SMOLT CONDITION AND TIMING OF ARRIVAL AT LOWER GRANITE RESERVOIR

Annual Report for 1986 Operations

Prepared By

Edwin W. Buettner, Fishery Research Biologist
and
V. Lance Nelson, Sr. Fishery Technician
Idaho Department of Fish and Game
600 South Walnut
P.O. Box 25
Boise, Idaho 83707

Prepared For

Dale Johnson, Project Manager
U.S. Department of Energy
Bonneville Power Administration
Division of Fish and Wildlife
P.O. Box 3621
Portland, Oregon 97208
Project No. 83-323B
Contract No. DE-AI79-83BP11631

September 1987

TABLE OF CONTENTS

LIST OF TABLES

LIST OF TABLES (Continued)

LIST OF FIGURES

ABSTRACT

This project monitored the daily passage of smolts during the 1986 spring outmigration at two migrant traps, one each on the Snake and Clearwater rivers.

Average migration rates for freeze-branded chinook salmon smolts were 28.2 km per day and 22.1 km per day for steelhead trout smolts between release sites and the head of Lower Granite Reservoir.

The yearling chinook salmon migration begins in earnest when Salmon River discharge makes a significant rise in early to mid-April. Host yearling chinook salmon pass into Lower Granite Reservoir in April followed by passage of steelhead trout in May. Chinook salmon smolt recapture data from the Snake River trap suggest a strong dependence of migration rate on quantity of Snake and Salmon River discharge, although no statistical correlation exists at this time.

Daily and seasonal descaling rates were calculated for each species at each trap. Rates were highest for hatchery steelhead trout, intermediate for yearling chinook salmon, and lowest for wild steelhead trout . Descaling rates were generally higher in 1986 than those observed in 1984 and 1985.

Authors:

Edwin W. Buettner
Fishery Research Biologist

V. Lance Nelson
Sr. Fishery Technician

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 for hydroelectric generation can severely reduce flows necessary for downstream smolt migration. Thus, the NWPPC Columbia River Basin Fish and Wildlife Program proposed a 'Water Budget' for augmenting spring flows.

The water budget in the Columbia's Snake River tributary is 1.19 million acre-feet of stored water for use between April 15 through June 15 to enhance the smolt migration. To provide information on smolt movement prior to arrival at the lower Snake River reservoirs, the Idaho Department of Fish and Game (IDFG) monitors the daily passage of smolts at the head of Lower Granite Reservoir and 164 kilometers upriver at White Bird, Idaho, on the Salmon River. The Salmon River trap is operated only during low runoff years. This information allows the Fish Passage Center to anticipate river discharge needs into Lower Granite Reservoir and plan for effective passage or collection for transport of smolts arriving at Lower Granite Dam.

Additionally, the IDFG smolt monitoring project collects data on relative species composition, estimated passage, hatchery vs. wild ratios, travel time, migration rate, and smolt condition relative to scale loss. By monitoring smolt passage at Lower Granite Dam and at the head of Lower Granite Reservoir, migration rates under riverine and reservoir conditions can be compared and determined under various environmental conditions. By having monitoring sites on both the Snake and Clearwater arms of Lower Granite Reservoir, the migration timing of smolts from each drainage can be determined individually. Also, the relative composition of hatchery and wild stocks of steelhead trout can be determined, information useful to document the rebuilding of wild stocks which is being undertaken in other NWPPC projects.

Within the short life span of the smolt monitoring program, we have yet to encounter a lower than normal spring runoff as occurred in 1973 and 1977. We believe smolt monitoring will be most beneficial under such conditions, as low flows will slow the migration. In such a year, knowledge of when most smolts have left tributaries and entered areas which can be affected by releases of stored waters will allow water budget managers to make the most timely use of the limited water budget resource. Perfecting the smolt monitoring technique in years prior to such a low water condition will increase the probability that smolt survival can be maximized through water budget management.

OBJECTIVES

1 To develop a technique to index the relative abundance of smolts entering Lower Granite Reservoir throughout the outmigration season.

2 To establish timing and success of outmigration for the various groups of hatchery-produced and wild chinook salmon and steelhead trout smolts as they leave the Salmon River drainage during low flow years.

3 To establish travel time from the Salmon River index site at White Bird or from the point of release to the index sites at the upper end of Lower Granite Reservoir.

4 To correlate travel time with river flows from index sites to Lower Granite Reservoir and Dam.

5 To assist in estimating total fish abundance and collection efficiency at Lower Granite Dam.

6 To determine where, when, and to what extent descaling occurs to hatchery-reared chinook salmon and steelhead trout smolts released upstream from Lower Granite Dam and develop management alternatives to reduce scale loss.

METHODS

Releases of Hatchery-Produced Smolts

We obtained information from hatcheries which release steelhead trout and chinook salmon juveniles in the Snake River system upriver from Lower Granite Dam. The information included species, number, time, and location of release, and the identifying freeze brand if used. This allowed us to anticipate the passage of the various release groups and branded fish at downriver trapping sites.

Smolt Monitoring Traps

We stationed one scoop trap (Raymond and Collins 1974) on the Clearwater River and a dipper trap (Mason 1966) on the Snake River during the spring of 1986 (Figure 1). We removed smolts daily from the traps for examination, enumeration, and release back to the river. We measured and examined 150 to 300 chinook salmon and steelhead trout smelts each day for scale loss when available. Up to 2,000 smolts were examined daily for hatchery brands, and the remaining catch was then enumerated by species and released. Only smolts examined for scale loss or brands were anesthetized with Tricaine Methanesulfonate (MS-222). These fish were allowed to recover from anesthesia before being released to the river.

