduled to begin in mid-May to collect age 0 migrants, but high flows, heavy debris, and mechanical problems delayed trap operation for six weeks.

Chinook salmon and 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. Up to 100 hatchery chinook salmon, 50 wild chinook salmon, 60 hatchery steelhead trout, all wild steelhead trout, and all age 0 chinook salmon were PIT-tagged daily, when available. Median travel time of the daily PIT-tagged release groups was converted to migration rate. This 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.

All fish captured in the Snake River trap were passively interrogated for PIT tags as they entered the **live** well. All fish captured in the screw trap were interrogated when they were examined. The interrogation and tagging information was sent to the PTAGIS Data Center (managed by Pacific States Marine Fisheries Commission) daily.

The PIT tag interrogation system on the Snake River trap consisted of an 8-inch PVC pipe with two interrogation coils (D-4 and D-6). Each coil was connected to an exciter card and a PIT tag reader. The system did not have the capability to provide exact time of capture. Since it was checked once daily, the interrogation time was set to 00:00 h. Coil efficiency tests were conducted on the dipper trap interrogation system. Five hundred forty test tags were sent through the system and the reading efficiency was 97.2 for both coils combined.

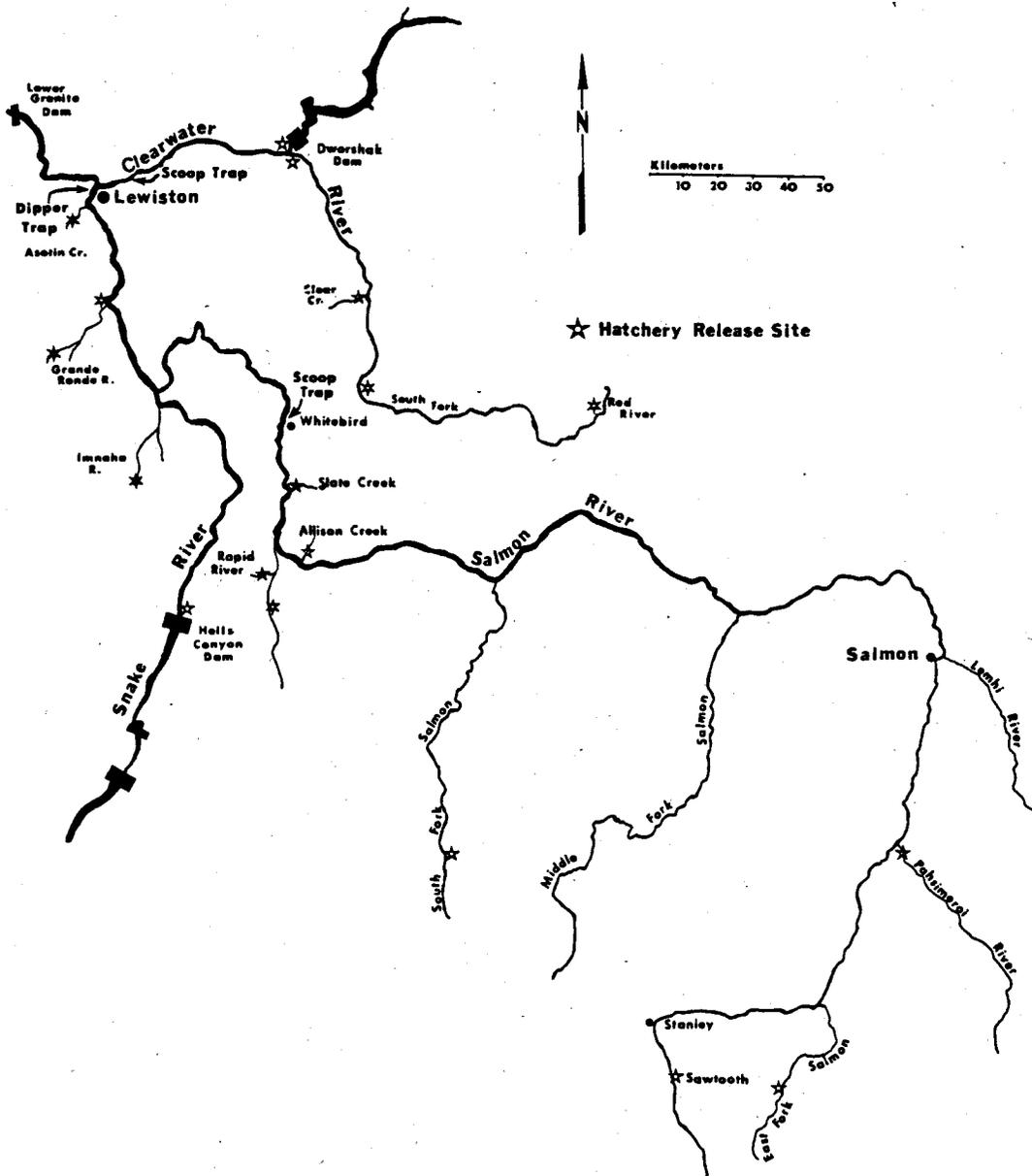


Figure 1. Map of study area.

The coil efficiency observed in 1993 was similar to the coil efficiency estimated in 1991 (98.5%).

### **Clearwater River Trap**

The Clearwater River scoop trap was installed 10 km upstream from the convergence of the Clearwater River and Snake River arms of Lower Granite Reservoir (4.5 km upstream from slack water). The river channel at this location forms a bend and is 150 to 200 m wide and 4 to 7 m deep, depending on discharge. Trap operation began March 23 and continued until May 4, when high discharge and debris forced the termination of operations. Trapping operations resumed on July 7 to collect age 0 migrants produced from fall chinook redds were discovered on the lower Clearwater River in the fall of 1992. Trapping operations were terminated for the year on July 30.

Chinook salmon and steelhead trout smolts were PIT-tagged at the Clearwater River trap to estimate travel time from the head of Lower Granite Reservoir to Lower Granite Dam for Clearwater River fish. Up to 100 hatchery chinook salmon, 50 wild chinook salmon, 60 hatchery steelhead trout, all wild steelhead trout, and all age 0-chinook salmon were PIT-tagged daily, when available. Median travel time of the daily PIT-tagged release groups was converted to migration rate. This was correlated with mean Lower Granite Reservoir inflow discharge for the median, travel time to determine how changes in discharge affected smolt migration rate through Lower Granite Reservoir.

All fish were interrogated for PIT tags as the fish 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 Clearwater River trap consisted of a 4-inch PVC pipe with two interrogation coils (D-0 and D-2). Each coil was attached to an exciter card and a PIT tag reader. This system was battery-operated. Coil efficiency tests were not conducted in 1993, but it was estimated to be 98.8% in 1991.

### **Salmon River Trap**

The Salmon River scoop trap was installed 1.6 km downstream from the White Bird Gauge (river km 86.6) between a rock island and the western shore, and immediately over a rock shelf. This location was chosen because juvenile migrants are concentrated both vertically and laterally due to the morphology of the site, thus making them more vulnerable to capture. River width at this location is approximately 70m and depth ranges from 1.5 m at 4 thousand cubic feet/second (kcfs) to 5.0 m at 25 kcfs. Trap operation began on March 19 and continued uninterrupted until May 12 when high discharge forced the termination of operations for the season.

Chinook salmon and steelhead trout juveniles were PIT-tagged at the Salmon River trap to estimate travel time from the trap to Lower Granite Dam for Salmon River fish. Up to 100 hatchery chinook salmon, 50 wild chinook salmon, 60 hatchery steelhead, and all wild steelhead were PIT-tagged daily when available. Median travel time of the daily PIT-tagged release groups was converted to migration rate. This was correlated with mean Lower Granite Reservoir inflow for the median travel time to determine how changes in discharge affected smolt migration rate through Lower Granite Reservoir.

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 consisted of a 3-foot-long piece of PVC pipe surrounded by two interrogation coils (A and B).

Each coil was connected to an exciter card which was in turn attached to a single PIT tag reader. The reader was connected to a personal computer which contained software that placed a date and time stamp with each PIT tag code that was interrogated. The entire system was powered by a 12-volt deep cycle battery. The efficiency of the system was not estimated, but literature supplied from the manufacturer indicates that we should expect efficiencies of at least 95%.

### 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 1993 trap operations, trap efficiencies were not calculated for any of the smolt traps. Previous trap efficiency estimates are reported by 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, Clearwater, 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 and Clearwater River traps to determine travel time from the head of Lower Granite Reservoir to Lower Granite and Little Goose dams. 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 Lower Granite and Little Goose Dam collection facilities were determined for each daily release group. A minimum recapture number, sufficient for use in travel time and migration 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 spring/summer chinook salmon, wild spring/summer chinook salmon, hatchery steelhead trout, and wild steelhead trout groups marked at the Snake, Clearwater, or Salmon River traps.

The migration rate/discharge relations for PIT-tagged chinook salmon, hatchery steelhead trout, and wild steelhead trout were individually examined for 1988,1993 using analysis of covariance to determine if there were groups of years with common slopes and intercepts. Plots are used to help identify years that differ when non-homogeneous slopes among years are found. Subsequent analyses were run, without these years, to determine if common slopes and intercepts existed for a smaller subset of years. If the final hypothesis of common intercepts was not rejected, then a significant difference in the migration rate/discharge relations among years was not detected and the yearly data were pooled. After pooling, linear regression was used to find the best-fitting

Table 1. River mile & kilometer location for the Snake River Drainage.

	Mouth of Columbia		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 @ trap site	873.6	1405.6	549.3	883.8	441.8	710.9	409.7	659.2	--	--	307.9	495.4
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	--	--	53.0	85.3
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	133.9	215.4
Lower Monumental Dam	365.9	588.7	41.6	66.9	65.9	106.0	98.0	157.7	--	--	181.2	291.5
Pahsimeroi Hatchery	817.5	1315.4	493.2	793.6	385.7	620.6	353.6	568.9	--	--	251.8	405.1
Rapid River Hatchery	605.8	974.7	281.5	452.9	174.0	280.0	141.9	228.3	--	--	40.1	64.5
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	--	--	53.2	85.6
Salmon River trap site	565.7	910.2	241.4	388.4	133.9	215.4	101.8	163.8	--	--	0.0	0.0
Sawtooth Hatchery	896.7	1444.2	573.3	922.4	465.8	749.5	433.7	697.8	--	--	331.9	534.0
Snake River Mouth	324.3	521.8	0.0	0.0	107.5	172.9	139.6	224.6	145.7	234.5	241.4	388.4
Snake River trap site	463.9	746.4	139.6	224.6	32.1	51.6	0.0	0.0	--	--	101.8	163.8
S.F. Salmon @ Knox Bridge	719.7	1158.0	395.4	636.2	287.9	463.2	255.8	411.6	--	--	154.0	247.8
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	--	--	--	--

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, and McNary Dam collection facilities included data from 1988 to 1993 for the Snake River trap, 1989 to 1993 for the Clearwater River trap, and 1993 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 from Lower Granite Dam were reared at eight locations in Idaho and one in Oregon. The Washington Department of Fisheries released no chinook salmon juveniles in the Snake River drainage upstream from Lower Granite Dam that contributed to the 1993 outmigration. A total of 5,583,741 chinook salmon smolts were released at 14 locations in Idaho and 2 locations in Oregon (Table 2).

During the late summer and fall of 1992, seven groups of chinook salmon juveniles (727,562 chinook salmon) were released from Idaho hatcheries. All other chinook salmon releases for the 1993 outmigration occurred in the spring of 1993 (Table 2).

#### **Steelhead Trout**

Steelhead trout were reared at five locations in Idaho, one in Washington, and one in Oregon for release into the Snake River drainage upstream from Lower Granite Dam. A total of 9,414,448 steelhead trout smolts were released at 19 locations in Idaho, 7 locations in Oregon, and 2 locations in Washington (Table 3). Fall releases of steelhead trout juveniles have not been included in this total.

### **Smolt Monitoring Traps**

#### **Snake River Trap Operation**

The Snake River trap captured 15,271 hatchery and 2,683 wild age 1 chinook salmon, 58 age 0 chinook salmon, 35,183 hatchery steelhead trout, 3,046 wild steelhead trout, and 8 sockeye/kokanee salmon *O. nerka*. Due to the significant amount of trap downtime (32 d) during the migration season, the 1993 trap catch is probably not a true representation of smolt passage. The total numbers reported are lower than would have been realized had the trap been in operation throughout the migration season.

Table 2. Hatchery chinook salmon released into the Snake River system upriver from Lower Granite Dam, contributing to the 1993 outmigration.

Release site (hatchery)	Stock	Release date	Number released (number branded) [number PIT-tagged]	Brand
<b>Salmon River</b>				
South Fork Salmon River @ Knox Bridge (McCall)	Summer	4/3-5/5	607,298 [5,013]	
Pahsimeroi Ponds (Pahsimeroi)	Summer	4/14-19	375,000 [600]	
Sawtooth Weir (Sawtooth)	Spring	10/2-8/92	414,972 [4,800]	
		4/5-8	109,753	
Upper Salmon River (Sawtooth)	Spring	10/2-7/92	198,039 [2,400]	
		4/20	51,819 [800]	
East Fork Salmon River (Sawtooth)	Spring	4/20	35,172 [350]	
Rapid River (Rapid River)	Spring	4/14-19	2,060,300 [1,825]	
<b>Drainage Total</b>			<b>3,852,353</b>	
<b>Snake River and Non-Idaho Tributaries</b>				
Hells Canyon (Rapid River)	Spring	4/16	200,300 [100]	
Lookingglass Creek @ River KM 3.5 (Lookingglass)	Spring	4/7	448,219 (20,695) (20,537) (20,541) (20,047) [1,997]	LA-A-1 RA-A-1 LA-A-3 RA-A-3
Imnaha River @ River KM 74.2 (Lookingglass)	Spring	4/12	157,659 (20,271) (20,384) (20,385) (20,094) [1,991]	LA-A-2 RA-A-2 LA-A-4 RA-A-4
<b>Drainage Total</b>			<b>806,178</b>	

Table 2. Continued.

Release site (hatchery)	Stock	Release date	Number released (number branded) [number PIT-tagged]	Brand
<b>Clearwater River</b>				
Clear Creek (Kooskia National Fish Hatchery)	Spring	4/19	343,437 [1,200]	
North Fork Clearwater River (Dworshak National Fish Hatchery)	Spring	4/8-5/6	467,222 [4,500]	
Squaw Creek (Rapid River)	Spring	7/23/92	10,126 [700]	
White Sands (Rapid River)	Spring	7/23/92	90,125 [1,400]	
Red River (Red River)	Spring	10/19/92	6,000 [900]	
Walton Creek (Powell Ponds)	Spring	9/5/92	500	
Crooked Fork Creek (Powell Ponds)	Spring	9/5/92	7,800 [48]	
<b>Drainage Total</b>			<b>925,210</b>	
<b>GRAND TOTAL</b>			<b>5,583,741</b>	

Table 3. Hatchery steelhead trout released into the Snake River system upriver from Lower Granite Dam, contributing to the 1993 outmigration.

<u>Release site (hatchery)</u>	<u>Stock</u>	<u>Release date</u>	<u>Number released (number branded) (number PIT-tagged)</u>	<u>Brand</u>
<b>Salmon River</b>				
Little Salmon River @ Hazard Creek (Magic Valley)	B	4/16-20	325,300 [300]	
(Hagerman National Fish Hatchery)	A	4/12	92,841	
Little Salmon River @ Warm Springs Bdg. (Hagerman National Fish Hatchery)	A	4/14-23	454,475	
North Fork Salmon River (Magic Valley)	A	4/16-22	190,500 [200]	
East Fork Salmon River (Magic Valley)	B	4/7-9	497,400 [300]	
• Lemhi River (Magic Valley)	A	4/14-16	198,500 [200]	
Salmon River @ Ellis Bridge (Magic Valley)	A	4/12-13	266,300 [200]	
Pahsimeroi Trap (Niagara Springs)	A	4/19-24	761,800 [600]	
Salmon River @ Challis (Magic Valley)	A	4/13	260,600 [100]	
Salmon River @ Sawtooth (Hagerman National Fish Hatchery)	A	3/12-24 & 4/9	729,520 [300]	
Salmon River @ Slate Creek (Magic Valley)	B	4/15	187,100	
Salmon River @ Hammer Creek (Hagerman National Fish Hatchery)	A	4/26-30	211,006	
<b>Drainage Total</b>			<b>4,175,342</b>	

Table 3. Continued.

<u>Release site (hatchery)</u>	<u>Stock</u>	<u>Release date</u>	<u>Number released (number branded) [number PIT-tagged]</u>	<u>Brand</u>
<b><u>Snake River and Non-Idaho Tributaries</u></b>				
Hells Canyon (Niagara Springs)	A	4/24-27	353,600 [300]	
Catherine Creek @River Km 32 (Irrigon)	A	4/15-16	62,563	
Spring Creek @ River Km 1.6 (Irrigon)	A LAJ-2	4/19 & 5/5	656,227 (20,735) [493]	RAJ-2
Little Sheep Creek @River Km 24 (Irrigon)	A LAJ-1	4/28	286,694 (20,198) (20,771) (20,314) [1,437]	RAJ-1 LAJ-3 RAJ-3
Deer Creek @River Km 0.16 (Irrigon)	A	4/23 & 5/7	432,977 [902]	
Imnaha River @River Km 36.8 (Irrigon)	A	4/29	53,692	
Grande Ronde River @River Km 264 (Irrigon)	A	4/12-15	200,111	
Wild Cat Creek @River -Km 1.6 (Lyons Ferry)	A	4/15 & 19	50,188	
Grande Ronde River @River Km 46.4 (Lyons Ferry)	A	4/5-30	291,711	
Asotin Creek @River Km 0.8 (Lyons Ferry)	A	4/15-22	136,050	
<b>Drainage Total</b>			<b>2,523,813</b>	

Table 3. Continued.

Release site (hatchery)	Stock	Release date	Number released (number branded) [number PIT-tagged]	Brand
<b>Clearwater River</b>				
Clearwater River (Dworshak National Fish Hatchery)	B	5/3-4	1,217,990 (10,000) (10,000) (10,000) (10,000) [1500]	RDR-1 RDR-3 LDR-1 LDR-3
Clea Creek (Dworshak National Fish Hatchery)	B	4/19-23	342,874	
Kamiah Bridge (Dworshak National Fish Hatchery)	B	4/19-23	88,500	
South Fork Clearwater River ○ River Km 14 ○ (Dworshak National Fish Hatchery)	B	4/19-23	239,792	
Sout Fork h Clearwater River @ Stites (Clearwater)	B	4/12-14	326,300 [300]	
Mill Creek (Dworshak National Fish Hatchery)	B	4/19-23	178,894	-
Cottonwood Creek (Dworshak National Fish Hatchery)	B	4/19-23	320,943 (21,000)	RAR-2
<b>Drainage Total</b>			<b>2,715,293</b>	
<b>GRAND TOTAL</b>			<b>9,414,448</b>	

The 1993 outmigration year was the first time all hatchery chinook salmon produced in Idaho were marked. To compare 1993 data with previous years data, total catch of hatchery chinook salmon was added to total catch of wild chinook salmon. Total catch of chinook salmon (wild + hatchery) was 17,954 in 1993 ("normal" flow year). The 1993 catch of chinook salmon was about nine times greater than in 1992, nearly five times greater than in 1991, but was 56% less than in 1989 (near normal flow year).

Hatchery chinook salmon began arriving at the trap on April 9. There was a minor peak of passage from April 9 to April 13. The major peak of passage began on April 21 and continued until May 14. The major peak of passage probably lasted about a week longer than reported, however, because trap operations were temporarily terminated due to high discharge and debris on May 14 (Figure 2). Operations resumed on May 26. Nineteen percent of the total catch of hatchery chinook salmon were captured in April, 80% in May, and 0.05% in June.

Wild chinook salmon passage was similar to that of hatchery chinook salmon. Monthly catch totals of wild chinook salmon included 12% captured in April, 84% in May, and 4% in June. Wild chinook salmon passage had virtually ended by July 1.

Physical characteristics were used to differentiate between age 0 chinook salmon and other chinook salmon. Peak movement of age 0 chinook salmon was during May and June. Age 0 chinook salmon catch at the Snake River trap had nearly ceased by the end of June. The low numbers of age 0 chinook salmon caught at the Snake River trap was probably due to the significant amount of trap downtime experienced during the peak passage of age 0 chinook salmon.

There was one major peak in hatchery steelhead trout passage. The peak began on April 18 and reached its maximum on May 4; however, collection remained high (greater than 700 fish per day) until mid-May. During this period, 33,987 hatchery steelhead trout, or 97% of the season total, were collected; only 1% of the total catch was collected in June. In the past four years (low flow years), 3% to 17% of the total hatchery steelhead trout catch was collected in June. The low total catch of hatchery steelhead trout in June of 1993 was probably a result of high discharge that occurred in April and May. Twenty-seven percent of the hatchery steelhead trout were captured in April, 72% in May, and 1% in June, 1993.

Total catch of hatchery steelhead trout in 1993 (normal flow year) was the highest on record (35,183). The hatchery steelhead trout catch in 1993 was 1.7 times higher than in 1992, 1.8 times greater than in 1991, and 1.5 times higher than in 1989 (near normal flow year). The trap location near the thalweg coupled with high discharge were probably the reasons for the elevated hatchery steelhead collection in 1993.

Timing of wild steelhead trout passage was similar to hatchery steelhead trout passage (Figure 3). Ninety-nine percent of the wild steelhead passage occurred in April and May. Only 1% of wild steelhead passage occurred in June. Peak periods of passage were associated with increases in discharge. Eighteen percent of the wild steelhead trout were captured in April, 81% in May, and 1% in June.

