September 1998

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

Annual Report 1996

DOE/BP-11631-13

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

This document should be cited as follows:

Buettner, Edwin W. and A. F. Brimmer, Idaho Department of Fish and Game, 1998, Smolt Monitoring at the Head of Lower Granite Reservoir and Lower Granite Dam, Annual Report 1996 to Bonneville Power Administration, Portland, OR, Contract No. De-BI79-83BP11631, Project No. 83-323-00, 65 electronic pages (BPA Report DOE/BP-11631-13)

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

ANNUAL REPORT 1996

by

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Funded by:

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

IDFG 98-38
Modification No. A020
Project No. 83-323 B
Contract Number DE-BI79-83BP11631

SEPTEMBER 1998

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ABSTRACT

This project monitored the daily passage of chinook salmon *Oncorhynchus tshawytscha* and steelhead trout *O. mykiss* smolts during the 1996 spring outmigration at migrant traps on the Snake River and Salmon River.

All hatchery chinook salmon released above Lower Granite Dam were marked with a fin clip in 1996. Total annual hatchery chinook salmon catch at the Snake River trap was only 12% of the 1995 number. The wild chinook catch was only 17% of the 1995 catch. Hatchery steelhead trout catch was only 37% of 1995 numbers and wild steelhead trout catch was 51% of 1995. The Snake River trap collected 19 age 0 chinook salmon and 16 sockeye/kokanee salmon *O. nerka*. A difference in trap catch between years is due to fluctuations not only in smolt production, but also differences in trap efficiency and duration of trap operation associated with high flows. Trap operations were terminated for the season due to high flows and trap damage on May 16. The 1995 and 1996 field seasons were years we tried to reduce trap catch by operating the traps five days a week. This would affect the trap catch comparison between years.

Hatchery chinook salmon catch at the Salmon River trap was 14% and wild chinook salmon catch was 19% of 1995 numbers. The 1996 hatchery steelhead trout collection was 2.4 times greater than the 1995 catch. Wild steelhead trout collection in 1996 was 61% of the 1995 catch.

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 1996 was unable to detect a significant relation for hatchery chinook salmon, but found a 1.9-fold increase in migration rate due to a 50 kcfs increase in discharge between 100 and 150 kcfs for wild chinook salmon, 1.5 times for hatchery steelhead trout, and 1.5 times for wild steelhead.

For fish marked at the Salmon River trap, statistical analysis of the 1996 data was unable to detect a significant relation between migration rate and discharge for hatchery chinook salmon, but a two-fold increase in discharge from 100-150 kcfs increased migration rate by 11.3 times for wild chinook salmon, 1.7 times for hatchery steelhead trout, and 1.5 times for wild steelhead trout.

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 is not comparable with the prior five years (1988-1992). Cumulative interrogations at the four dams for fish marked at the Snake River trap were 68% for hatchery chinook, 73% for wild chinook, 80% for hatchery steelhead, and 78% for wild steelhead. Cumulative interrogations at the four dams for fish marked at the Salmon River trap were 50% for hatchery chinook salmon, 62% for wild chinook salmon, 69% for hatchery steelhead trout, and 73% for wild steelhead trout.

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INTRODUCTION

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

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

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

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

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

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

OBJECTIVES

1. Provide daily trap catch data at the head of Lower Granite Reservoir for TMT's use in implementing the NMFS Biological Opinion.

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 brand and passive integrated transponder (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, hatchery steelhead trout, and wild steelhead trout from the head of Lower Granite Reservoir to Lower Granite Dam using PIT-tagged smolts marked at the traps and PIT-tagged smolts passing the traps from upriver hatchery releases and rearing areas.

5. Determine cumulative interrogation rate at Lower Granite, Little Goose, Lower Monumental, and McNary dams during the spring outmigration period for PIT-tagged hatchery and wild spring/summer chinook salmon, hatchery and wild steelhead trout.

6. Correlate smolt migration rate with river flow for fish moving in riverine and reservoir environments.

7. Determine trap efficiency for each species at each trap over a range of discharges.

8. Evaluate timing of returning adult wild and natural steelhead crossing Lower Granite Dam.

METHODS

Releases of Hatchery-Produced Smolts

Anadromous hatchery release information was reported for hatchery smolts which contributed to the 1996 outmigration in the Snake River drainage, upstream of Lower Granite Dam. This information-included species, number released, date, release location, number passive integrated transponder (PIT) tagged, number freeze branded, and associated brand.

Smolt Monitoring Traps

During the 1996 outmigration, two smolt-monitoring traps were operated to monitor the passage of juvenile chinook salmon and steelhead trout. A scoop trap (Raymond and Collins 1974) was located on the Salmon River, near Slate Creek, Idaho. Because of higher than normal flows early in the migration season the screw trap was not needed this season. A dipper trap (Mason 1966), was located on the Snake River near Lewiston, Idaho (Figure 1).

The scoop trap on the Clearwater River was not operated in 1996 due to budget cuts. Smolts were captured, examined, and enumerated daily at the traps and released back to the river. Fork length of up to 100 smolts for each species were measured to the nearest millimeter. Up to 100 hatchery chinook salmon, 75 wild chinook salmon, 60 hatchery steelhead trout, and all wild steelhead trout were PIT-tagged daily, when available. Up to 2,000 fish were examined for hatchery brands at the Snake River trap. Fish were not examined for brands at the other trap locations. Smolts were anesthetized before handling with tricaine methanesulfonate (MS-222). These fish were allowed to recover from the anesthesia before being returned to the river.

Prior to the 1996 outmigration season, the Fish Passage Center requested that all smolt-monitoring projects reduce handling of fish listed under the Endangered Species Act. To comply with this request, sampling regimes and quotas were adjusted at all of this project's collection sites. Sampling periods were based on a standard workweek (Monday-Friday) with Saturday and Sunday left available, if necessary, to fill quotas. Once 500 hatchery chinook salmon, 375 wild chinook salmon and 300 hatchery steelhead trout, and 300 wild steelhead trout were PIT tagged to fulfill the weekly quota, operations were suspended until the beginning of the next sampling period. Generally, the daily PIT tag quotas were observed.

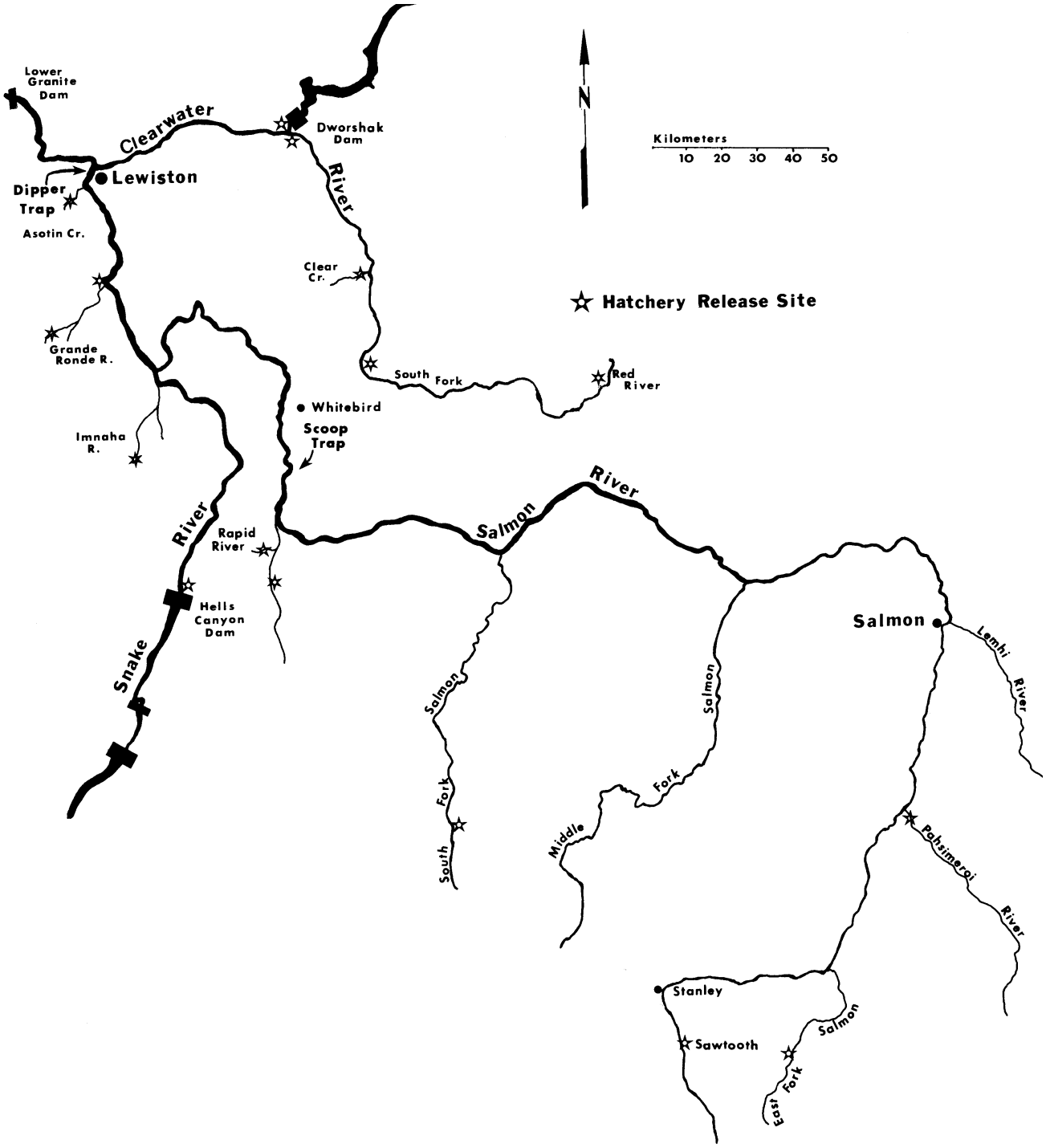
Water temperature (C°) and turbidity (m) were recorded daily at each trap using a centigrade thermometer and 20 cm secchi disk. The Snake River discharge was measured at the U.S. Geological Survey (USGS) Anatone gauge (#13334300), 44.4 km upstream from the Snake River trap. Clearwater River discharge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

Snake River Trap

The Snake River trap was positioned approximately 40 m downstream from the Interstate Bridge, between Lewiston, Idaho and Clarkston, Washington. The trap was attached 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 convergence of the Snake and Clearwater arms. River width and depth at this location are approximately 260 m and 12 m, respectively.

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. Median travel time of the daily PIT-tagged release groups was converted to migration rate. Migration rate was correlated with mean Lower Granite Reservoir inflow discharge for the number of days equal to the median travel time to determine how changes in discharge affected smolt migration rate through Lower Granite Reservoir.

Figure 1. Map of Study


Lower Granite Dam
Clearwater River
Dworshak Dam
Lewiston
Dipper Trap
Asotin Cr.
Clear Cr.
Grande Ronde R.
South Fork
Red River
Whitebird
Scoop Trap
Imnaha R.
Salmon River
Rapid River
Snake River
Hells Canyon Dam
Salmon
Lemhi River
Salmon
Middle Fork
Salmon
South Fork
Pahsimeroi River
Stanley
Sawtooth
Salmon
East Fork
N
Kilometers
10 20 30 40 50
Hatchery Release Site

Snake River trap operation began on March 17 and continued through May 16, 1996. The Snake River Trap was not in operation for a total of 19 days during the 1996 season due to mechanical failure, heavy debris loads or because quotas were reached. All fish captured in the Snake River trap were passively interrogated for PIT tags as they entered the live well. 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 consists of an 8-inch PVC pipe with two interrogation coils (D-4 and D-6). Each coil is connected to an exciter card and a PIT tag reader. The system does not have the capability to provide exact time of capture. Since it is checked once daily, the interrogation time is set to 00:00 h. Coil efficiency tests were conducted on the dipper trap interrogation system. Six hundred sixty-three test tags were sent through the system. The reading efficiency was calculated to be 97.4% for both coils combined.

Clearwater River Trap

The Clearwater River trap was not operated during the 1996 outmigration due to funding cuts.

Salmon River Trap

A new location for the Salmon River scoop and screw traps was utilized in 1995 and 1996. The new Salmon River trap site was located at rkm 103, approximately 17 km upstream from the previous trapping location and 1.6 km downstream from Slate Creek. The screw trap was not operated during the 1996 season because flows were high enough in March that the scoop trap functioned well. The traps were operated at the same location, which was immediately downstream of the upper U.S. Highway 95 bridge at Twin Bridges. The new location was chosen to allow the traps to be operated through a wider discharge range. River width at this location is approximately 90 m and varies with discharge.

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

Trap operation began on March 13 and continued until May 15 when operations were terminated for the season due to high water. Operations were temporarily suspended for 16 days during the 1996 field season because weekly quotas had been reached or due to mechanical failure. All fish were interrogated for PIT tags as they were removed from the live well. The tagging and interrogation files were sent to the PTAGIS Data Center daily.

The PIT tag interrogation system on the Salmon River trap consists of a 4-inch PVC pipe with two interrogation coils. Each coil is connected to an exciter card (D-8) which is in turn, attached to a single PIT tag reader. Coil efficiency tests were conducted on the Salmon River trap interrogation system in 1996. Five hundred test tags were sent through the system. Reading efficiency was calculated to be 100% for both coils combined.

Trap Efficiency

Trap efficiency is the proportion of the migration run being sampled. Since trap efficiency may change as river discharge changes, efficiency has been estimated several times through the range of discharge at which the trap was operated. A linear regression equation (Ott 1977) describing the relation of trap efficiency and discharge was derived to estimate efficiency at any given discharge. During the 1996 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 and Salmon River traps. Median arrival (or passage) date is the date the 50th percentile fish arrived at the trap or collection facility. Smolts were PIT-tagged at the Snake River trap to determine travel time from the head of Lower Granite Reservoir to Lower Granite Dam. Smolts were PIT-tagged at the Salmon River trap to determine migration rate in a free-flowing section of river plus Lower Granite Reservoir. Distances from release point to recovery location are listed in Table 1. Individual arrival times at the Lower Granite collection facility were determined for each daily release group. A minimum recapture number, sufficient for use in travel time and migration 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 or Salmon River traps.

The migration rate/discharge relations for PIT-tagged chinook salmon, hatchery steelhead trout, and wild steelhead trout released from the Snake River trap were individually examined from 1988 to 1996 using analysis of covariance to determine if there were groups of years with common slopes and intercepts. Plots were used to help identify years that differ when non-homogeneous slopes between years were found. Subsequent analyses were run, without these years, to determine if common slopes and intercepts existed for a smaller subset of years. Also, the analysis of variance was used to determine if there was a sufficient overlap in the covariate (discharge) between years to continue the analysis (Ostle and Mensing 1975). If the final hypothesis of common intercepts was not rejected, then a significant difference in the migration rate/discharge relations between years was not detected and the yearly data were pooled. After pooling, linear regression was used to find the best-fitting equation to describe the relation between migration rate and discharge for an individual species over several years.

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

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

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 1996 for the Snake River trap, 1989 to 1995 for the Clearwater River trap, and 1993 to 1996 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 nine locations in Idaho, one in Oregon, and one in Washington. A total of 2,161,552 chinook salmon smolts were released at ten locations in Idaho and two locations in Oregon (Table 2). There were no fall releases of hatchery chinook salmon that contributed to the 1996 outmigration.

Steelhead Trout

Steelhead trout were reared at six locations in Idaho, one in Washington, and two in Oregon for release into the Snake River drainage upstream from Lower Granite Dam. A total of 10,180,384 steelhead trout smolts were released at 23 locations in Idaho, five locations in Oregon, and two 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 3,163 hatchery and 1,140 wild age-1 chinook salmon, 8,921 hatchery steelhead trout, 896 wild steelhead trout, 16 sockeye/kokanee salmon *Oncorhynchus nerka* (Table 4) and 19 age 0 chinook salmon in 1996.

Hatchery chinook salmon first arrived at the trap on April 4. Catch rates remained below 100 fish per day until April 15. A minor peak in passage of hatchery chinook salmon began on April 15 and continued through April 22. The first major peak in passage began on April 24 and concluded on April 30. During this period, forty-three percent of the season total was captured. Catch rates decreased after April 30 and remained below 100 fish per day until May 14. On May 15, a large increase in passage was observed. Trap operations were terminated on May 16 due to high discharge and debris. Therefore, the duration and magnitude of the second peak in

Table 2. Hatchery chinook salmon released into the Snake River system upriver from Lower Granite Dam contributing to the 1996 outmigration.