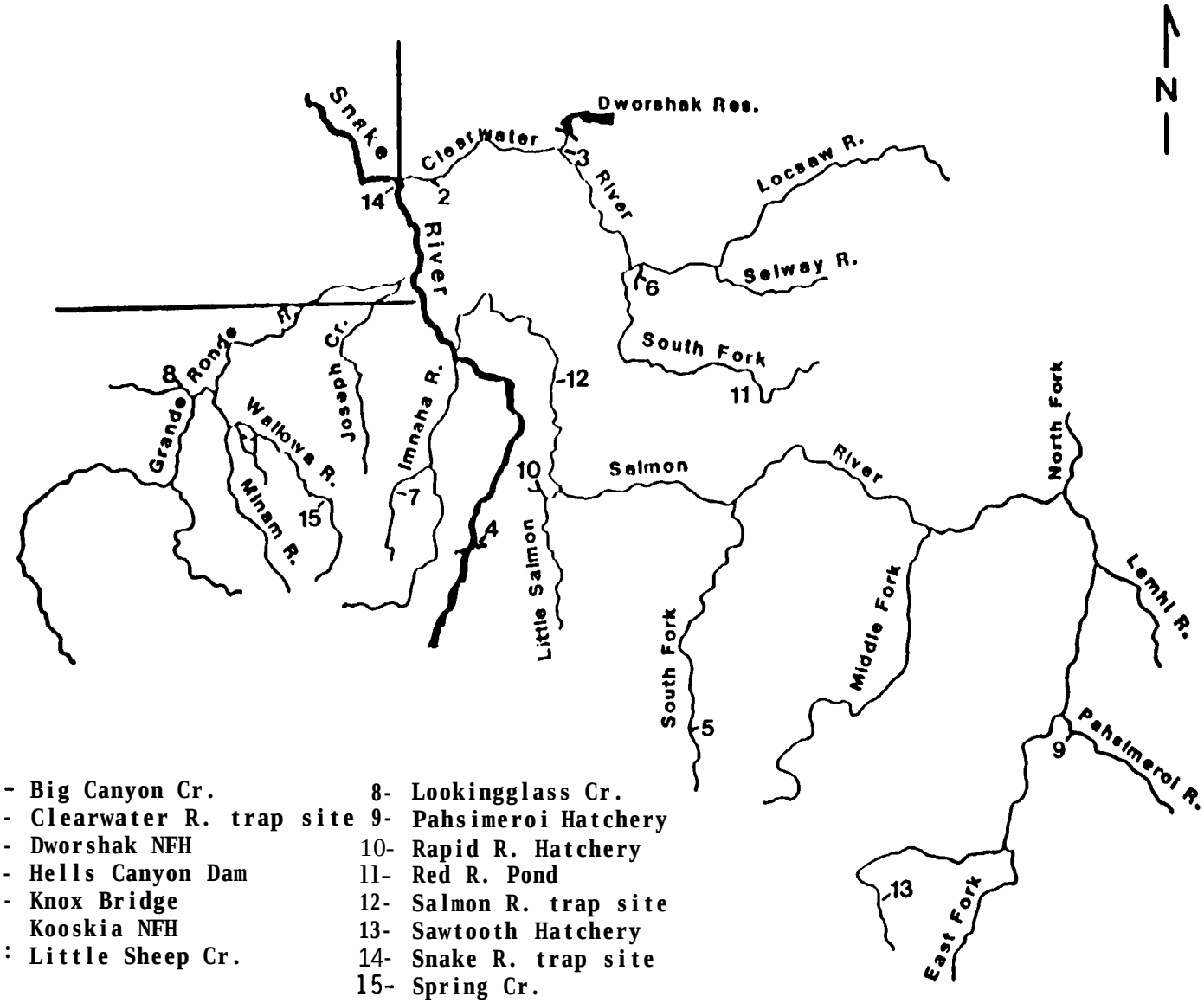


Figure 1. Map of study area.

To quantify scale loss, each side of a smolt was separated into five areas, and each area was examined as shown on the juvenile descaling form (Figure 2). A area was considered "descaled" if 402 or more of the scales were missing. If at least two areas on one side of a fish were descaled, then the fish was considered descaled. Additionally, beginning in 1985 a fish was also considered to be descaled if a band of scales were missing from at least one side of a fish, and the amount of missing scales was equal to or greater than the loss of 40% or more scales from two areas on a side of a fish as described above. Thus, since 1985 a smolt could be more easily classified as descaled than in previous years. We often refer to such scale loss as "classical" descaling to distinguish it from other types of descaling. A fish was considered to have "scattered" descaling if at least 10% of scales were missing from at least one side of the fish.

At each trap, we recorded water temperature and turbidity each day using a centigrade thermometer and 20 cm Secchi disc. The U.S. Weather Service provided daily information on river discharge. The Snake River trap discharge was measured at the USGS Anatone gauge (#13334300). The Clearwater River trap discharge was measured at the USGS Spalding gauge (#13342500). The Salmon River trap discharge was measured at the USGS White Bird gauge (#13317000).

Salmon River Trap

The Salmon River trap is operated only during a below normal water year. A below normal water year is one in which the February stream flow forecast at White Bird, provided by Soil Conservation Service, Snow Survey in early March, is less than 902 of the 25-year average. A tentative decision to operate the trap is made in early February using the January stream flow forecast. If the January forecast is near 90% of normal, preparation to operate the Salmon trap will begin. The final decision is then made using the February forecast in early March.

During 1986. the January stream flow forecast for the White Bird gauge was 76% of average. By February, the forecast had increased to over 100% of normal so the final decision was made not to operate the trap.

Snake River Trap

The Snake River migrant dipper trap was positioned about 40 m downstream from the Interstate Bridge and was attached to bridge piers by steel cables. This is at the head of Lower Granite Reservoir 0.5 km above the confluence of the Snake and Clearwater rivers. River width and depth at this location are approximately 260 m and 12 m, respectively.

Trap operation began March 14, 1986. The trap was not operated from May 29 to June 15 due to high discharge and debris. Trap operation terminated June 26. 1986.

TRAP JUVENILE DESCALING FORM (RECORDER_____)

DATE_____ SITE_____ TIME_____ SECCHI DISC_____

H_2O TEMP._____DISCHARGE_____TOTAL CHINOOK_____TOTAL STEELHEAD_____

TOTAL SOCKEYE_____ TOTAL YOY CHINOOK_____ TRAP DOWNTIME (HRS.)_____

BRAND USED_____ DAILY NO. BRANDED_____ NO. EXAM. FOR HATCHERY BRANDS:

EFFICIENCY: STEELHEAD_____CHINOOK_____

NO. FISH CLIPPED:	NO. EXAM. FOR CLIPS:	NO. CLIPPED RECAPTURES:
CH_____	CH_____	CH_____
SH_____	SH_____	SH_____
SW_____	SW_____	SW_____

REMARKS_____

RIGHT LEFT

6. SCATTERED 7. EYE/HEAD INJURIES 8. DEAD

DESCALED CHINOOK	DESCALED STEELHEAD
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9	9
10	10
11	11
12	12
13	13
14	14
15	15
16	16
17	17
18	18
19	19
20	20
21	21
22	22
23	23
24	24
25	25

TOTAL FISH SAMPLED _____ TOTAL FISH SAMPLED _____

TOTAL DESCALED ___ % DESCALED ___ TOTAL DESCALED ___ % DESCALED ___

40% DESCALING (ABOVE BELLY) IN ANY SINGLE (1) AREA CONSTITUTES DESCALING.
ANY TWO (2) AREAS ON THE SAME SIDE RESULTS IN FISH CLASSIFIED AS DESCALED.

Figure 2. Form used to record smolt passage and descaling information. Drawings show the five areas on each side of a smolt which are considered independently for scale loss.

SmOlts were freeze branded (Mighell 1969) and released at the Snake River trap to estimate travel time from the head of Lower Granite Reservoir to Lower Granite Dam. The brand was changed at three-day intervals to document changes in travel time as environmental conditions changed. Ten unique brand groups were marked during the 1986 trapping season. Up to 2.000 smolts WERE branded daily when available. The remaining catch was counted and returned to the river.

To estimate trap efficiency, chinook salmon were marked with a caudal fin clip and steelhead trout with an opercle punch every fourth day and released 5.5 km upstream from the Snake River trap. Fish examined for brands were also checked for caudal fin clips and opercle punches.

Clear-water River Trap

The Clearwater River scoop trap was installed 10 km upstream from the river mouth, 4.5 km upstream from the head of Lower Granite Reservoir. The river channel at this location forms a bend and is 150 to 200 m wide and four to seven meters deep, depending on discharge.

Trap operation began March 21, 1986 and continued until May 26 when increasing discharge terminated trap operation for the season.

Trap efficiency tests were conducted periodically throughout the season by releasing fin clipped smolts 7 km upriver from the trap. When available, up to 1,500 chinook salmon were caudal clipped and released upstream. Four groups of steelhead trout of approximately 4,000 each were freeze branded at Dworshak NFH and released at one-week intervals above the trap during late April and May.

Descaling

Chinook salmon descaling rates were estimated at six Idaho chinook salmon hatcheries prior to smolt release. Descaling rates were also estimated at the time of release for the McCall and Rapid River off-hatchery release groups. Kooskia NFH. Dworshak NFH, Rapid River, and Pahsimeroi hatcheries release chinook salmon smolts directly from the hatchery to a stream.