Despite 32 d of trap downtime, Snake River trap catch for wild steelhead trout was 1.7 times greater than the 1992 total of 2,691. The 1993 trap catch of wild steelhead trout was 26% less than in 1991, 11% less than in 1990, but 1.4 times greater than in 1989.

The screw trap did not catch any anadromous fish in 1993. The reason for poor trap performance seemed to be its location. The trap would probably function more efficiently in a smaller river where a greater percentage of the river flowed through the trap and velocity was higher.

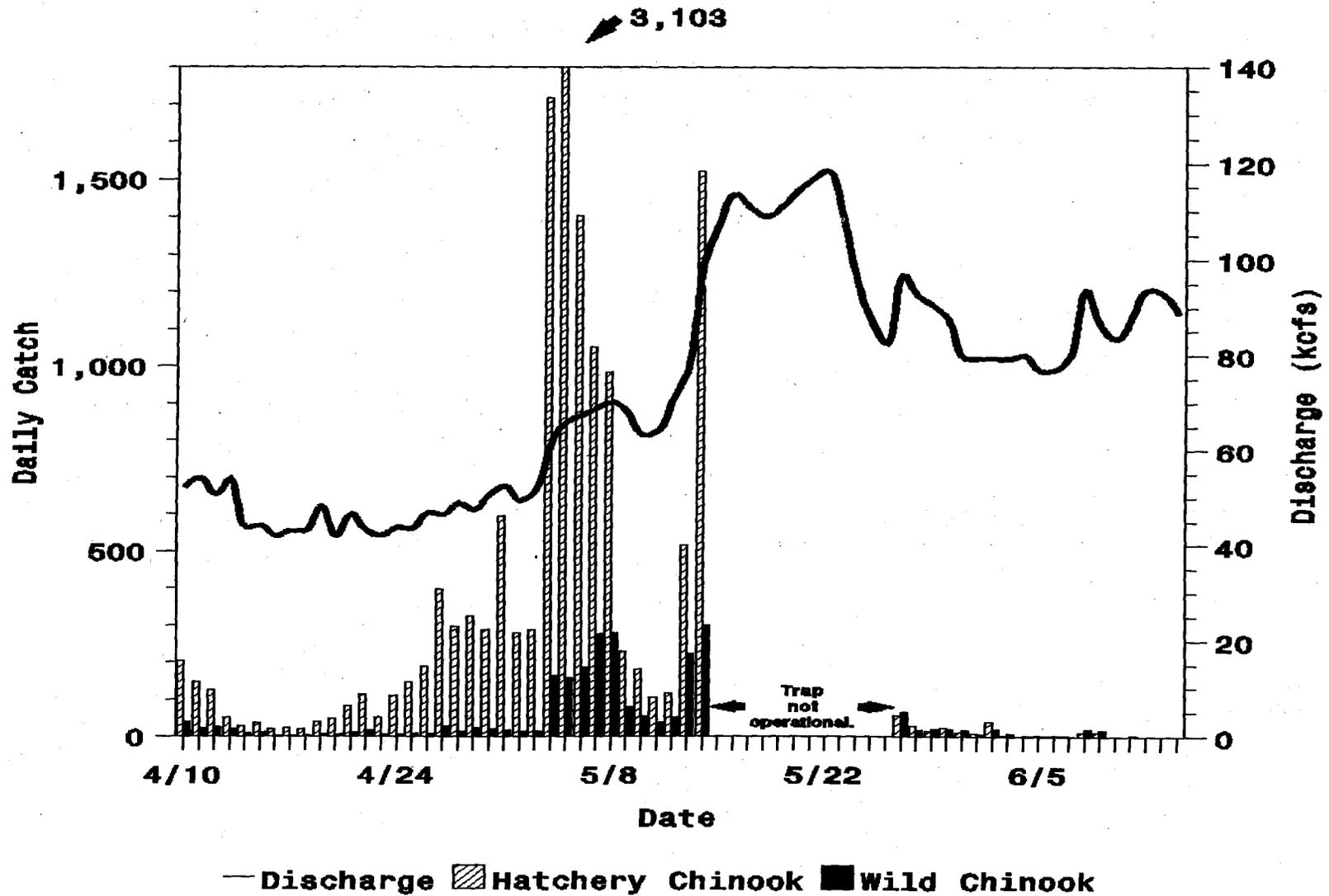


Figure 2. Snake River trap daily catch of hatchery chinook salmon and wild chinook salmon overlaid by Snake River discharge, 1993.

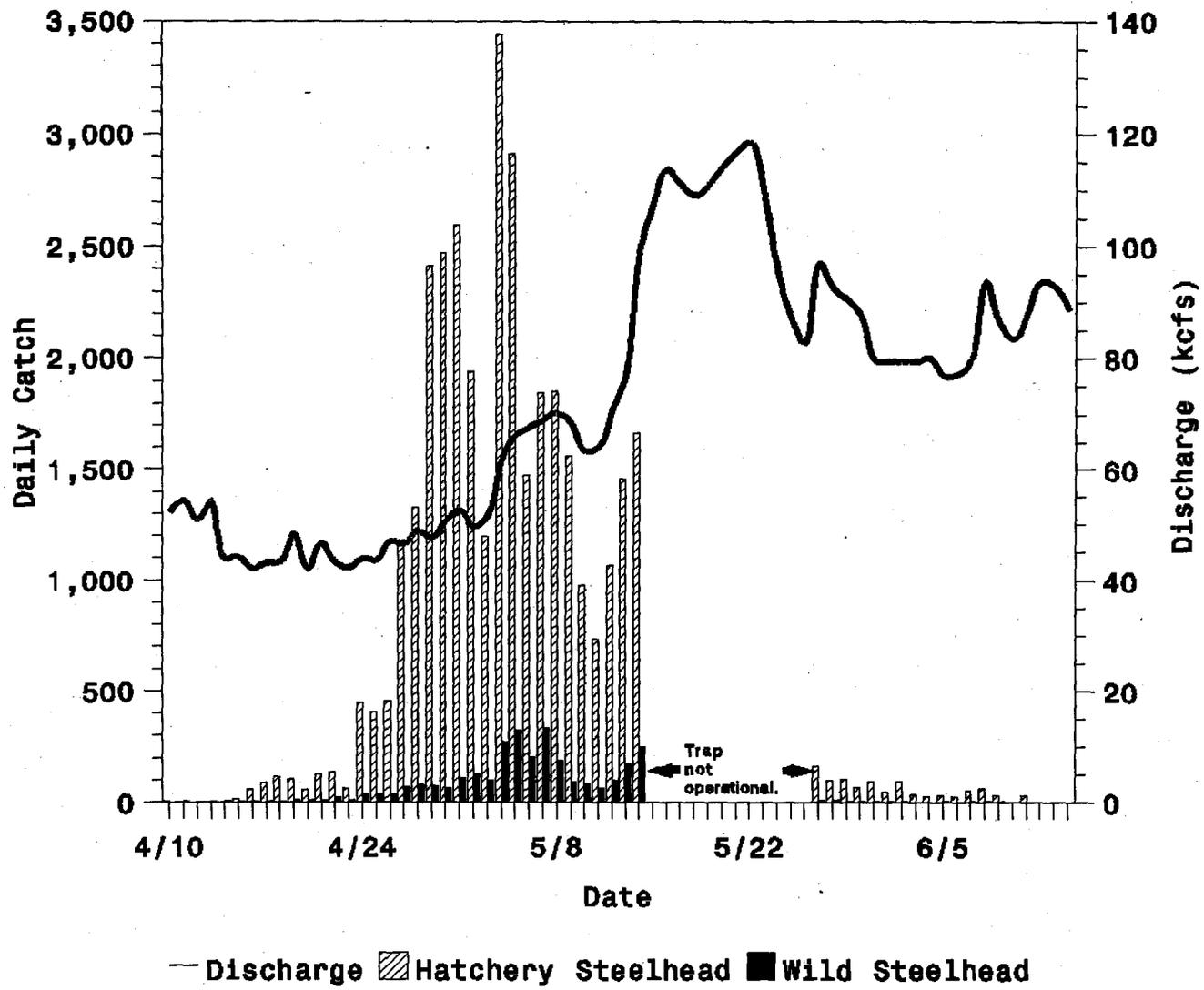


Figure 3. Snake River trap daily catch of hatchery steelhead trout and wild steelhead trout overlaid by Snake River discharge, 1993.

Average discharge in March was 37.9 kcfs (Figure 3), which was 16.2 kcfs higher than in 1992 and 2.5 kcfs lower than in 1989. Average April discharge was 49.9 kcfs, with a peak of 75.7 kcfs on April 6. April average discharge was 25.3 kcfs higher than in 1992 and 8.7 kcfs lower than in 1989. Average May discharge was 85.7 kcfs with a peak of 119 kcfs on May 22, which was the high discharge for the season. May average discharge was 53.0 kcfs higher than in 1992 and 33.7 kcfs higher than in 1989. May average discharge was the highest since 1984 (118.7 kcfs). Flow was high at the beginning of June but slowly decreased throughout the month. Average discharge for June was 74.8 kcfs which was 57.9 kcfs higher than in 1992 and 30.0 kcfs higher than in 1989. The historical records indicate that June average discharge has not been this high since 1984 (134.2 kcfs). July average discharge was 32.5 kcfs. Flow had dropped to 26.6 kcfs by the end of July.

Snake River water temperature at the trap steadily increased throughout the sampling season (Figure 4). By the end of the season, July 30, water temperature had risen to 18°C. Water temperatures were generally 2°C to 5°C cooler than in 1992.

Secchi disk transparency fluctuated throughout the sampling season (Figure 4). Influenced mainly by localized rain or thunderstorms, secchi disk transparency shows no relation to discharge.

### **Clearwater River Trap Operation**

The Clearwater River trap caught 9,761 age 1 hatchery chinook salmon, 320 age 1 wild chinook salmon, 27 age 0 chinook salmon, 10,122 hatchery steelhead trout, 882 wild steelhead trout, and 42 sockeye/kokanee salmon in 1993. Total catch of hatchery chinook salmon was added to the total catch of wild chinook salmon. The total chinook salmon trap catch for 1993 (10,081) was about 880 less than the 1992 total of 85,434, 74% less than the total catch in 1991, but just slightly higher than the lowest trap catch of 9,938 in 1989.

Although outmigration conditions were excellent in 1993, the total trap catch of chinook salmon was less than that observed in 1990, 1991, and 1992 (drought years). The reduction in trap catch was probably a function of trap location, discharge, and a reduced number of hatchery chinook salmon in the system. About two million fewer hatchery chinook salmon were released in 1993 than in 1992.

Two major peaks of hatchery chinook salmon passage were observed at the Clearwater River trap (Figure 5). The first began on April 9 and ended on April 17. This peak was associated with chinook salmon passing the trap from Dworshak National Fish Hatchery releases. The second peak began on April 20 and continued to April 28. The second peak was associated with the releases from Kooskia National Fish Hatchery, Dworshak National Fish Hatchery, and fall-released smolts that were outplanted in Squaw Creek, White Sands Creek, and Red River.

Wild chinook salmon began arriving at the trap as early as March 26. Numbers remained low (fewer than ten fish daily) until April 10. Wild chinook salmon did not exhibit any large peaks in passage, but rather a low steady rate of passage that lasted from April 10 to May 4, when operations were terminated due to high discharge.

Hatchery steelhead trout began showing up in the trap catch in high numbers (>100 fish/d) on April 15. There were two major peaks of hatchery steelhead trout passage. The first peak began on April 20 and lasted until May 2, and was associated with movement of smolts outplanted in the Clearwater River system upstream of Dworshak and Clearwater hatcheries. The second major peak in passage occurred on May 4, and was associated with the release directly from Dworshak

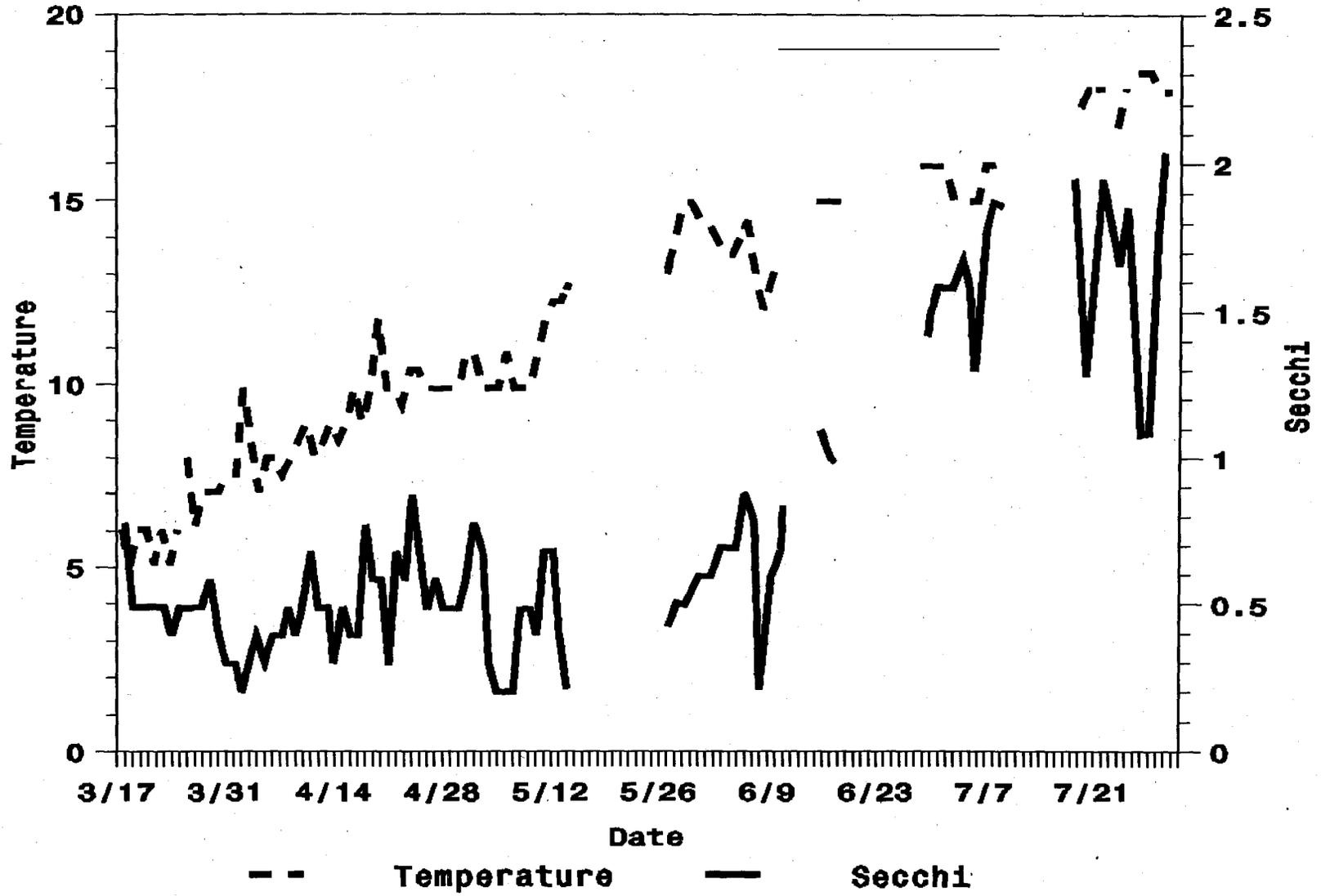


Figure 4. Daily temperature and secchi disk transparency at the Snake River trap, 1993.

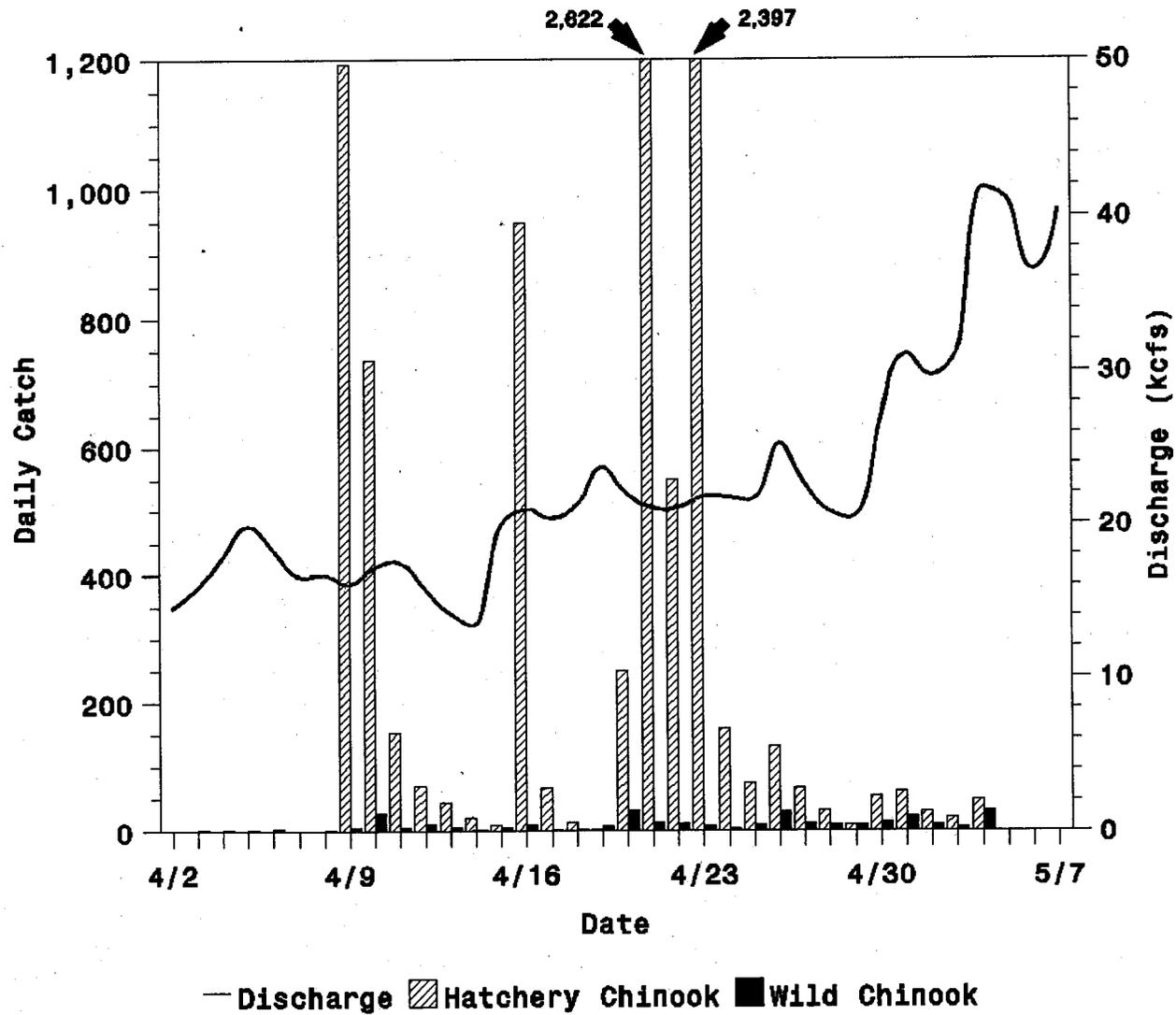


Figure 5. Clearwater River trap daily catch of hatchery chinook salmon and wild chinook salmon overlaid by Clearwater River discharge, 1993.

National Fish Hatchery (Figure 6). The 1993 hatchery steelhead trout trap catch was about 1.4 times higher than in 1992, slightly higher than in 1991 (9,231) and six times higher than in 1989, a near normal flow year.

Wild steelhead trout were present in the trap catch in low numbers (1 to 26 fish/d) from March 26 until April 26. Peak passage of wild steelhead trout began on April 26 and lasted through May 4, when operations were terminated due to high discharge (Figure 6). Trap catch of wild steelhead trout in 1993 was 75% lower than in 1992, but virtually the same as in 1991. The large disparity in catch between 1992 and 1993 was due to differences in timing of outmigrating wild steelhead trout between each year. Wild steelhead trout passage occurred about two weeks later in 1993 than in 1992. Consequently, a significant portion of the wild steelhead trout outmigration was missed because high discharge interrupted operations during the time of suspected peak passage.

Clearwater River discharge, measured at the Spalding gauge, ranged from 3.4 kcfs to 17.9 kcfs during March. Average discharge was 11.1 kcfs for the month which was about the same as in 1991 and 1992. Discharge began to increase in April and ranged from 13.4 to 26.8 kcfs. Average discharge (19.3 kcfs) was about 3.0 kcfs greater than in 1991 and 1992. May discharge ranged from 29.7 kcfs to 68.1 kcfs. Average May discharge (47.5 kcfs) was 18.3 kcfs higher than in 1992 and 9.0 kcfs higher than in 1991.

Clearwater River water temperature at the trap in the beginning of the season was 6°C and gradually increased to 15°C by the end of the trapping season on July 30 (Figure 7). Water temperatures fluctuated throughout the season due to localized precipitation and cold water releases from Dworshak Reservoir. Secchi disk transparency in the Clearwater River fluctuated throughout the trapping season and ranged from 0.1 m to 2.4 m (Figure 7).