Release site (hatchery)	Stock	Release Date	No. released (No. Branded) No. PIT Tagged
Salmon River			
South Fork Salmon River @ Knox Bridge (McCall)	Summer	4/11-15/96	585,654 [29,512]
Rapid River (Rapid River)	Spring	3/19-4/16/96	379,167 [19,186]
Salmon River @ Blaine County Bridge (Sawtooth)	Spring	3/26/96	25,006 [763]
		Drainage Total	**989,827**
Snake River and Non-Idaho Tributaries			
Hells Canyon @ Pittsburg Landing (Clearwater) (Lyons Ferry)	Spring	4/9/96	67,818
	Fall	4/12-15/96 & 06/06-07/10/96	114,299 [12,123] 21,299 [800]
Imnaha River @ R.Km. 70 (Lookingglass)	Spring	4/2/96	91,240 [4,727]
Lookingglass Cr. @ R.Km. 4.0 (Lookingglass)	Spring	4/4/96	139,112 [7,172]
		Drainage Total	**433,768**
Clearwater River			
Clearwater River @ Big Canyon Creek (Lyons Ferry)	Fall	6/06-7/10/96	7,456 [600]
Clear Creek @ Kooskia NFH (Kooskia NFH)	Spring	4/12/96	333,794 [16,441]
North Fork Clearwater @ Dworshak (Dworshak NFH)	Spring	4/11/96	102,903 [5,070]
Walton Creek @ Powell Ponds (Powell Ponds)	Spring	4/11-4/16/96	232,731 [11,436]
Crooked River @ Crooked River Weir (Crooked River)	Spring	4/10/96	37,071 [2,100]
Red River @ Red River Weir (Red River)	Spring	4/10/96	24,002 [1,214]
		Drainage Total	**737,957**
		GRAND TOTAL	**2,161,552**

Table 3. Hatchery steelhead trout released into the Snake River system upriver from Lower Granite Dam contributing to the 1996 outmigration.

Release site (hatchery)	Stock	Release Date	No. released No. Branded No. PIT Tagged	Brand
Salmon River				
L. Salmon River	B	4/08-12/96	403,281	
@ Hazard Creek			[304]	
(Magic Valley)				
(Hagerman NFH)	A	4/24/96	130,911	
L. Salmon River	A	3/25-27/96	158,008	
@ Warm Springs Bdg.			[300]	
(Niagara Springs)				
(Hagerman NFH)	A	4/10/96	398,355	
Salmon River	A	4/15-16/96	127,708	
@ R.Km.509			[300]	
(Magic Valley)				
East Fork Salmon	B	4/12/96	38,320	
River @ Herd Creek		&		
(Magic Valley)		4/24-5/04/96	452,054	
			[600]	
Salmon River	A	4/17-19/96	207,245	
@ Bruno Bridge			[300]	
(Magic Valley)				
Salmon River	A	4/15-24/96	201,212	
@ Lemhi River			[300]	
(Magic Valley)				
Pahsimeroi River	A	5/16/96	21,196	
@ Pahsimeroi Trap				
(Hagerman NFH)				
(Niagara Springs)	A	4/9-25/96	799,220	
(Pahsimeroi)			[300]	
	A	4/10-5/16/96	21,190	
			[1,400]	
Salmon River	A	4/15-17/96	201,968	
@ McNabb Point			[300]	
(Magic Valley)				

Table 3. Hatchery steelhead trout released into the Snake River system upriver from Lower Granite Dam contributing to the 1996 outmigration (Continued).

Release site (hatchery)	Stock	Release Date	No. released No. Branded No. PIT Tagged	Brand
Salmon River	A	4/15/96	68,575 [1,518]	
@ Sawtooth Weir (Hagerman NFH)			[300]	
		4/19/96	554,499 [900]	
		5/16/96	107,532 [1,801]	
Salmon River @ Torrey's Hole (Hagerman NFH)	A	4/19/96	66,022 [300]	
Upper Salmon River @ Slate Creek (Magic Valley)	B	4/26-5/02/96	236,297 [306]	
Lower Salmon River @ Hammer Creek (Niagara Springs)	A	4/28-29/96	106,025 [300]	
Lower Salmon River @ Pine Bar Rapids (Niagara Springs)	A	4/27/96	30,090	
		Drainage Total	**4,329,708**	
~~**Snake River and Non-Idaho Tributaries**~~				
Hells Canyon Dam (Niagara Springs)	A	3/26-4/26/96	630,152 [300]	
Catherine Creek @ R.Km. 27.2 (Irrigon)	A	4/10-11/96	62,481	
Spring Creek @ R.Km. 0.8 (Wallowa)	A	4/8/96	249,540 (20,428)	RA-A-1
		4/09-23/96	244,941 (19,280)	LA-A-1
		5/13-23/96	161,894	

Table 3. Hatchery steelhead trout released into the Snake River system upriver from Lower Granite Dam contributing to the 1996 outmigration (Continued).

	Release site (hatchery)	Stock	Release Date	No. released No. Branded No. PIT Tagged	Brand
Little Sheep Creek	A	4/29/96	322,103		
@ R.Km. 8			(17,993)	RA-A-2	
(Irrigon)			(18,637)	LA-A-2	
			(17,307)	RA-A-4	
Deer Creek	A	4/17/96	273,780		
@ R.Km. 0.5			[995]		
(Irrigon)		5/6/96	75,017		
		5/07-21/96	74,751		
Grande Ronde River	A	4/08-11/96	200,021		
@ R.Km. 252					
(Irrigon)					
Grande Ronde River	A	4/1-30/96	249,530		
@ R.Km. 56.3					
(Lyons Ferry)					
Asotin Creek	A	4/18-19/96	38,500		
@ R.Km. 56.0					
(Lyons Ferry)					
		Drainage Total	2,582,710		
Clearwater River					
Clearwater River	B	4/29-5/02/96	1,377,435		
@ Dworshak NFH			(8,776)	RDT-1	
(Dworshak NFH)			(9,686)	RDT-3	
			(9,483)	LDT-4	
			(9,052)	LDT-2	
			[5,088]		
Clear Creek	B	4/22-24/96	366,566		
@ Kooskia NFH					
(Dworshak)	B	4/17-24/96	298,442		
(Clearwater)			[600]		
Clearwater River	B	4/22-24/96	154,271		
@ Kamiah Bdg.					
(Dworshak NFH)					

Table 3. Hatchery steelhead trout released into the Snake River system upriver from Lower Granite Dam contributing to the 1996 outmigration (Continued).

	Release site (hatchery)	Stock	Release Date	No. released No. Branded No. PIT Tagged	Brand
South Fork Clearwater River @ R.Km 14.0 (Dworshak NFH)	4/22-24/96	205,240			
South Fork Clearwater River @ Cottonwood Creek (Dworshak NFH)	B	4/22-24/96	184,057		
(Clearwater)	B	4/18/96	121,290 [300]		
South Fork Clearwater River @ Red House Hole (Dworshak NFH)	B	4/22-25/96	193,070		
(Clearwater)	B	4/17/96	181,214 [300]		
South Fork Clearwater River @ R.Km. 28.8 (Clearwater)	B	4/18/96	126,009 [300]		
Crooked River @ R.Km. 9.0 (Clearwater)	B	4/15/96	46,018 [1,799]		
Red River @ Soda Creek (Clearwater)	B	4/16 & 17/96	14,354 [4,000]		
		Drainage Total	**3,267,966**		
		GRAND TOTAL	**10,180,384**		

Table 4. Historical cath of hatchery chinook salmon (HC), wild chinook salmon (WC), hatchery steelhead trout (HS), and wild steelhead trout (WS) collected at the Snake, Clearwater, and Salmon River traps for the outmigration years of 1993 through 1996.

		Snake R. Trap	Clearwater R.Trap	Salmon R. Trap
1996	HC	3,163	No Data	6,205
	WC	1,140		1,776
	HS	8,921		9,566
	WS	896		304
1995	HC	26,919	13,475	45,349
	WC	65,564	1,534	9,396
	HS	23,994	8,314	3,948
	WS	1,750	285	499
1994	HC	22,789	32,789	38,902
	WC	1,471	1,343	4,774
	HS	31,662	4,615	7,383
	WS	3,439	1,798	564
1993	HC	15,271	9,761	28,326
	WC	2,683	320	51,147
	HS	35,183	10,122	7,315
	WS	3,046	882	948

passage is not known (Figure 2). Peaks in hatchery chinook salmon passage were associated with increases in Snake River discharge. There were no hatchery chinook salmon captured in March. Seventy-two percent of the total catch was captured in April and 28% in May (trap operated for 14 days in May). The timing of the 1996 hatchery chinook salmon outmigration was similar to the timing observed in 1995.

Wild chinook salmon were first captured at the Snake River trap on March 14. Numbers remained below 20 fish per day until April 9. A small increase in passage was observed from April 9 to April 12. After April 12, numbers of wild chinook captured declined and remained under 75 per day until May 15. A large increase in passage of wild chinook salmon began on May 15, but the duration and magnitude is not known since trapping operations were terminated the following day (Figure 2). The timing of the 1996 outmigration of wild chinook salmon was similar to what was observed in 1995. Peaks in wild chinook salmon passage were associated with increases in Snake River discharge. Less than one percent of the total catch of wild chinook salmon was captured in March, 60% in April, and 39% in May (trap operated for 14 days in May).

Physical characteristics were used to differentiate between age 0 chinook salmon and other chinook salmon. Peak trap catch of age 0 chinook salmon occurred in May when 63% of the season total (12 fish) was collected. The majority of age 0 chinook salmon probably outmigrated after trapping operations had been terminated for the year.

Hatchery steelhead trout were first observed at the trap on March 14. Catch rates remained below two fish per day for the remainder of the month. Two large peaks in passage were observed at the Snake River trap in 1996 (Figure 3). The first peak began on April 15 and subsided on April 29. During this period, 2,126 hatchery steelhead trout were captured (24% of season total). The second and final peak in passage began on May 2 and was still in progress when trapping operations were terminated for the season (May 16). During this period, 6,486 hatchery steelhead trout were captured at the Snake River trap (73% of season total). Analysis of catch by month revealed that less than one percent of the season total was collected in March, 25% in April, and 75% in May (trap operated for 14 days in May).

Wild steelhead trout passage timing was similar to hatchery steelhead trout passage (Figure 3). The largest peak in passage began on April 28 and subsided on May 12. Seventy-one percent of the total catch for the season was collected during this period. Less than one percent of the total catch of wild steelhead trout was collected in March, 28% in April, and 72% in May.

Snake River discharge, measured at the Anatone gauge, ranged from 57.9 kcfs to 86.0 kcfs (March). The average discharge in March of 71.1 kcfs, was 34.7 kcfs greater than in 1995, 47.5 kcfs greater than in 1994, and 33.2 kcfs greater than in 1993. The average April discharge was 82.7 kcfs, with a peak of 103.3 kcfs on April 12. April average discharge was 41.0, 50.8, 32.8 kcfs greater than in 1995, 1994, and 1993 respectively. The average May discharge of 82.6 kcfs, was 4.5 kcfs greater than in 1995, 37.7 kcfs greater than in 1994, but 4.2 kcfs than in 1993.

Water temperature at the Snake River trap was 5.0^0 C. at the beginning of the trapping season. Water temperature gradually increased throughout the sampling season and reached a maximum of 13EC on May 13(Figure 4).

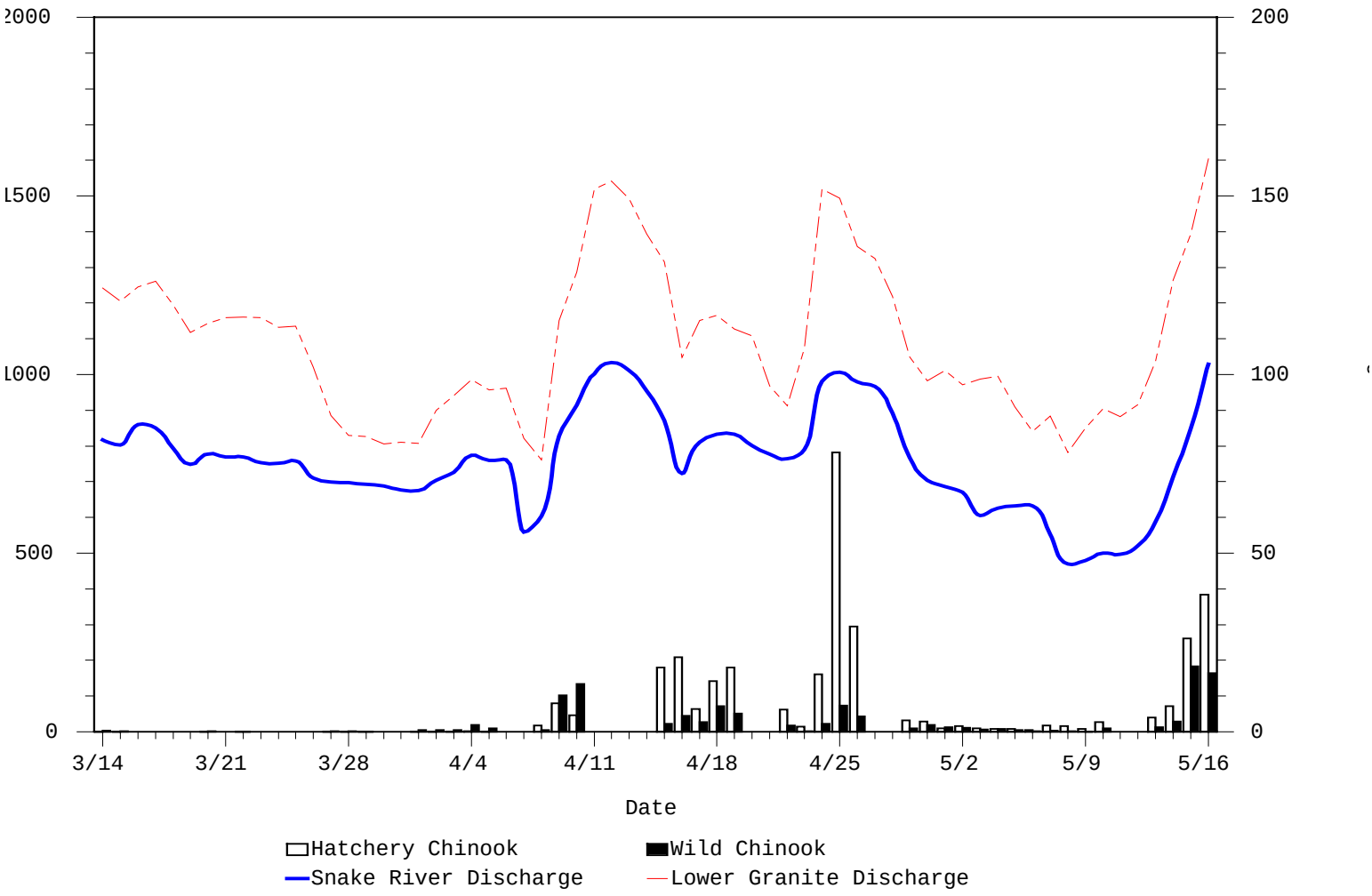


Figure 2. Snake River trap catch of hatchery chinook and wild chinook salmon overlaid by Snake River discharges, 1996.