Steelhead trout smolt descaling rates were estimated at three Idaho hatcheries prior to release and six release sites at the time of release.

Examination of 200 to 900 smolts from representative groups of chinook salmon and steelhead trout were conducted at hatcheries and again at release sites to estimate the percentage of smolts having significant scale loss. The condition of the smolts was compared with that observed at trapping sites along the migration routes where up to 300 chinook salmon and steelhead trout smolts were measured daily when available.

Trap Efficiency

To estimate the number of smolts passing a trap, it is necessary tc know what fraction of the migration is being trapped. Additionally, this fraction, which is the trapping efficiency, may change as river discharge changes. To create an equation which describes the relationship between discharge and efficiency. efficiency must be estimated several times over the range of discharge within which the trap is operated. A linear regression of efficiency on discharge is then calculated from the data, after which an efficiency can be predicted from a known discharge.

Trap efficiencies tests are conducted every four days if enough smolts are available to mark. During 1986. four groups of steelhead trout smolts of 4.000 each were freeze branded and held at Dworshak NFH. These groups were released at one-week intervals upstream from the Clearwater River trap for efficiency test. These groups were also used to determine travel time through Lower Granite Reservoir.

Travel Time and Migration Rates

Travel time and migration rates for hatchery-released chinook salmon and steelhead trout were calculated using median arrival times at the Snake River trap and at Lower Granite Dam. In order to provide additional information on smolt movement through Lower Granite pool, smolts were freeze branded at the Snake River trap and median arrival time was calculated at Lower Granite Dam.

RESULTS AND DISCUSSION

Hatchery Releases

Chinook Salmon

Chinook salmon released into the Snake River drainage above Lower Granite Dam were reared at seven locations in Idaho and one in Oregon. A total of 5,503.726 chinook salmon smolts were released at eight locations in Idaho and Oregon (Tabie 1).

A release of 741.684 spring chinook salmon juveniles was made into Lcokingglass Creek/Grande Ronde River by Lookingglass Hatchery during the fall of 1985. The remainder of spring chinook salmon smolt releases occurred in the spring of 1986.

Table 1. Hatchery chinook salmon released into the Snake River system upriver from Lower Granite Dam, 1986.

Release site (hatchery)	Stock	Release date	No. released (no. branded)	Brand
Salmon River				
Sawtooth Hat. (Sawtooth)	Spring	3/17	333,742 (34,475)	RDY- 1
S.F. Salmon R. (McCall)	Summer	3/24-31 (3/28)	970.348 (43,325)	RDY-3
Pahsimeroi R. (Pahsimeroi)	Summer Spring	3/15 3/15	80.948 12.095	
Rapid River (Rapid River)	Spring	3/15-4/7 (3/27)	1,594,688 (42.950)	LDY-1
Drainage Total			2.991.821	
Snake River and Non-Idaho Tributaries				
Hells Canyon (Rapid River)	Spring	3/26-28 (3126)	140.000 (42,950)	LDY-3
Lookingglass Creek (Lookingglass)	Spring	4/2	620,901 (19.955) (19,982)	RAJ-2 RAJ-4
Lookingglass Creek (Lookingglass)	Spring	9/18/85	741.684 (20,108) (20,129)	RAJ-1 RAJ-3
Drainage Total			1,502,585	

Table 1. Continued.

Release site (hatchery)	Stock	Release date	No. released (no. branded)	Brand
Clearwater River				
Red River Pond (Rapid River)	Spring	4/4	152,000	
N.F. Clearwater (Dworshak NFH)	Spring	4/2	506,320 (40,675)	RAY-2
Clear Creek (Kooskia NFH)	Spring	3/26	351.000	
Drainage Total			1.009.320	
Grand Total			5,503,726	

Steelhead Trout

Steelhead trout were reared at three hatcheries in Idaho, one in Washington, and one in Oregon for release upriver from Lower Granite Dam. A total of 6,608,665 steelhead trout smolts were released at 12 locations in Idaho, Oregon, and Washington (Table 2).

Niagara Springs Hatchery released 330.520 steelhead trout juveniles in the Snake River at Hells Canyon during the fall of 1985. The remainder of steelhead trout smolt releases occurred in the spring of 1986.

Smolt Monitoring Traps

Salmon River Trap Operation

Because of the near normal spring runoff, the Salmon River trap was not operated in 1986.

Snake River Trap Operation

The Snake River trap was operated from March 14 through May 28 and again from June 16 until June 26. High discharge prevented trap operation May 29 through June 15.

Trap catch during the 1986 season was 27,568 yearling chinook salmon, 220 subyearling chinook salmon, 1,211 wild steelhead trout, 5,059 hatchery steelhead trout, and 224 sockeye salmon. The majority of the chinook salmon (73%) were captured during April, while 62% of the steelhead trout were captured during May. Wild steelhead trout passed earlier, 492 in April and 47% in May, than did hatchery steelhead trout, 33X in April and 66% in May (Figure 3). The ratio of wild and hatchery steelhead trout in the catch was 1:4. Although some sockeye salmon were trapped during March and April, their passage mainly occurred in May. Subyearling chinook salmon passage began in mid-March and peaked the last two weeks of June.

Snake River discharge, measured at the Anatone gauge, range from 72,100 cfs to 99,200 cfs during March when the trap was in operation (Figure 4). The average April discharge was 77,323 cfs, with a peak of 88,800 cfs April 2. Discharge in May remained similar to April's until the 28th of May when the river rose to 111,800 cfs. Trap operation was discontinued at this point due to the high discharge and debris load in the river, and trapping was not attempted again until June 16 when the discharge dropped to 88,100 cfs. Peak discharge of 156.300 cfs during this time period occurred on June 2.

Water temperature at the beginning of the season was 7 ^{o}C and increased to 9 ^{o}C by the end of March (Figure 4). Temperature increased steadily and was 19 ^{o}C by the end of June.

Table 2. Hatchery steelhead trout released into the Snake River system upriver from Lower Granite Dam, 1986.

Release site (hatchery)	Stock	Release date	No. released (no. branded)	Brand
Salmon River				
Pahsimeroi River (Niagara Springs)	A	4/1-3	614,038	
Panther Creek (Niagara Springs)	A	4/5-7	246,320	
E.F. Salmon R. (Hagerman NFH)	B	4/7-9	525,316	
		(4/8)	(51,325)	LDT-4
Hazard Creek (Hagerman NFH)	A	4/24	302,303	
Sawtooth Hat. (Hagerman NFH)	A	4/8-10	699,715	
		(4/9)	(52,300)	LDT-2
Drainage Total			2,387,692	
Snake River and Non-Idaho Tributaries				
Hells Canyon	A	11/13-15/85	330,520	
(Niagara Springs)	A	4/25-5/2	819,495	
		(4/9)	(49,800	RDT-2
Little Sheep Cr.	A	4/25-30	115,616	
(Irrigon)		(4/27)	(13,217)	RAJ-2
		(4/28)	(13,240)	RAJ-4
Spring Cr.	A	4/25-5/5	194,553	
(Irrigon)		(5/1)	(14,871)	RAJ-1
		(5/2)	(14,878)	RAJ-3
		(4/30)	(14,987)	LAJ-1
		(4/30)	(14,998)	LAJ-3
Cottonwood Cr.	A	4/24-5/6	124,200	
(Lyonns Ferry)		(4/28)	(20,205	RAIJ-1
		(4/28)	(20,038)	RAIJ-2 &4
		(4/28)	(20,234)	RAIJ-3
Asotin Creek	A	4/28-30	44,650	
(Lyonns Ferry)	A			
Drainage Total			1,629,034	

Table 2. Continued.