### **Salmon River Trap Operation**

The Salmon River trap captured 28,326 age 1 hatchery chinook salmon, 5,147 age 1 wild chinook salmon, 7,315 hatchery steelhead trout, and 948 wild steelhead trout. Small numbers (fewer than ten fish) of hatchery chinook salmon were collected daily during the latter part of March. Fish numbers began to increase on April 14 and increased significantly on April 17 due to the arrival of the Rapid River hatchery fish. Numbers began to decline after April 17 and continued to decrease throughout the remainder of the month. Chinook passage began to increase again on May 1 and peaked on May 4. Collections of hatchery chinook salmon remained high (>200 fish/d) through May 12 when operations were terminated for the year. due to high discharge (Figure 8). Less than 1% of the hatchery chinook salmon was captured in March, 77% in April, and 22% in May.

Wild chinook salmon began arriving at the Salmon River, trap in low numbers (fewer than 10 fish daily) in mid-March. There were two major peaks in chinook passage (Figure 8). The first-peak began on April 6 and reached its maximum on April 16. The second began on May 1 and peaked on May 6. Nearly 6% of the wild chinook salmon were collected in March. Sixty-four percent were captured in April and 30% in May.

Two major peaks of hatchery steelhead trout passage were observed at the Salmon River trap. The first began on April 14 and peaked on April 22 (Figure 9). The second began on May 1 and peaked on May 6. There were no hatchery steelhead trout collected in March. Thirty-six percent were collected in April and 64% in May.

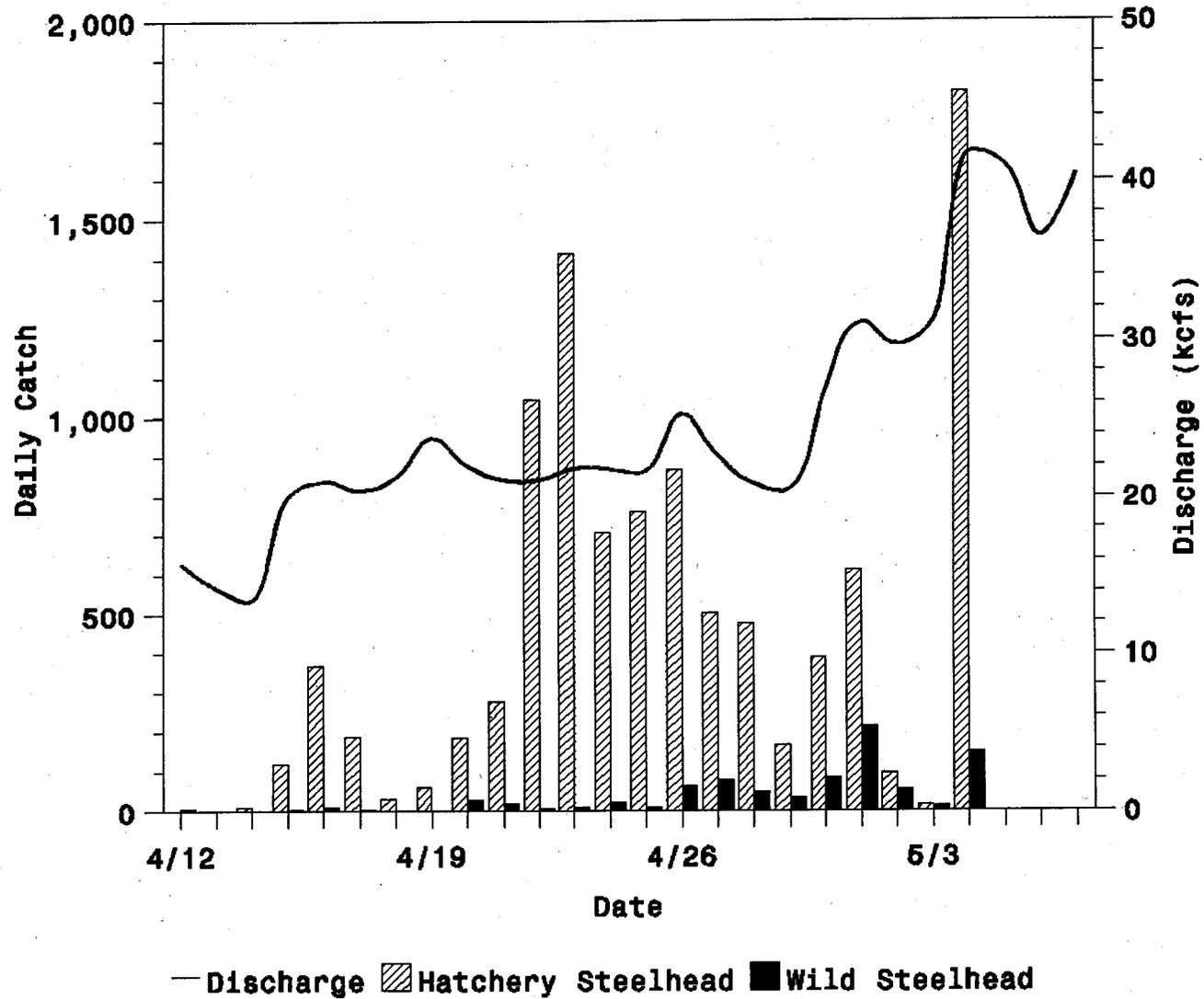


Figure 6. Clearwater River trap daily catch of hatchery steelhead trout and wild steelhead trout overlaid by Clearwater River discharge, 1993.

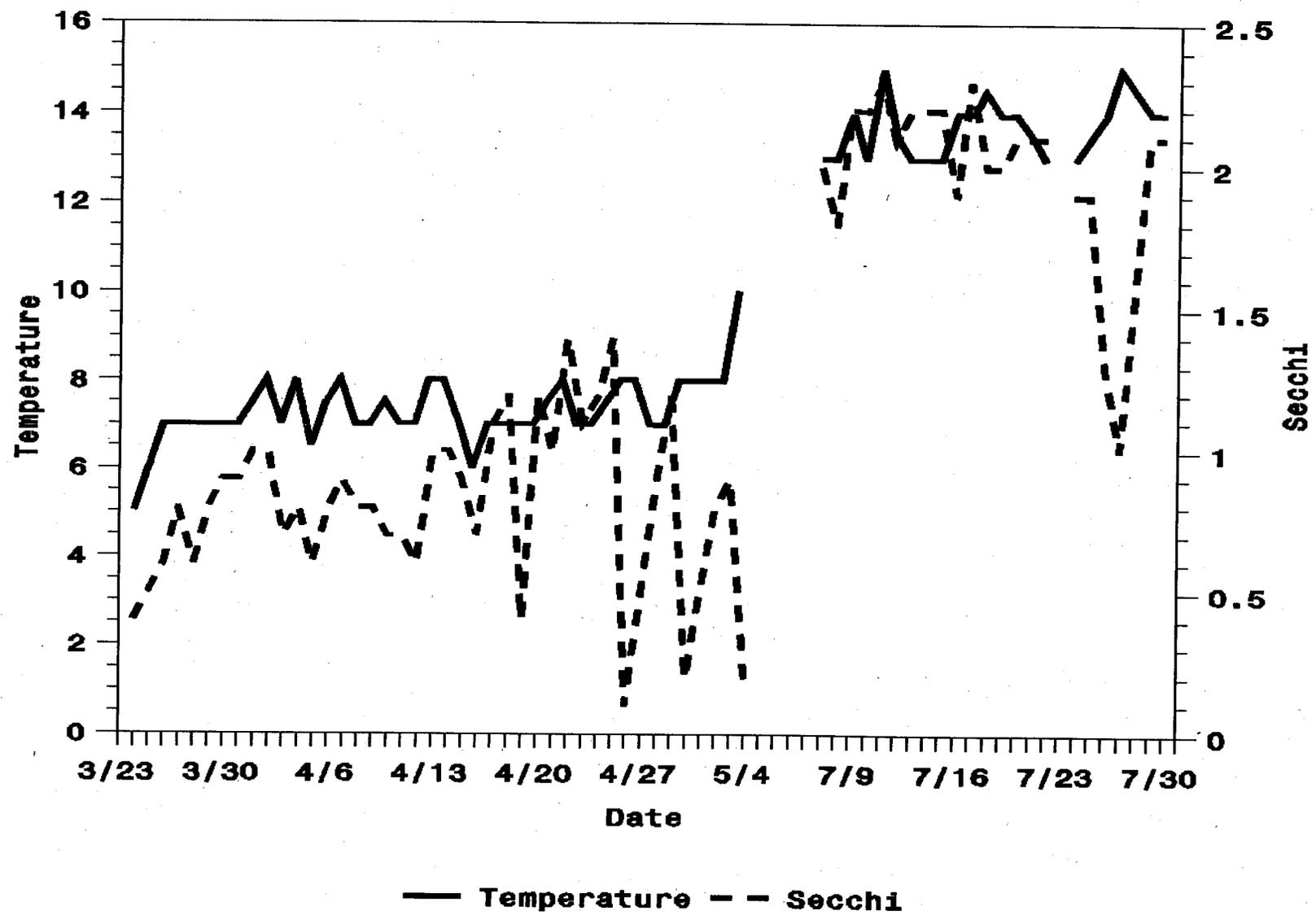


Figure 7. Daily temperature and secchi disk transparency at the Clearwater River trap, 1993.

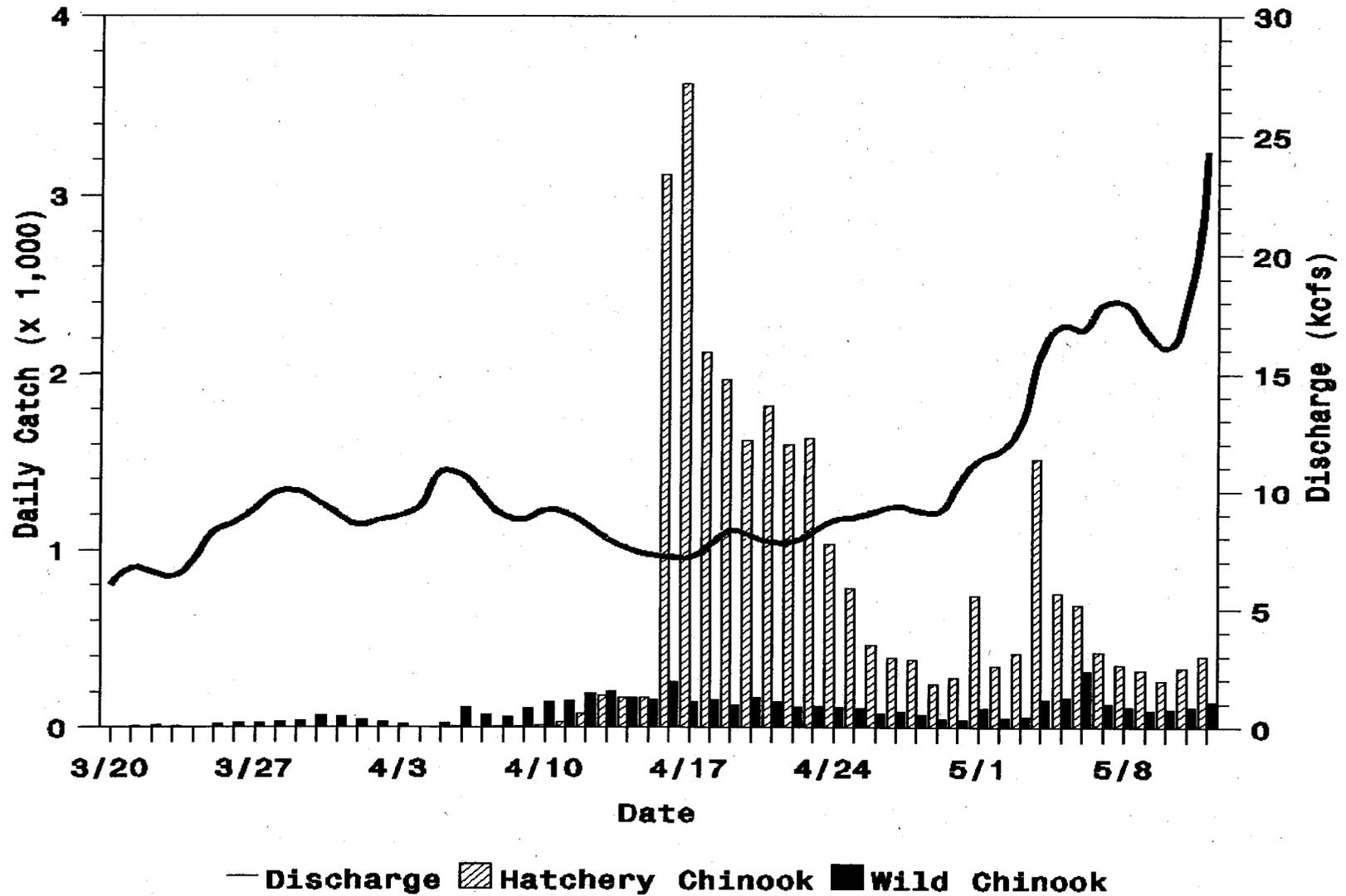


Figure 8. Salmon River trap daily catch of hatchery chinook salmon and wild chinook salmon overlaid by Salmon River discharge, 1993.

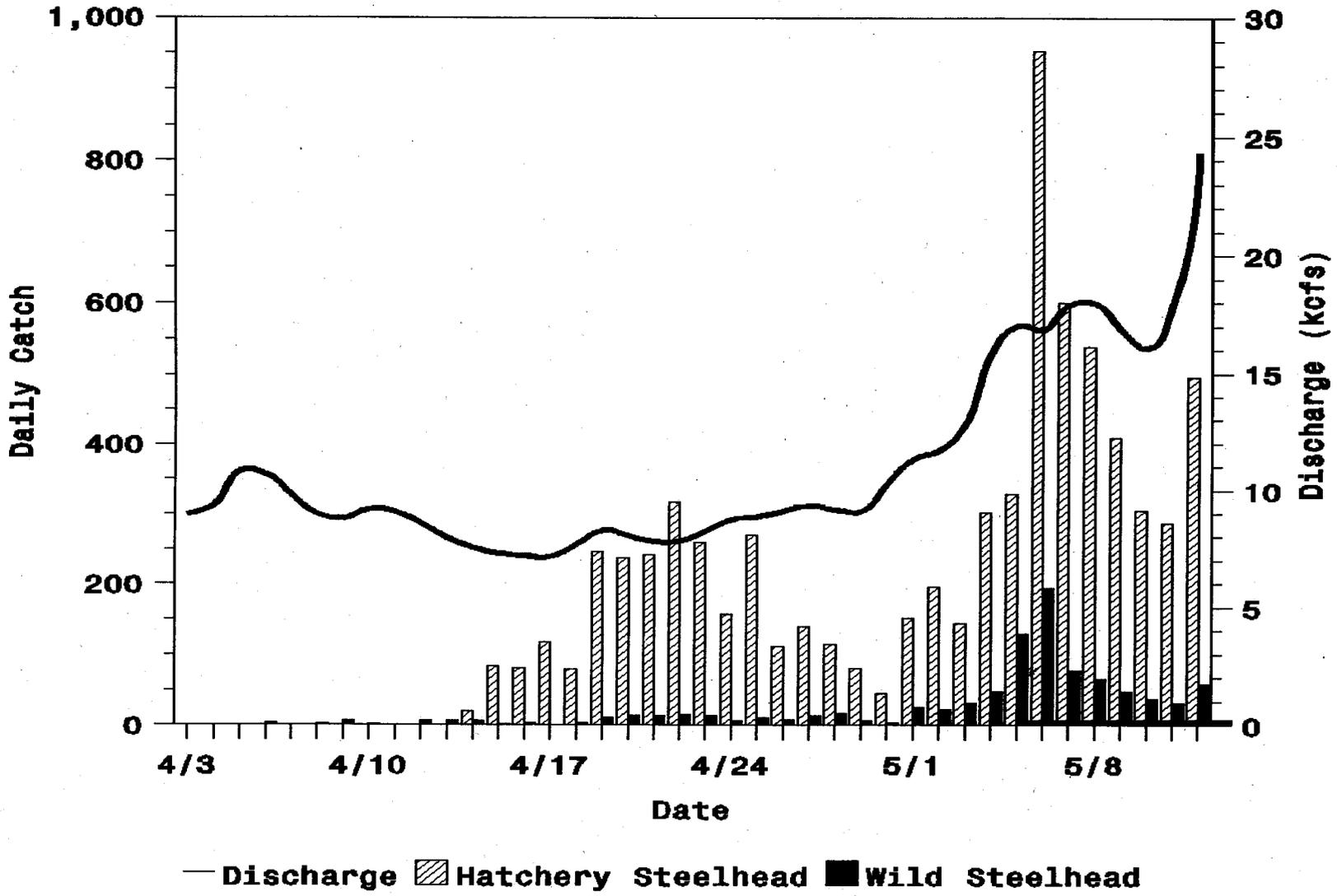


Figure 9. Salmon River trap daily catch of hatchery steelhead trout and wild steelhead trout overlaid by Salmon River discharge, 1993.

Wild steelhead trout began to arrive in small numbers (less than 10 fish) as early as March 24. Wild steelhead passage began to increase towards the end of April and peaked on May 6. Nearly 19% of the total was collected in April and 81% in May.

Salmon River discharge for March, measured at the White Bird gauge, ranged from 2.9 to 10.0 kcfs and averaged 5.6 kcfs (Figure 9). Average March discharge in 1993 was similar to that experienced in 1992, but 1.0 kcfs higher than in 1991. Discharge increased in April and ranged from 7.2 to 10.9 kcfs. April average discharge was 8.7 kcfs, which was 1.4 kcfs lower than in 1992 but 2.0 kcfs higher than in 1991. May average discharge was 38.9 kcfs and ranged from 11.3 kcfs to 64.2 kcfs. May average discharge for 1992 and 1991 was 19.5 kcfs and 18.9 kcfs, respectively.

Salmon River water temperature at the trap was 6°C at the beginning of the field season. Water temperatures gradually increased throughout the field season to a maximum of 11°C when the operation was terminated on May 12. Secchi disk transparency in the Salmon River fluctuated throughout the trapping season and ranged from 0.3 m to 1.5 m (Figure 10).

### Travel Time and Migration Rates

#### **Release Sites to Snake River Trap**

**Hatchery Chinook Salmon**-In 1993, 72 hatchery spring chinook salmon were interrogated at the Snake River trap. Four of the seven fish interrogated from the Lookingglass Hatchery release took about one d and the other three fish took about 25 d to reach the trap. One of the five fish from the Imnaha River weir took one d and the other four fish migrated in 15-20 d. Mean travel time for 12 McCall fish released on the South Fork of the Salmon River at the Knox Bridge was 25 d. These fish were used in a time-of-release study. Two groups of fish were released in early April (April 3 and April 9) and took about 36 d to reach the Snake River trap. The fish released on April 22 took 13 d and the single fish interrogated from the late release group (May 5) took 20 d to reach the trap. A second group of fish were released from the Knox Bridge on April 3 and their travel time was the same, 36 d. Three fish from the Pahsimeroi Hatchery release were interrogated and they took 19-21 d. Mean travel time for 14 Rapid River Hatchery fish was 14 d.

Eighteen hatchery chinook salmon tagged at the Salmon River trap were interrogated at the Snake River trap. A fish tagged on April 16 took 26 d to travel to the Snake River trap. Fish tagged in late April (April 27-29) and early May (May 1-4) took four days, and fish from mid-May (May 8-12) took less than two d. Both river discharge and smoltification were increasing during this period which accounts for the decrease in travel time. Five hatchery chinook salmon tagged at the Salmon River trap on May 12 took only 24 to 30 hours (h) to migrate to the Snake River trap, a distance of 164 km.

**Wild Chinook Salmon**-In 1993, 35 wild chinook salmon were interrogated at the Snake River trap. Sixteen of the fish were tagged in the spring of 1993, 11 of which were tagged at the Salmon River trap, 17 were marked in the summer/fall of 1992, and 2 were fall chinook tagged on the Snake River in June. Twenty-one of the fish were interrogated between May 1 and 13, with 13 of them arriving on May 13, which was the beginning of a large rapid increase in discharge and was also the d trap operation was halted due to high flow. Two of the latest arriving fish (arrival dates May 27 and June 8) were from the headwaters of the Salmon River.