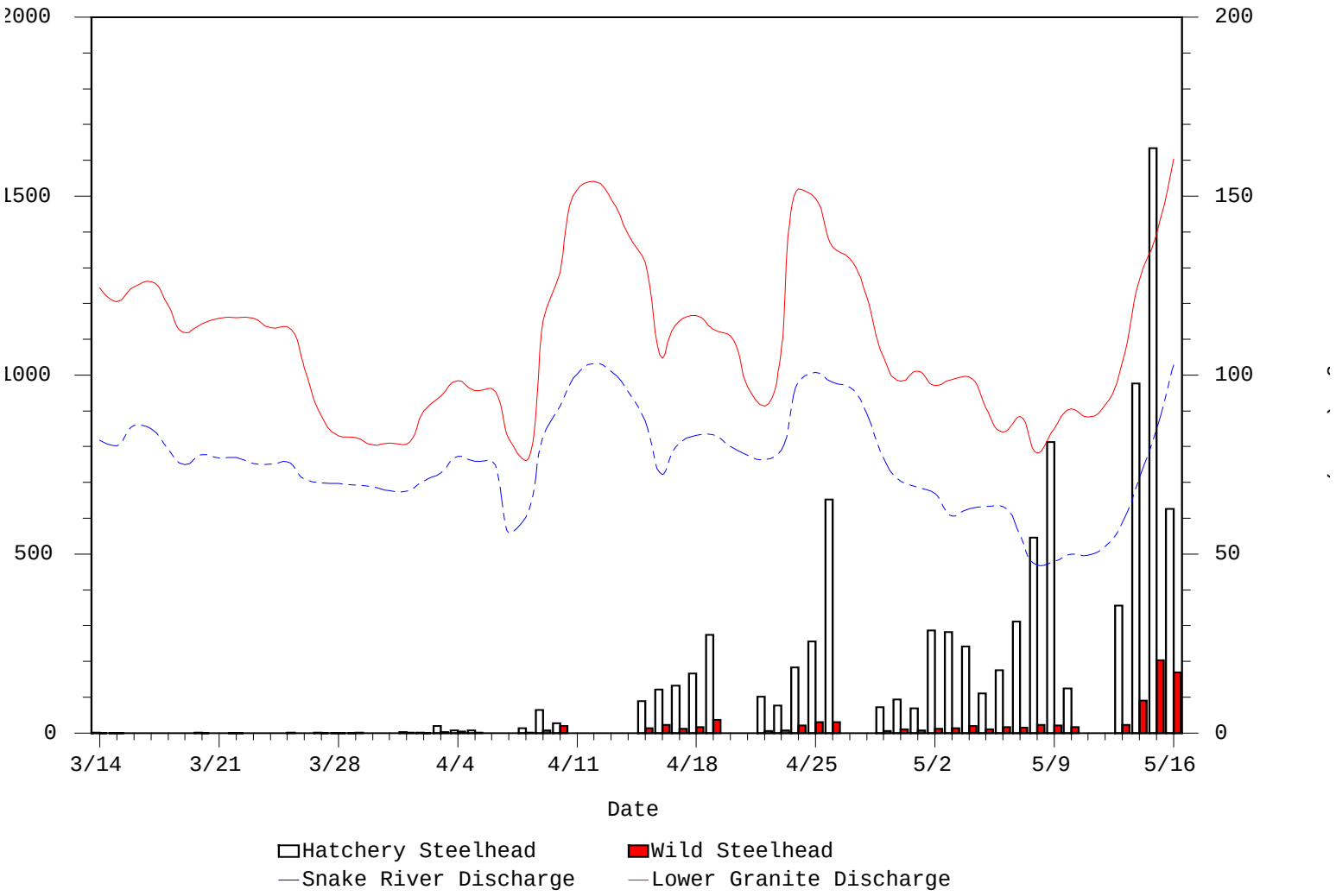


Figure 3. Snake River trap daily catch of hatchery steelhead trout and wild steelhead trout over laid by Snake River discharges, 1996.

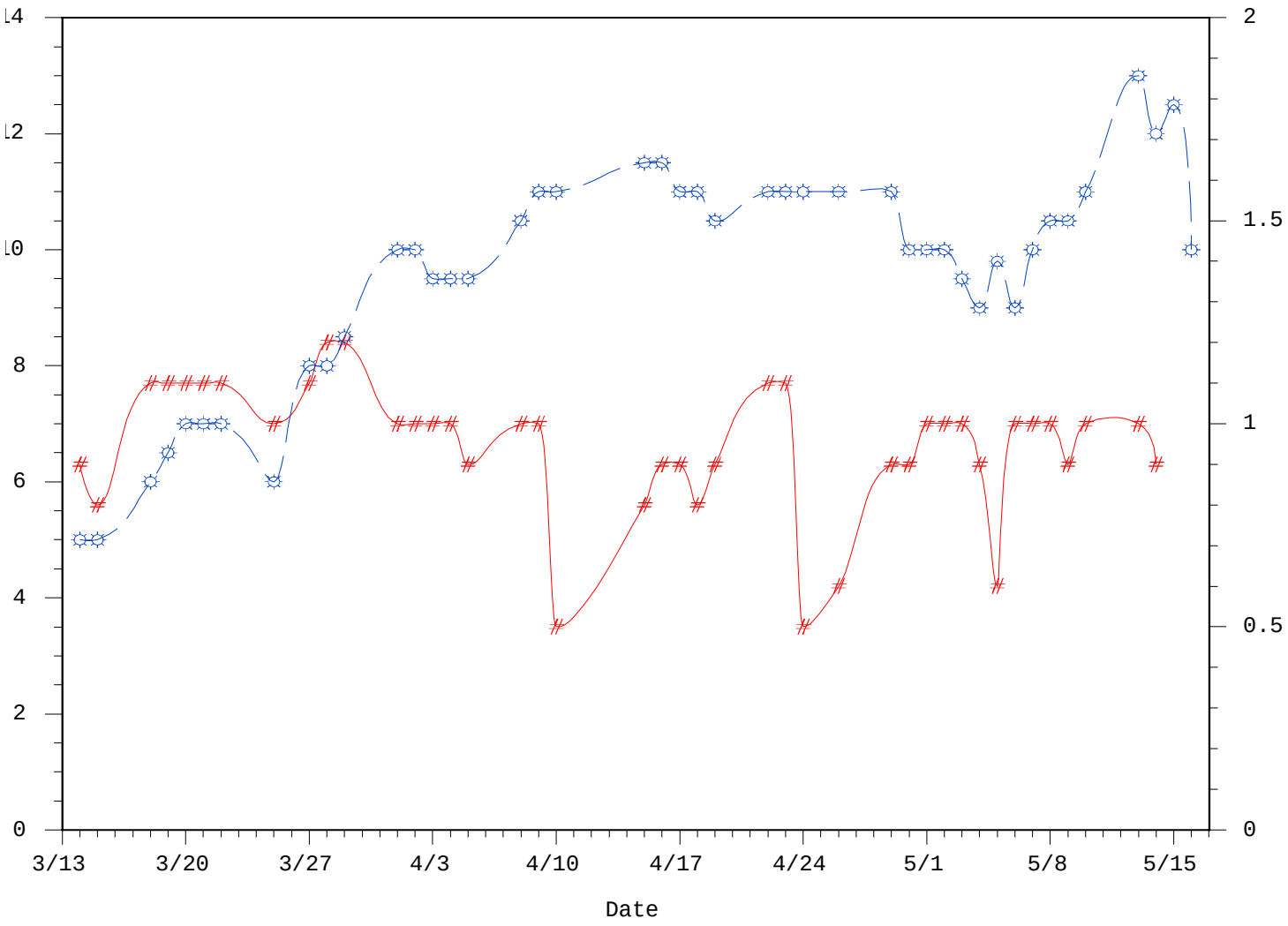


Figure 4. Daily temperatures and secchi dish transparencies at Snake River Trap, 1996.

Secchi disk transparency measurements were taken daily at the Snake River trap. Transparencies fluctuated throughout the trapping season and ranged from 0.5 m to 1.2 m (Figure 4).

Salmon River Trap Operation

The Salmon River scoop trap captured 6,205 age-1 hatchery chinook salmon, 1,776 age-1 wild chinook salmon, 9,566 hatchery steelhead trout, 304 wild steelhead trout and four sockeye salmon (Table 4).

Large numbers (>150 per day) of hatchery chinook salmon were collected daily during the latter part of March (Figure 5). Hatchery chinook salmon collected during this time, originated from Rapid River Hatchery. Collections remained high (>100 per day) until April 26 when the catch rate dropped to less than 50 hatchery chinook salmon per day. Any additional peaks in passage that may have occurred after April 26 were not detected due to poor trap location (trap not in thalweg). Daily trap catch of hatchery chinook salmon remained low (<100 per day) for the remainder of the trapping season (Figure 5). The timing of the 1996 hatchery chinook salmon outmigration was similar to 1995. Twenty-three percent of the total catch of hatchery chinook salmon was captured in March, 72% was collected in April, and 5% in May (trap operated for 13 days in May).

Wild chinook salmon began arriving at the Salmon River trap in relatively high numbers (>50 per day) in mid-March. There were two peaks in wild chinook passage (Figure 5). The first peak began on March 14 and reached its maximum on March 18. The second began on April 5 and continued until April 26. Wild chinook salmon were collected at a rate of less than 15 fish per day for the remainder of the season. Any additional peaks in passage that may have occurred after April 26 were not detected due to poor trap location (trap not in thalweg). The timing of the wild chinook salmon outmigration was similar to that observed in 1995. Approximately 40% of the total catch of wild chinook salmon was collected in March, 56% was captured in April, and 4% in May (trap operated for 13 days in May).

One major peak in hatchery steelhead trout passage was observed at the Salmon River trap in 1996. Steelhead trout trap catch began to increase on April 15 and reached its peaked on May 3 (Figure 6). Trapping operations were terminated on May 15 due to high discharge. Any additional peaks in passage that may have occurred after May 15 were not detected. Less than one percent of the season total catch was captured in March, 30% was collected in April, and 70% in May.

Wild steelhead trout began to arrive in small numbers (<5 per day) at the beginning of April. Wild steelhead trout passage began to increase on April 10 and peaked on April 11. Passage began to increase again on the April 25 and reached its maximum on May 1. The timing of the wild steelhead trout outmigration was similar to that observed in 1995. Less than one percent of the season total was captured in March, 46% was collected in April, and 54% in May.

Salmon River discharge in March, measured at the White Bird gauge, ranged from 6.7 kcfs to 11.3 kcfs and averaged 9.1 kcfs. Average March discharge in 1996 was 1.4 kcfs greater than in 1995, 4.7 kcfs greater than in 1994, and 3.5 kcfs greater than in 1993. Discharge increased in April and ranged from 8.5 kcfs to 29.5 kcfs. The April average discharge of 18.8 kcfs was 9.0, 8.1, and 10.1 kcfs greater than in 1995, 1994, and 1993, respectively. May average discharge was 41.5 kcfs and ranged from 16.9 kcfs to 79.7 kcfs. May average discharge for 1995, 1994, and 1993 was 32.3, 20.3, and 38.9 kcfs, respectively.

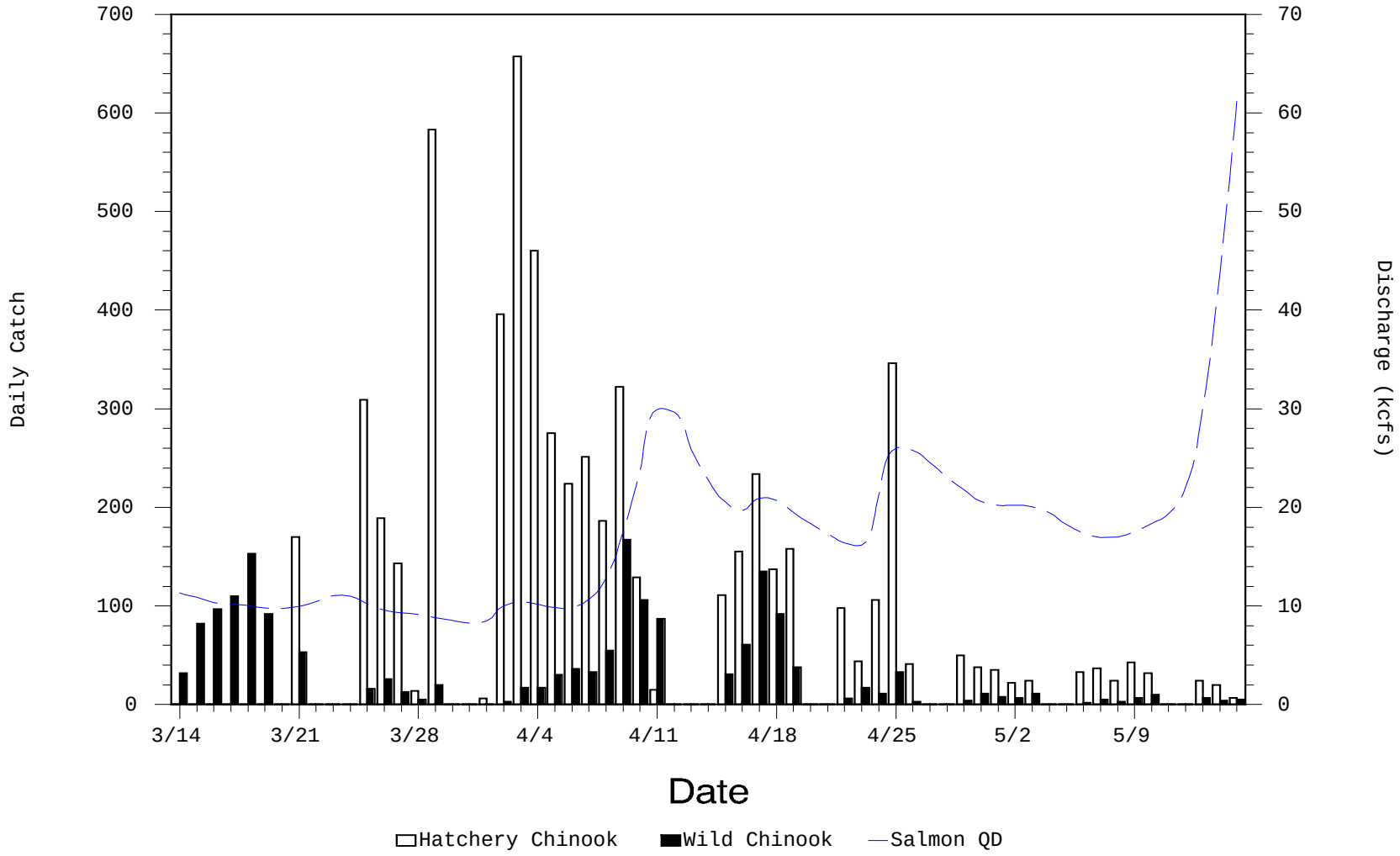


Figure 5. Salmon River trap daily catch of hatchery chinook salmon and wild chinook salmon overlaid by Salmon River discharge, 1996.

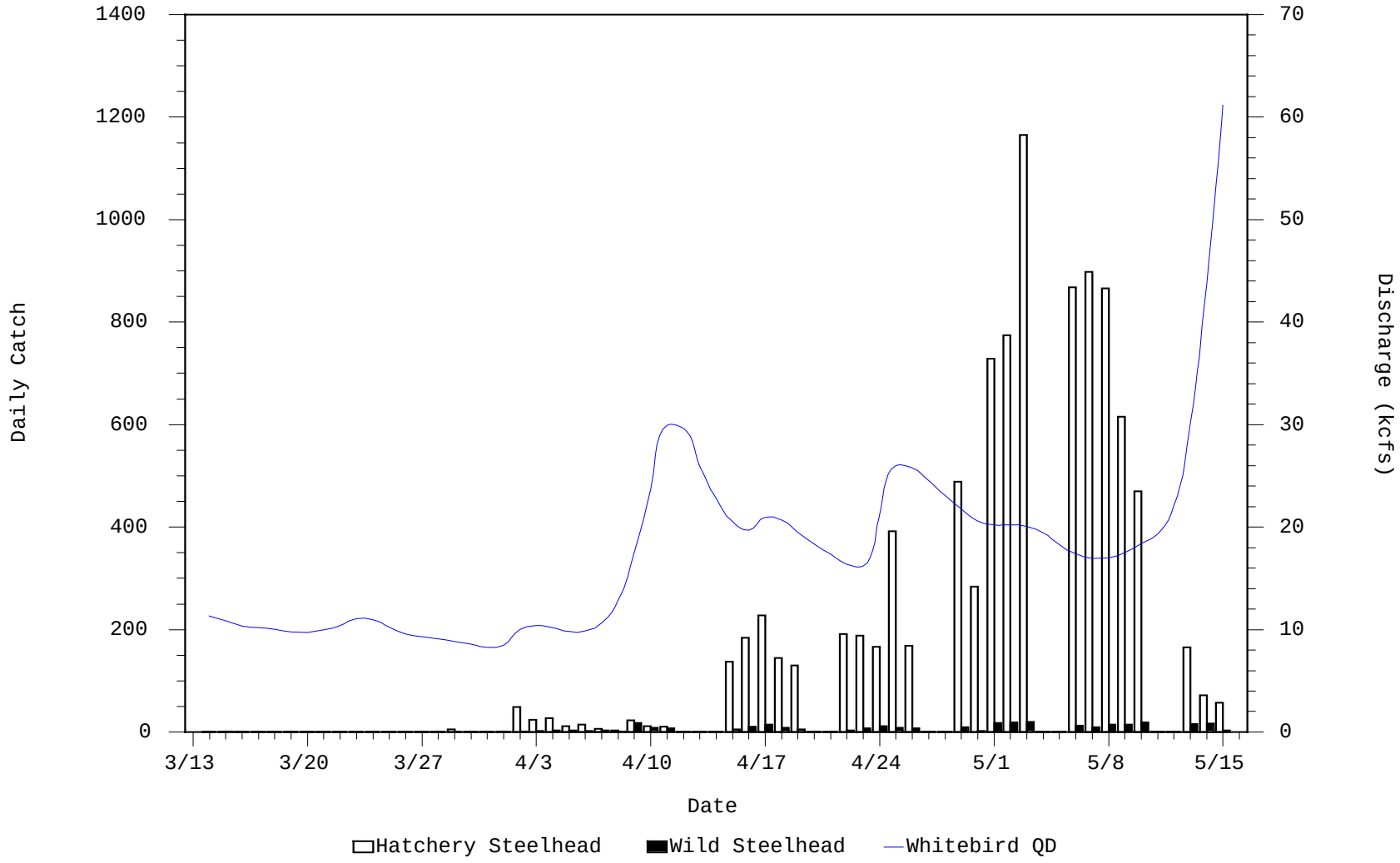


Figure 6. Salmon River trap daily catch of hatchery steelhead trout and wild steelhead trout overlaid by Salmon River discharge, 1996.