Release site (hatchery)	Stock	Release date	No. released (no. branded)	Brand
Clearwater River				
Clearwater River (Dworshak NFH)	B	5/7	1,239,541 (35,025)	RDT-4
S.F. Clearwater R. (Dworshak NFH)	B	4/18	1,352,398	
Drainage Total			2,591,939	
Grand Total			6,608,665	

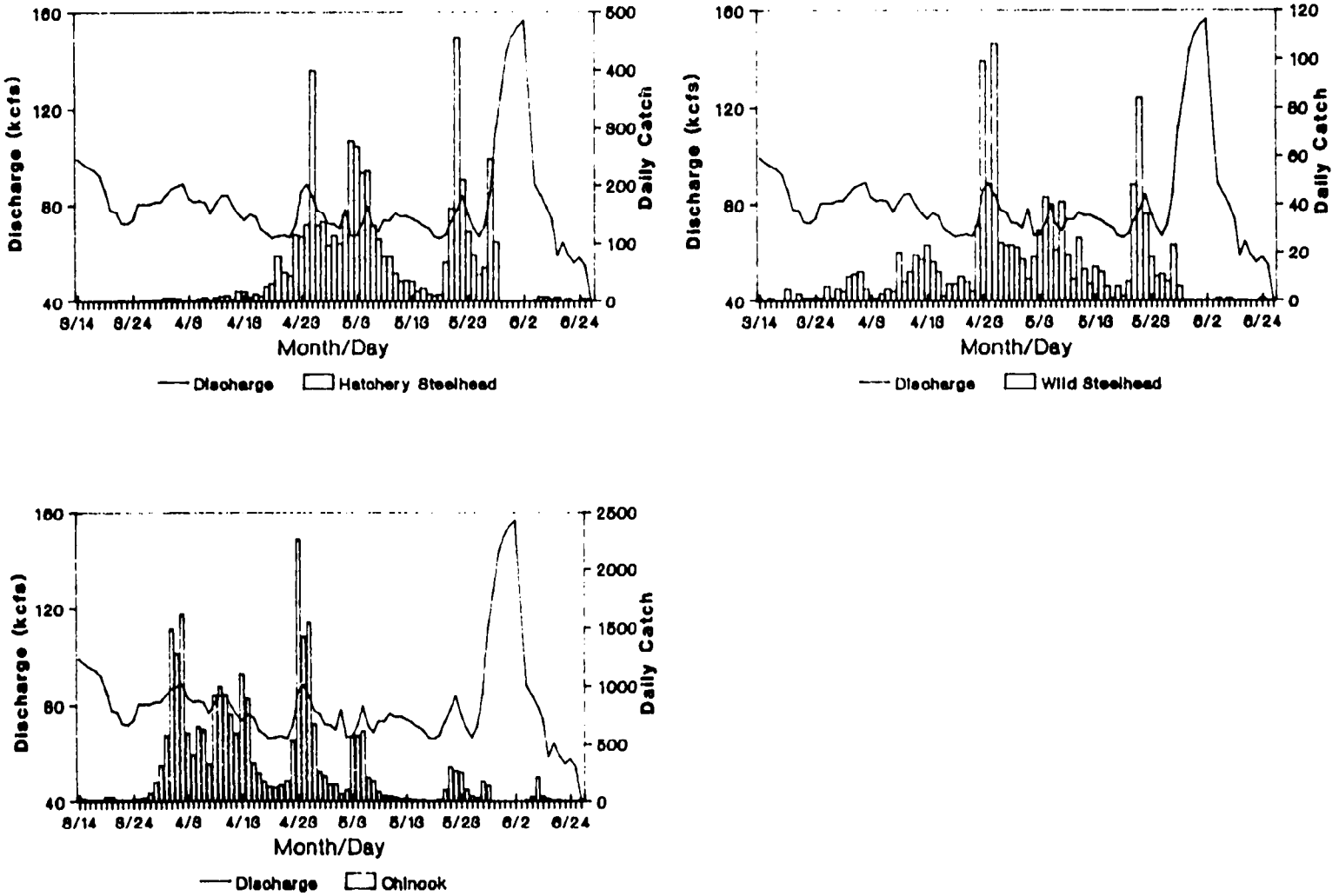


Figure 3. Snake River trap daily catch for yearling chinook salmon, wild steelhead trout, and hatchery steelhead trout overlaid by Snake River discharge, 1986.

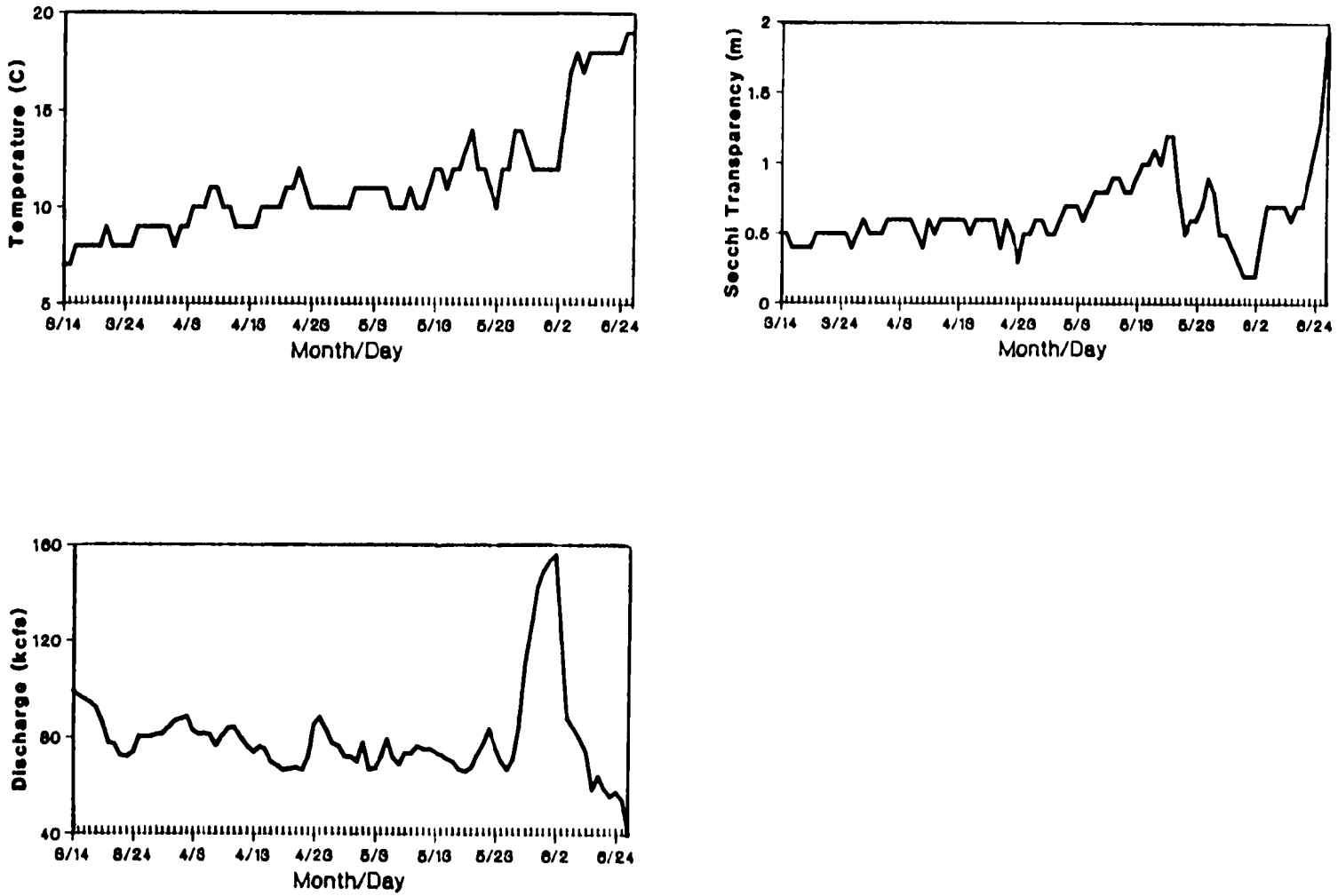


Figure 4. Daily temperature, Secchi disk transparency, and discharge at the Snake River trap, 1986.