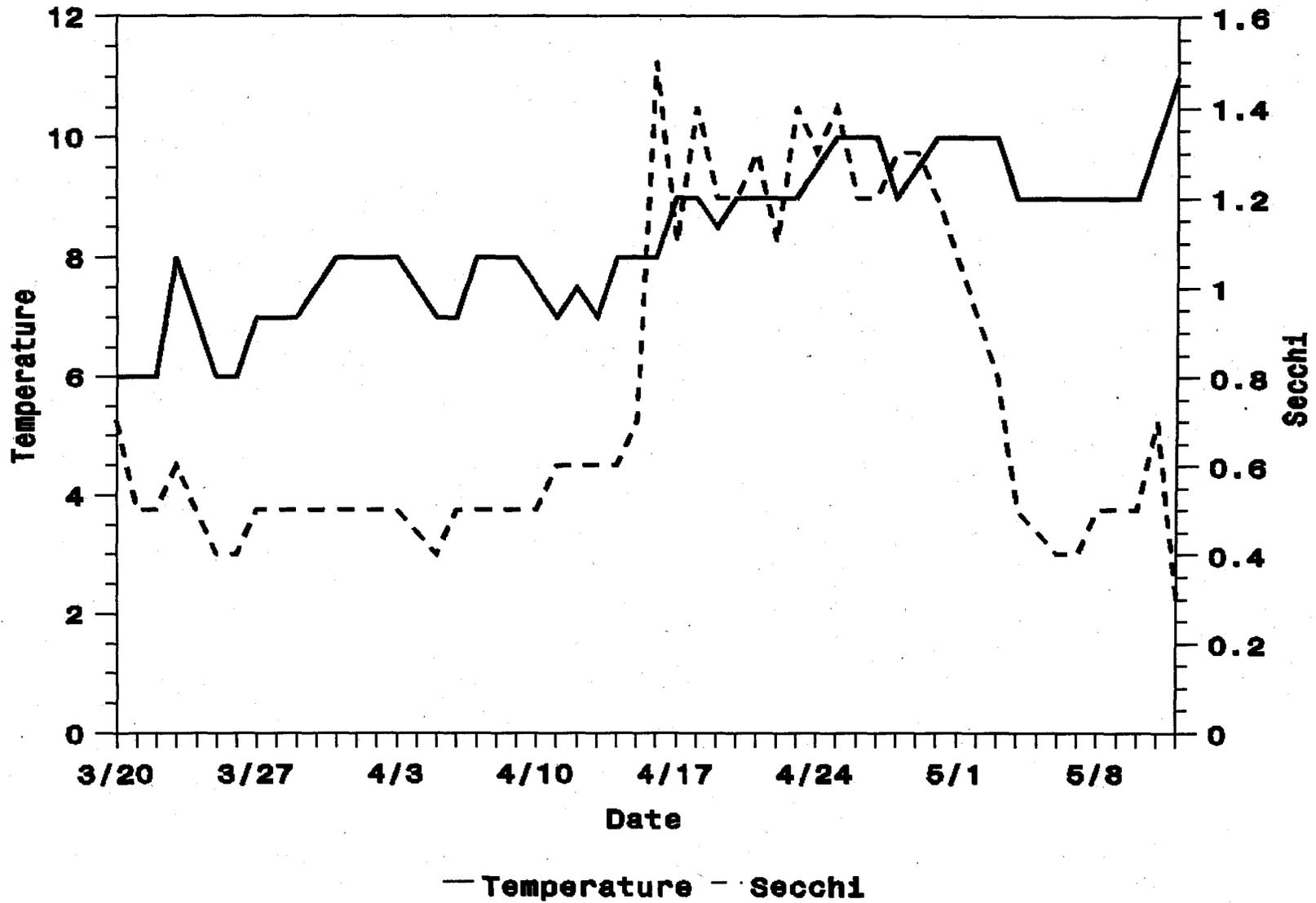


Figure 10. Daily temperature and secchi disk transparency at the Salmon River trap, 1993.

**Hatchery Steelhead Trout**-In 1993, 47 PIT-tagged hatchery steelhead trout were interrogated at the Snake River trap. Mean travel time of one group reared at Irrigon Hatchery and released at Big Canyon facility was about 9 d (22 km/d). The Snake River trap interrogated 1% (10 fish) of this group. Mean travel time for the Little Sheep Creek group was about 3 d (48 km/d) and 0.6% (9 fish) were interrogated at the trap. Two fish from the Wallowa Hatchery release site were interrogated at the trap. The Hells Canyon release group mean travel time was about 3 d (58 km/d), with 2.3% (7 fish) being interrogated at the trap. One fish from the Hazard Creek release, two from the North Fork Salmon River release, three from the Lemhi River release and one from the Pahsimeroi release were interrogated at the trap.

Eleven hatchery steelhead trout tagged at the Salmon River trap were interrogated at the Snake River trap. Travel time varied from 8 d to 1 d but most of the fish took less than 2 d and six of the fish took about 1 d.

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

**Hatchery Chinook Salmon**-In 1993, there were 65 PIT-tagged hatchery chinook salmon interrogated at the Clearwater River trap, 46 from Dworshak National Fish Hatchery, and 19 from Kooskia National Fish Hatchery. Because of the short distance between Dworshak National Fish Hatchery and the trap, fish generally took less than a d to arrive at the trap. The Dworshak PIT tag groups were used in a time-of-release study. The group released on April 8 was interrogated at 1.9%, those released on April 22 were interrogated at 1.23%, and those on May 3 at 0.35%. Mean travel time for Kooskia National Fish Hatchery chinook was about 2 d. The group that was released on April 19 was interrogated at 1.95%. A small group was released on March 21 from Kooskia National Fish Hatchery, but none were interrogated at the Clearwater River trap.

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

**Hatchery Chinook Salmon**-In 1993, 44 hatchery chinook salmon were interrogated at the Salmon River trap. Only two release groups had enough fish interrogated at the trap to calculate travel time; one group released in the South Fork Salmon River and one from Rapid River Hatchery. Mean travel time for fish from the South Fork Salmon River was 23 d. The South Fork Salmon River release was divided into a time-of-release study and a group for the Smolt Monitoring Program. The number of fish interrogated from the April 3 release was two (0.4%), two from the April 9 release (0.4%), and none from the April 22 or May 5 release. Another group was released on April 3, and 13 fish were interrogated (0.43%) at the Salmon River trap.

Mean travel time for the group released from Rapid River Hatchery was 7 d. Interrogations at the Salmon River trap were 19 fish (0.7%).

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

**Hatchery Chinook Salmon PIT Tag Groups**-In 1993, sufficient numbers of hatchery chinook salmon were PIT-tagged daily at the Snake River trap to provide 33 daily release groups (3,207 total PIT-tagged hatchery chinook salmon) for estimating travel time and migration rates through Lower Granite Reservoir. Median travel time ranged from 15.9 d in mid-April to 2.8 d in mid-May (Appendix A-1).

Table 4. Migration rates (km/d), stratified by 5-kcfs intervals from the Snake River trap to Lower Granite Dam, 1993.

Discharge interval	Hatchery chinook	Wild chinook	Hatchery steelhead	Wild steelhead
60 - 65	4.57	5.47	10.25	13.25
65 - 70	7.80	-	13.12	16.82
70 - 75	8.47	9.10	14.60	-
75 - 80	11.60	9.90	17.90	18.10
80 - 85	11.45		18.20	19.40
85 - 90	11.80	12.00	-	21.50
90 - 95	14.60	-	18.70	
95 - 100	9.70	10.20	18.75	19.80
100 - 105	12.83	12.20	22.87	25.90
105 - 110	11.60	-	16.40	-
110 - 115	10.00	7.30	21.63	22.10
115 - 120	-	9.70	24.23	
120 - 125	11.30	-	23.50	-
125 - 130	-	6.90	18.20	-
130 - 135	18.60	-	-	-
135 - 140	-	-	24.50	20.20
140 - 145	12.20	12.30	-	26.70
145 - 150	-	-	23.60	-
150 - 155	16.10	-	18.30	-
155 - 160	-	-	-	-
160 - 165	-	13.80	-	-

Data stratified by 5-kcfs groups were used in a linear regression analysis (Table 4). Migration rate was significantly related to discharge, indicating that PIT-tagged chinook salmon migration rate increased in Lower Granite Reservoir as discharge increased (Table 5).

In 1993, hatchery chinook salmon smolts were PIT-tagged at the Clearwater River trap to provide travel time information through Lower Granite Reservoir for Clearwater River chinook salmon. Twenty daily groups (totaling 1,624 hatchery chinook salmon) were released from the Clearwater River trap from April 9 through May 4 (Appendix A-5).

Data stratified by 5-lcfs groups were used for a linear regression analysis (Table 6). The linear regression analysis of the Clearwater River Hatchery chinook salmon PIT tag data showed a correlation between migration rate and discharge (Table 5).

The PIT tag sample rate at the dams changed significantly during the 1993 outmigration, mainly due to the initiation of forced spill. This is the first year since the Smolt Monitoring Project began PIT tagging in 1987 that a significant period of forced 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 sample rate of these fish is decreased because a portion of the fish that would normally be sampled, instead pass 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 also affected by spill. 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 portion of these higher floating fish to the spill where they are not interrogated. A greater portion of the deeper migrating, slower moving fish may migrate through the turbines and are 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 when data were corrupted due to operational changes.

The 1993 hatchery chinook salmon PIT tag groups released from the Snake River trap at discharge levels greater than 95 kcfs were affected by spill. These data were corrupted to a degree that we cannot interpret the data above 95 kcfs. If the corrupted data are removed from the migration rate/discharge regression, then the relation is much stronger, although sample size is reduced by about half (Table 7).

The hatchery chinook salmon 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 (1988-1993). Due to the inability to differentiate between hatchery and wild, the 1988 through 1992 chinook salmon data was a combination of both hatchery and wild. Probably less than 10% of the chinook PIT-tagged in those years were wild. The analysis of covariance was used with the data averaged by 5-kcfs groups. Only data prior to spill was used in 1993.

Table 5. Linear regression statistics for migration rate/discharge relation by species, rearing type, and trap, using data stratified by 5-kcfs intervals, 1993.

Species	Trap	N	Intercept	slope	r <sup>2</sup>	P
Hatchery	SNK	14	-2.189	1.003	0.620	0.001
chinook	CLW	6	-8.572	2.327	0.937	0.002
	SAL	14	-2.589	1.277	0.848	<0.001
Wild	SNK	10	-0.851	0.673	0.343	0.075
chinook	CLW	--	--	-	--	--
	SAL	14	-1.939	1.158	0.656	<0.001
Hatchery	SNK	16	-0.277	0.689	0.597	<0.001
steelhead	CLW	8	0.057	0.552	0.348	0.124
	SAL	12	-2.683	1.406	0.725	<0.001
Wild	SNK	9	-0.276	0.723	0.818	0.001
steelhead	CLW	7	-0.480	0.747	0.797	0.007
	SAL	10	-0.362	0.944	0.789	0.001

SNK = Snake River Trap  
 CLW = Clearwater River Trap  
 SAL = Salmon River Trap

Table 6. Migration rates (km/d), stratified by 5-kcfs intervals, from the Clearwater River trap to Lower Granite Dam, 1993.

Discharge interval	Hatchery chinook	Wild chinook	Hatchery steelhead	Wild steelhead
60 - 65	2.80	-	8.83	12.83
65 - 70	3.80	-	13.65	15.47
70 - 75	4.28	-	10.93	15.40
75 - 80	5.30	-	13.50	17.40
80 - 85	5.90	-	11.70	17.70
85 - 90	-	-	12.20	-
90 - 95	6.00	-	13.50	19.50
95 - 100	5.70	-	-	-
100 - 105	9.50	-	13.30	18.40

Table 7. Linear regression statistics for migration rate/discharge relation by species, rearing type, and trap, using data prior to spill, 1993.

Species	Trap	N	Intercept	Slope	r <sup>2</sup>	P
Hatchery	SNK	7	-9.276	2.635	0.880	0.00
chinook	CLW	8	-7.044	1.961	0.854	0.00
	SAL	7	-5.924	2.050	0.946	<0.001
Wild	SNK	5	-6.806	2.042	0.756	0-055
chinook	SAL	8	-7.240	2.377	0.817	0.002
Hatchery	SNK	7	-3.820	1.500	0.900	0.00
steelhead	CLW	7	-0.373	0.652	0.321	0.18
	SAL	8	-6.839	2.361	0.863	0.001
Wild	SNK	6	-2.333	1.199	0.972	<0.001
steelhead	CLW	6	-1.669	1.024	0.919	0.00
	SAL	6	-0.910	1.074	0.735	0.029

SNK = Snake River Trap  
 CLW = Clearwater River Trap  
 SAL = Salmon River Trap

The analysis showed a significant difference in the migration rate/discharge relation between years (slope of the lines) at the 0.05 level of significance ( $F=9.971$ ,  $N=54$ ,  $P<0.001$ ). A graph of the data showed that 1989 data had a slightly steeper slope (Figure 11). After removing the 1989 data, the analysis was re-run. A significant difference in the slopes **could** not be detected ( $F=2.529$ ,  $N=44$ ,  $P=0.059$ ). Because of the violation of the assumption of equal range between years in the independent variable, discharge, the analysis of covariance can not be continued. The five years of data (1988 and 1990-1993) were combined and the linear regression analysis was run. The regression equation on the combined data was significant ( $r^2=0.855$ ,  $N=44$ ,  $P<0.001$ ):

$$\ln (\text{migration rate}) = -3.606 + 1.339 \ln (\text{mean discharge}).$$

Comparing the 1988 through 1993 migration rate/discharge equations for chinook, it is apparent that in the discharge range for the available data, between 30 and 120 kcfs, all years showed the same basic pattern: as discharge increases, migration rate increases (Figure 11). The amount of increase between 60 and 100 kcfs is consistent for 1988 and 1990-1993 (two-fold) but slightly higher for 1989 (three-fold). Irrespective of minor differences in the slopes or heights of the lines from the six years data all years show the same trend; increased flow in Lower Granite Reservoir increases migration rate through the reservoir.

In 1993, hatchery chinook salmon smolts were PIT-tagged at the Salmon River trap to provide travel time information from the lower Salmon River to Lower Granite Dam for Salmon River hatchery chinook salmon. Thirty-one daily groups (totaling 3,139 hatchery chinook salmon) were released from the Salmon River trap from April 12 through May 12 (Appendix A-9).

Data stratified by 5-kcfs groups were used in the regression analysis (Table 8). The linear regression analysis of the Salmon River hatchery chinook salmon PIT tag data showed a strong correlation between migration rate and discharge (Table 5).

Because of the bias caused by spill's effect on sample rate, linear regression analysis was conducted on data prior to spill (Table 7). When the linear regression data for hatchery chinook salmon released from the Salmon River trap is analyzed graphically it is apparent that there is a major difference in the slopes of the two data sets. The linear regression calculated using the data prior to spill indicates fish migrate 6.8 km/d faster at 100 kcfs than the linear regression using all the data. This is additional evidence that spill adversely affected the ability to estimate migration rate for tag groups that migrated past Lower Granite Dam partially or totally with spill.

The Salmon River trap operation was terminated due to high flows on May 12. The Snake River trap operation was terminated due to high flows and debris on May 13. Five hatchery chinook tagged at the Salmon River trap on May 12 were captured at the Snake River trap between about 1400 h to 2200 h on the May 13. These fish migrated 164 km in 24 to 30 h which means they were moving 5.6 to 7 km/h. The Salmon River discharge increased from about 25 kcfs to 35 kcfs over this 24 h period, which is about one-third its spring maximum during a normal flow year. Snake River discharge was approaching 100 kcfs when trap operations were terminated at 2200 h on May 13. It was probable that chinook salmon could maintain this rate of movement from the lower Salmon River to the mouth of the Columbia prior to the dams. At a rate of 7 km/h it would take a fish less than 6 d to make that journey.

Wild chinook salmon PIT tag groups-In 1993, wild chinook salmon smolts were PIT-tagged at the Snake River trap to provide travel time information through Lower Granite Reservoir. Eighteen daily groups (totaling 1,131 wild chinook salmon) were released from the Snake River trap from April 10 through June 8 (Appendix A-2).

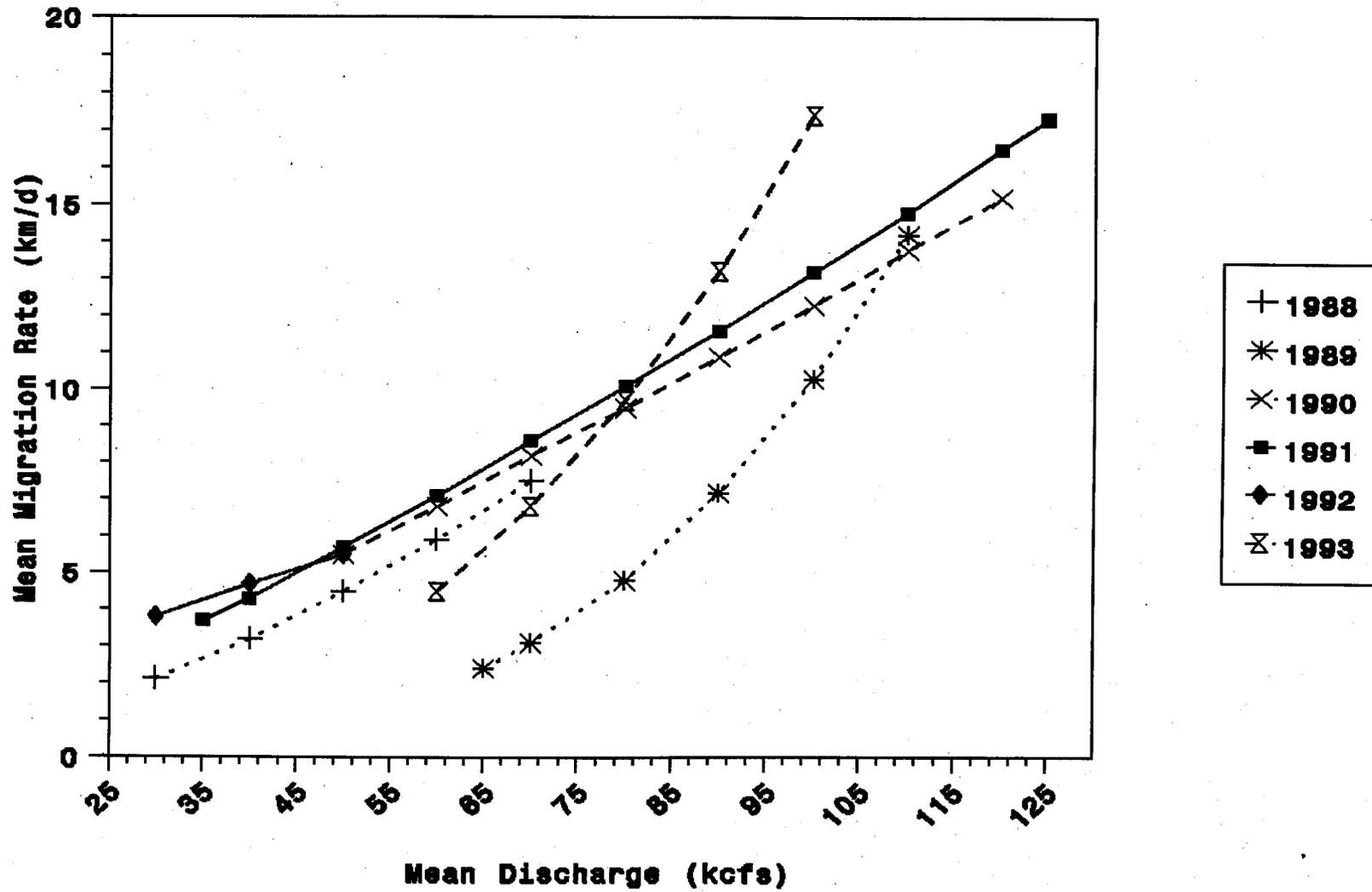


Figure 11. Chinook salmon migration rate/discharge relations for Snake River trap PIT-tag groups, 1988-1993.

Table 8. Migration rates (km/d), stratified by 5-kcfs intervals, from the Salmon River trap to Lower Granite Dam, 1993.

Discharge interval	Hatchery chinook	Wild chinook	Hatchery steelhead	Wild steelhead
60 - 65	13.40	16.88	23.14	30.90
65 - 70	15.06	12.05	20.10	38.05
70 - 75	20.67	25.00	27.30	43.70
75 - 80	22.50	25.35	32.07	-
80 - 85	25.20	28.00	41.50	-
85 - 90	26.60	32.30	45.40	42.40
90 - 95	28.35	35.45	63.90	65.10
95 - 100	23.70	39.50	45.10	47.80
100 - 105	27.05	28.20	49.98	56.68
105 - 110	-	-	-	51.50
110 - 115	30.65	28.60	-	64.30
115 - 120	25.15	34.10	45.40	-
120 - 125	-	31.10	48.40	-
125 - 130	38.20	-	-	-
130 - 135	47.00	46.20	69.90	74.50
135 - 140	-	-	-	-
140 - 145	-	-	-	-
145 - 150	44.70	45.80	-	-

Data stratified by 5-kcfs groups were used in the regression analysis (Table 4). The linear regression analysis of the Snake River wild chinook salmon PIT tag data could not detect a relation between migration rate and discharge (Table 5). Dam operations, mainly spill, adversely affects sample rate of PIT-tagged groups at Lower Granite Dam. When the linear regression analysis is conducted on data prior to spill, then a strong correlation is found (Table 7).

In 1993, only 317 wild chinook salmon were PIT-tagged at the Clearwater River trap for migration rate analysis. Not enough data was available to develop the migration rate/discharge relation for wild chinook salmon.

In 1993, wild chinook salmon smolts were PIT-tagged at the Salmon River trap to provide travel time information through Lower Granite Reservoir. Forty-two daily groups (totaling 2,169 wild chinook salmon) were released from the Salmon River trap from March 27 through May 12 (Appendix A-10).

Data stratified by 5-kcfs was used in the regression analysis (Table 8). The linear regression analysis of the Salmon River wild chinook salmon PIT tag data detected a correlation between migration rate and discharge (Table 5).

Because of the bias caused by spill's effect on sample rate, linear regression analysis was conducted on data prior to spill (Table 7). When the linear regression data is analyzed graphically, it is obvious that there is a major difference in the slopes of the two data sets. The linear regression calculated using the data prior to spill indicates fish migrate 10.9 km/d faster at 100 kcfs than the linear regression using all the data. This is additional evidence that spill adversely affected the ability to estimate migration rate for tag groups that migrated past Lower Granite Dam partially or totally with spill.

**Hatchery Steelhead Trout PIT Tag Groups**-Sufficient numbers of hatchery steelhead trout were PIT-tagged daily at the Snake River trap to provide 43 daily release groups (2,521 individual fish) to be used in median migration rate calculations through Lower Granite Reservoir. Median travel time ranged from 7.3 to 1.8 d (7.1 km/d to 28.2 km/d migration rate) and averaged 2.8 d (18.3 km/d), which was three times faster than in 1992 (Appendix A-3). Inflow discharge during the period when the PIT tag groups migrated through the reservoir averaged 96 kcfs in 1993, which was 81% (43 kcfs) higher than in 1992.