Water temperatures at the Salmon River trap ranged from 3.0EC to 9.5EC. and fluctuated throughout the field season (Figure 10). Secchi disk transparency fluctuated throughout the trapping season and ranged from 0.1 m to 1.6 m (Figure 7).

Travel Time and Migration Rates

Release Sites to Snake River Trap

Hatchery chinook salmon. In 1996, 129 hatchery chinook salmon were interrogated at the Snake River trap. Two chinook salmon from Clear Creek, a tributary of the Middle Fork Clearwater River, were captured with an average travel time of 6 d. Ten spring chinook salmon released from the Imnaha River Weir were captured at the Snake River trap. Migration time ranged from 5 to 22 d with the mean travel time being 18 d. Thirteen hatchery chinook released from Lookingglass Hatchery were captured at the Snake River trap. Travel time ranged from 2 to 20 d and averaged 10 d. Twenty-six spring chinook salmon released from Rapid River Hatchery were captured at the trap. Travel time ranged from 20 to 57 d and averaged 34 d. Thirty-six McCall hatchery summer chinook salmon released on the South Fork of the Salmon River at the Knox Bridge were captured at the Snake River trap. Travel time varied from 5 to 34 d and averaged 27 d. Thirty-one hatchery fall chinook salmon released on the Snake River at Pittsberg Landing were captured at the Snake River trap. Travel time varied from less than 1 day to over 2 d and averaged about 1 d.

Eight hatchery chinook salmon tagged at the Salmon River trap were interrogated at the Snake River trap. Travel time ranged from 8 d to 18 d and averaged 14 d for the season. Because flows were high for a considerable portion of the late migration season, which decreased Snake River trap efficiency, and the trap operation stopped on May 16, faster migrating fish were not sampled at a representative rate and this would increase the estimate for average travel time for the season.

Three hatchery chinook salmon that were tagged on the NMFS survival study were captured at the Snake River trap. Travel time ranged from less than 1 d to 15 d and averaged about 7 d.

Wild chinook salmon. In 1996, 28 wild chinook salmon were interrogated at the Snake River trap. Twelve of the fish were tagged in the spring of 1996, six of which were tagged at the Salmon River trap, and 16 were marked in the summer/fall of 1995. The only location where wild chinook salmon were released with sufficient numbers interrogated at the Snake River trap was from the Salmon River trap. Travel time from the Salmon River trap to the Snake River trap ranged from 2 d to 19 d averaged 8 d for the migration season.

Hatchery steelhead trout. In 1996, 15 PIT-tagged hatchery steelhead trout were interrogated at the Snake River trap. There were not enough recaptures at the Snake River trap from any release location to estimate travel time.

Wild steelhead trout. In 1996, there was one PIT-tagged wild steelhead trout interrogated at the Snake River trap.

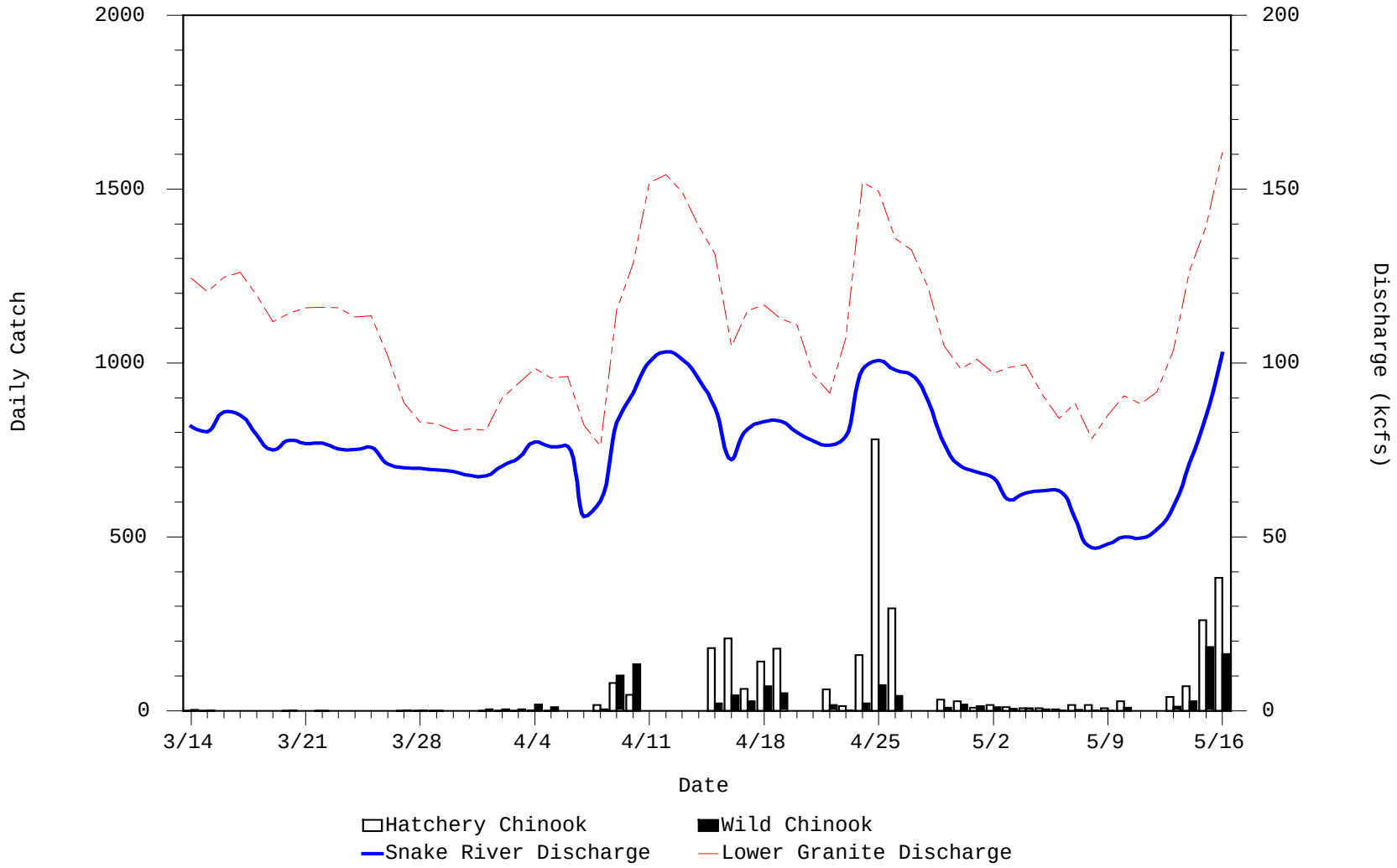


Figure 7.Daily temperatures and sechhi disk transparencies at the Salmon River trap, 1996.

Sockeye Salmon. In 1996, there were two hatchery sockeye salmon interrogated at the Snake River trap. One fish was released from the Redfish Lake Creek trap on May 2. Travel time was 10 d. The other fish was released into Redfish Lake on October 10, 1995.

Release Sites to the Salmon River Trap

Hatchery chinook salmon. In 1996, 273 PIT-tagged 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 with 91 recaptures was released in the South Fork Salmon River. Travel time for fish from the South Fork Salmon River ranged from 1 d to 32 d and averaged 8 d. The other group was released from Rapid River with 181 being recaptured at the Salmon River trap. Travel time ranged from less than 1 d to 51 d and averaged 15 d.

Wild chinook salmon. In 1996, 13 PIT-tagged wild chinook salmon were interrogated at the Salmon River trap. Four were from fall marking on the Marsh Creek trap, one from fall marking at the weir on the East Fork Salmon River, two from fall marking at the Sawtooth trap, one from spring marking at the Lemhi weir, four from fall tagging on the South Fork Salmon River trap, and one from marking on the Salmon River trap.

Hatchery steelhead trout. In 1996, 16 PIT-tagged hatchery steelhead trout were interrogated at the Salmon River trap. Release locations were two from Herd Creek, two from Lemhi River, two from the Little Salmon River, two from the Panther Creek trap, three from the Salmon River, one from the Salmon River at the North Fork, one from Sawtooth Hatchery, and three from Sawtooth trap.

Wild steelhead trout. In 1996, one PIT-tagged wild steelhead trout were interrogated at the Salmon River trap. It was released in the East Fork of the South Fork of the Salmon River in July 1995.

Sockeye salmon. In 1996, no PIT-tagged wild or hatchery sockeye salmon were interrogated at the Salmon River trap.

Head of Lower Granite Reservoir to Lower Granite Dam

The PIT tag sample rate at the dams changed significantly during the 1996 outmigration mainly due to the fluctuation of spill. This is the fourth year since the Smolt Monitoring Project began PIT tagging in 1987 that a significant period of spill occurred. The following example illustrates how median travel time estimates are affected by spill.

A group of fish tagged and released at the Snake River trap passes Lower Granite Dam over a ten-day period. When spill occurs, the facility sampling efficiency for these fish is decreased because a portion of the fish that would normally be sampled, instead 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 affected by the incorrect estimate of the median migration period. If discharge were increasing for the passage period of the above group and spill occurred during the second half thereby making the date of median passage earlier, then mean discharge for that group is also underestimated.

Another effect spill may have on migration rate is that the more highly smolted fish are more buoyant and migrate higher in the water column. They are also the fastest migrating fish (Beeman and Rondorf, in press). The ten-foot-deep debris boom in front of the turbines at Lower Granite Dam may divert a greater 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 powerhouse and be collected and subsequently interrogated (Giorgi et al. 1988). This type of bias would incorrectly estimate migration rate with the estimated median migration rate being less than the true rate. This makes any interpretation of the PIT tag data at the dams extremely difficult during the periods of major operational changes. It also means that if fish that are collected at Lower Granite Dam are transported then the portion of the population that passes Lower Granite is no longer representative of the population that arrived at Lower Granite.

Hatchery chinook salmon PIT tag groups. In 1996, hatchery chinook salmon smolts were PIT-tagged at the Snake River trap to provide travel time information through Lower Granite Reservoir. Seventeen daily PIT tag groups (1,450 total PIT-tagged hatchery chinook salmon) were released from the Snake River trap between April 9 and May 16 (Appendix A, Table A-1), providing median travel time estimates ranging from 14.5 d (3.6 km/d) in early April to 3.2 d (16.3 km/d) in mid-May.

Data stratified by 5-kcfs groups (Table 5), were used in a linear regression analysis. A significant relation between migration rate and discharge was not detected at the 0.05 level of significance but was detected at the 0.1 level, indicating that PIT-tagged chinook salmon migration rate increased in Lower Granite Reservoir as discharge increased (Table 6). The inability to detect a strong relation between migration rate and discharge is probably not due to this relation being weak but to the fact that 50% of the data occurs in only a 10 kcfs discharge range and due to the fact that spill was occurring during the entire migration period.

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 among the eight years of available data (1988-1995). The 1996 data was not added to this analysis due to the weak relation. Due to the inability to differentiate between hatchery and wild, the 1988 through 1992 chinook salmon data were 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. The analysis showed a significant difference in the slope of the migration rate/discharge relation between years at the 0.05 level of significance ($F=9.163$, $N=76$, $P<0.001$). A graph of the data showed that 1989, 1993 pre-spill, and 1995 pre-spill data had slightly steeper slopes (Figure 8). With the three years data removed, a significant difference in the slopes was not detected ($F=1.161$, $N=45$, $P=0.345$). The analysis of variance was used to determine if there was a sufficient overlap in the covariate (discharge) between years to continue with the analysis of covariance ($F=3.583$, $N=45$, $P<0.067$). The analysis of covariance was continued using the 1988,1990-1992, and 1994 data to determine if there was a significant difference in the intercepts (height) of the lines. The analysis was unable to detect a difference in the intercepts ($F=2.393$, $N=45$, $P=0.067$) and the data were pooled. Linear regression analysis was conducted ($r^2=0.851$, $N=45$, $p<0.001$). The best linear regression equation was:

$$\ln(\text{migration rate}) = -3.485 + 1.306 \ln(\text{mean discharge}).$$

Table 5. Migration rates (km/d), stratified by 5-kcfs intervals from the Snake River trap to Lower Granite Dam, 1996.

Discharge interval	Hatchery chinook	Wild chinook	Hatchery steelhead	Wild steelhead
80 - 85	8.50	-	22.60	-
85 - 90	6.10	-	21.60	23.50
90 - 95	-	7.90	20.20	21.10
95 -100	11.50	-	27.35	25.30
100 - 105	5.30	-	30.40	-
105 - 110	8.50	6.90	27.75	28.00
110 - 115	5.92	8.90	30.57	25.30
115 - 120	4.70	8.15	31.53	31.45
120 - 125	-	-	-	-
125 - 130	-	-	37.90	35.60
130 - 135	-	8.20	37.20	38.25
135 - 140	-	8.20	-	-
140 - 145	-	-	-	-
145 - 150	-	17.80	38.40	35.05
150 - 155	-	-	37.70	-
155 - 160	11.50	-	-	-
160 - 165	-	-	-	-
165 - 170	16.30	19.90	38.10	-
170 - 175	-	-	-	-
175 - 180	-	-	-	-
180 - 185	12.60	18.60	-	-

Table 6. Liner regression statistics for migration rate/discharge realtion by species, rearing type, and trap, using data stratified by 5-kcfs intervals, 1996.

Species	Trap	N	Intercept	Slope	r^2	P
Hatchery	SNK	10	-2.403	0.949	0.338	0.078
chinook	SAL	7	-7.302	2.105	0.334	0.175
wild	SNK	9	-5.477	1.617	0.700	0.005
chinook	SAL	5	-25.670	5.974	0.938	0.007
Hatchery	SNK	13	-0.965	0.926	0.838	<0.001
steelhead	SAL	11	-2.034	1.263	0.636	0.003
Wild	SNK	9	-1.616	1.059	0.824	0.001
steelhead	SAL	5	-0.482	0.971	0.701	0.077

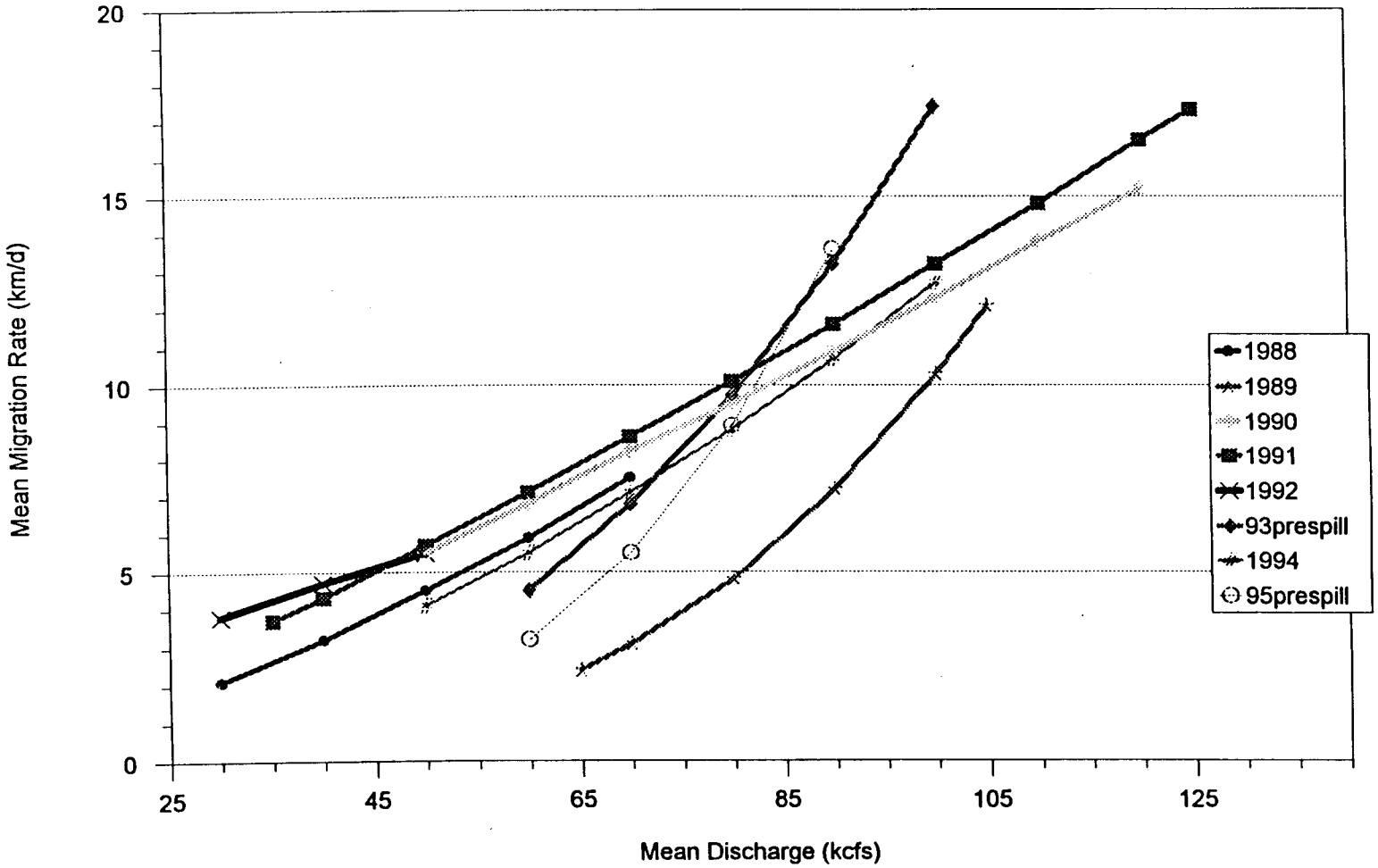


Figure 8. Chinook salmon migration rate/discharge relations for Snake River trap PIT-tag groups, 1988-1995.