Secchi disk transparency remained near 0.5 m during March and increased only slightly in April (Figure 4). May transparencies increased to 1.2 m by May 18. then decreased to 0.5 m by the end of May in conjunction with the peak of the Snake River discharge. The greatest Secchi disc transparency recorded during the 1986 season was 1.4 m on June 26.

Clearwater River Trap Operation

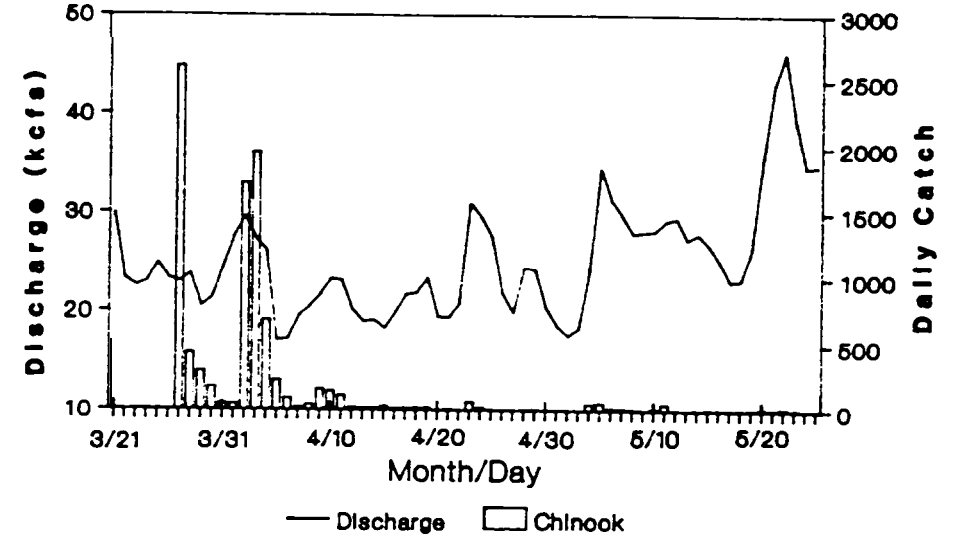
The Clearwater River trap operated from March 21 until May 26. Spring runoff in the Clearwater River drainage mainly occurred before trap operation began in 1986, and there was only one day during the operation period when the trap was not fished. As flows increased during the season, the trap was moved toward the northern shore where water velocities were lower.

The Clearwater River trap captured 9.509 chinook salmon, 965 hatchery steelhead trout, and 123 wild steelhead trout in 1986. The majority of the chinook salmon passed in late March and early April (Figure 5). Large numbers of chinook salmon arrived the day following their release from Dworshak NFH. and the majority of the chinook salmon captured were probably of hatchery origin. Approximately 29% of the hatchery steelhead trout captured by the Clearwater trap occurred in two days, April 27 and 28. These fish were assumed to be from the South Fork of the Clearwater River release. Hatchery steelhead trout comprised 892 of the Clear-dater River trap catch (Figure 5).

Water temperature at the Clearwater River trap was 6 ^{o}C the beginning of the season, March 21, and rose to 10 ^{o}C by the first week of April. By the end of April, the water temperature had fallen back to 6 ^{o}C and fluctuated between 6 ^{o}C and 11.5 ^{o}C during May (Figure 6). The high temperature for the season of 11.5 ^{o}C was recorded May 25.

Discharge during March and April ranged from 17,300 cfs to 31.000 cfs and averaged 22.900 cfs (Figure 6). Spring runoff began May 4, and the river peaked at 46,100 cfs on May 22.

Secchi disc transparency in the Clearwater River exceeded one meter throughout the season with the exception of one day in April and three days in May (Figure 6). By the second week of April, Secchi disc readings of over 2 m were being recorded. The transparency of the Clearwater fluctuated between 1.2 m and 2.7 m during April and May, influenced by precipitation events and soil erosion.



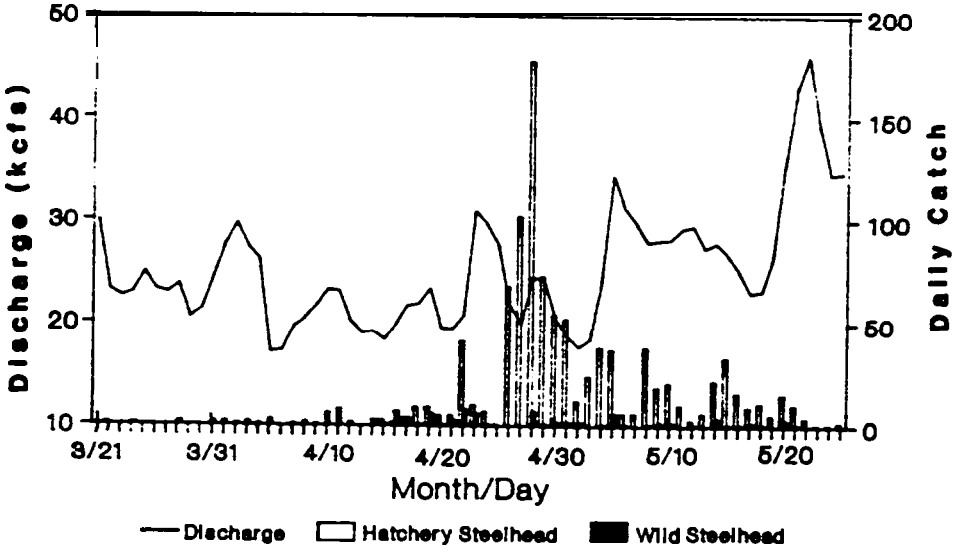
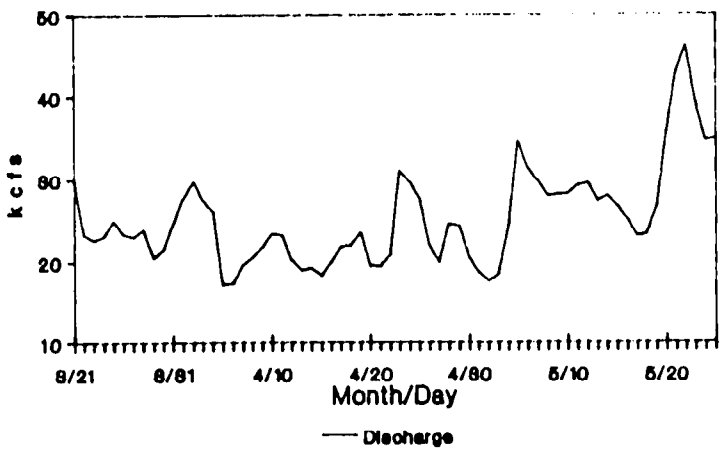
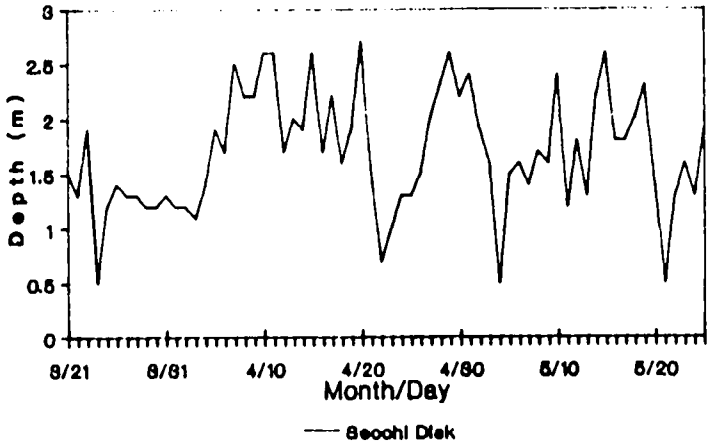