Data stratified by 5-kcfs groups were used in the regression analysis (Table 4). The linear regression analysis detected a significant relation between migration rate in Lower Granite Reservoir and average Lower Granite discharge (inflow) for PIT-tagged hatchery steelhead trout groups (Table 5). The equation shows that as discharge increases, migration rate increases for PIT-tagged hatchery steelhead trout marked at the Snake River trap. Sample rate was effected by operational changes (mainly spill) at Lower Granite Dam. If the linear regression analysis is conducted on data prior to spill, the relation is stronger (Table 7).

Using 1993 data prior to spill, a significant difference was not detected in the slope of the regression lines from 1988 through 1991 and 1993 data ( $F=1.519$ ,  $N=56$ ,  $P=0.212$ ). The slope of the regression line for 1992 was slightly less steep than the other years data (Figure 12). Because of the violation of the assumption of equal range between years in the independent variable (discharge), the analysis of covariance cannot be continued. Using the above five years data, a 2-fold increase in discharge will translate into a 2.9-fold increase in migration rate through Lower Granite Reservoir for hatchery steelhead marked at the Snake River trap.

Nineteen groups of hatchery steelhead trout (1,102 individual fish) were PIT-tagged at the Clearwater River trap in 1993 for use in median migration rate calculations through Lower Granite Reservoir (Appendix A-7). Median travel time ranged from 10.1 to 3.9 d (6.1 km/d to 15.7 km/d) and averaged 5.7 d (10.7 km/d). The average hatchery steelhead migrated 4.1 km/d faster through Lower Granite Reservoir in 1993 than in 1992. Average inflow discharge to Lower Granite Reservoir during the period the PIT tag groups were migrating through the reservoir was 77 kcfs which was 23 kcfs higher than in 1992.

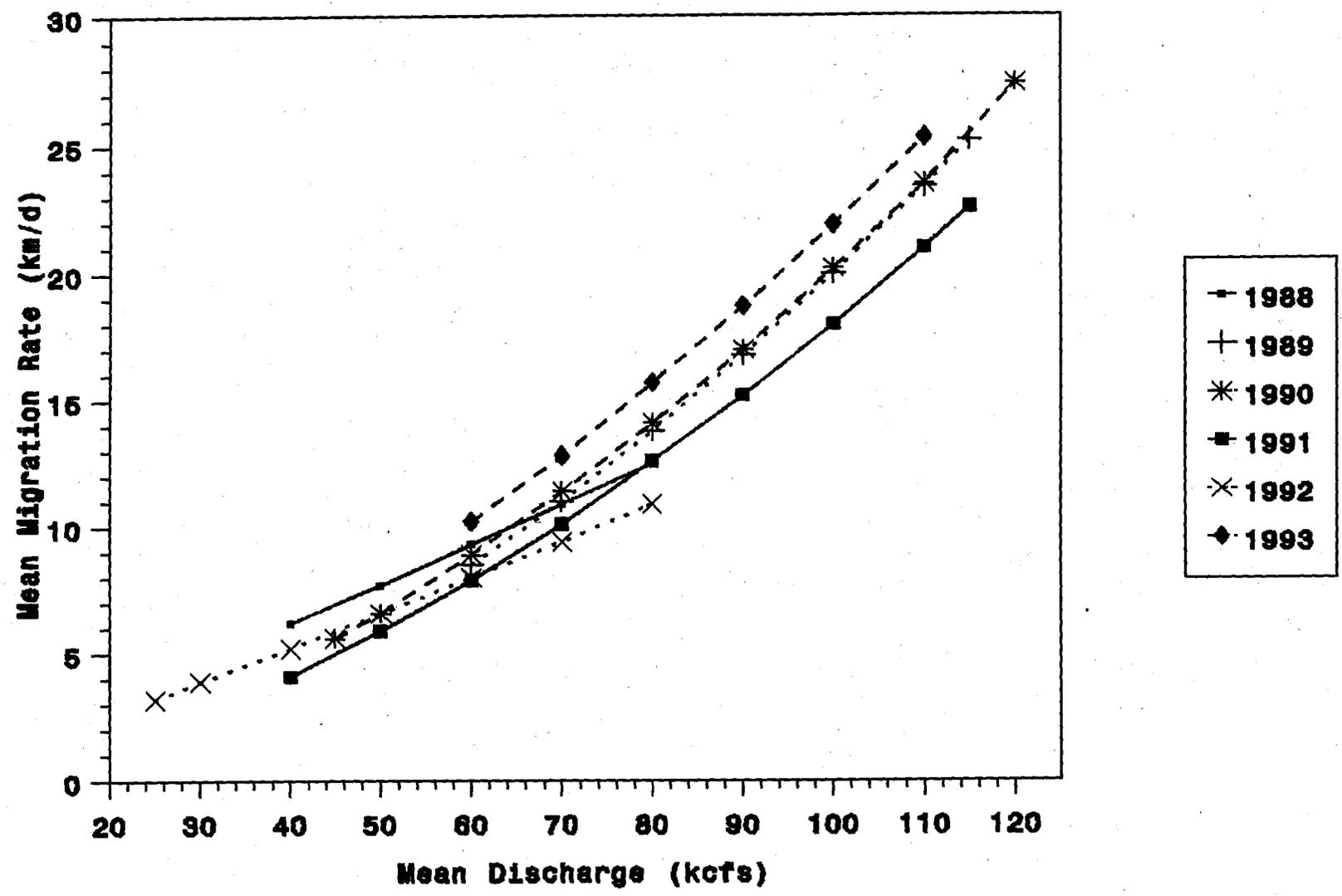


Figure 12. Hatchery steelhead migration rate/discharge relations for Snake River trap PIT-tag groups, 1988-1993.

Data stratified by 5-kcfs groups were used in the regression analysis (Table 6). The linear regression analysis failed to detect a significant relation between migration rate in Lower Granite Reservoir and average Lower Granite inflow discharge for Clearwater River PIT-tagged hatchery steelhead trout. A significant relation may have been masked because the discharge range of the data is narrow, and the PIT tag groups which were interrogated at Lower Granite Dam during discharge levels greater than 85 kcfs passed when sample rates were inconsistent due to dam operations related to spill.

Twenty-eight groups of hatchery steelhead trout (1,641 individual fish) were PIT-tagged at the Salmon River trap in 1993 for use in median migration rate calculations to Lower Granite Reservoir (Appendix A-il). Median travel time ranged from 12.9 to 3.1 d (16.7 km/d 69.9 km/d) and averaged 6.9 d (37.0 km/d)'. Average inflow discharge to Lower Granite Reservoir during the period PIT tag groups were migrating through the reservoir was 84 kcfs.

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 in Lower Granite Reservoir and average Lower Granite discharge (inflow) for PIT-tagged hatchery steelhead trout groups (Table 5). The equation shows that as discharge increases, migration rate increases for PIT-tagged hatchery steelhead trout marked at the Salmon River trap.

The sample rate at Lower Granite Dam was affected by operational changes (mainly spill) at the dam. If the linear regression analysis is conducted on the data prior to spill, the relation is much stronger (Table 7).

**Wild Steelhead Trout PIT Tag Groups**-Sufficient numbers of wild steelhead trout were PIT-tagged at the Snake River trap to provide 22 daily release groups (2,867 individual fish) for estimating travel time and migration rate in Lower Granite Reservoir (Appendix A-4). Median travel time ranged from 4.1 d (12.6 km/d) to 1.9 d (27.4 km/d) and averaged 2.7 d (19.8 km/d). Wild steelhead traveled, on the average, 1.6 times faster in 1993 than in 1992. Mean discharge in 1993 was 30 kcfs higher than in 1992, and maximum discharge was 66 kcfs higher in 1993.

Data stratified by 5-kcfs groups were used in. the regression analysis (Table 4). Linear regression analysis showed a strong significant relation between median migration rate in Lower Granite Reservoir and mean discharge for PIT-tagged wild steelhead trout groups (Table 5). The analysis shows that 82% of the variation in migration rate is accounted for by changes in discharge. In other words, migration rate is very dependent on discharge; the higher the discharge, the faster wild steelhead trout migrate.

Because of the bias caused by spill's effect on sample rate, linear regression analysis was conducted on data prior to spill (Table 7). The regression analysis on data prior to spill indicates that 97% of the variation on migration rate is accounted for by changes in discharge. -

The wild steelhead trout migration rate/discharge relation for fish released from the Snake River trap was examined to see if this relation was constant over years. The analysis of covariance was used to determine if there was a significant difference among years (1988-1993) in migration rates using groups averaged by 5-kcfs intervals. The analysis showed no significant difference among years for the slopes of the wild steelhead trout migration rate/discharge relations (F=1.498, N=62, P=0.206). Because of the violation of the assumption of equal range between years in the independent variable, discharge, the analysis of covariance cannot be continued. The data was pooled and the linear regression analysis was run using the log transformed data (r<sup>2</sup>=0.842, N=62, P<0.001). The best linear regression equation was:

' In (migration rate) -2.088 + 1.117 In (mean discharge).

The analysis indicates that 84% of the variation in migration rate for PIT-tagged wild steelhead trout released from the Snake River trap between 1988 and 1993 was accounted for by changes in discharge. The equation shows that a two-fold increase in discharge will increase migration rate 2.5 times.

Thirteen wild steelhead trout PIT-tagged groups (850 individual fish) were released from the Clearwater River trap in 1993 for use in median migration rate calculations through Lower Granite Reservoir (Appendix A-8). Median travel time ranged from 5.1 d to 3.2 d (12.1 to 19.5 km/d respectively) and averaged 3.9 d (16.0 km/d). In 1993, average travel time for wild steelhead PIT-tagged at the Clearwater River trap was two d less than in 1992. Average discharge for the PIT-tagged wild steelhead trout migration season was 75.0 kcfs, which was about 28 kcfs higher than in 1992.

Data stratified by 5-kcfs groups were used in the regression analysis (Table 6). The linear regression analysis showed a significant relation between migration rate in Lower Granite Reservoir and average inflow discharge to the Reservoir for wild steelhead trout groups released from the Clearwater River trap (Table 5). Because of the bias caused by spill's effect on collection efficiency, linear regression analysis was conducted on data prior to spill (Table 7). The analysis indicates that 92% of the variation in wild steelhead trout migration rate for fish released from the Clearwater River trap is accounted for by changes in discharge. Discharge is a very important variable associated with the rate of movement of wild steelhead trout in the Lower Granite Reservoir. As discharge increases, so does migration rate.

Eighteen groups of wild steelhead trout (907 individual fish) were PIT-tagged at the Salmon River trap in 1993 for use in median migration rate calculations to Lower Granite Reservoir (Appendix A-12). Median travel time ranged from 7.6 to 2.9 d (28.4 km/d 74.5 km/d) and averaged 4.7 d (49.5 km/d). Average inflow discharge to Lower Granite Reservoir during the period PIT tag groups were migrating through the reservoir was 89.0 kcfs.

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 in Lower Granite Reservoir and average Lower Granite discharge (inflow) for PIT-tagged wild steelhead trout groups (Table 5). The equation shows that as discharge increases, migration rate increases for PIT-tagged wild steelhead trout marked at the Salmon River trap.

### **Age 0 Chinook Salmon Migration Rate and Interrogation Rate**

In 1993, only 39 age 0 chinook salmon were PIT-tagged at the Snake River trap. Not enough data are available to perform a statistical analysis between migration rate and discharge or to calculate interrogation rate for age 0 chinook salmon in 1993.

### **Interrogation Rate of PIT-Tagged Fish**

Interrogation data in 1993 are not comparable with other 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 therefore total interrogations may be greater in 1993 than in previous years. Because this data does not adequately correspond to previous years interrogation data, comparisons with previous years should not be made.

Interrogation rate of Snake River trap daily release groups for PIT-tagged hatchery chinook salmon and wild chinook salmon at Lower Granite Dam, after combining to remove groups with inadequate sample size, ranged between 22.3% to 50.0% and 26.7% to 62.5% respectively (Appendix B-1 and B-2). Cumulative interrogation rate (including Lower Granite, Little Goose, Lower Monumental, and McNary dams) ranged between 41.5% and 89.7% and averaged 69.0% for hatchery fish. Wild chinook salmon ranged between 54.0% to 87.5% and averaged 73.6% (Table 9).

Interrogation rate of Clearwater River trap daily release groups for PIT-tagged hatchery chinook salmon and wild chinook salmon at Lower Granite Dam, after combining to remove groups with inadequate sample size, ranged from 27.8% to 44.0% and averaged 34.1% for hatchery fish (Appendix B-5). Not enough wild chinook salmon were tagged at the Clearwater River trap to estimate interrogation rate. Cumulative interrogation, including Lower Granite, Little Goose Dam, Lower Monumental, and McNary dams, ranged between 47.2% and 65.0% and averaged 57.2% (Table 9).

Interrogation rates of Salmon River trap daily release groups for PIT-tagged hatchery chinook salmon and wild chinook salmon at Lower Granite Dam, after combining to remove groups with inadequate sample size, ranged from 22.2% to 47.5% and averaged 36.5% for hatchery fish (Appendix B-9). Wild chinook salmon ranged from 30.0% to 71.7% and averaged 51.3% (Appendix B-10). Cumulative interrogation, including Lower Granite, Little Goose Dam, Lower Monumental, and McNary Dam, ranged from 49.5% to 73.7% and averaged 61.2%. Wild chinook salmon cumulative interrogation rates ranged between 48.0% to 90.0% and averaged 74.4% (Table 9).

Percent interrogation of Snake 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 31.1% to 93.5% and averaged 76.4% (Appendix B-3). Seasonal cumulative interrogation rate of PIT-tagged hatchery steelhead trout to Lower Granite, Little Goose, Lower Monumental, and McNary dams ranged between 50.8% and 100% and averaged 88.7% (Table 9).

Percent interrogation of Clearwater 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 43.1% to 85.7% and averaged 73.8% (Appendix B-7). Interrogation rates at Lower Granite, Little Goose, Lower Monumental, and McNary dams, combined, for Clearwater River trap hatchery steelhead trout daily PIT tag release groups, ranged from 55.2% to 100% and averaged 83.7% (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 45.0% to 83.6% and averaged 73.3% (Appendix B-11). Seasonal cumulative interrogation rate of PIT-tagged hatchery steelhead trout to Lower Granite, Little Goose, Lower Monumental, and McNary dams ranged between 66.7% and 95.0% and averaged 83.6% (Table 9).

Percent interrogation of Snake River trap wild steelhead trout daily PIT tag release groups at Lower Granite Dam, after combining to remove groups with small sample size, ranged from 41.7% to 88.0 and averaged 69.1% (Appendix B-4). Cumulative interrogation rate of PIT-tagged wild steelhead trout to Lower Granite, Little Goose, Lower Monumental, and McNary dams, combined, ranged from 58.8% to 97.7% and averaged 84.2% (Table 9).

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

Site	Year	Species <sup>a</sup>	Number Tagged	Number interrogated Site						Totals			
				Lower Granite		Little Goose		Lower Monumental		McNary		number	percent
				number	percent	number	percent	number	percent	number	percent		
Snake	1993	CH	3,203	1,336 (41.7)	494 (15.4)	246 (7.7)	134 (4.2)	2,210 (69.0)					
		CW	1,125	576 (51.1)	150 (13.3)	57 (5.1)	46 (4.1)	828 (73.6)					
		SH	2,521	1,925 (76.4)	235 (9.3)	63 (2.5)	13 (0.5)	2,236 (88.7)					
		SW	2,867	1,982 (69.1)	267 (9.3)	133 (4.6)	32 (1.1)	2,414 (84.2)					
Clearwater	1993	CH	1,624	553 (34.1)	193 (11.9)	106 (6.5)	77 (4.7)	929 (57.2)					
		CW	298	134 (45.0)	43 (14.4)	25 (8.4)	18 (6.0)	220 (73.8)					
		SH	1,102	813 (73.8)	79 (7.2)	24 (2.2)	6 (0.5)	922 (83.7)					
		SW	849	560 (66.0)	106 (12.5)	58 (6.8)	9 (1.1)	733 (86.3)					
Salmon	1993	CH	3,138	1,144 (36.5)	385 (12.3)	233 (7.4)	157 (5.0)	1,919 (61.2)					
		CW	2,169	1,112 (51.3)	286 (13.2)	125 (5.8)	91 (4.2)	1,614 (74.4)					
		SH	1,641	1,203 (73.3)	112 (6.8)	44 (2.7)	13 (0.8)	1,372 (83.6)					
		SW	902	575 (63.7)	73 (8.1)	36 (4.0)	5 (0.6)	689 (76.4)					
Snake	1992	CH	410	166 (40.5)	83 (20.2)	-	48 (11.7)	297 (72.4)					
		CU	615	249 (40.5)	106 (17.2)	-	72 (11.7)	427 (69.4)					
		TOTAL CHINOOK	1,025	415 (40.5)	189 (18.4)	-	120 (11.7)	724 (70.6)					
		SH	3,904	1,496 (38.3)	227 (5.8)	-	30 (0.8)	1,753 (44.9)					
		SW	2,538	1,511 (59.5)	307 (12.1)	-	31 (1.2)	1,849 (72.9)					
Clearwater	1992	CH	5,200	1,654 (31.8)	745 (14.3)	-	429 (8.25)	2,828 (54.4)					
		CU	1,461	502 (34.4)	202 (13.8)	-	136 (9.3)	840 (57.5)					
		TOTAL CHINOOK	6,661	2,156 (32.4)	947 (14.2)	-	565 (8.5)	3,668 (55.1)					
		SH	1,567	823 (52.5)	118 (7.5)	-	6 (0.4)	947 (60.4)					
		SW	2,996	1,599 (53.4)	477 (15.9)	-	113 (3.8)	2,189 (73.1)					
Snake	1991	CU	2,131	929 (43.6)	409 (19.2)	-	115 (5.4)	1,453 (68.2)					
		SH	2,577	2,032 (78.9)	268 (10.4)	-	11 (0.4)	2,311 (89.7)					
		SW	3,549	2,266 (63.9)	625 (17.6)	-	66 (1.9)	2,957 (83.3)					

Table 9. Continued.

Site	Year	Species <sup>a</sup>	Number Tagged	Number interrogated/Site					
				Lower Granite number (percent)	Little Goose number (percent)	Lower Monumental number (percent)	McNary number (percent)	Totals number (percent)	
Clearwater	1991	CU	3,943	1,483 (37.6)	668 (16.9)	-	235 (6.0)	2,386 (60.5)	
		SH	1,215	926 (76.2)	89 (7.3)	3 (0.3)	1,018 (83.8)		
		SW	727	409 (56.3)	102 (14.0)	-	28 (3.9)	539 (74.1)	
Snake	1990	CU	2,245	956 (42.6)	310 (13.8)	-	180 (8.0)	1,446 (64.4)	
		SH	3,112	2,272 (73.0)	282 (9.1)	-	33 (1.1)	2,587 (83.1)	
		SW	3,078	2,016 (65.5)	356 (11.6)	-	60 (2.0)	2,432 (79.0)	
Clearwater	1990	CU	4,242	1,359 (32.0)	674 (15.9)	-	281 (6.6)	2,314 (54.6)	
		SH	1,228	880 (71.1)	63 (5.1)	10 (0.8)	953 (77.6)		
		SW	1,300	767 (59.0)	126 (9.7)	22 (1.7)	915 (70.4)		
Snake	1989	CU	6,222	2,384 (38.3)	1,367 (22.0)	-	482 (7.7)	4,233 (68.0)	
		SH	2,525	1,773 (70.2)	268 (10.6)	35 (1.4)	2,076 (82.2)		
		SW	1,798	1,170 (65.1)	240 (13.3)	52 (2.9)	1,462 (81.3)		
Clearwater	1989	CU	2,441	756 (31.0)	452 (18.5)	-	140 (5.7)	1,348 (55.2)	
		SH	290	173 (59.7)	16 (5.5)	2 (0.7)	191 (65.9)		
		SW	104	53 (51.0)	16 (15.4)	-	3 (2.9)	72 (69.2)	
Snake	1988	CU	3,767	1,237 (32.8)	543 (14.4)	-	299 (7.9)	2,079 (55.2)	
		SH	1,743	1,101 (61.3)	190 (10.9)	12 (0.7)	1,271 (72.9)		
		SW	1,186	698 (58.9)	166 (14.0)	20 (1.7)	884 (74.5)		
Snake	1987 <sup>b</sup>	CU	3,275	1,067 (32.9)	338 (10.3)	-	308 (9.4)	1,713 (52.3)	
		SH	827	324 (39.2)	52 (6.3)	6 (0.7)	382 (46.2)		
		SW	464	229 (49.4)	48 (10.3)	8 (1.7)	285 (61.4)		

<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 Clearwater River trap wild steelhead trout daily PIT tag release groups at Lower Granite Dam, after combining to remove groups with small sample size, ranged from 47.1% to 71.4% and averaged 66.0% (Appendix B-8). The combined interrogation rates at Lower Granite, Little Goose, Lower Monumental, and McNary for daily wild steelhead trout PIT tag groups released from the Clearwater River trap at Lower Granite Dam ranged from 64.7% to 90.6% and averaged 86.3% (Table 9).

Percent interrogation of Salmon River trap wild steelhead trout daily PIT tag release groups at Lower Granite Dam, after combining to remove groups with small sample size, ranged from 34.5% to 92.3% and averaged 63.7% (Appendix B-12). The combined interrogation rates at Lower Granite, Little Goose, Lower Monumental, and McNary for daily wild steelhead trout PIT tag groups released from the Salmon River trap at Lower Granite Dam ranged from 39.7% to 95.2% and averaged 76.4% (Table 9).