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The analysis of covariance was conducted on the three years data (1989, 1993 pre-spill, 1995 pre-spill) that were removed from the above analysis. No significant difference was detected between the slopes of the three years data ($F=1.807$, $N=24$, $P=0.193$) but a significant difference was detected in the intercepts ($F=56.971$, $N=24$, $P<0.001$). The graph showed that the height of the 1989 data was different (Figure 8). The analysis was continued using the 1993 and 1995 prespill data and no significant difference in the intercept could be detected ($F=2.570$, $N=14$, $P=0.137$). The two years data were pooled and the linear regression analysis conducted ($r^2=0.916$, $N=14$, $P<0.001$). The best linear regression equation was:

ln (migration rate) = -12.069 + 3.261 ln (mean discharge).

Comparing the 1988 through 1995 migration rate/discharge equations for chinook, it is apparent that in the discharge range between 30 and 150 kcfs, all years showed the same basic pattern: as discharge increases, migration rate increases (Figure 8). The amount of increase between 60 and 100 kcfs is consistent for 1988, 1990 to 1992, and 1994 (2.0-fold) but considerably higher for 1989 (5.6-fold) and 1993 pre-spill and 1995 pre-spill (5.3-fold).

Twenty-seven daily groups (totaling 2,554 hatchery chinook salmon) were released from the Salmon River trap from March 21 through May 13 (Appendix A, Table A-5), providing median travel time estimates ranging from 45.5 d (4.7 km/d) in mid-March to 5.6 d (38.6 km/d) in mid-May. Data stratified by 5-kcfs groups (Table 7), were used in the regression analysis. The linear regression analysis was unable to detect a significant relation between migration rate and discharge (Table 6). The analysis was unable to detect a relation due to the fact that 85% of the migration rate data occurred in only a 15 kcfs discharge range.

Wild chinook salmon PIT-tag groups. In 1996, wild chinook salmon smolts were PIT tagged at the Snake River trap to provide travel time information through Lower Granite Reservoir. Twelve daily groups (totaling 842 wild chinook salmon) were released from the Snake River trap from March 9 through May 16 (Appendix A, Table A-2).

Data stratified by 5-kcfs groups (Table 5) were used in the regression analysis. The linear regression analysis of the Snake River wild chinook salmon PIT tag data detected a significant correlation between migration rate and discharge (Table 6).

In 1996, wild chinook salmon smolts were PIT tagged at the Salmon River trap to provide travel time information through Lower Granite Reservoir. Twenty-two daily groups (totaling 1,425 wild chinook salmon) were released from the Salmon River trap from March 14 through April 30 (Appendix A, Table A-6).

Data stratified by 5-kcfs groups (Table 7) were used in the regression analysis. The linear regression analysis of the Salmon River wild chinook salmon PIT tag data detected a significant correlation between migration rate and discharge (Table 6).

Hatchery steelhead trout PIT tag groups. Sufficient numbers of hatchery steelhead trout were PIT-tagged daily at the Snake River trap to provide 23 daily release groups (1,363 individual fish) for median migration rate calculations through Lower Granite Reservoir from April 3 through May 16 (Appendix A, Table A-3). Median travel time ranged from 2.6 to 1.4 d (20.2 km/d to 38.4 km/d migration rate) and averaged 1.7 d (30.9 km/d). Linear regression

Table 7. Migration rates (km/d), stratified by 5-kcfs intervals from the Salmon River trap to Lower Granite Dam, 1996.

Discharge Interval	Hatchery Chinook	Wild Chinook	Hatchery Steelhead	Wild Steelhead
80-85	-	-	-	-
85-90	-	-	40.40	48.80
90-95	16.10	-	42.60	-
95-100	-	-	34.62	49.50
100-105	12.90	-	53.80	59.60
105-110	9.48	7.71	-	-
110-115	6.66	11.20	45.80	48.90
115-125	24.30	19.05	-	-
125-130	-	21.55	50.00	-
130-135	-	-	75.60	-
135-140	-	-	59.30	-
140-145	-	-	86.10	80.80
145-150	-	-	-	-
150-155	-	-	-	-
155-160	38.60	-	-	-
160-165	-	-	-	-

analysis detected a significant relation between migration rate in Lower Granite Reservoir and average Lower Granite inflow (Table 5) for PIT-tagged hatchery steelhead trout groups (Table 6). The equation shows that as discharge increases, migration rate increases.

Hatchery steelhead trout migration rate/discharge relation for Snake River trap PIT tag groups was examined to determine if there was a difference in this relation between years (1988-1996). The analysis of covariance was used with the data averaged by 5-kcfs groups. The analysis showed a significant difference in the slope of the migration rate/discharge relation between years ($F=5.719$, $N=103$, $P<0.001$).

The slope of the regression line for 1988, 1992, and 1994 was slightly less steep than the other years data and the height of the 1996 regression line was higher (Figure 9). Interestingly, the three years (1988, 1992, and 1994) are the poorest flow years of the present drought. After removing the four years data, a significant difference in the slopes was not detected between the remaining years ($F=0.488$, $N=55$, $P=0.744$). The analysis of covariance was continued and a significant difference was detected in the intercepts (heights) of the five years data ($F=5.227$, $N=55$, $P=0.001$). Figure 9 shows the differences are minor, so the data were pooled, despite the difference in the height of the lines, and the regression analysis was run. A very strong relation was found between migration rate and discharge ($r^2=0.871$, $N=55$, $P<0.001$). The linear regression equation was:

$$\ln(\text{migration rate}) = -4.177 + 1.556 \ln(\text{mean discharge}).$$

The analysis of covariance was used with the three years data (1988, 1992, and 1994), which were removed from the above analysis, and no significant difference between years was detected ($F=0.013$, $N=27$, $P=0.987$). The analysis of covariance was continued and a

significant difference was detected in the intercepts (heights) of the three years data (F=4.618, N=27, P=0.021). Figure shows that the differences were not major, so the data were pooled despite the difference in the height of the lines and the regression analysis was run. A very strong relation was found between migration rate and discharge (r^2=0.865, N=27, P<0.001). The linear regression equation was:

ln (migration rate) = -2.568 + 1.163 ln (mean discharge).

Using the two data sets from above, a two-fold increase in discharge will translate into a 2.9-fold increase in migration rate through Lower Granite Reservoir for the first group and a 2.2-fold increase for the second group of hatchery steelhead marked at the Snake River trap. Fish from the three severe drought years had slightly faster migration rates below 65 kcfs and slightly slower migration rates above 65 kcfs than do fish from the higher flow years, implying the importance to fish migration of other factors (water temperature, migration timing, stock, smoltification, etc.) are greater in extreme low flow years. These data also imply that the other factors do not move fish as well as higher flow does thereby emphasizing the importance of discharge to move fish downriver.

The 1996 data stands alone in that the height of the regression line is greater than the other eight years data. This is also the highest flow year of the nine years tested. A two-fold increase in discharge will translate into a 1.9-fold increase in migration rate.

Twenty-four groups of hatchery steelhead trout (1,410 fish) were PIT-tagged at the Salmon River trap in 1996 for use in median migration rate calculations to Lower Granite Reservoir (Appendix A, Table A-7). Median travel time ranged from 13.6 to 2.2 d (15.9 km/d to 98.4 km/d) and averaged 4.3 d (49.8 km/d).

Data stratified by 5-kcfs groups were used in the regression analysis (Table 7). The linear regression analysis detected a significant relation between migration rate in Lower Granite Reservoir and average Lower Granite discharge for PIT-tagged hatchery steelhead trout groups marked at the Salmon River trap (Table 6). The equation shows that as discharge increases, migration rate increases.

Wild steelhead trout PIT-tag groups. Sufficient numbers of wild steelhead trout were PIT-tagged at the Snake River trap to provide 14 daily release groups (655 fish) for estimating travel time and migration rate to Lower Granite Dam (Appendix A, Table A-4). Median travel time ranged from 2.4 d (21.1 km/d) to 1.3 d (40.2 km/d) and averaged 1.7 d (29.9 km/d).

Data stratified by 5-kcfs groups were used in the regression analysis (Table 5). 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 6). 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.

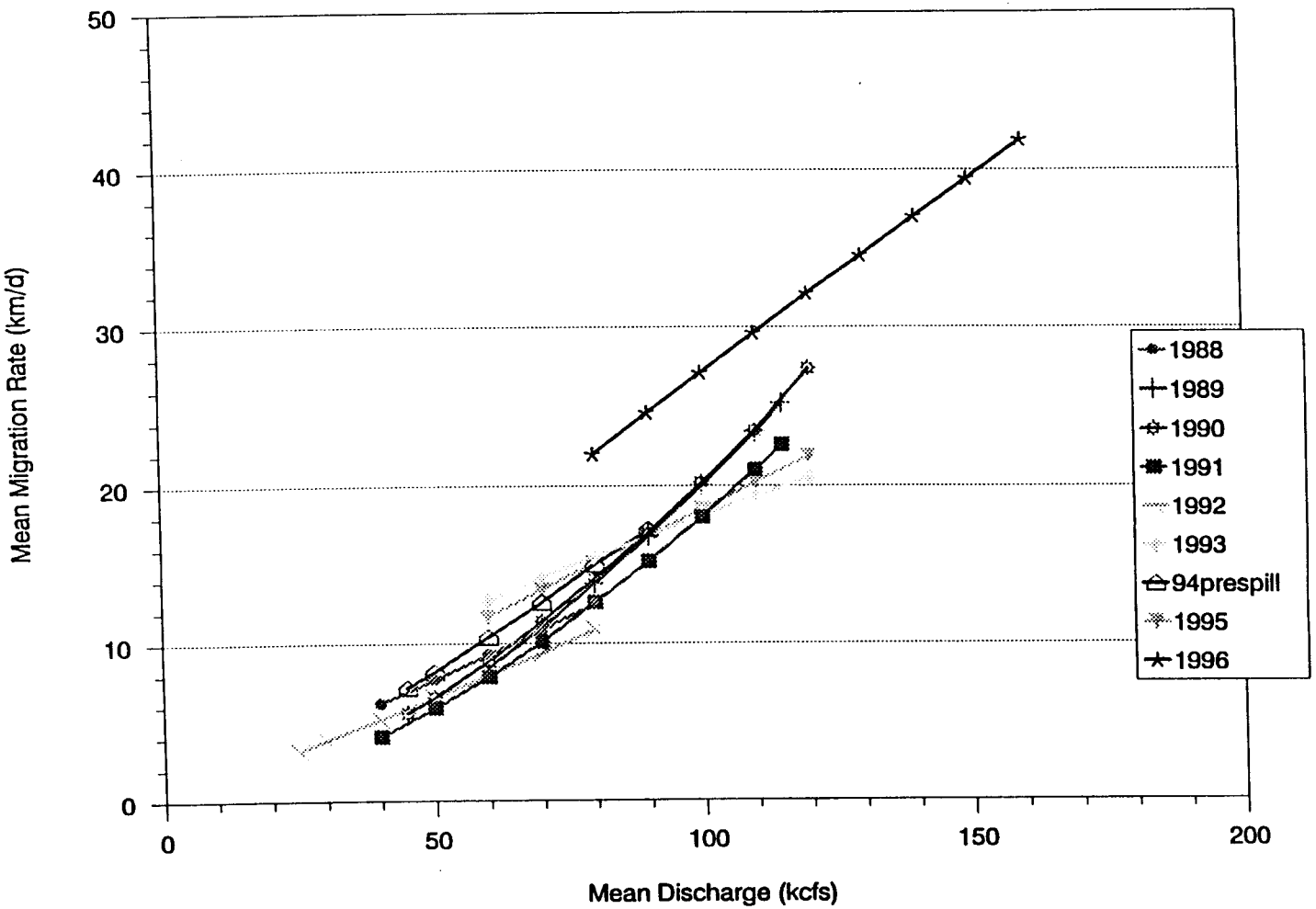

Figure 9. Hatchery steelhead migration rate/discharge relations for Snake River trap PIT-tag groups, 1988-1996.

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 between years (1988-1996) in migration rates using groups averaged by 5-kcfs intervals. The analysis showed no significant difference in the slopes between years for wild steelhead trout migration rate/discharge relations (F=1.499, N=95, P=0.172). The analysis was continued and a significant difference was detected in the intercepts (height) of the regression lines between years (F=2.276, N=95, P=0.0290). The height of the regression line for 1996 was higher than the other eight year data. When it was removed and the analysis of covariance continued no significant difference was detected between years (F=0.985, N=86, P=0.449). The data were pooled minus the 1996 data and the linear regression analysis was run using the log transformed data (r^2=0.840, N=86, P<0.001). The best linear regression equation was:

ln (migration rate) = -1.920 + 1.079 ln (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 1995 was accounted for by changes in discharge. The equation shows that a two-fold increase in discharge will account for a 2.1-fold increase migration rate.

Flows in 1996 were the highest in the nine years tested. A two-fold increase in discharge in 1996 accounted for a 2.1-fold increase in migration rate as with the other years data. The difference in 1996 was the fish were migrating slightly faster at a given discharge (2 km/d faster at 50 kcfs and 4 km/d faster at 100 kcfs).

Five groups of wild steelhead trout (102 fish) were PIT-tagged at the Salmon River trap in 1996 for use in median migration rate calculations to Lower Granite Dam (Appendix A, Table A-8). Median travel time ranged from 4.4 to 2.3 d (48.9 km/d to 93.7 km/d) and averaged 3.7 d (58.2 km/d).

Data stratified by 5-kcfs groups were used in the regression analysis (Table 7). The linear regression analysis was unable to detect a significant relation between migration rate and average discharge for PIT-tagged wild steelhead trout groups marked at the Salmon River trap at the 0.05 level but was able to detect a difference at the 0.1 level (Table 6). The equation shows that as discharge increased, migration rate increased.

Interrogation of PIT-Tagged Fish

Interrogation data in 1996 are not directly comparable with the earlier years. All species-run-rearing types will be underestimated due to a reduction in collection efficiency during spill at the dams. During other times of the season the interrogation rate may vary sporadically due to fluctuations in turbine operations. The fourth collection facility in the system, at Lower Monumental Dam, became operational in 1993 and therefore total interrogations may be greater beginning in 1993 than in previous years. Therefore, any comparison in trends of cumulative detections at dams must be done cautiously, in a manner that incorporates these additional factors.

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 from 20.0% to 60.0% and 22.9% to 55.6%

respectively (Appendix B, Tables B-1, B-2). Cumulative interrogation rate (including Lower Granite, Little Goose, Lower Monumental, and McNary dams) ranged between 58.6% and 81.1% and averaged 67.9% for hatchery fish. Wild chinook salmon ranged between 50.7% and 90.6% and averaged 73.4% (Table 8).