Figure 5. Clearwater River trap daily catch for yearling chinook salmon, wild steelhead trout, and hatchery steelhead trout overlaid by Clearwater River discharge, 1986.





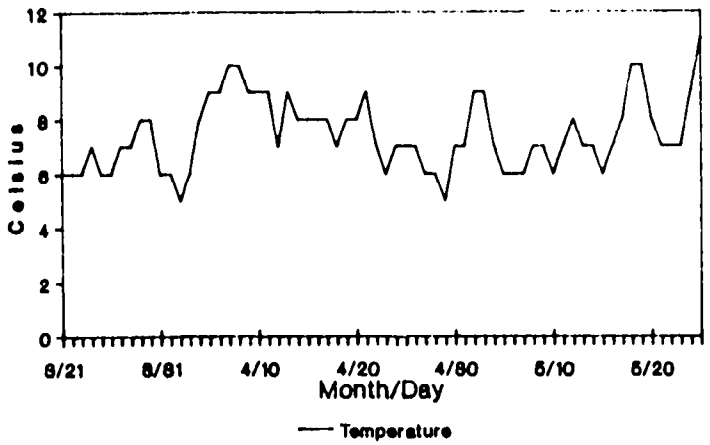


Figure 6. Daily discharge, Secchi disk transparency, and temperature at the Clearwater River trap, 1986.

Descaling

Descaling of Chinook Salmon Smolts et Hatcheries and Release Sites

Classical descaling rate at hatcheries ranged from 0 to 2.7% with a mean of 0.9%. The highest classical descaling was observed at Kooskia NFH. These values compare closely to those observed in 1985, being only slightly higher.

Classical descaling of chinook salmon at the two observed off-hatchery release sites, Snake River at Hells Canyon Dam and South Fork Salmon River, were 1.8% and 1.5%. respectively. These compare to hatchery observations of 1.4% and 0%. respectively, at Rapid River and McCall hatcheries.

Fish with 10% or more of their scales missing from at least one side in a scattered fashion may be as unhealthy as fish which exhibit classical descaling. Chinook salmon 'scattered' descaling at hatcheries ranged from 0.3% to 26.7% with a mean of 5.34%.

The highest percent scattered descaling was observed at Kooskia NFH, which also had the highest classical descaling rate.

Scattered descaling at the two observed off-hatchery release sites, Snake River at Hells Canyon Dam and South Fork Salmon River, were 3.6 and 1.0%. respectively. These compare to hatchery observations of 0.5% at both Rapid River and McCall hatcheries (Table 3).

Two-area descaling exists when the sum of the number of the ten areas on a fish (Figure 2) which are at least 40% descaled and the number of sides of a fish which exhibit scattered descaling equal two or greater. This type of descaling is probably as detrimental to fish health as classical descaling. Two-area descaling at four of the six Idaho chinook salmon hatcheries showed slight increases (1% or less) over classical descaling. At the remaining two hatcheries, Sawtooth showed an increase of 4.5% two-area over classical descaling, and Kooskia NFH had an increase of 12.7% Two-area descaling at the two observed off-hatchery release sites increased less than 1.5% over that observed at the hatchery of origin.

Descaling of Steelhead Trout at Hatcheries and Release Sites

Classical descaling rate at the three Idaho steelhead trout hatcheries. Dworshak NFH. Niagara Springs, and Hagerman NFH, were 0.2. 1.4. and 1.5%. respectively (Table 4). These values compare to 1985 rates of 0.7. 0.1, and 0% classical descaling.

Two-area descaling rates at the three hatcheries showed approximately the same magnitude of decrease at Dworshak NFH and increase at both Niagara Springs and Hagerman NFH. Scattered descaling rate in 1986 was greater at all three hatcheries than was observed in 1985. ranging from 1.3 to 3.6 times greater, with Niagara Springs showing the greatest increase.

Table 3. Chinook salmon descaling rates (percent) at hatcheries and release sites, 1986.

Hatchery (release site)	Classical	Two-area	Scattered
Rapid River Hatchery	1.4	1.8	0.5
(Snake R. @ Hells Canyon Dam)	1.8	2.7	3.6
McCall Hatchery	0	0.5	0.5
(S.F. Salmon R. @ Knox Bridge)	1.5	2.0	1.0
Pahsimeroi Hatchery	2.0	3.0	1.3
Sawtooth Hatchery	0.2	2.5	3.1
Kooskia NFH	2.7	15.3	26.7
Dworshak NFH	0	0	1.7

Table 4. Steelhead trout descaling rates (percent) at hatcheries and release sites, 1986.

Hatchery (release site)	Classical	Two-area	Scattered
Dworshak NFH	0.2	3.9	9.2
Niagara Springs Hatchery	1.4	3.2	2.9
(Snake R. @ Hells Canyon Dam)	1.0	1.6	2.0
(Panther Creek)	2.7	5.3	2.7
(Pahsimeroi R.)	1.0	2.7	2.3
Hagerman NFH	1.5	3.6	2.8
(Hazard Creek)	3.3	6.6	11.6
(Salmon R. @ Sawtooth Hat.)	0	0.7	1.0
(E.F. Salmon R.)	0.7	1.7	1.0

Descaling rate at release sites in 1986 for classical, two-area, and scattered conditions showed no trend toward increased descaling due to transport. Two transported groups had an increase in descaling while the remaining four examined groups showed a decrease in all descaling categories from what was observed at the hatcheries (Table 4). Degree of scale loss is likely associated with illness or other stresses fish have undergone prior to being transported.

Chinook Salmon Descaling at Traps

The only observed descaling of subyearling chinook salmon at either trap site occurred at the Snake River trap in the third week of May. From a small sample of 14 fish, 28.57% were classically descaled.

Weekly classical descaling rates for yearling chinook salmon at the Snake River trap ranged from 0.74 to 4.8%. the peak occurring in late May. Classical descaling at the Clearwater River trap ranged from 0.09% in early April to 8.45% during the third week of May. Seasonal averages in 1986 at the Snake River and Clearwater River traps were 3.8% and 0.7%. respectively (Table 5). The Snake River value shows an increase over 1984 and 1985 data, while the Clearwater River data are similar to 1985 and lower than 1984 by 50%. Descaling rates at Lower Granite Dam ranged between 0.65% and 5.56%. The average descaling rate at Lower Granite for the season was 3.5%.