### SUMMARY

Hatchery chinook salmon releases above Lower Granite Dam were 51% of the 1992 count, while hatchery steelhead trout releases remained the same. This was the first year wild chinook salmon could be differentiated from hatchery salmon. Hatchery production of chinook salmon in the Clearwater River drainage was 27%, the Grande Ronde drainage was 47%, and the Salmon River drainage was 66% of 1992. Although total hatchery steelhead trout production above Lower Granite was the same as in 1992, production in the Clearwater River drainage increased 118%, the Grande Ronde was 97%, and the Salmon River was 95% of 1991 production levels. Hatchery production of chinook salmon and steelhead trout released above Lower Granite Dam in 1993 was 5,583,741 and 9,414,448, respectively.

The Snake River trap was operated on the east side of the river from March 17 through July 30, but was out of operation for 32 d during this period due to high flow and mechanical failures. The Snake River trap captured 15,271 age 1 hatchery chinook salmon, 2,683 wild chinook salmon, 58 age 0 chinook salmon, 35,183 hatchery steelhead trout, and 3,046 wild steelhead trout.

The screw trap was operated from June 29 to July 30, with a main purpose of collecting age 0 chinook salmon. The screw trap did not capture any anadromous fish in 1993.

The Clearwater River trap was operated from March 23 through May 4. In an attempt to collect fall chinook migrants, the trap was also operated from July 7 to July 30. Clearwater River trap catch was 9,761 age 1 hatchery chinook salmon, 320 age 1 wild chinook salmon, 27 age 0 chinook salmon, 10,122 hatchery steelhead trout, and 882 wild steelhead trout.

The Salmon River trap was operated in 1993. This is the first year since 1987 that this trap was operated. Trap operation began on March 19 and continued until May 12, when operations were terminated due to high discharge. Trap catch was 28,326 age 1 hatchery chinook salmon, 5,147 age 1 wild chinook salmon, 7,315 hatchery steelhead trout, and 948 wild steelhead trout.

Fish were PIT-tagged for migration rate statistics at all three traps. The number of fish PIT-tagged at the Snake River trap was 9,716, Clearwater River trap was 3,873, and Salmon River trap was 7,850.

A significant migration rate/discharge relation was detected for hatchery chinook salmon released from each of the three traps to Lower Granite dam. A significant migration rate/discharge relation was also detected for wild chinook salmon from the Snake River and Salmon River traps to Lower Granite. Not enough fish were tagged at the Clearwater River trap to calculate statistics. A

significant migration rate/discharge relation was detected for both hatchery and wild steelhead trout from all traps except for hatchery steelhead from the Clearwater River trap. The inability to detect a relation for hatchery steelhead trout from the Clearwater River trap was probably due to the lack of data over a wide range of discharge, and the inconsistent collection efficiency at Lower Granite Dam caused by operational changes during the 1993 outmigration.

In all instances where the migration rate/discharge relation was significant, the same trend was seen; as discharge increased migration rate increased. A two-fold increase in discharge would generally produce a two- to three-fold increase in migration rate.

Interrogation rates from 1993 were not comparable to previous years because of the addition of a new collection facility at Lower Monumental Dam and because the collection efficiency changed during the outmigration due to operational changes and spill at the dams.

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Appendix A.

Travel time from traps to Lower Granite Dam and associated mean discharge for daily PIT tag release groups from Snake, Salmon, and Clearwater river traps.

Appendix A-1. PIT-tagged hatchery chinook salmon travel time, with 95% confidence intervals, from the Snake River trap to Lower Granite Dam, 1993.

Release date	Median travel time (day)	Confidence interval <sup>a</sup>		Percent number captured	Mean captured (percent)	Discharge (kcfs)
		Upper	Lower			
4/9	14.41	10.5	17.5	44	43.1	63.58
4/10	14.67	12.07	15.77	45	44.1	63.27
4/11	14.23	12.58	15.76	49	49.0	63.05
4/12	15.93	12.96	18.62	45	44.6	63.23
4/13,14	14.50	12.30	18.36	28	35.9	63.13
4/15,16,17	11.59	10.68	13.15	33	41.8	63.53
4/18,19	8.78	5.80	12.42	24	40.7	64.46
4/20	10.22	7.77	11.23	23	25.0	64.31
4/21	8.57	7.70	10.36	39	47.6	64.54
4/22	7.54	6.49	9.23	69	46.0	64.55
4/24	6.64	5.46	7.97	43	43.4	67.20
4/25	7.06	6.12	7.45	41	40.6	70.17
4/26	5.84	5.32	6.53	47	45.6	71.37
4/27	5.77	4.73	6.38	45	43.7	72.67
4/28	5.78	-	7.08	37	36.6	74.57
4/29	4.43	3.97	5.09	45	44.6	75.67
4/30	4.53	3.88	5.04	50	49.0	82.76
5/1	4.47	4.03	5.20	46	45.5	84.07
5/2	4.36	3.97	4.66	48	48.0	88.85
5/3	3.54	3.25	3.90	45	45.0	94.78
5/4	3.39	2.77	4.17	69	58.0	100.20
5/5	3.85	3.57	4.28	36	36.0	102.90
5/6	3.93	3.42	5.03	42	41.6	102.40
5/7	5.32	4.39	6.20	49	49.5	99.00
5/8	5.31	4.68	6.14	39	39.0	99.14
5/9	5.40	4.72	6.15	27	26.7	104.70
5/10	4.46	3.71	4.85	34	33.7	105.72
5/11	3.63	3.44	4.29	21	22.3	121.97
5/12	2.77	2.45	3.52	32	32.3	131.73
5/13	3.20	2.63	3.52	46	45.5	154.00
5/27,28	4.24	3.08	4.79	37	45.7	140.80
5/29,30,31-6/1,2,3	5.19	4.05	7.08	46	46.5	110.90
6/5,7,8,9	6.13	2.88	9.92	13	44.8	120.23

<sup>a</sup> Confidence intervals calculated with nonparametric statistics.

Appendix A-2. PIT-tagged wild chinook salmon travel time, with 95% confidence intervals, from the Snake River trap to Lower Granite Dam, 1993.

Release date	Median travel time (dav)	Confidence interval <sup>a</sup>		Percent number captured	Mean captured (percent)	Discharge (kcfs)
		Upper	Lower			
4/9,10,11	12.59	11.13	13.79	40	59.7	63.48
4/12,13,14,15	11.32	10.41	13.05	38	59.4	62.34
4/16,17,18,19, 20,21,22,23,24	6.71	5.72	8.01	38	59.4	64.17
4/25,26,27,28	5.65	4.96	6.48	35	56.5	72.67
4/29,30	5.21	4.04	6.83	23	56.1	76.24
5/1,2,3	4.31	3.44	5.17	27	56.2	88.85
5/4	3.58	2.72	4.60	29	58.0	101.35
5/5	4.67	3.56	5.43	33	54.1	102.44
5/6	4.61	3.34	5.44	30	62.5	100.44
5/7	4.78	3.81	7.52	30	60.0	99.00
5/8	5.38	4.27	6.07	28	56.0	99.14
5/9,10	4.81	4.64	6.45	35	44.9	116.10
5/11,12	4.18	3.41	5.36	31	35.6	141.88
5/13	3.74	3.41	4.80	28	48.3	160.93
5/27,28	7.51	4.79	14.05	43	53.1	127.80
5/29,30	5.95	3.12	7.38	18	38.3	116.97
5/31-6/1,2	4.86	3.41	6.68	20	44.4	110.90
6/3,4,7,8,9,16	13.02	10.23	15.27	31	50.8	112.79
6/17 <sup>b</sup>	13.82	0	0	3	50.0	81.45

<sup>a</sup> Confidence intervals calculated with nonparametric statistics.

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

Appendix A-3. PIT-tagged hatchery steelhead travel time, with 95% confidence intervals, from the Snake River trap to Lower Granite Dam, 1993.

Release date	Median travel time (day)	Confidence interval <sup>a</sup>		Percent number captured	Mean captured (percent)	Discharge (kcfs)
		Upper	Lower			
4/13 <sup>b</sup>	7.52	0	0	1	100.0	62.21
4/14, 15, 16.	3.97	3.61	4.92	60	77.9	62.75
4/17	5.31	4.85	7.68	42	70.0	63.44
4/18	6.96	4.47	8.16	44	69.8	63.21
4/19	7.28	4.87	9.02	41	65.1	63.51
4/20	4.62	4.23	6.71	44	77.2	62.58
4/21	4.85	3.78	7.02	51	82.3	62.74
4/22	4.33	3.73	6.83	49	80.3	62.30
4/23	4.65	3.81	5.70	49	80.3	64.46
4/24	4.44	3.77	5.98	45	73.8	65.30
4/25	4.31	3.30	5.61	45	69.2	66.17
4/26	3.13	2.99	4.65	51	85.0	67.23
4/27	4.16	3.43	5.56	43	70.5	69.08
4/28	3.54	3.04	5.47	53	79.1	73.17
4/29	2.98	2.78	3.17	38	63.3	75.50
4/30	2.88	2.55	4.01	47	78.3	79.07
5/1	2.79	2.64	3.07	72	85.7	79.40
5/2	2.83	2.52	3.41	51	83.6	84.27
5/3	2.76	2.13	3.19	57	93.4	93.07
5/4	2.23	2.04	2.79	51	83.6	100.35
5/5 -	2.45	2.13	3.09	51	83.6	101.25
5/6	1.85	1.72	2.21	48	76.2	102.35
5/7	1.99	1.80	2.15	51	86.4	104.55
5/8	2.70	2.09	3.15	51	76.1	99.17
5/9	3.08	2.62	3.58	54	88.5	95.30
5/10	2.84	2.66	3.01	49	81.7	96.93
5/11	2.46	2.13	2.87	40	66.7	99.10
5/12	1.83	1.72	2.46	37	61.7	118.80
5/13	2.83	2.57	3.16	38	62.3	154.00
5/27	2.19	1.82	2.91	42	66.7	146.20
5/28	2.11	1.67	3.79	45	73.8	139.35
5/29	2.84	2.08	3.45	47	77.0	129.27
5/30	2.13	1.85	3.09	49	80.3	124.50
5/31	2.51	1.91	2.64	53	86.9	116.10
6/1	2.24	1.72	2.75	38	76.0	115.65
6/2	2.51	2.46	3.02	60	84.5	112.67
6/3	2.00	1.63	2.64	30	88.2	110.75
6/4	2.51	2.16	3.73	21	87.5	104.23
6/5	2.79	2.14	4.02	22	75.9	102.57
6/7	2.06	1.86	2.72	46	90.2	117.95
6/8	2.29	2.04	2.81	56	86.2	122.95
6/9	2.76	1.92	3.09	29	93.5	114.27
6/11	2.17	1.99	3.25	30	90.9	120.40
6/16	3.15	1.94	8.82	7	87.5-	107.43

<sup>a</sup> Confidence intervals calculated with nonparametric 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, 1993.

Release date	Median travel time (day)	Confidence interval <sup>a</sup>		Percent number captured	Mean captured (percent)	Discharge (kcfs)
		Upper	Lower			
4/9,10,11,12,13,14	4.71	3.72	5.56	33	73.3	60.48
4/17,18,19,20	4.09	3.50	7.29	27	65.9	64.45
4/21,22,23	3.54	3.30	4.09	35	79.5	62.30
4/24	3.48	2.44	5.07	23	59.0	64.70
4/25	3.32	2.80	4.12	28	71.8	66.17
4/26	2.68	2.54	3.84	23	65.7	67.23
4/27	3.00	2.79	3.39	39	59.1	66.27
4/28	3.37	2.85	3.96	50	64.1	69.73
4/29	3.02	2.80	3.24	57	76.0	75.50
4/30	2.92	2.40	3.79	50	82.0	79.07
5/1	2.65	2.46	2.97	87	77.7	79.40
5/2	2.66	2.39	3.32	85	67.5	84.27
5/3	2.40	2.05	2.89	72	73.5	88.30
5/4	2.11	2.02	2.21	217	81.0	100.35
5/5	2.01	1.91	2.17	350	78.0	101.25
5/6	1.88	1.61	2.44	59	84.3	102.35
5/7	1.98	1.84	2.12	236	77.1	104.55
5/8	2.57	2.13	3.01	93	72.7	99.17
5/9	2.83	2.43	3.76	40	76.9	95.30
5/10	2.62	2.45	2.76	66	77.6	96.93
5/11	2.43	1.91	2.72	36	59.0	99.10
5/12	2.32	1.77	3.01	49	50.0	118.80
5/13	1.93	1.80	2.14	171	40.7	144.85
5/27,28,29	2.55	1.51	3.76	18	58.1	136.90
5/30,31-6/1,2	2.51	1.59	2.96	18	72.0	116.10
6/4,5,7,8	2.19	2.01	2.94	22	88.0	117.95

<sup>a</sup>Confidence intervals calculated with nonparametric statistics.

Appendix A-5. PIT-tagged hatchery chinook salmon travel time, with 95% confidence intervals, from the Clearwater River trap to Lower Granite Dam, 1993.

Release date	Median travel time (day)	Confidence interval <sup>a</sup>		Percent number captured	Mean captured (percent)	Discharge (kcfs)
		Upper	Lower			
4/9	22.00	19.50	25.12	29	28.2	64.62
4/10	22.82	19.48	25.73	43	43.0	65.93
4/11	24.43	20.86	27.45	35	30.2	67.78
4/12	22.48	20.42	28.36	25	35.2	66.32
4/13,14,15	24.26	17.74	30.57	21	28.4	70.62
4/16	16.39	13.77	18.29	44	44.0	65.94
4/17,18	14.81	12.44	17.51	33	41.2	66.31
4/19 <sup>b</sup>	27.49	0	0	1	100.0	88.54
4/20	13.28	8.71	14.44	36	35.6	67.72
4/21	13.57	11.07	15.38	33	33.0	71.05
4/22	13.24	11.65	16.58	29	29.9	71.55
4/23	11.19	9.09	14.71	31	30.7	69.97
4/24	11.12	9.78	14.73	34	34.0	73.34
4/25	11.66	9.60	14.00	20	27.8	78.88
4/26	10.74	8.34	13.38	34	34.0	80.32
4/27,28	10.00	8.28	13.65	32	33.0	81.51
4/29,30	8.76	7.32	11.55	25	39.7	91.71
5/1	12.18	6.79	15.12	18	30.0	94.94
5/2,3	10.78	6.13	13.60	16	31.4	95.98
5/4	9.99	4.00	37.25	14	35.0	103.32

<sup>a</sup> Confidence intervals calculated with nonparametric 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 Clearwater River trap to Lower Granite Dam, 1993.

Release date	Median travel time (day)	Confidence interval <sup>a</sup>		Percent number captured	Mean captured (percent)	Discharge (kcfs)
		Upper	Lower			
4/9 <sup>b</sup>	20.33	0	0	1	16.7	63.93
4/10 <sup>1)</sup>	13.05	0	15.93	13	48.1	63.48
4/11 <sup>1)</sup>	16.02	0	0	4	80.0	63.38
4/12 <sup>1)</sup>	10.62	0	0	3	27.3	62.66
4/13 <sup>13)</sup>	17.24	0	0	1	20.0	63.45
4/14 <sup>1)</sup>	7.46	0	0	1	50.0	61.90
4/15 <sup>1)</sup>	11.41	0	0	3	60.0	62.53
4/16 <sup>1)</sup>	11.42	7.31	16.60	6	60.0	63.21
4/19 <sup>1)</sup>	12.52	0	0	2	25.0	67.14
4/20 <sup>1)</sup>	10.04	7.08	14.07	14	43.8	64.31
4/21 <sup>b)</sup>	11.13	0	0	3	33.3	67.45
4/22 <sup>b)</sup>	9.68	4.69	14.63	6	54.5	67.74
4/23 <sup>1)</sup>	7.30	0	0	1	14.3	64.86
4/24 <sup>b)</sup>	17.74	0	0	1	25.0	83.57
4/25 <sup>1)</sup>	6.05	3.64	7.41	7	77.8	67.95
4/26 <sup>1)</sup>	11.08	8.30	19.37	12	40.0	80.32
4/27 <sup>b)</sup>	7.48	0	0	4	36.4	73.50
4/28 <sup>1)</sup>	5.80	0	0	4	44.4	74.57
4/29 <sup>b)</sup>	8.09	5.40	18.72	6	60.0	85.22
4/30 <sup>b)</sup>	8.07	0	0	4	33.3	90.14
5/1 <sup>b)</sup>	5.52	4.94	7.81	12	52.2	89.80
5/2 <sup>1)</sup>	5.80	0	0	4	40.0	93.35
5/3 <sup>b)</sup>	5.67	0	0	4	66.7	98.03
5/4 <sup>b)</sup>	8.91	5.89	10.98	16	51.6	100.12

<sup>a</sup> Confidence intervals calculated with nonparametric 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 Clearwater River trap to Lower Granite Dam, 1993.

Release date	Median	Confidence		Percent number captured	Mean	Discharge
	travel time (day)	interval <sup>a</sup>				
		Upper	Lower			
4/12 <sup>b</sup>	6.28	0	0	1	100.0	61.77
4/13 <sup>b</sup>	6.79	0	0	1	100.0	62.21
4/14,15	6.63	4.45	14.26	19	76.0	62.66
4/16.	8.92	5.77	12.77	43	69.4	62.66
4/17	7.18	5.18	10.14	37	60.7	62.96
4/18	9.82	3.95	23.89	8	80.0	64.10
4/19	10.14-	7.18	13.74	25	43.1	64.63
4/20	9.02	7.11	12.70	48	77.4	64.18
4/21	5.61	4.84	7.36	46	75.4	63.68
4/22	5.13	4.01	6.71	43	68.3	63.52
4/23	4.92	4.16	5.67	54	85.7	64.46
4/24	5.29	4.45	6.77	44	73.3	65.48
4/25	3.91	3.51	6.58	47	68.1	66.17
4/26	6.54	5.12	8.48	53	84.1	72.06
4/27	5.32	4.86	8.58	47	68.1	71.96
4/28	5.21	4.23	7.28	49	81.7	73.78
4/29	4.54	3.61	6.27	43	71.7	76.24
4/30	5.27	3.66	6.21	48	80.0	82.76
5/1	5.03	4.46	6.17	49	81.7	87.78
5/2,3	4.56	4.14	5.60	57	77.0	91.06
5/4	4.64	3.26	5.99	51	85.0	101.94

<sup>a</sup> Confidence intervals calculated with nonparametric 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 Clearwater River trap to Lower Granite Dam, 1993.

Release date	Median travel time (day)	Confidence interval <sup>a</sup>		Percent number captured	Mean captured (percent)	Discharge (kcfs)
		Upper	Lower			
4/10,11,12,13,14,15,16	4.72	3.61	6.76	19	70.4	62.38
4/17,19,20	5.09	3.80	7.38	16	51.6	62.58
4/21,22,23	4.58	3.34	6.29	20	60.6	63.52
4/24,25	3.67	3.37	4.74	18	62.1	65.30
4/26	4.44	3.47	6.15	39	61.9	66.80
4/27	3.90	3.43	4.50	51	67.1	69.08
4/28	3.99	3.53	4.81	32	66.7	73.17
4/29	4.38	3.06	5.67	16	47.1	75.67
4/30	3.20	2.75	4.50	59	69.4	79.07
5/1	3.25	2.83	3.40	147	69.0	79.40
5/2	3.48	2.50	4.36	32	60.4	84.27
5/3	3.15	1.81	8.42	10	71.4	93.07
5/4	3.34	2.70	4.39	101	71.1	100.20

<sup>a</sup> Confidence intervals calculated with nonparametric statistics.

Appendix A-9. PIT-tagged hatchery Chinook salmon travel time, with 95% confidence intervals, from the Salmon Rive trap to Lower Granite Dam, 1993.

Release date	Median travel time (day)	Confidence interval <sup>a</sup>		Percent number captured	Mean captured (percent)	Discharge (kcfs)
		Upper	Lower			
4/8 <sup>b</sup>	13.46	0	0	1	100.0	63.90
4/11,12	17.86	16.48	20.93	41	38.0	63.52
4/13	19.11	15.79	20.68	47	47.5	65.24
4/14	18.10	16.96	20.44	38	37.6	65.29
4/15	17.36	14.66	20.45	43	40.6	65.65
4/16	14.64	12.42	16.92	46	47.4	64.77
4/17	13.83	12.49	16.27	33	33.0	65.08
4/18	14.81	13.65	17.52	41	40.6	67.33
4/19	12.94	12.33	14.51	48	46.6	67.14
4/20	12.53	10.49	14.08	38	33.3	67.72
4/21	13.30	11.56	15.13	40	39.6	68.97
4/22	10.96	10.27	12.51	41	40.6	68.51
4/23	12.37	10.65	13.11	37	37.0	72.32
4/24	9.81	9.18	11.15	40	38.1	70.86
4/25	9.49	8.15	10.76	39	39.0	71.77
4/26	10.05	8.99	10.55	38	38.0	78.36
4/27	9.11	8.58	10.42	39	39.0	79.47
4/28	8.56	8.17	10.42	29	29.0	83.11
4/29	8.95	7.48	10.30	45	44.6	87.40
4/30	7.41	6.75	8.88	45	44.6	88.04
05/1	8.00	6.45	9.79	32	31.4	93.49
05/2	7.22	5.94	8.70	35	34.3	94.91
5/3	9.08	5.57	11.22	35	35.0	97.12
5/4	7.15	6.15	9.38	36	36.0	100.41
5/5	8.96	7.63	9.78	34	34.0	103.90
5/6	9.64	8.37	10.53	34	34.3	116.24
5/7	7.73	7.39	10.46	22	22.2	111.28
5/8	7.69	7.36	8.57	30	30.0	119.71
5/9	6.44	5.62	7.12	30	29.7	113.52
5/10	5.64	5.40	6.53	29	29.0	125.47
5/11	4.58	3.94	6.81	25	25.3	132.04
5/12	4.82	3.90	9.48	36	36.7	149.84

<sup>a</sup> Confidence intervals calculated with nonparametric statistics.