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 14.7% to 38.2% and averaged 24.2% for hatchery fish (Appendix B, Table B-5). Wild chinook salmon ranged from 20.0% to 40.0% and averaged 26.7% (Appendix B, Table B-6). Hatchery chinook cumulative interrogation, including Lower Granite, Little Goose, Lower Monumental, and McNary dams, ranged from 41.0% to 66.7% and averaged 50.4%. Wild chinook salmon cumulative interrogation rates ranged between 47.1% and 77.7%, and averaged 61.9% (Table 8).

Percent interrogation of Snake River trap hatchery steelhead trout and wild steelhead trout daily PIT tag release groups at Lower Granite Dam, after combining to remove groups with small sample size, ranged from 25.0% to 86.2% for hatchery fish (Appendix B, Table B-3). Wild steelhead trout ranged from 29.8% to 87.5%, (Appendix B, Table B-4). Seasonal cumulative interrogation rate of PIT-tagged hatchery steelhead trout to Lower Granite, Little Goose, Lower Monumental, and McNary dams ranged between 67.0% and 96.6%, and averaged 79.6% (Table 8). Wild steelhead trout cumulative interrogation rates ranged between 62.5% and 100%, and averaged 77.7% (Table 8).

Percent interrogation of Salmon River trap hatchery steelhead trout daily PIT tag release groups at Lower Granite Dam, after combining to remove groups with small sample size, ranged from 22.4% to 70.0% (Appendix B, Table B-7). Wild steelhead trout ranged from 31.2% to 73.7% (Appendix B, Table B-8). Seasonal cumulative interrogation rate of PIT-tagged hatchery steelhead trout to Lower Granite, Little Goose, Lower Monumental, and McNary dams ranged between 50.0% to 86.7%, and averaged 68.6% (Table 8). Wild steelhead trout ranged from 43.8% to 100% and averaged 72.9% (Table 8).

Table 8. Interrogations of PIT-tagged fish from the Snake River trap, 1987-1996; Clearwater River trap, 1989-1995; and Salmon River trap, 1993-1996, at downstream collection facilities.

				Number Interrogated/Site									
Site	**Year**	**Species**	**# Tagged**	**Lower Granite**		**Little Goose**		**Lower Monumental**		**McNary**		**Total**	
				No	**%**	**No**	**%**	**No**	**%**	**No**	**%**	**No**	**%**
Snake	1996	CH	1,450	497	34.3	259	17.9	189	13.0	40	2.8	985	67.9
	1995	CH	3,927	1,646	41.9	643	16.4	430	11.0	153	3.9	2,872	73.1
	1994	CH	2,844	885	31.1	332	11.7	223	7.8	329	11.6	1,769	62.2
	1993	CH	3,203	1,336	41.7	494	15.4	246	7.7	134	4.2	2,210	69.0
	1992	CH	410	166	40.5	83	20.2	-	0.0	48	11.7	297	72.4
	1996	CW	842	269	31.9	190	22.6	119	14.1	40	4.8	618	73.4
	1995	CW	2,067	1,023	49.5	366	17.7	216	10.5	68	3.3	1,673	80.9
	1994	CW	934	354	37.9	95	10.2	82	8.8	83	8.9	614	65.7
	1993	CW	1,125	576	51.2	150	13.3	57	5.1	46	4.1	829	73.7
	1992	CU	615	249	40.5	106	17.2	-	0.0	72	11.7	427	69.4
	1991	CU	2,131	929	43.6	409	19.2	-	0.0	115	5.4	1,453	68.2
	1990	CU	2,245	956	42.6	310	13.8	-	0.0	180	8.0	1,446	64.4
	1989	CU	6,222	2,384	38.3	1,367	22.0	-	0.0	482	7.7	4,233	68.0
	1988	CU	3,767	1,237	32.8	543	14.4	-	0.0	299	7.9	2,079	55.2
	1987b	CU	3,275	1,067	32.6	338	10.3	-	0.0	308	9.4	1,713	52.3
	1996	SH	1,363	675	49.5	247	18.1	139	10.2	24	1.8	1,085	79.6
	1995	SH	2,244	1,477	65.8	236	10.5	165	7.4	19	0.8	1,897	84.5
	1994	SH	3,239	1,298	40.1	216	6.7	112	3.5	40	1.2	1,666	51.4

Table 8. Interrogations of PIT-tagged fish from the Snake River trap, 1987-1996; Clearwater River trap, 1989-1995; and Salmon River trap, 1993-1996, at downstream collection facilities (Continued).

				Number Interrogated/Site									
Site	**Year**	**Species**	**# Tagged**	**Lower Granite**		**Little Goose**		**Lower Monumental**		**McNary**		**Total**	
				No	**%**	**No**	**%**	**No**	**%**	**No**	**%**	**No**	**%**
Snake	1992	SH	3,904	1,496	38.3	227	5.8	-	0.0	30	0.8	1,753	44.9
	1991	SH	2,577	2,032	78.9	268	10.4	-	0.0	11	0.4	2,311	89.7
	1990	SH	3,112	2,272	73.0	282	9.1	-	0.0	33	1.1	2,587	83.1
	1989	SH	2,525	1,773	70.2	268	10.6	-	0.0	35	1.4	2,076	82.2
	1988	SH	1,743	1,069	61.3	190	10.9	-	0.0	12	0.7	1,271	72.9
	1987	SH	827	324	39.2	52	6.3	-	0.0	6	0.7	382	46.2
	1996	SW	655	293	44.7	137	20.9	67	10.2	12	1.8	509	77.7
	1995	SW	1,537	967	62.9	195	12.7	122	7.9	13	0.8	1,297	84.4
	1994	SW	2,840	1,546	54.4	319	11.2	158	5.6	51	1.8	2,074	73.0
	1993	SW	2,867	1,982	69.1	267	9.3	133	4.6	32	1.1	2,414	84.2
	1992	SW	2,538	1,511	59.5	307	12.1	-	0.0	31	1.2	1,849	72.9
	1991	SW	3,549	2,266	63.8	625	17.6	-	0.0	66	1.9	2,957	83.3
	1990	SW	3,078	2,016	65.5	356	11.6	-	0.0	60	1.9	2,432	79.0
	1989	SW	1,798	1,170	65.1	240	13.3	-	0.0	52	2.9	1,462	81.3
	1988	SW	1,186	698	58.9	166	14.0	-	0.0	20	1.7	884	74.5
	1987	SW	464	229	49.4	48	10.3	-	0.0	8	1.7	285	61.4
Clearwater	1995	CH	2,467	950	38.5	414	16.8	269	10.9	109	4.4	1,742	70.6
	1994	CH	1,998	500	25.0	192	9.6	188	9.4	247	12.4	1,127	56.4
	1993	CH	1,624	553	34.1	193	11.9	106	6.5	77	4.7	929	57.2
	1992	CH	5,200	1,654	31.8	745	14.3	-	0.0	429	8.3	2,828	54.4

Table 8. Interrogations of PIT-tagged fish from the Snake River trap, 1987-1996; Clearwater River trap, 1989-1995; and Salmon River trap, 1993-1996, at downstream collection facilities (Continued).

				Number Interrogated/Site									
Site	**Year**	**Species**	**# Tagged**	**Lower Granite**		**Little Goose**		**Lower Monumental**		**McNary**		**Total**	
				No	**%**	**No**	**%**	**No**	**%**	**No**	**%**	**No**	**%**
Clearwater	1995	CW	1,051	464	44.1	173	16.5	88	8.4	37	3.5	762	72.5
	1994	CW	761	308	40.5	94	12.4	81	10.6	41	5.4	524	68.9
	1993	CW	298	134	45.0	43	14.4	25	8.4	18	6.0	220	73.8
	1992	CU	1,461	502	34.4	202	13.8	-	0.0	136	9.3	840	57.5
	1991	CU	3,943	1,483	37.6	668	16.9	-	0.0	235	6.0	2,386	60.5
	1990	CU	4,242	1,359	32.0	674	15.9	-	0.0	281	6.6	2,314	54.6
Clearwater	1989	CU	2,441	756	31.0	452	18.5	-	0.0	140	5.7	1,348	55.2
	1995	SH	867	602	69.4	69	8.0	56	6.5	3	0.3	730	84.2
	1994	SH	1,250	729	58.3	119	9.5	30	2.4	10	0.8	888	71.0
	1993	SH	1,102	813	73.8	79	7.2	24	2.2	6	0.5	922	83.7
	1992	SH	1,567	823	52.5	118	7.5	-	0.0	6	0.4	947	60.4
	1991	SH	1,215	926	76.2	89	7.3	-	0.0	3	0.2	1,018	83.8
	1990	SH	1,228	880	71.7	63	5.1	-	0.0	10	0.8	953	77.6
	1989	SH	290	173	59.7	16	5.5	-	0.0	2	0.7	191	65.9
	1995	SW	268	157	58.6	40	14.9	16	6.0	1	0.4	214	79.9
	1994	SW	1,297	421	32.5	150	11.6	106	8.2	24	1.9	701	54.0
	1993	SW	849	560	66.0	106	12.5	58	6.8	9	1.1	733	86.3
	1992	SW	2,996	1,599	53.4	477	15.9	-	0.0	113	3.8	2,189	73.1
	1991	SW	1,300	767	59.0	126	9.7	-	0.0	22	1.7	915	70.4
	1990	SW	727	409	56.3	102	14.0	-	0.0	28	3.9	539	74.1
	1989	SW	104	53	51.0	16	15.4	-	0.0	3	2.9	72	69.2

Table 8. Interrogations of PIT-tagged fish from the Snake River trap, 1987-1996; Clearwater River trap, 1989-1995; and Salmon River trap, 1993-1996, at downstream collection facilities (Continued).

				Number Interrogated/Site									
Site	**Year**	**Species**	**# Tagged**	**Lower Granite**		**Little Goose**		**Lower Monumental**		**McNary**		**Total**	
				No	**%**	**No**	**%**	**No**	**%**	**No**	**%**	**No**	**%**
Salmon	1996	CH	2,554	618	24	343	13.4	258	10.1	67	2.6	1,286	50.4
	1995	CH	5,074	1,777	35.0	757	14.9	531	10.5	186	3.7	3,251	64.1
	1994	CH	3,633	870	23.9	322	8.9	258	7.1	358	9.9	1,808	49.8
	1993	CH	3,138	1,144	36.5	385	12.3	233	7.4	157	5.0	1,919	61.2
	1996	CW	1,425	381	26.7	289	20.3	181	12.7	31	2.2	882	61.9
	1995	CW	3,937	1,790	45.5	689	17.5	366	9.3	122	3.1	2,967	75.4
	1994	CW	2,913	1,113	38.2	287	9.9	188	6.5	202	6.9	1,790	61.4
	1993	CW	2,169	1,112	51.3	286	13.2	125	5.8	91	4.2	1,614	74.4
	1996	SH	1,410	598	42.4	205	14.5	140	9.9	24	1.7	967	68.6
	1995	SH	1,556	937	60.2	190	12.2	118	7.6	14	0.9	1,259	80.9
	1994	SH	2,596	1,001	38.6	164	6.3	70	2.7	36	1.4	1,271	49.0
	1993	SH	1,641	1,203	73.3	112	6.8	44	2.7	13	0.8	1,372	83.6
Salmon	1996	SW	251	112	44.6	49	19.5	21	8.4	1	0.4	183	72.9
	1995	SW	435	251	57.7	59	13.6	32	7.4	1	0.2	343	78.9
	1994	SW	532	260	48.9	44	8.3	32	6.0	10	1.9	346	65.0
	1993	SW	902	575	63.7	73	8.1	36	4.0	5	0.6	689	76.4

[a]CH=hatchery chinook, CW=wild chinook, CU=unknown chinook, SH=hatchery steelhead, SW=wild steelhead.

[b]Bias may exist as only "quality" fish were tagged.

SUMMARY

Hatchery chinook salmon releases above Lower Granite Dam for 1996 were 18.6% of 1995 numbers and 26.9% of 1994's total. Hatchery steelhead trout releases were 107.3% of 1995 numbers and 108.9% of 1994 numbers. Hatchery production of chinook salmon in the Clearwater River drainage was 14.8%, the Snake River and non-Idaho tributaries 21.4%, and the Salmon River drainage-21.4% of 1995. Hatchery production of steelhead trout in the Clearwater River drainage was 110%, the Snake River and non-Idaho tributaries was 101%, and the Salmon River was 109% of last year's total. Hatchery production of chinook salmon and steelhead trout released above Lower Granite Dam was 2,161,552 and 10,180,384 respectively, in 1996.

The Snake River trap was operated on the east side of the river from March 17 through May 16, and was out of operation for 19 days during this period due to high flow, mechanical failures, and because quotas were reached. The Snake River trap captured 3,163 age-1 hatchery chinook salmon, 1,140 wild chinook salmon, 19 age 0 chinook salmon, 8,921 hatchery steelhead trout, 896 wild steelhead trout, and 16 sockeye/kokanee.

The Salmon River trap was operated on the east side of the river from March 13 through May 15, and was out of operation for 16 days during this period due to high flow, mechanical failures, and because quotas were reached. The Salmon River trap captured 6,205 age-1 hatchery chinook salmon, 1,776 wild chinook salmon, 9,566 hatchery steelhead trout, 304 wild steelhead trout, and four sockeye/kokanee.

A significant migration rate/discharge relation was unable to be detected for hatchery chinook salmon released from both traps to Lower Granite Dam. A significant migration rate/discharge relation was detected for wild chinook salmon from both traps to Lower Granite Dam. A significant migration rate/discharge relation was detected for hatchery steelhead trout released from both traps to Lower Granite Dam. A significant migration rate/discharge relation was detected for wild steelhead trout from the Snake River trap at the 0.05 level and Salmon River traps at the 0.1 level of significance.

In all instances where the migration rate/discharge relation was significant, the same trend was seen; as discharge increased migration rate increased. A 40 kcfs (60-100 kcfs) increase in discharge would generally produce about a two-fold increase in migration rate for hatchery chinook salmon released from the Snake River trap during the low flow years 1988, 1990-1992, and 1994 and about a five-fold increase for near normal flow years 1989, 1993, and 1995. Hatchery and wild steelhead trout released from the Snake River trap both showed about a two to three-fold increase in migration rate with a two-fold increase in discharge.

The four-dam interrogation rates for 1996 were only comparable to 1993-1995, because of the addition of a new collection facility at Lower Monumental Dam in 1993. The comparability between the four years is questionable 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 to Lower Granite Dam for fish PIT-tagged at Smolt Monitoring Project traps on the Snake and Salmon rivers, 1996.

Table A-1. PIT-tagged hatchery chinook salmon travel time, with 95% confidence intervals, from the Snake River trap to Lower Granite Dam, 1996.

Release Discharge Date	Median Travel Time (Day)	Confidence Interval [a] Upper	Lower	Number Captured	Percent Captured (%)	Mean (kcfs)
4/8,9	14.41	16.36	10.67	26	29.5	121.69
4/10	14.46	17.75	4.37	13	30.2	124.15
4/15	6.04	9.53	4.40	24	25.8	112.64
4/16	8.62	9.28	5.35	29	31.9	115.70
4/17	7.74	9.30	4.59	19	31.1	116.91
4/18	8.27	10.76	7.16	36	40.4	119.21
4/19	7.52	8.31	6.31	49	44.1	120.98
4/22	10.55	15.41	4.39	19	32.2	115.87
4/23[b]	3.21	19.07	1.92	7	16.1	136.12
4/24	8.85	9.67	7.83	105	35.0	119.18
4/26	9.82	11.13	7.32	50	41.3	105.90
4/29,30-5/1	8.47	11.21	4.34	16	24.6	92.93
5/2,7,9	6.04	7.71	4.70	18	48.6	89.37
5/10	4.49	7.52	4.23	15	57.7	100.10
5/13	5.73	7.50	3.55	13	37.1	156.31
5/14	3.68	4.12	3.15	68	31.6	158.14
5/15	3.17	4.74	2.58	27	27.8	166.05
5/16	4.10	5.66	2.74	15	20.0	181.84

[a]Confidence intervals calculated with nonparametric statistics.
[b]Not used in statistical analysis because analysis showed too few recaptures.

Table A-2. PIT-tagged wild chinook salmon travel time, with 95% confidence intervals, from the Snake River trap to Lower Granite Dam, 1996.