Hatchery Steelhead Trout Descaling at Traps

Classical descaling of hatchery steelhead trout at both the Snake River and Clearwater River traps showed an increase over previous years (Table 5). The Snake River trap averaged 14.5% for the season, with weekly rates ranging from 2.1% to 10.0%. the peak occurring in late May. The Clearwater River trap averaged 6.3%. with a range of 1.3% in late April to 9.1% in the second week of May.

Descaling of hatchery steelhead trout at Lower Granite Dam ranged from 1.6% recorded in mid-June to 7.6% in late April.

Wild Steelhead Trout Descaling at Traps

Classical descaling of wild steelhead trout at both the Snake and Clearwater river traps was greater than observed in 1984 and 1985 (Table 5). The Snake River trap showed a seasonal average of 2.7%. with a range of 0.7% to 16.7% occurring in late April and mid-March, respectively. The Clearwater River trap had only two weeks in which descaling of wild steelhead trout occurred, the second week of May at 10.0% and the third week of May at 14.3%. The seasonal average at the Clear-water trap was 0.8%.

Descaling of wild steelhead trout at Lower Granite Dam during 1986 ranged from 1.1% the third week of May to 2.6% the fourth week of May.

Table 5. Seasonal mean classical descaling rates (percent) for yearling chinook salmon, hatchery steelhead trout, and wild steelhead trout at the Clearwater River and Snake River traps in 1984, 1985. and 1986 and the Salmon River trap in 1984 and 1985.

Species	Year	Salmon River	Snake River	Clearwater River
Yearling chinook salmon	1984	4.5	2.5	1.5
	1985	2.4	2.6	0.6
	1986		3.8	0.7
Hatchery steelhead trout	1984	8.7	5.5	4.1
	1985	10.1	6.2	2.1
	1986		14.5	6.3
Wild steelhead trout	1984	2.1	1.4	0.4
	1985	0.7	0.8	0.7
	1986		2.7	0.8

The 1986 season was the second year that the classical descaled criterion included fish that had scales missing in a longitudinal band (#9s) as well as when two or more areas per side were descaled. The data from 1985 are directly comparable to 1986. while the 1984 data would be expected to be somewhat lower.

Trap Efficiency

Snake River Trap

This trap should provide low variance estimates of efficiency and clearly define the relationship between efficiency and discharge. The trap operates almost continually through the season: it is always in the same location, and the fish which enter the live well have no chance of being washed from it, as is occasionally possible with scoop traps. Average efficiency for yearling chinook salmon is 1.2% based on three years data, and the range in estimates is from near zero (0.2%) to 2.5% (Table 6).

The 1984 through i986 trap efficiency data were subjected to a Duncan's New Multiple Range test (Ott 1977). No significant difference was found between the means for the three years at the 0.05 level of significance. Therefore, the 1984 through 1986 efficiency data were pooled to give the best estimate of trap efficiency. The 95% confidence limits on the mean estimate are near 13% of the estimate.

$$x \pm cl = 0.0120 + 0.0015$$

There is no obvious relationship between discharge and chinook salmon trapping efficiency at the Snake River trap (Table 6). One possible explanation is that as discharge varies, the river channel characteristics change little. Therefore, the percent of river flow sampled by the trap is not affected by changes in discharge.

Sufficient numbers of steelhead trout smolts were captured to make meaningful trap efficiency tests in 1985 and 1986 only. The range in discharge during the tests was 47,000 to 68,000 cfs in 1985 and 72,000 to 80,000 cfs in 1986. There was no obvious correlation between efficiency and discharge (Table 7). A t-test on the mean values from the two years revealed no significant difference (t = 0.41); therefore, the 1985 and 1986 data were pooled for the estimate of trap efficiency. The mean steelhead trout trapping efficiency is 0.0067, with the 95% confidence interval as 37% of the estimate:

$$\bar{x} \; t \; cl = 0.0067 \pm 0.0025$$

Table 6. Snake River trap efficiency tests for chinook salmon smolts. 1984 through 1986.

Release date		Recapture/ Mark	Efficiency	Discharge (kcfs)
1984				
	3/2	26/1,388	0.0187	84
	3/28	10/545	0.0183	75
	4/8	3/589	0.0051	77
	4/12	7/309	0.0227	81
	4/16	9/806	0.0112	92
	4/19	23/1,061	0.0217	104
	4/24	8/812	0.0098	101
	4/28	5/267	0.0187	86
	5/4	41179	0.0223	81
	5/9	2/95	0.0211	93
1985	3/22	11/1,124	0.0098	43
	4/2	31/840	0.0250	56
	4/6	7/1,092	0.0064	64
	4110	4/1,490	0.0027	79
	4/12	15/1,276	0.0118	77
	4/16	121915	0.0131	80
	5/5	4/338	0.0118	42
1986	3/29	23/1,881	0.0122	86
	4/7	1311,237	0.0105	80
	4/12	26/1,530	0.0170	74
	4117	2/1,141	0.0018	67
	4/24	1111,417	0.0078	80
	4/28	3/803	0.0037	72
	5119	4/703	0.0057	76

Overall efficiency and 95% confidence limits:

0.0120 t 0.0015

Limit as percent of estimate = 13%.

Table 7. Snake River trap efficiency tests for steelhead trout smolts, 1985 and 1986.

Release date	Recapture/ Mark	Efficiency	Discharge (kcfs)
1985			
5/4	8/811	0.0099	55
5/8	1/185	0.0054	54
5/18	1/492	0.0020	50
5/21	2/314	0.0064	68
1986			
4/24	1/179	0.0056	80
4/30	12/874	0.0137	72
5/21	3/1,345	0.0022	76

Overall efficiency and 95% confidence limits:

0.0067 ± 0.0025

Limit as percent of estimate = 37%.

Clearwater River Trap

Trap efficiency for yearling chinook salmon was tested five times in 1984, six times in 1985. and three times in 1986. Tests conducted in 1984 were within a discharge range from 21,000 to 33.000 cfs. in 1985 within a range from 9.100 to 31.000 cfs. and in 1986 within the range from 21,000 to 29.000 cfs (Table 8). There is no obvious relationship between the variables. Efficiency estimates range from 0.0021 to 0.0517. Over three years, 10,842 chinook salmon were marked, and 135 were recaptured in the 14 tests for an average trap efficiency of 0.0125 with a 95% confidence interval of 0.0021. A Duncan's New Multiple Range test was conducted on the three years of efficiency data and revealed no significant difference in the mean trap efficiencies for 1984 through 1986. The data were, therefore, pooled for the best estimate of trap efficiency. Trap efficiency will continue to be estimated. The overall mean efficiency value will continue to be used estimating the number of chinook salmon passing the trap unless a significant correlation with discharge is observed.

Four groups of hatchery steelhead trout of approximately 4,000 each were freeze branded in 1986 at Dworshak NFH, held there, and released at approximate one-week intervals upstream from the Clearwater River trap from mid-April through mid-May. A t-test on the mean efficiencies from 1985 and 1986 revealed a significant difference ($t = 2.81$) between them so the 1985 and 1986 efficiencies were not pooled. Only the 1986 data were used and produced a mean trap efficiency of 0.09%. with a 95% confidence interval on the estimate of 0.05 (Table 9).