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

Appendix A-10. PIT-tagged wild chinook salmon travel time, with 95% confidence intervals, from the Salton River trap to Lower Granite Dam, 1993.

Release date	Median travel time (day)	Confidence interval <sup>a</sup>		Percent number captured	Mean captured (percent)	Discharge (kcfs)
		Upper	Lower			
3/26,27	28.57	24.54	29.80	23	45.1	68.97
3/28,29	27.20	25.69	28.06	33	45.8	68.30
3/30	26.78	24.36	29.35	28	54.9	66.57
3/31	24.57	22.26	25.33	28	54.9	66.48
4/1	23.49	21.47	24.90	23	52.3	66.57
4/2,3	21.26	19.51	23.75	27	57.4	66.96
4/4,5	20.48	17.60	22.20	31	60.8	66.55
4/6	17.25	15.63	20.68	32	64.0	66.25
4/7	16.81	15.56	17.85	29	58.0	64.35
4/8	14.60	13.79	16.28	30	60.0	63.84
4/9	15.35	13.38	18.45	28	56.0	63.41
4/10	13.84	12.20	15.35	23	46.0	63.31
4/11	13.44	12.47	14.47	30	60.0	63.08
4/12	13.42	11.90	14.66	33	58.9	62.55
4/13	11.91	10.57	12.72	28	54.9	62.37
4/14	12.74	11.50	15.53	29	56.9	62.72
4/15	11.49	10.58	13.74	33	67.3	62.53
4/16,17	12.95	10.89	13.52	43	53.8	63.74
4/18	11.65	8.86	14.61	27	50.0	64.39
4/19	10.48	9.52	12.45	30	55.6	64.63
4/20	10.38	9.63	12.27	31	60.8	64.31
4/21,22	9.75	8.39	11.36	36	53.7	65.84
4/23	9.03	7.75	12.43	24	44.4	68.33
4/24	8.75	8.02	9.89	30	60.0	70.01
4/25	8.49	7.37	10.41	18	40.0	70.92
4/26	8.50	7.11	9.68	25	50.0	75.67
4/27	8.48	7.40	9.55	24	48.0	76.58
4/28	8.01	7.47	9.45	24	48.0	81.01
4/29	7.39	6.67	8.14	33	71.7	83.13
4/30	6.66	6.24	7.69	23	54.8	88.04
5/1	6.88	5.57	8.39	24	47.1	91.94
5/2	5.44	4.47	6.44	24	48.0	91.06
5/3	5.46	4.45	6.54	27	55.1	96.78
5/4	7.11	5.40	9.89	22	44.0	100.41
5/5	8.51	6.88	9.77	25	50.0	103.90
5/6	7.43	6.31	8.52	27	52.9	100.06
5/7	7.53	6.90	8.62	20	37.7	111.28
5/8	7.59	5.65	8.32	15	30.0	119.71
5/9	6.93	5.80	8.74	17	34.0	121.91
5/10	5.41	4.77	6.78	17	34.0	116.10
5/11	4.67	4.13	5.54	20	40.0	132.04
5/12	4.70	3.44	5.35	18	36.0	149.84

<sup>a</sup> Confidence intervals calculated with nonparametric statistics.

Appendix A-il. PIT-tagged hatchery steelhead travel time, with 95% confidence intervals, from the Salmon River trap to Lower Granite Dam, 1993.

Release date	Median	Confidence		Percent number captured	Mean	Discharge (kcfs)
	travel time (day)	<u>interval</u> <sup>a</sup>				
		Upper	Lower			
4/15	12.55	9.09	17.08	47	82.5	63.33
4/16	11.10	8.83	14.47	42	70.0	63.21
4/17	12.94	8.96	17.84	22	75.9	64.12
4/18	12.78	7.13	18.48	38	71.7	65.40
4/19	8.68	7.32	12.68	47	78.3	64.46
4/20	8.89	7.08	10.11	48	80.0	64.18
4/21	7.74	6.44	11.19	50	75.8	64.43
4/22	6.76	5.70	9.07	51	83.6	64.41
4/23	9.26	7.57	12.39	47	77.0	68.33
4/24	8.81	7.50	11.70	54	83.1	70.01
4/25	7.13	5.65	11.09	47	75.8	70.17
4/26	7.89	6.16	10.19	34	56.7	72.86
4/27	8.98	6.19	10.44	43	71.7	79.47
4/28	6.80	5.15	8.19	48	78.7	77.93
4/29	5.31	4.43	7.20	42	70.0	76.24
4/30	5.19	3.86	7.41	34	75.6	82.76
5/1	5.19	4.75	5.87	48	80.0	87.78
5/2	4.37	4.09	4.83	45	77.6	88.85
5/3	3.37	3.14	3.67	47	77.0	93.07
5/4	3.67	3.16	5.13	48	80.0	101.35
5/5	4.60	3.18	6.89	46	76.7	102.44
5/6	4.21	3.27	6.68	50	83.3	102.40
5/7	4.10	3.11	5.69	48	78.7	100.57
5/8	4.78	4.07	6.09	40	66.7	99.14
5/9	5.29	5.01	5.99	41	67.2	104.70
5/10	4.74	4.42	5.70	36	60.0	116.10
5/11	4.45	3.16	5.25	33	55.0	121.97
5/12	3.08	2.77	3.35	27	45.0	131.73

<sup>a</sup> Confidence intervals calculated with nonparametric statistics.

Appendix A-12. PIT-tagged wild steelhead travel time, with 95% confidence intervals, from the Salmon River trap to Lower Granite Dam, 1993.

Release date	Median travel time (day)	Confidence interval <sup>a</sup>		Percent number captured	Mean captured (percent)	Discharge (kcfs)
		Upper	Lower			
4/2,6,7,10,1 12,13,14 4/15,16,17,1 19,20	16.27	8.95	25.29	16	64.0	63.23
4/21	6.76	5.43	10.73	19	63.3	63.51
4/22	6.35	4.98	7.48	12	92.3	63.68
4/23	7.59	0.00	0.00	1	50.0	64.55
4/24	4.57	4.11	5.36	9	64.3	64.46
4/25	5.10	0.00	0.00	4	66.7	65.48
4/26,27,28,2	6.36	0.00	0.00	4	66.7	67.95
4/30-5/1,2	4.92	4.48	6.39	36	80.0	73.78
5/3	5.08	4.52	6.39	30	58.8	87.78
5/4	3.31	3.17	4.31	26	81.2	93.07
5/5	3.21	2.64	4.05	34	81.0	100.20
5/6	3.44	3.18	3.72	91	71.1	102.43
5/7	3.37	3.17	3.55	126	67.7	103.00
5/8	4.44	3.77	4.99	47	61.0	100.57
5/9	4.50	4.35	5.35	46	70.8	99.14
5/10	5.24	4.14	6.65	24	51.1	104.70
5/11	4.19	3.66	4.74	16	43.2	105.72
5/12	3.35	3.05	4.10	15	46.9	110.10
	2.89	2.42	4.54	20	34.5	131.73

<sup>a</sup> Confidence intervals calculated with nonparametric statistics.

Appendix B.

Interrogations at Lower Granite, Little Goose, Lower Monumental,  
and McNary dams of fish PIT-tagged at Snake, Salmon, and Clearwater  
River traps.

Appendix B-1. PIT-tagged hatchery chinook salmon interrogations at Lower Granite, Little Goose, Lower Monumental and McNary dams from the Snake River trap, 1993.

Date	Interrogated			Interrogated		Interrogated		Interrogated		Total interrogated	Total percent
	Number tagged	at Lower Granite	Perce	at Little Goose	Percent	at Lower Monumental	Percent	at McNary	Percent		
4/9	102	44	43.1	24	23.5	4	3.9	6	5.9	78	76.5
4/10	102	45	44.1	18	17.6	6	5.9	3	2.9	72	70.6
4/11	100	49	49.0	21	21.0	7	7.0	2	2.0	78	79.0
4/12	101	45	44.6	18	17.8	12	11.9	4	4.0	79	78.2
4/13,14	78	28	35.9	19	24.4	8	10.3	2	2.6	57	73.1
4/15,16,17	79	33	41.8	18	22.8	2	2.5	1	1.3	54	68.4
4/18,19	59	24	40.7	14	23.7	4	6.8	0	0.0	42	71.2
4/20	46	23	50.0	5	10.9	5	10.9	0	0.0	33	71.7
4/21	82	39	47.6	18	22.0	8	9.8	4	4.9	69	84.1
4/22,23	150	69	46.0	17	11.3	20	13.3	5	3.3	111	74.0
4/24	99	43	43.4	18	18.2	10	10.1	7	7.1	77	78.8
4/25	100	41	41.0	16	16.0	15	15.0	3	3.0	75	75.0
4/26	103	47	45.6	19	18.4	7	6.8	2	1.9	75	72.8
4/27	103	45	43.7	12	11.7	13	12.6	2	1.9	72	69.9
4/28	101	37	36.6	17	16.8	17	16.8	4	4.0	75	74.3
4/29	101	45	44.6	12	11.9	11	10.9	5	5.0	73	72.3
4/30	102	50	49.0	18	17.6	9	8.8	4	3.9	81	79.4
5/1	101	46	45.5	14	13.9	10	9.9	2	2.0	72	71.3
5/2	100	48	48.0	18	18.0	11	11.0	2	2.0	79	79.0
5/3	100	45	45.0	19	19.0	11	11.0	4	4.0	79	79.0
5/4	119	69	58.0	7	5.9	8	6.7	3	2.5	87	73.1
5/5	100	36	36.0	13	13.0	4	4.0	5	5.0	58	58.0
5/6	101	42	41.6	7	6.9	3	3.0	5	5.0	57	56.4
5/7	99	49	49.5	9	9.1	0	0.0	7	7.1	65	65.7
5/8	100	39	39.0	9	9.0	1	1.0	7	7.0	56	56.0
5/9	101	27	26.7	9	8.9	5	5.0	9	8.9	50	49.5
5/10	101	34	33.7	10	9.9	4	4.0	5	5.0	53	52.5
5/11	94	21	22.3	4	4.3	5	5.3	9	9.6	39	41.5
5/12	99	32	32.3	13	13.1	3	3.0	5	5.1	53	53.5
5/13,14	171	46	26.9	26	15.2	8	4.7	13	7.6	93	54.4
5/27,28	81	37	45.7	23	28.4	3	3.7	2	2.5	65	80.2
5/29,30,31,											
6/1,2,3	99	45	45.5	19	19.2	9	9.1	2	2.0	75	75.8
6/5,7,8,9	29	13	44.8	10	34.5	3	10.3	0	0.0	26	89.7
Total	3,203	1,336	41.7	494	15.4	246	7.7	134	4.2	2,210	69.0

Appendix B-2. PIT-tagged wild chinook salmon interrogations at Lower Granite, Little Goose, Lower Monumental and McNary dams from the Snake River trap, 1993.

Date	Number tagged	Interrogated at Lower Granite	Percent	Interrogated at Little Goose	Percent	Interrogated at Lower Monumental	Percent	Interrogated at McNary	Percent	Total interrogated	Total percent
4/9,10,11	67	40	59.7	14	20.9	2	3.0	2	3.0	58	86.7
4/12,13,14,15	64	38	59.4	13	20.3	2	3.1	3	4.7	56	87.5
4/16,17,18,19, 20,21,22,23,24	64	38	59.4	9	14.1	4	6.3	4	6.3	55	86.0
4/25,26,27,28	62	35	56.5	5	8.1	5	8.1	2	3.2	47	75.8
4/29,30	41	23	56.1	4	9.8	4	9.8	0	0.0	31	75.6
5/1,2,3	48	27	56.2	7	14.6	4	8.3	1	2.1	39	81.3
5/4	50	29	58.0	8	16.0	2	4.0	1	2.0	40	80.0
5/5	61	33	54.1	7	11.5	1	1.6	4	6.6	45	73.8
5/6	48	30	62.5	5	10.4	2	4.2	1	2.1	38	79.2
5/7	50	30	60.0	0	0.0	0	0.0	3	6.0	33	66.0
5/8	50	28	56.0	4	8.0	2	4.0	1	2.0	35	70.0
5/9,10	78	35	44.9	9	11.5	2	2.6	1	1.3	47	60.3
5/11,12	87	31	35.6	6	6.9	3	3.4	7	8.0	47	54.0
5/13	105	28	26.7	12	11.4	6	5.7	13	12.3	59	56.2
5/27,28	81	46	56.8	13	16.0	6	7.4	2	2.5	67	82.7
5/29,30	47	20	42.6	7	14.9	8	17.0	1	2.1	36	76.5
5/31-6/1,2	45	21	46.7	14	31.1	3	6.7	0	0.0	38	84.4
6/3,4,5, 8,9,16	63	35	57.4	11	17.5	0	0.0	0	0.0	46	73.0
6/17	6	4	--	1	--	0	--	0	--	5	--
6/30	1	1	--	0	--	0	--	0	--	1	--
7/6	2	1	--	0	--	0	--	0	--	1	--
7/11	3	1	--	0	--	1	--	0	--	2	--
7/13	2	1	--	1	--	0	--	0	--	2	--
Total	1,125	5,765	51.1	150	13.3	57	5.1	46	4.1	828	73.6

Appendix B-3. PIT-tagged hatchery steelhead interrogations at Lower Granite, Little Goose, Lower Monumental and McNary dams from the Snake River trap, 1993.

Date	Interrogated at Lower Granite			Interrogated at Little Goose		Interrogated at Lower Monumental		Interrogated at McNary		Total interrogated	Total percent
	Number tagged	Number	Percent	Number	Percent	Number	Percent	Number	Percent		
4/13	1	1	--	0	--	0	--	0	--	1	--
4/14,15,16	77	60	77.9	11	14.3	1	1.3	2	2.6	74	96.1
4/17	60	42	70.0	10	16.7	1	1.7	1	1.7	54	90.0
4/18	63	44	69.8	12	19.0	1	1.6	0	0.0	57	90.5
4/19	63	41	65.1	9	14.3	1	1.6	0	0.0	51	81.0
4/20	57	44	77.2	9	15.8	0	0.0	0	0.0	53	93.0
4/21	62	51	82.3	5	8.1	0	0.0	1	1.6	57	91.9
4/22	61	49	80.3	8	13.1	0	0.0	2	3.3	59	96.7
4/23	61	49	80.3	9	14.8	0	0.0	1	1.6	59	96.7
4/24	61	45	73.8	10	16.4	2	3.3	0	0.0	57	93.4
4/25	65	45	69.2	11	16.9	1	1.5	1	1.5	58	89.2
4/26	60	51	85.0	2	3.3	1	1.7	0	0.0	54	90.0
4/27	61	43	70.5	8	13.1	1	1.6	0	0.0	52	85.2
4/28	67	53	79.1	7	10.4	1	1.5	0	0.0	61	91.0
4/29	60	38	63.3	8	13.3	5	8.3	1	1.7	52	86.7
4/30	60	47	78.3	6	10.0	3	5.0	0	0.0	56	93.3
5/1	84	72	85.7	3	3.6	3	3.6	0	0.0	78	92.9
5/2	61	51	83.6	3	4.9	2	3.3	1	1.6	57	93.4
5/3	61	57	93.4	1	1.6	1	1.6	0	0.0	59	96.7
5/4	61	51	83.6	3	4.9	2	3.3	0	0.0	56	91.8
5/5	61	51	83.6	4	6.6	0	0.0	0	0.0	55	90.2
5/6	63	48	76.2	5	7.9	3	4.8	0	0.0	56	88.9
5/7	59	51	86.4	2	3.4	3	5.1	0	0.0	56	94.9
5/8	67	51	76.1	6	9.0	1	1.5	0	0.0	58	86.6
5/9	61	54	88.5	2	3.3	0	0.0	0	0.0	56	91.8
5/10	60	49	81.7	1	1.7	0	0.0	0	0.0	50	83.3
5/11	60	40	66.7	6	10.0	2	3.3	0	0.0	48	80.0
5/12	60	37	61.7	0	0.0	2	3.3	1	1.7	40	66.7
5/13	61	19	31.1	8	13.1	3	4.9	1	1.6	31	50.8
5/14	60	19	31.7	14	23.3	5	8.3	0	0.0	38	63.3
5/27	63	41	65.1	9	14.3	7	11.1	0	0.0	57	90.5
5/28	61	45	73.8	12	19.7	1	1.6	0	0.0	58	95.1
5/29	61	47	77.0	5	8.2	0	0.0	1	1.6	53	86.9
5/30	61	49	80.3	2	3.3	1	1.6	0	0.0	52	85.2
5/31	61	53	86.9	3	4.9	1	1.6	0	0.0	57	93.4
6/1	50	38	76.0	1	2.0	3	6.0	0	0.0	42	84.0
6/2	71	60	84.5	6	8.5	1	1.4	0	0.0	67	94.4
6/3	34	30	88.2	1	2.9	0	0.0	0	0.0	31	91.2
6/4	24	21	87.5	1	4.2	0	0.0	0	0.0	22	91.7
6/5	29	22	75.9	3	10.3	1	3.4	0	0.0	26	89.7
6/7	51	46	90.2	2	3.9	0	0.0	0	0.0	48	94.1
6/8	65	55	84.6	3	4.6	2	3.1	0	0.0	60	92.3
6/9	31	29	93.5	1	3.2	1	3.2	0	0.0	31	100.0
6/11	33	29	87.9	3	9.1	0	0.0	0	0.0	32	97.0
6/16	8	7	--	0	--	0	--	0	--	7	--
Total	2,521	1,925	76.4	235	9.3	63	2.5	13	0.5	2,236	88.7

Appendix B-4. PIT-tagged wild steelhead trout interrogations at Lower, Granite, Little Goose, Lower Monumental and McNary dams from the Snake River trap, 1993.

Date	Interrogated at Lower		Interrogated at Little Goose		Interrogated at Lower Monumental		Interrogated at McNary		Total interrogated	Total percent
	Number tagged	Granite Percent	Goose Percent	Monumental Percent	McNary Percent					
4/9,10,11,12,13,14,15,16	45	34 75.6	4 8.9	0 0.0	1 2.2	39	86.7			
4/17,18,19,20	41	27 65.9	6 14.6	0 0.0	0 0.0	33	80.5			
4/21,22,23	44	35 79.5	8 18.2	0 0.0	0 0.0	43	97.7			
4/24	39	23 59.0	5 12.8	2 5.1	4 10.3	34	87.2			
4/25	39	28 71.8	7 17.9	0 0.0	3 7.7	38	97.4			
4/26	35	22 62.9	5 14.3	2 5.7	1 2.9	30	85.7			
4/27	66	39 59.1	18 27.3	0 0.0	1 1.5	58	87.9			
4/28	78	50 64.1	11 14.1	6 7.7	1 1.3	68	87.2			
4/29	75	57 76.0	6 8.0	3 4.0	1 1.3	67	89.3			
4/30	61	50 82.0	2 3.3	3 4.9	2 3.3	57	93.4			
5/1	112	87 77.7	5 4.5	7 6.2	0 0.0	99	88.4			
5/2	126	85 67.5	14 11.1	12 9.5	0 0.0	111	88.1			
5/3	98	71 72.4	15 15.3	5 5.1	0 0.0	91	92.9			
5/4	268	217 81.0	20 7.5	5 1.9	0 0.0	242	90.3			
5/5	449	348 77.5	36 8.0	29 6.5	2 0.4	414	92.2			
5/6	70	59 84.3	3 4.3	4 5.7	0 0.0	66	94.3			
5/7	306	236 77.1	24 7.8	18 5.9	0 0.0	278	90.8			
5/8	128	94 73.4	9 7.0	3 2.3	0 0.0	106	82.8			
5/9	52	39 75.0	4 7.7	0 0.0	0 0.0	43	82.7			
5/10	85	67 78.8	1 1.2	2 2.4	0 0.0	70	82.4			
5/11	61	36 59.0	5 8.2	2 3.3	0 0.0	43	70.5			
5/12	98	49 50.0	10 10.2	4 4.1	2 2.0	65	66.3			
5/13	410	171 41.7	41 10.0	16 3.9	13 3.2	241	58.8			
5/27,28,29	31	18 58.1	7 22.6	2 6.5	1 3.2	28	90.3			
5/30,31-6/1,2	25	18 72.0	2 8.0	4 16.0	0 0.0	24	96.0			
6/4,5,7,8,9,11,25	22	22 88.0	0 0.0	0 0.0	0 0.0	22	88.0			
Total	2,867	1,982 69.1	267 9.3	133 4.6	32 1.1	2,414	84.2			

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Appendix B-5. PIT-tagged hatchery chinook salmon interrogations at Lower Granite, Little Goose, Lower Monumental and McNary dams from the Clearwater River trap, 1993.