Release Discharge Date	Median Travel Time (Day)	Confidence Interval [a] Upper	Lower	Number Captured	Percent Captured (%)	Mean (kcfs)
4/5[b]	11.37	0.00	0.00	2	22.2	118.73
4/8[b]	9.29	0.00	0.00	1	25.0	126.58
4/9	8.67	10.37	6.31	22	22.9	130.63
4/10	6.26	8.26	5.01	44	33.8	137.07
4/15,16	7.43	9.13	3.75	19	29.2	106.95
4/17	7.73	8.04	3.77	11	42.3	116.91
4/18	6.21	7.11	5.85	33	51.6	112.53
4/19,22	5.41	7.39	3.93	15	23.4	111.85
4/23[b]	2.38	0.00	0.00	1	50.0	136.23
4/24	4.98	6.95	3.79	42	45.2	132.75
4/26	5.36	7.90	2.78	19	45.2	115.75
4/29,30-5/1,2,7	6.52	9.71	5.40	18	34.0	92.26
5/10[b]	4.46	0.00	0.00	5	55.6	100.10
5/13[b]	2.16	0.00	0.00	3	30.0	123.17
5/14	2.91	3.35	2.48	36	30.0	149.20
5/15	2.59	4.55	1.86	19	26.0	166.05
5/16	2.78	3.52	2.33	16	31.4	181.17

[a] Confidence intervals calculated with nonparametric statistics.
[b] Not used in statistical analysis because analysis showed too few recaptures.

Table A-3. PIT-tagged hatchery steelhead travel time, with 95% confidence Intervals, from the Snake River trap to Lower Granite Dam, 1996.

Release Discharge Date	Median Travel Time (Day)	Confidence Interval [a] Upper	Lower	Number Captured	Percent Captured (%)	Mean (kcfs)
4/3	2.41	3.39	2.09	10	50.0	96.10
4/5[b]	2.72	0.00	0.00	1	14.3	87.55
4/8	2.01	2.61	1.46	7	50.0	106.63
4/9,10	1.61	2.23	1.50	22	24.4	131.90
4/15	1.68	1.96	1.54	31	51.7	117.13
4/16	1.85	2.06	1.63	26	43.3	112.17
4/17	1.83	2.00	1.60	32	42.7	114.83
4/18	1.46	1.57	1.34	22	48.9	114.70
4/19	1.73	2.32	1.55	25	41.7	106.83
4/22	1.76	1.88	1.70	45	73.8	116.87
4/23	1.36	1.44	1.28	50	86.2	129.65
4/24	1.37	1.57	1.29	93	62.0	150.70
4/26	1.35	1.45	1.28	40	65.6	134.15
4/29	1.70	2.09	1.50	41	68.3	101.47
4/30	1.73	1.84	1.52	34	56.7	98.83
5/1	1.79	2.45	1.53	32	53.3	99.00
5/2	1.76	1.98	1.59	28	46.7	98.47
5/7	2.28	2.57	1.83	15	25.0	83.87
5/9	2.39	2.73	1.88	25	41.7	87.93
5/10	2.56	2.83	2.40	32	52.5	93.50
5/13	1.49	1.55	1.45	35	58.3	115.05
5/14	1.48	1.52	1.42	30	50.0	132.95
5/15	1.35	1.47	1.26	28	46.7	149.90
5/16	1.35	1.47	1.21	28	30.8	165.45

[a] Confidence intervals calculated with nonparametric statistics.
[b] Not used in statistical analysis because analysis showed too few recaptures.

Table A-4. PIT-tagged wild steelhead trout travel time, with 95% confidence intervals, from the Snake River trap to Lower Granite Dam, 1996.

Release Discharge Date	Median Travel Time (Day)	Confidence Interval [a] Upper	Lower	Number Captured	Percent Captured (%)	Mean (kcfs)
4/9[b]	1.61	0.00	0.00	4	50.0	131.90
4/10[b]	1.23	0.00	0.00	1	5.0	140.30
4/15	1.84	2.35	1.48	10	76.9	117.13
4/16	2.06	2.42	1.57	13	59.1	112.17
4/17	1.80	2.39	1.34	8	66.7	114.83
4/18	2.32	2.80	2.18	9	52.9	113.43
4/19,22	1.84	2.37	1.63	23	85.7	106.83
4/23	1.45	1.54	1.21	7	87.5	129.65
4/24	1.65	1.90	1.43	39	75.0	145.73
4/26	1.29	1.51	1.16	16	53.3	134.15
4/29,30-5/1,2,7,9	2.04	2.51	1.70	22	66.6	99.00
5/9	2.20	2.65	2.02	12	57.1	87.93
5/10	2.44	2.61	2.05	9	56.2	90.13
5/13	1.48	1.68	1.41	9	40.9	115.05
5/14	1.42	1.46	1.36	53	41.4	132.95
5/15	1.33	1.35	1.27	81	49.4	149.90
5/16[b]	1.31	0.00	0.00	3	5.3	165.45

[a] Confidence intervals calculated with nonparametric statistics.
[b] Not used in statistical analysis because analysis showed too few recaptures.

Table A-5. PIT-tagged hatchery chinook salmon travel time, with 95% confidenceintervals, from the Salmon River trap to Lower Granite Dam, 1996.

Release Discharge Date	Median Travel Time (Day)	Confidence Interval [a] Upper	Lower	Number Captured	Percent Captured (%)	Mean (kcfs)
3/20,21	38.77	41.73	34.98	42	21.2	110.69
3/25	34.38	43.08	30.63	19	19.0	110.33
3/26	45.45	47.17	33.37	23	23.0	105.76
3/27	36.65	40.34	30.27	19	19.0	109.11
4/1[b]	45.54	0.00	0.00	2	33.3	111.22
4/2	31.53	37.49	27.81	41	22.4	113.62
4/3	26.43	30.28	23.55	28	28.9	117.21
4/4	28.54	33.79	24.22	24	25.0	115.53
4/5	30.23	37.10	22.48	16	17.4	114.77
4/6	25.65	31.29	21.42	26	26.5	117.51
4/7	25.45	35.38	21.49	32	32.7	118.33
4/8	24.34	35.14	15.79	23	25.0	119.78
4/10	28.64	34.46	20.72	21	22.8	114.27
4/11	11.57	0.00	0.00	1	6.7	121.66
4/15	28.30	30.14	26.26	22	25.6	106.17
4/16	29.05	30.76	26.70	19	22.4	107.11
4/17	27.13	28.25	25.54	30	33.7	106.04
4/18	26.91	28.17	15.42	20	21.5	106.91
4/19	26.30	28.19	24.77	25	25.3	106.55
4/22	22.87	24.01	21.12	22	22.9	106.52
4/23	23.39	26.56	20.14	11	27.5	109.40
4/24	21.27	22.53	19.32	26	25.5	107.17
4/25	21.29	22.25	20.21	36	25.4	107.55
4/26	20.63	25.61	17.09	13	33.3	108.51
4/29,30	16.66	19.22	13.70	16	19.5	101.48
5/1,2	13.40	16.01	11.74	21	38.2	94.54
5/7	8.84	11.19	7.18	10	27.8	105.19
5/8,9	8.88	9.32	7.17	17	26.2	124.97
5/10,13,14	5.58	16.74	4.99	13	18.3	156.31
5/15[b]	21.6	0.00	0.00	1	14.3	155.43

[a] Confidence intervals calculated with nonparametric statistics.
[b] Not used in statistical analysis because analysis showed too few recaptures.

Table A-6. PIT-tagged wild chinook salmon travel time, with 95% confidence intervals, from the Salmon River trap to Lower Granite Dam, 1996.

Release Discharge Date	Median Travel Time (Day)	Confidence Interval [a] Upper	Lower	Number Captured	Percent Captured (%)	Mean (kcfs)
3/14	36.42	41.50	29.86	9	28.1	109.89
3/15	35.36	36.22	32.63	18	22.2	109.49
3/16	34.41	35.61	31.52	21	21.6	109.17
3/17	29.89	34.36	29.29	19	25.3	108.13
3/18	31.63	32.97	29.87	17	23.0	108.19
3/19	32.13	35.58	30.73	19	21.1	107.94
3/20	29.76	34.90	26.82	10	22.7	107.72
3/21	28.76	34.41	26.70	13	26.0	107.49
3/25,26,27	23.34	24.64	21.95	18	33.3	105.73
4/4,5,6	13.38	20.32	10.48	10	26.5	118.32
4/7	14.36	18.23	10.31	11	33.3	119.01
4/8	10.32	15.47	5.12	11	20.0	125.67
4/10	9.71	11.46	8.72	19	25.7	128.63
4/11	11.13	13.33	8.53	26	34.7	122.86
4/15	9.50	28.94	7.30	10	32.3	117.14
4/16	14.88	26.46	9.33	24	40.0	115.72
4/17	15.80	18.52	13.54	38	29.2	114.27
4/18	17.61	26.40	9.35	24	27.0	110.63
4/19	27.54	29.42	8.14	11	28.9	110.61
4/22,23,24,25	15.21	20.44	10.25	20	30.3	107.37
4/26,30-5/1,2	15.26	22.94	11.66	11	37.9	97.58
5/7[b]	11.73	0.00	0.00	2	40.0	124.32
5/8[b]	9.01	0.00	0.00	1	33.3	113.40
5/9[b]	8.58	0.00	0.00	2	28.6	124.97
5/10[b]	6.49	0.00	0.00	2	20.0	114.33
5/13[b]	16.99	0.00	0.00	2	28.6	150.28
5/15[b]	4.85	0.00	0.00	1	20.0	174.77

[a] Confidence intervals calculated with nonparametric statistics.
[b] Not used in statistical analysis because analysis showed too few recaptures.

Table A-7. PIT-tagged hatchery steelhead travel time, with 95% confidence intervals, from the Salmon River trap to Lower Granite Dam, 1996.

Release Discharge Date	Median Travel Time (Day)	Confidence Interval [a] Upper	Lower	Number Captured	Percent Captured (%)	Mean (kcfs)
4/2	8.40	10.00	3.83	11	22.4	97.39
4/3,4	15.39	43.42	8.38	11	22.0	116.74
4/5,6,7	7.39	13.77	4.94	11	34.4	119.19
4/10[b]	7.54	0.00	0.00	2	18.2	132.36
4/11[b]	3.50	0.00	0.00	3	30.0	145.20
4/15	4.96	11.41	3.50	31	38.8	115.28
4/16	4.42	10.23	3.48	24	40.0	112.04
4/17	3.95	9.41	3.38	25	41.7	110.44
4/18	6.21	7.81	5.01	30	50.0	112.53
4/19	4.75	7.23	3.80	12	30.0	111.85
4/22	4.31	5.00	3.80	34	56.7	127.16
4/23	3.63	3.96	3.16	40	66.7	135.40
4/24	2.92	4.42	2.58	42	70.0	142.43
4/25	3.08	5.52	2.44	37	61.7	134.88
4/26	4.24	6.36	3.04	25	41.7	118.68
4/29	7.86	14.05	5.08	24	40.0	95.91
4/30	6.37	10.57	3.65	28	46.7	95.69
5/1	4.97	8.60	3.61	24	39.3	95.25
5/2	4.53	8.04	4.03	25	41.7	93.13
5/7	5.33	5.77	4.39	32	53.3	87.00
5/8	5.71	7.41	4.76	29	48.3	94.81
5/9	5.01	7.57	4.08	21	35.0	97.58
5/10	4.00	4.92	3.65	24	40.0	100.10
5/13	2.65	3.33	2.32	14	23.3	132.47
5/14	2.19	2.62	2.07	25	42.4	142.10
5/15	2.58	7.16	2.01	14	25.5	166.05

[a] Confidence intervals calculated with nonparametric statistics.
[b] Not used in statistical analysis because analysis showed too few recaptures.

Table A-8. PIT-tagged wild steelhead travel time, with 95% confidence intervals, from the Salmon River trap to Lower Granite Dam, 1996.

Release Discharge Date	Median Travel Time (Day)	Confidence Interval [a] Upper	Lower	Number Captured	Percent Captured (%)	Mean (kcfs)
4/5[b]	7.95	0.00	0.00	1	33.3	116.58
4/7[b]	3.84	0.00	0.00	1	50.0	110.80
4/11[b]	6.55	0.00	0.00	1	14.3	132.81
4/15,16,17,18,19	4.41	12.00	3.08	14	29.8	110.44
4/22[b]	15.52	0.00	0.00	2	66.7	107.74
4/23,24,25	3.12	4.56	2.47	18	66.6	142.43
4/26[b]	5.51	0.00	0.00	5	71.4	113.09
4/29,30-5/1,2	4.35	5.44	3.79	20	41.7	97.48
5/7,8,9	4.42	4.84	4.25	22	56.4	86.72
5/10	3.62	4.38	3.41	14	73.7	100.10
5/13,14,15	2.33	2.49	2.07	14	38.9	142.10

[a] Confidence intervals calculated with nonparametric statistics.
[b] Not used in statistical analysis because analysis showed too few recaptures.

APPENDIX B

Interrogations at Lower Granite, Little Goose, Lower Monumental, and McNary dams
of fish PIT-tagged at Smolt Monitoring Project traps
on the Snake and Salmon rivers, 1996.

Table B-1. PIT-tagged hatchery chinook salmon interrogations at Lower Granite, Little Goose, Lower Monumental and McNary dams from the Snake River trap, 1996.

Date	Number tagged	Int. at Lower Granite	%	Int. at Little Goose	%	Int. at Lower Monumental	%	Int. at McNary	%	Total Int.	Total %
4/8,9	88	26	29.5	16	18.2	13	14.8	3	3.4	58	65.9
4/10	43	13	30.2	13	30.2	4	9.3	4	9.3	34	79.1
4/15	93	24	25.8	13	14.0	20	21.5	2	2.2	59	63.4
4/16	91	29	31.9	22	24.2	11	12.1	3	3.3	65	71.4
4/17	61	19	31.1	18	29.5	3	4.9	0	0.0	40	65.6
4/18	89	36	40.4	12	13.5	11	12.4	5	5.6	64	71.9
4/19	111	49	44.1	23	20.7	13	11.7	5	4.5	90	81.1
4/22	58	19	32.8	6	10.3	15	25.9	2	3.4	42	72.4
4/23	13	7	53.8	2	15.4	1	7.7	0	0.0	10	76.9
4/24	132	53	40.2	25	18.9	15	11.4	5	3.8	98	74.2
4/26	121	50	41.3	17	14.1	17	14.0	3	2.5	87	71.9
4/29, 30-5/1	65	16	24.6	18	27.7	5	12.3	0	0.0	39	60.0
5/2	15	6	40.0	4	26.7	2	13.3	0	0.0	12	80.0
5/7	15	9	60.0	1	6.7	1	6.7	0	0.0	11	73.3
5/9	7	3	42.9	2	28.6	0	0.0	0	0.0	5	71.4
5/10	26	15	57.7	1	3.9	3	11.5	1	3.8	20	76.9
5/13	35	13	37.1	4	11.4	4	11.4	0	0.0	21	60.0
5/14	215	68	31.6	29	13.5	24	11.2	5	2.3	126	58.6
5/15	97	27	27.8	16	16.5	15	15.5	0	0.0	58	59.8
5/16	75	15	20.0	17	22.6	12	16.0	2	2.7	46	61.3
Total	**1,450**	**497**		**259**		**189**		**40**		**985**	

Table B-2. PIT-tagged wild chinook salmon interrogations at Lower Granite, Little Goose, Lower Monumental and McNary dams from the Snake River trap, 1996.

Date	Number tagged	Int. at Lower Granite	%	Int. at Little Goose	%	Int. at Lower Monumental	%	Int. at McNary	%	Total Int.	Total %
4/3	4	0	0.0	1	25.0	2	50.0	0	0.0	3	75.0
4/5	9	2	22.2	6	66.7	0	0.0	0	0.0	8	88.9
4/8	4	1	25.0	3	75.0	0	0.0	0	0.0	4	100.0
4/9	96	22	22.9	27	28.1	19	19.8	3	3.1	71	74.0
4/10	130	44	33.8	40	30.8	12	9.2	8	6.2	104	80.0
4/15,16	65	19	29.2	6	9.2	15	23.1	7	10.8	47	72.3
4/17	26	11	42.3	3	11.5	3	11.5	0	0.0	17	65.4
4/18	64	33	51.6	16	25.0	6	9.4	3	4.7	58	90.6
4/19,22	64	15	23.4	20	31.3	9	14.1	5	7.8	49	76.6
4/23	2	1	50.0	0	0.0	0	0.0	0	0.0	1	50.0
4/24	20	5	25.0	7	35.0	4	20.0	1	5.0	17	85.0
4/26	42	19	45.2	6	14.3	6	14.3	4	9.5	35	83.3
4/29,30-5/1,2,7	53	18	34.0	10	18.9	8	15.1	5	9.4	41	77.4
5/10	9	5	55.6	0	0.0	1	11.1	0	0.0	6	66.7
5/13	10	3	30.0	4	40.0	1	10.0	0	0.0	8	80.0
5/14	120	36	30.0	24	20.0	14	11.7	2	1.7	76	63.3
5/15	73	19	26.0	6	8.2	11	15.1	1	1.4	37	50.7
5/16	51	16	31.4	11	21.6	8	15.7	1	2.0	36	70.6
Total	**842**	**269**		**190**		**119**		**40**		**618**	

Table B-3. PIT-tagged hatchery steelhead interrogations at Lower Granite, Little Goose, Lower Monumental, and McNary dams from the Snake River trap, 1996.