Date	Interrogated at Lower Granite			Interrogated at Little Goose		Interrogated at Lower Monumental		Interrogated at McNary		Total interrogated	Total percent
	Number tagged		Percent		Percent		Percent		Percent		
4/9	103	29	28.2	17	16.5	6	5.8	9	8.7	61	59.2
4/10	100	43	43.0	7	7.0	7	7.0	4	4.0	61	61.0
4/11	116	35	30.2	8	6.9	7	6.0	5	4.3	55	47.4
4/12	71	25	35.2	11	15.5	4	5.6	2	2.8	42	59.2
4/13, 14, 15	74	21	28.4	11	14.9	6	8.1	0	0.0	38	51.4
4/16	100	44	44.0	10	10.0	7	7.0	3	3.0	64	64.0
4/17, 18	80	33	41.3	14	17.5	3	3.8	2	2.5	52	65.0
4/20	101	36	35.6	8	7.9	6	5.9	4	4.0	54	53.5
4/21	100	33	33.0	7	7.0	7	7.0	5	5.0	52	52.0
4/22	97	29	29.9	13	13.4	13	13.4	7	7.2	62	63.9
4/23	101	31	30.7	19	18.8	8	7.9	2	2.0	60	59.4
4/24	100	34	34.0	14	14.0	3	3.0	5	5.0	56	56.0
4/25	72	20	27.8	4	5.6	7	9.7	3	4.2	34	47.2
4/26	97	34	35.1	10	10.3	7	7.2	3	3.1	54	56.7
4/27, 28	97	32	32.9	12	12.4	3	3.1	8	8.2	55	58.7
4/29, 30	63	25	39.7	6	9.5	3	4.8	3	4.8	37	58.7
5/1	60	18	30.0	11	18.3	5	6.7	1	1.7	35	58.3
5/2, 3	51	16	31.4	5	9.8	3	5.9	6	11.8	30	58.8
5/4	40	14	35.0	6	15.0	<b>1</b>	2.5	5	12.5	26	65.0
<b>Total</b>	<b>1,624</b>	<b>553</b>	<b>34.1</b>	<b>193</b>	<b>11.9</b>	<b>106</b>	<b>6.5</b>	<b>77</b>	<b>4.7</b>	<b>929</b>	<b>57.2</b>

Appendix B-6. PIT-tagged wild chinook salmon interrogations at Lower Granite, Little Goose, Lower Monumental and McNary dams from the Clearwater River trap, 1993.

Date	Number tagged	Interrogated at Lower Granite		Interrogated at Little Goose		Interrogated at Lower Monumental		Interrogated at McNary		Total interrogated	Total percent
		Number	Percent	Number	Percent	Number	Percent	Number	Percent		
4/9	6	1	--	2	--	0	--	1	--	4	--
4/10	27	13	48.1	6	22.2	1	3.7	4	14.8	24	88.9
4/11	5	4	--	0	--	0	--	0	--	4	--
4/12	11	3	27.3	2	18.2	2	18.2	0	0.0	7	63.6
4/13	5	1	--	0	--	3	--	0	--	4	--
4/14	2	1	--	1	--	0	--	0	--	2	--
4/15	5	3	--	1	--	0	--	0	--	4	--
4/16	10	6	60.0	2	20.0	1	10.0	0	0.0	9	90.0
4/17	1	0	--	0	--	1	--	0	--	1	--
4/18	1	0	--	0	--	0	--	1	--	1	--
4/19	8	2	--	0	--	2	--	0	--	4	--
4/20	32	14	43.8	7	21.9	1	3.1	1	3.1	23	71.9
4/21	9	3	--	0	--	0	--	1	--	4	--
4/22	11	6	54.5	1	9.1	1	9.1	1	9.1	9	81.8
4/23	7	1	--	0	--	1	--	0	--	2	--
4/24	4	1	--	2	--	0	--	0	--	3	--
4/25	9	7	--	1	--	1	--	0	--	9	--
4/26	30	12	40.0	2	6.7	5	16.7	3	10.0	22	73.3
4/27	11	4	36.4	4	36.4	2	18.2	0	0.0	10	90.9
4/28	9	4	--	1	--	1	--	3	--	9	--
4/29	10	6	60.0	1	10.0	1	10.0	0	0.0	8	80.0
4/30	12	4	33.3	1	8.3	0	0.0	0	0.0	5	41.7
5/1	23	12	52.2	5	21.7	1	4.3	0	0.0	18	78.3
5/2	10	4	40.0	2	20.0	0	0.0	0	0.0	6	60.0
5/3	6	4	--	0	--	0	--	0	--	4	--
5/4	31	16	51.6	2	6.5	0	0.0	3	9.7	21	67.7
7/8	2	1	--	0	--	0	--	0	--	1	--
7/21	1	1	--	0	--	0	--	0.	--	1	--
Total	298	134	45.0	43	14.4	25	8.4	18	6.0	220	73.8

Appendix B-7. PIT-tagged hatchery steelhead interrogations at Lower Granite, Little Goose, Lower Monumental and McNary dams from the Clearwater River trap, 1993.

Date	Interrogated			Interrogated		Interrogate		Interrogated		Total interrogated	Total percent
	Number tagged	at Lower Granite	Percent	at Little Goose	Percent	at Lower Monumental	Percent	at McNary	Percent		
4/12	1	1		0	--	0	--	0	--	1	--
4/13	1	1	--	0	--	0	--	0	--	1	--
4/14,15	25	19	76.0	2	8.0	0	0.0	0	0.0	21	84.0
4/16	62	43	69.4	0	0.0	2	3.2	1	1.6	46	74.2
4/17	61	37	60.7	10	16.4	0	0.0	1	1.6	48	78.7
4/18	10	8	80.0	1	10.0	1	10.0	0	0.0	10	100.0
4/19	58	25	43.1	6	10.3	1	1.7	0	0.0	32	55.2
.4/20	62	48	77.4	2	3.2	0	0.0	0	0.0	50	80.6
4/21	61	46	75.4	0	0.0	0	0.0	1	1.6	47	77.0
4/22	63	43	68.3	7	11.1	0	0.0	0	0.0	50	79.4
4/23	63	54	85.7	4	6.3	0	0.0	0	0.0	58	92.1
4/24	60	44	73.3	7	11.7	2	3.3	0	0.0	53	88.3
4/25	69	47	68.1	5	7.2	2	2.9	2	2.9	56	81.2
4/26	63	53	84.1	5	7.9	3	4.8	0	0.0	61	96.8
4/27	69	47	68.1	7	10.1	1	1.4	0	0.0	55	79.7
4/28	60	49	81.7	4	6.7	0	0.0	0	0.0	53	88.3
4/29	60	43	71.7	4	6.7	2	3.3	0	0.0	49	81.7
4/30	60	48	80.0	1	1.7	4	6.7	0	0.0	53	88.3
5/1	60	49	81.7	2	3.3	2	3.3	0	0.0	53	88.3
5/2,3	74	57	77.0	7	9.5	4	5.4	1	1.7	69	93.2
5/4	60	51	85.0	5	8.3	0	0.0	0	0.0	56	93.3
Total	1,102	813	73.8	79	7.2	24	2.2	6	0.5	922	83.7

Appendix B-8. PIT-tagged wild steelhead trout interrogations at Lower Granite, Little Goose, Lower Monumental and McNary dams from the Clearwater River trap, 1993.

Date.	Number tagged	Interrogated at Lower Granite	Percent	Interrogated at Little Goose	Percent	Interrogated at Lower Monumental	Percent	Interrogated at McNary	Percent	Total interrogated	Total percent
4/10,12,13,											
14,15,16	27	19	70.4	6	22.2	0	0.0	0	0.0	25	92.6
4/17,19,20	31	16	51.6	5	16.1	0	0.0	0	0.0	21	67.7
4/21,22,23	33	20	60.6	6	18.2	0	0.0	0	0.0	26	78.8
4/24,25	29	18	62.1	3	10.3	1	3.4	2	6.9	24	82.8
4/26	63	39	61.9	11	17.5	3	4.8	1	1.6	54	85.7
4/27	76	51	67.1	9	11.8	2	2.6	0	0.0	62	81.6
4/28	48	32	66.7	8	16.7	1	2.1	0	0.0	41	85.4
4/29	34	16	47.1	2	5.9	4	11.8	0	0.0	22	64.7
4/30	85	59	69.4	4	4.7	3	3.5	2	2.4	68	80.0
5/1	213	147	69.0	25	11.7	11	5.2	1	0.5	184	86.4
5/2	53	32	60.4	9	17.0	6	11.3	1	1.9	48	90.6
5/3	14	10	71.4	1	7.1	1	7.1	0	0.0	12	85.7
5/4	142	101	71.1	17	12.0	9	6.3	1	0.7	128	90.1
Total	849	560	66.0	106	12.5	58	6.8	9	1.1	733	86.3

Appendix B-9. PIT-tagged hatchery chinook salmon interrogations at Lower Granite, Little Goose, Lower Monumental and McNary dams from the Salmon River trap, 1993.

Date	Interrogated at Lower Granite			Interrogated at Little Goose		Interrogated at Lower Monumental		Interrogated at McNary		Total interrogated	Total percent
	Number tagged		Percent		Percent		Percent		Percent		
4/8	1	1	--	0	--	0	--	0	--		
4/11,12	108	41	38.0	17	15.8	3	2.8	5	4.6	66	61.1
4/13	99	47	47.5	15	15.2	8	8.1	3	3.0	73	73.7
4/14	101	37	36.6	14	13.9	5	4.7	3	3.0	59	58.4
4/15	106	43	40.6	11	10.4	5	4.7	4	3.8	63	59.4
4/16	97	46	47.4	13	13.4	8	8.2	3	3.1	70	72.2
4/17	100	33	33.0	13	13.0	15	15.0	1	1.0	62	62.0
4/18	101	41	40.6	19	18.8	5	5.0	4	4.0	69	68.3
4/19	103	48	46.6	10	9.7	7	6.8	2	1.9	67	65.0
4/20	114	38	33.3	19	16.7	7	6.1	1	0.9	65	57.0
4/21	101	40	39.6	11	10.9	11	10.9	4	4.0	66	65.3
4/22	101	41	40.6	13	12.9	11	10.9	1	1.0	66	65.3
4/23	99	37	37.4	12	12.1	16	16.2	4	4.0	69	69.7
4/24	105	40	38.1	8	7.6	10	9.5	5	4.8	63	60.0
4/25	100	39	39.0	16	16.0	8	8.0	2	2.0	65	65.0
4/26	100	38	38.0	19	19.0	7	7.0	6	6.0	70	70.0
4/27	100	39	39.0	13	13.0	7	7.0	1	1.0	60	60.0
4/28	100	29	29.0	12	12.0	11	11.0	3	3.0	55	55.0
4/29	101	45	44.6	6	5.9	12	11.9	5	5.0	68	67.3
4/30	101	45	44.6	9	8.9	4	4.0	2	2.0	60	59.4
5/1	102	32	31.4	14	13.7	12	11.8	10	9.8	68	66.7
5/2	102	34	33.3	17	16.7	8	7.8	5	4.9	64	62.7
5/3	100	35	35.0	13	13.0	3	3.0	7	7.0	58	58.0
5/4	100	35	35.0	10	10.0	2	2.0	8	8.0	55	55.0
5/5	100	34	34.0	10	10.0	7	7.0	4	4.0	55	55.0
5/6	99	34	34.3	6	6.1	3	3.0	6	6.1	49	49.5
5/7	99	22	22.2	11	11.1	5	5.1	14	14.1	52	52.5
5/8	100	30	30.0	12	12.0	9	9.0	5	5.0	56	56.0
5/9	101	30	29.7	9	8.9	4	4.0	8	7.9	51	50.5
5/10	100	29	29.0	5	5.0	9	9.0	9	9.0	52	52.0
5/11	99	25	25.3	14	14.1	9	9.1	10	10.1	58	58.6
5/12	98	36	36.7	14	14.3	2	2.0	12	12.2	64	65.3
Total	3,138	1,144	36.5	385	12.3	233	7.4	157	5.0	1,919	61.2



Appendix B-10. PIT-tagged wild chinook salmon interrogations at Lower Granite, Little Goose, Lower Monumental and McNary dams from the Salmon River trap, 1993.

Date	Interrogated			Interrogated		Interrogated		Interrogated		Total interrogated	Total percent
	Number tagged	at Lower Granite	Percent	at Little Goose	Percent	at Lower Monumental	Percent	at McNary	Percent		
3/26,27	51	23	45.1	6	11.8	2	3.9	2	3.9	33	64.7
3/28,29	72	33	45.8	17	23.6	2	2.8	2	2.8	54	75.0
3/30	51	28	54.9	9	17.6	1	2.0	1	2.0	39	76.5
3/31	51	28	54.9	4	7.8	0	0.0	5	9.8	37	72.5
4/1	44	23	52.3	5	11.4	2	4.5	3	6.8	33	75.0
4/2,3	47	27	57.4	8	17.0	2	4.3	2	4.3	39	83.0
4/4,5	51	31	60.8	7	13.7	3	5.9	0	0.0	41	80.4
4/6	50	32	64.0	9	18.0	2	4.0	2	4.0	45	90.0
4/7	50	29	58.0	9	18.0	2	4.0	0	0.0	40	80.0
4/8	50	30	60.0	7	14.0	3	6.0	1	2.0	41	82.0
4/9	50	28	56.0	9	18.0	3	6.0	1	2.0	41	82.0
4/10	50	23	46.0	5	10.0	2	4.0	8	16.0	38	76.0
4/11	50	30	60.0	7:	14.0	1	2.0	2	4.0	40	80.0
4/12	56	33	58.9	7	12.5	0	0.0	4	7.1	44	78.6
4/13	51	28	54.9	10	19.6	2	3.9	2	3.9	42	82.4
4/14	51	29	56.9	8	15.7	2	3.9	2	3.9	41	80.4
4/15	49	33	67.3	10	20.4	1	2.0	0	0.0	44	89.8
4/16,17	80	43	53.8	13	16.3	3	3.8	2	2.5	61	76.3
4/18	54	27	50.0	6	11.1	4	7.4	2	3.7	39	72.2
4/19	54	30	55.6	5	9.3	4	7.4	2	3.7	41	75.9
4/20	51	31	60.8	7	13.7	5	9.8	1	2.0	44	86.3
4/21,22	67	36	53.7	9	13.4	3	4.5	1	1.5	48	73.1
4/23	52	24	46.2	6	11.5	9	17.3	2	3.8	41	78.8
4/24	50	30	60.0	3	6.0	8	16.0	1	2.0	42	84.0
4/25	45	18	40.0	6	13.3	7	15.6	2	4.4	33	73.3
4/26	50	25	50.0	5	10.0	7	14.0	2	4.0	39	78.0
4/27	50	24	48.0	8	16.0	3	6.0	1	2.0	36	72.0
4/28	50	24	48.0	7	14.0	4	8.0	2	4.0	37	74.0
4/29	46	33	71.7	4	8.7	0	0.0	1	2.2	38	82.6
4/30	42	23	54.8	6	14.3	3	7.1	0	0.0	32	76.2
5/1	51	24	47.1	6	11.8	4	7.8	1	2.0	35	68.6
5/2	50	24	48.0	8	16.0	6	12.0	0	0.0	38	76.0
5/3	49	27	55.1	6	12.2	0	0.0	4	8.2	37	75.5
5/4	50	22	44.0	8	16.0	3	6.0	3	6.0	36	72.0
5/5	50	25	50.0	2	4.0	5	10.0	0	0.0	32	64.0
5/6	51	27	52.9	3	5.9	0	0.0	4	7.8	34	66.7
5/7	53	20	37.7	8	15.1	2	3.8	2	3.8	32	60.4
5/8	50	15	30.0	5	10.0	3	6.0	1	2.0	24	48.0
5/9	50	17	34.0	3	6.0	3	6.0	5	10.0	28	56.0
5/10	50	17	34.0	6	12.0	1	2.0	5	10.0	29	58.0
5/11	50	20	40.0	3	6.0	3	6.0	3	6.0	29	58.0
5/12	50	18	36.0	6	12.0	5	10.0	7	14.0	36	72.0
Total	2,169	1,112	51.3	286	13.2	125	5.8	91	4.2	1,614	74.4

Appendix B-11. PIT-tagged hatchery steelhead trout interrogations at Lower Granite, Little Goose, Lower Monumental and McNary dams from the Salmon River trap, 1993.

Date	Interrogated			Interrogated			Interrogated			Total interrogated	Total percent
	Number tagged	at Lower Granite	Percent	at Little Goose	Percent	at Lower Monumental	Percent	at McNary	Percent		
4/15	57	47	82.5	1	1.8	1	1.8	1	1.8	50	87.7
4/16	60	42	70.0	5	8.3	0	0.0	0	0.0	47	78.3
4/17	29	22	75.9	2	6.9	1	3.4	0	0.0	25	86.2
4/18	53	38	71.7	3	5.7	0	0.0	0	0.0	41	77.4
4/19	60	47	78.3	5	8.3	0	0.0	0	0.0	52	86.7
4/20	60	48	80.0	3	5.0	1	1.7	1	1.7	53	88.3
4/21	66	50	75.8	6	9.1	0	1.5	0	0.0	57	86.4
4/22	61	51	83.6	5	8.2	0	0.0	0	0.0	56	91.8
4/23	61	47	77.0	7	11.5	0	0.0	0	0.0	54	88.5
4/24	65	54	83.1	6	9.2	1	1.5	0	0.0	61	93.8
4/25	62	47	75.8	5	8.1	1	1.6	1	1.6	54	87.1
4/26	60	34	56.7	2	3.3	3	5.0	1	1.7	53	66.7
4/27	60	43	71.7	4	6.7	1	1.7	1	1.7	49	81.7
4/28	61	48	78.7	2	3.3	1	1.6	1	1.6	52	85.2
4/29	60	42	70.0	9	15.0	2	3.3	0	0.0	53	88.3
4/30	45	34	75.6	3	6.7	2	4.4	1	2.2	40	88.9
5/1	60	48	80.0	4	6.7	4	6.7	1	1.7	57	95.0
5/2	58	45	77.6	3	5.2	3	5.2	0	0.0	51	87.9
5/3	61	47	77.0	2	3.3	4	6.6	0	0.0	53	86.9
5/4	60	48	80.0	2	3.3	1	1.7	0	0.0	51	85.0
5/5	60	46	76.7	3	5.0	2	3.3	0	0.0	51	85.0
5/6	60	50	83.3	3	5.0	1	1.7	0	0.0	54	90.0
5/7	61	48	78.7	5	8.2	2	3.3	0	0.0	55	90.2
5/8	60	40	66.7	3	5.0	2	3.3	0	0.0	45	75.0
5/9	61	41	67.2	3	4.9	3	4.9	1	1.6	48	78.7
5/10	60	36	60.0	3	5.0	1	1.7	1	1.7	41	68.3
5/11	60	33	55.0	4	6.7	3	5.0	0	0.0	40	66.7
5/12	60	27	45.0	9	15.0	3	5.0	3	5.0	42	70.0
Total	1,641	1,203	73.3	112	6.8	44	2.7	13	0.8	1,372	83.6

Appendix B-12. PIT-tagged wild steelhead trout interrogations at Lower Granite, Little Goose, Lower Monumental and McNary dams from the Salmon River trap, 1993.

Number Date	Interrogated at Lower Granite		Interrogated at Little Goose		Interrogated at Lower Monumental		Interrogated at McNary		Total interrogated	Total percent	
	Percent	Percent	Percent	Percent	Percent	Percent					
4/2, 6, 7, 10, 11, 12, 13, 14 4/15 16 18	31	16	51.6	6	19.4	0	0.0	0.	0.0	22	71.0
19, 20	30	19	63.3	4	13.3	3	10.0	0	0.0	26	86.7
4/21	13	12	92.3	0	0.0	0	0.0	0	0.0	12	92.3
4/22	2	1	--	0	--	0	--	0	--	1	--
4/23	14	9	64.3	2	14.3	1	7.1	0	0.0	12	85.7
4/24	6	4	--	1	--	0	--	1	--	6	--
4/25	6	4	--	0	--	1	--	0	--	5	--
4/26, 27, 28, 29	45	35	77.8	2	4.4	2	4.4	1	2.2	40	88.9
4/30-5/1, 2	51	30	58.8	8	15.7	4	7.8	0	0.0	42	82.3
5/3	32	26	81.2	3	9.4	0	0.0	1	3.1	30	93.8
5/4	42	34	81.0	6	14.3	0	0.0	0	0.0	40	95.2
5/5	128	91	71.1	5	3.9	8	6.2	1	0.8	105	82.0
5/6	186	126	67.7	16	8.6	10	5.4	0	0.0	152	81.7
5/7	77	47	61.0	11	14.3	3	3.9	1	1.3	62	80.5
5/8	65	46	70.8	2	3.1	0	0.0	0	0.0	48	73.8
5/9	47	24	51.1	1	2.1	1	2.1	0	0.0	26	55.3
5/10	37	16	43.2	3	8.1	2	5.4	0	0.0	21	56.8
5/11	32	15	46.9	1	3.1	0	0.0	0	0.0	16	50.0
5/12	58	20	34.5	2	3.4	1	1.7	0	0.0	23	39.7
Total	902	575	63.7	73	8.1	36	4.0	5	0.6	689	76.4

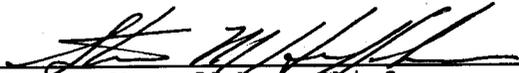
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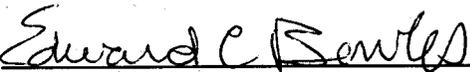
Edwin W. Buettner  
Senior Fishery Research Biologist

Arnold F. Brimmer  
Senior Fishery Technician

Approved by:

IDAHO DEPARTMENT OF FISH AND GAME

  
\_\_\_\_\_  
Steven M. Huffaker, Chief  
Bureau of Fisheries

  
\_\_\_\_\_  
Edward C. Bowles  
Anadromous Fisheries Manager