Date	Number tagged	Int. at Lower Granite	%	Int. at Little Goose	%	Int. at Lower Monumental	%	Int. at McNary	%	Total Int.	Total %
4/3	20	10	50.0	3	15.0	1	5.0	1	5.0	15	75.0
4/5	7	1	14.3	1	14.3	3	42.9	0	0.0	5	71.4
4/8	14	7	50.0	4	28.6	1	7.1	0	0.0	12	85.7
4/9,10	90	22	24.4	42	46.6	10	11.1	2	2.2	76	84.4
4/15	60	31	51.7	16	26.7	6	10.0	2	3.3	55	91.7
4/16	60	26	43.3	15	25.0	6	10.0	1	1.7	48	80.0
4/17	75	32	42.7	15	20.0	10	13.3	1	1.3	58	77.3
4/18	45	22	48.9	15	33.3	4	8.9	1	2.2	42	93.3
4/19	60	25	41.7	16	26.7	5	8.3	0	0.0	46	76.7
4/22	61	45	73.8	8	13.1	3	4.9	0	0.0	56	91.8
4/23	58	50	86.2	3	5.2	2	3.4	1	1.7	56	96.6
4/24	60	36	60.0	5	8.3	5	8.3	2	3.3	48	80.0
4/26	61	40	65.6	4	6.6	7	11.5	0	0.0	51	83.6
4/29	60	41	68.3	6	10.0	4	6.7	0	0.0	51	85.0
4/30	60	34	56.7	11	18.3	2	3.3	1	1.7	48	80.0
5/1	60	32	53.3	4	6.7	4	6.7	5	8.3	45	75.0
5/2	60	28	46.7	4	6.7	9	15.0	1	1.7	42	70.0
5/7	60	15	25.0	10	16.7	18	30.0	1	1.7	44	73.3
5/9	60	25	41.7	15	25.0	4	6.7	0	0.0	44	73.3
5/10	61	32	52.5	7	11.5	5	8.2	0	0.0	44	72.1
5/13	60	35	58.3	3	5.0	7	11.7	1	1.7	46	76.7
5/14	60	30	50.0	7	11.7	4	6.7	2	3.3	43	71.7
5/15	60	28	46.7	10	16.7	11	18.3	0	0.0	49	81.7
5/16	91	28	30.8	23	25.3	8	8.8	2	2.2	61	67.0
Total	**1,363**	**675**		**247**		**139**		**24**		**1,085**	

Table B-4. PIT-tagged wild steelhead trout interrogations at Lower Granite, Little Goose, Lower Monumental, and McNary dams from the Snake River trap, 1996.

Date	Number tagged	Int. at Lower Granite	%	Int. at Little Goose	%	Int. at Lower Monumental	%	Int. at McNary	%	Total Int.	Total %
4/3	3	0	0.0	3	100.0	0	0.0	0	0.0	3	100.0
4/5	1	0	0.0	1	100.0	0	0.0	0	0.0	1	100.0
4/8	1	0	0.0	0	0.0	1	100.0	0	0.0	1	100.0
4/9	8	4	50.0	0	0.0	1	12.5	0	0.0	5	62.5
4/10	20	1	5.0	7	35.0	4	20.0	1	5.0	13	65.0
4/15	13	10	76.9	1	7.7	0	0.0	0	0.0	11	84.6
4/16	22	13	59.1	4	18.2	3	13.6	0	0.0	20	90.9
4/17	12	8	66.7	2	16.7	1	8.3	0	0.0	11	91.7
4/18	17	9	52.9	5	29.4	1	5.9	0	0.0	15	88.2
4/19,22	43	23	53.5	9	20.9	4	9.3	2	4.7	38	88.4
4/23	8	7	87.5	1	12.5	0	0.0	0	0.0	8	100.0
4/24	21	13	61.9	5	23.8	1	4.8	1	4.8	20	95.2
4/26	30	16	53.3	7	23.3	2	6.7	0	0.0	25	83.3
4/29,30-5/1,2,7,9	69	34	49.3	8	11.6	8	11.6	3	4.3	53	76.8
5/10	16	9	56.2	1	6.3	2	12.5	0	0.0	12	75.0
5/13	22	9	40.9	6	27.3	3	13.6	0	0.0	18	81.8
5/14	128	53	41.4	25	19.5	11	8.6	0	0.0	89	69.5
5/15	164	67	40.9	34	20.7	17	10.4	3	1.8	121	73.8
5/16	57	17	29.8	18	31.6	8	14.0	2	3.5	45	78.9
Total	**655**	**293**		**137**		**67**		**12**		**509**	

Table B-5. PIT-tagged hatchery chinook salmon interrogations at Lower Granite, Little Goose, Lower Monumental, and McNary dams from the Salmon River trap, 1996.

Date	Number tagged	Int. at Lower Granite	%	Int. at Little Goose	%	Int. at Lower Monumental	%	Int. at McNary	%	Total Int.	Total %
3/20,21	198	42	21.2	23	11.6	15	7.6	8	4.0	88	44.4
3/25	100	19	19.0	14	14.0	8	8.0	1	1.0	42	42.0
3/26	100	23	23.0	14	14.0	8	8.0	2	2.0	47	47.0
3/27	100	19	19.0	13	13.0	7	7.0	2	2.0	41	41.0
4/1	6	2	33.3	2	33.3	0	0.0	0	0.0	4	66.7
4/2	183	41	22.4	33	18.0	11	6.0	9	4.9	94	51.4
4/3	97	28	28.9	10	10.3	11	11.3	1	1.0	50	51.5
4/4	96	24	25.0	8	8.3	9	9.4	2	2.1	43	44.8
4/5	92	16	17.4	14	15.2	12	13.0	1	1.1	43	46.7
4/6	98	26	26.5	16	16.3	7	7.1	5	5.1	54	55.1
4/7	98	32	32.7	11	11.2	9	9.2	5	5.1	57	58.2
4/8	92	23	25.0	20	21.7	6	6.5	1	1.1	50	54.3
4/10	92	21	22.8	11	12.0	16	17.4	4	4.3	52	56.5
4/11	15	1	6.7	4	26.7	1	6.7	2	13.3	8	53.3
4/15	86	22	25.6	8	9.3	14	16.3	4	4.7	48	55.8
4/16	85	19	22.4	9	10.6	18	21.2	1	1.2	47	55.3
4/17	89	30	33.7	11	12.4	6	6.7	4	4.5	51	57.3
4/18	93	20	21.5	16	17.2	5	5.4	4	4.3	45	48.4
4/19	99	25	25.3	18	18.2	12	12.1	0	0.0	55	55.6
4/22	96	22	22.9	9	9.4	11	11.5	3	3.1	45	46.9
4/23	40	11	27.5	6	15.0	5	12.5	0	0.0	22	55.0
4/24	102	26	25.5	11	10.8	12	11.8	0	0.0	49	48.0
4/25	142	35	24.6	20	14.1	11	7.7	2	1.4	68	47.9
4/26	39	13	33.3	5	12.8	5	12.8	1	2.6	24	61.5
4/29	48	11	22.9	7	14.6	7	14.6	1	2.1	26	54.2
4/30	34	5	14.7	6	17.7	4	11.8	0	0.0	15	44.1
4/29.30	82	16	19.5	13	15.9	11	13.4	1	1.2	41	50.0
5/1,2	55	21	38.2	2	3.6	8	14.5	0	0.0	31	56.4
5/7	36	10	27.8	5	13.9	3	8.3	0	0.0	18	50.0
5/8	22	8	36.4	3	13.6	3	13.6	0	0.0	14	63.6
5/9	43	9	20.9	7	16.3	5	11.6	1	2.3	22	51.2
5/8,9	65	17	26.2	10	15.4	8	12.3	1	1.5	36	55.4
5/10,13,14	71	13	18.3	6	8.5	8	11.3	3	4.2	30	42.3
5/15	7	1	14.3	1	14.3	1	14.3	0	0.0	3	42.9
Total	**2,701**	**651**		**366**		**277**		**69**		**1,363**	

Table B-6. PIT-tagged wild chinook salmon interrogations at Lower Granite, Little Goose, Lower Monumental, and McNary dams from the Salmon River trap, 1996.

Date	Number tagged	Int. at Lower Granite	%	Int. at Little Goose	%	Int. at Lower Monumental	%	Int. at McNary	%	Total Int.	Total %
3/14	32	9	28.1	9	28.1	4	12.5	0	0.0	22	68.8
3/15	81	18	22.2	16	19.8	16	19.8	3	3.7	53	65.4
3/16	97	21	21.6	20	20.6	5	5.2	0	0.0	46	47.4
3/17	75	19	25.3	12	16.0	10	13.3	1	1.3	42	56.0
3/18	74	17	23.0	12	16.2	14	18.9	1	1.4	44	59.5
3/19	90	19	21.1	19	21.1	9	10.0	1	1.1	48	53.3
3/20	44	10	22.7	6	13.6	8	18.2	0	0.0	24	54.5
3/21	50	13	26.0	14	28.0	6	12.0	1	2.0	34	68.0
3/25,26,27	54	18	33.3	12	22.2	9	16.7	3	5.6	42	77.7
4/2	3	0	0.0	2	66.7	0	0.0	1	33.3	3	100.0
4/3	17	0	0.0	5	29.4	2	11.8	1	5.9	8	47.1
4/4,5,6	83	22	26.5	17	20.5	18	21.7	1	1.2	58	69.9
4/7	33	11	33.3	8	24.2	3	9.1	0	0.0	22	66.7
4/8	55	11	20.0	15	27.3	7	12.7	1	1.8	34	61.8
4/10	74	19	25.7	28	37.8	7	9.5	2	2.7	56	75.7
4/11	75	26	34.7	18	24.0	9	12.0	2	2.7	55	73.3
4/15	31	10	32.3	6	19.4	5	16.1	3	9.7	24	77.4
4/16	60	24	40.0	10	16.7	6	10.0	1	1.7	41	68.3
4/17	130	38	29.2	19	14.6	16	12.3	3	2.3	76	58.5
4/18	89	24	27.0	14	15.7	7	7.9	1	1.1	46	51.7
4/19	38	11	28.9	5	13.1	4	10.5	0	0.0	20	52.6
4/22,23 24,25	66	20	30.3	13	19.7	5	7.6	3	4.5	41	62.1
4/29	4	0	0.0	1	25.0	1	25.0	0	0.0	2	50.0
4/26,30-5/1,2	29	11	37.9	2	6.9	3	10.3	0	0.0	16	55.2
5/7	5	2	40.0	2	40.0	0	0.0	0	0.0	4	80.0
5/8	3	1	33.3	0	0.0	2	66.7	0	0.0	3	100.0
5/9	7	2	28.6	1	14.3	1	14.3	1	14.3	5	71.4
5/10	10	2	20.0	0	0.0	1	10.0	0	0.0	3	30.0
5/13	7	2	28.6	2	28.6	0	0.0	1	14.3	5	71.4
5/14	4	0	0.0	0	0.0	2	50.0	0	0.0	2	50.0
5/15	5	1	20.0	1	20.0	1	20.0	0	0.0	3	60.0
Total	**1,425**	**381**		**289**		**181**		**31**		**882**	

Table B-7. PIT-tagged hatchery steelhead trout interrogations at Lower Granite, Little Goose, Lower Monumental, and McNary dams from the Salmon River trap, 1996.

Date	Number tagged	Int. at Lower Granite	%	Int. at Little Goose	%	Int. at Lower Monumental	%	Int. at McNary	%	Total Int.	Total %
4/2	49	11	22.4	11	22.5	6	12.2	0	0.0	28	57.1
4/3,4,5	61	14	23.0	16	26.2	8	13.1	2	3.3	40	65.6
4/6,7	21	8	38.1	3	14.3	1	4.8	1	4.8	13	61.9
4/8	3	0	0.0	1	33.3	1	33.3	0	0.0	2	66.7
4/10	11	2	18.2	1	9.1	3	27.3	1	9.1	7	63.6
4/11	10	3	30.0	2	20.0	3	30.0	0	0.0	8	80.0
4/15	80	31	38.8	16	20.0	9	11.2	2	2.5	58	72.5
4/16	60	24	40.0	16	26.7	4	6.7	0	0.0	44	73.3
4/17	60	25	41.7	6	10.0	5	8.3	3	5.0	39	65.0
4/18	60	30	50.0	10	16.7	5	8.3	1	1.7	46	76.7
4/19	40	12	30.0	13	32.5	1	2.5	0	0.0	26	65.0
4/22	60	34	56.7	5	8.3	8	13.3	1	1.7	48	80.0
4/23	60	40	66.7	5	8.3	5	8.3	1	1.7	51	85.0
4/24	60	42	70.0	7	11.7	1	1.7	0	0.0	50	83.3
4/25	60	37	61.7	4	6.7	11	18.3	0	0.0	52	86.7
4/26	60	25	41.7	11	18.3	5	8.3	2	3.3	43	71.7
4/29	60	24	40.0	6	10.0	3	5.0	0	0.0	33	55.0
4/30	60	28	46.7	1	1.7	4	6.7	1	1.7	34	56.7
5/1	61	24	39.3	6	9.8	8	13.1	1	1.6	39	63.9
5/2	60	25	41.7	9	15.0	5	8.3	0	0.0	39	65.0
5/7	60	32	53.3	5	8.3	9	15.0	1	1.7	47	78.3
5/8	60	29	48.3	12	20.0	3	5.0	0	0.0	44	73.3
5/9	60	21	35.0	10	16.7	8	13.3	1	1.7	40	66.7
5/10	60	24	40.0	4	6.7	5	8.3	1	1.7	34	56.7
5/13	60	14	23.3	6	10.0	9	15.0	1	1.7	30	50.0
5/14	59	25	42.4	10	17.0	4	6.8	2	3.4	41	69.5
5/15	55	14	25.5	9	16.4	6	10.9	2	3.6	31	56.4
Total	**1,410**	**598**		**205**		**140**		**24**		**967**	

Table B-8. PIT-tagged wild steelhead trout interrogations at Lower Granite, Little Goose, Lower Monumental, and McNary dams from the Salmon River trap, 1996.

Date	Number tagged	Int. at Lower Granite	%	Int. at Little Goose	%	Int. at Lower Monumental	%	Int. at McNary	%	Total Int.	Total %
3/15	1	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
4/2	1	0	0.0	0	0.0	1	100.0	0	0.0	1	100.0
4/3	2	0	0.0	2	100.0	0	0.0	0	0.0	2	100.0
4/4	3	0	0.0	1	33.3	0	0.0	0	0.0	1	33.3
4/5	3	1	33.3	0	0.0	1	33.3	0	0.0	2	66.7
4/6	2	0	0.0	0	0.0	1	50.0	0	0.0	1	50.0
4/7	2	1	50.0	1	50.0	0	0.0	0	0.0	2	100.0
4/8	1	0	0.0	1	100.0	0	0.0	0	0.0	1	100.0
4/10	8	0	0.0	2	25.0	2	25.0	0	0.0	4	50.0
4/11	7	1	14.3	2	28.6	0	0.0	0	0.0	3	42.9
4/15,16, 17,18,19	42	14	33.3	17	40.5	4	9.5	0	0.0	35	83.3
4/22	3	2	66.7	0	0.0	0	0.0	0	0.0	2	66.7
4/23,24,25	27	19	70.4	2	7.4	1	3.7	0	0.0	21	77.8
4/26	7	5	71.4	2	28.6	0	0.0	0	0.0	7	100.0
4/29,30- 5/1,2	48	20	41.7	6	12.5	5	10.4	1	2.1	32	66.7
5/7,8,9	39	22	56.4	5	12.8	2	5.1	0	0.0	29	74.4
5/10	19	14	73.7	2	10.5	1	5.3	0	0.0	17	89.5
5/13	16	5	31.2	1	6.3	1	6.2	0	0.0	7	43.8
5/14	17	7	41.2	4	23.5	2	11.8	0	0.0	13	76.5
5/15	3	2	66.7	1	33.3	0	0.0	0	0.0	3	100.0
Total	**251**	**112**		**49**		**21**		**1**		**183**	

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