Travel Time and Migration Rates

Release Sites to the Snake River Trap

Chinook salmon. There were three groups of freeze-branded chinook salmon released in the upper Salmon River, one group released in the Snake River at Hells Canyon Dam, and four groups released in the Grande Ronde River. Distances from release sites to trapping locations are reported in Table 10. The Snake River trap captured 914 branded chinook salmon: approximately 0.4% of the freeze-branded fish were released.

Branded chinook salmon were transported to the South Fork Salmon River and Snake River at Hells Canyon Dam on March 24-31 and March 26, respectively. Branded chinook salmon were allowed to voluntarily leave Rapid River Hatchery beginning March 15. with March 27 approximating the median release date. Sawtooth Hatchery-branded chinook salmon were released on March 17. Two groups of branded chinook salmon were released from Lookingglass Hatchery during the fall (September 18) of 1985. and two groups were released in the spring (April 2) of 1986. Recovery of fall-reieased branded chinook salmon from Lookingglass Hatchery was very low. Only 16 brands were recaptured from the two groups, which totaled 40.200 branded chinook salmon released for a recovery rate of 0.04%. The majority of these two brand groups had already migrated past the Snake River trap location by the time the trap was put into operation on March 14.

Table 8. Clearwater River trap efficiency tests for chinook salmon smolts, 1984 through 1986.

Release date	Recaptures/ Mark	Efficiency	Discharge (kcfs)
1984			
4/5	4/418	0.0096	21
4/21	13/806	0.0161	33
4/25	3/489	0.0061	31
5/2	3/183	0.0164	24
5/6	1/42	0.0238	24
5/10	14/453	0.0309	24
1985			
3/25	14/607	0.0230	9
3/30	45/1,511	0.0298	9
4/5	6/1,079	0.0056	18
4/9	21940	0.0021	15
4/16	71929	0.0075	33
1986			
3/27	9/1,555	0.0058	22
4/2	8/1,714	0.0047	29
4/6	6/116	0.0517	21

Overall efficiency and 95% confidence limits:

0.0125 ± 0.0021

Limit as percent of estimate = 17%.

Table 9. Clear-water River trap efficiency for steelhead trout smolts, 1985 and 1986.

Release date	Recaptures1 Mark	Efficiency	Discharge (kcfs)
1985			
5/7	2/464	0.0043	29
5/11	1/384	0.0026	33
5114	1/106	0.0094	28
1986			
4114	714,140	0.0017	20
4/30	1/4,190	0.0002	20
5/7	2/4,260	0.0005	29
5/11	5/4,247	0.0012	29

1986 efficiency and 95% confidence limits:

0.0009 ± 0.0005

Limit as percent of estimate = 51%.

Table 10. River mile (kilometer) index for release site and trapping locations.

Site	From mouth of Columbia R.	From mouth of Snake R.	From L. Granite Dam	From Snake R. trap	From Salmon R. trap
Mouth of Snake R.	324.3				
	(521.8)				
Lower Granite Dam	431.8	107.5			
	(694.8)	(173.0)			
Snake R. trap site	463.9	139.6	32.1		
	(746.4)	(224.6)	51.6)		
Clearwater R. trap site	470.0	145.7	38.2		
	(756.2)	(234.4)	(61.5)		
Dworshak NFH	504.2	179.9	72.4		
	(811.3)	(289.5)	(116.5)		
Kooskia NFH	541.6	217.3	109.8		
	(871.4)	(349.6)	176.7		
Mouth of Grande Ronde R.	493.0	168.7	61.2	29.1	
	(793.2)	(271.4)	(98.5)	(46.8)	
Mouth of Salmon R.	512.5	188.2	80.7	48.6	
	(824.6)	(302.8)	(129.8)	(78.2)	
Hells Canyon Dam	571.3	247.0	139.5	107.4	
	(919.2)	(397.4)	(224.5)	(172.8)	
Salmon R. trap site	565.7	241.4	133.9	101.8	
	(910.2)	(388.4)	(215.4)	(163.8)	
Rapid R. Hatchery	605.8	281.5	174.0	141.9	40.1
	(974.7)	(452.9)	(280.0)	(228.3)	(64.5)
S. Fk. Salmon R. @ Knox Bridge	719.7	395.4	287.9	255.8	154.0
	(1,158.0)	(636.2)	(463.2)	(411.6)	(247.8)

Table 10. Continued.

Site	From mouth of Columbia R.	From mouth of Snake R.	From L. Granite Dam	From Snake R. trap	From Salmon R. trap
Pahsimeroi Hatchery	817.5	493.2	385.7	353.6	251.8
	(1,315.4)	(793.6)	(620.6)	(568.9)	(405.1)
E. Fk. Salmon R. @ trap site	873.6	549.3	441.8	409.7	307.9
	(1,405.6)	(883.8)	(710.9)	(659.2)	(495.4)
Sawtooth Hatchery	896.7	573.3	465.8	433.7	331.9
	(1,444.2)	(922.4)	(749.5)	(697.8)	(534.0)
Asotin Creek	469.6	145.3	37.8	5.7	
	(755.6)	(233.8)	(60.8)	(9.2)	
Cottonwood Creek	521.7	197.4	89.9	57.8	
	(839.4)	(317.6)	(144.6)	(93.0)	
Lookingglass Creek	580.4	256.1	148.6	116.5	
	(933.9)	(412.1)	(239.1)	(187.4)	
Big Canyon Creek	585.9	261.6	154.1	122.0	
	(942.7)	(420.9)	(247.9)	(196.3)	
Spring Creek	614.4	290.1	182.6	150.5	
	(988.6)	(466.8)	(293.8)	(242.2)	
Catherine Creek	636.9	312.6	205.1	173.0	
	(1,024.8)	(503.0)	(330.0)	(278.4)	
Little Sheep Creek	553.8	229.5	122.0	89.9	
	(891.1)	(369.3)	(196.3)	(144.6)	
S. Fk. Imnaha R.	516.0	191.7	84.2	52.1	
	(830.4)	(308.5)	(135.5)	(83.8)	
Red River	605.4				
	(974.1)				

Branded chinook salmon from the fall release from Lookingglass Hatchery were collected the second day the Snake River trap was operated (March 14). The spring-released branded chinook salmon did not start arriving until March 24. The Hells Canyon brand group began arriving first, followed by one of the Lookingglass groups (March 25), Rapid River group (March 28). Sawtooth group (March 31). McCall group (April l), and the second Lookingglass group (April 9). Median passage dates were April 3. April 5, April 10. April 14. April 23, and April 5, respectively (Table 11). For each of these groups, the 95% confidence intervals were less than + 2.4 days. Because the majority of the fish from the two brand groups released in the fall from Lookingglass were already past the Snake River trap, they will not be discussed further in this section.

The two branded chinook salmon groups from Lookingglass Hatchery migrated at the fastest rate, 65 km/day. The slowest moving groups were the South Fork Salmon River and Rapid River release groups (18 km/day and 19 km/day, respectively).

The daily number of chinook salmon captured at the Snake River trap was graphed for six brand groups and overlaid with Snake River discharge (Figure 7). As in previous years, increases in the number of branded chinook salmon captured at the trap corresponded to increases in discharge. During a normal water year, these increases in discharge range from about 10,000 to 50,000 cfs. In 1986, the increases in discharge that coincide to chinook salmon movement ranged from about 7,000 to 22,000 cfs.

The Hells Canyon. Rapid River, and two Lookingglass brand groups showed peak movement, with an increase in discharge which began on March 29. The Hells Canyon and Rapid River brand groups also had strong peaks corresponding to increases in discharge beginning on April 7 and 21. The South Fork Salmon River and Sawtooth chinook salmon brand groups peaked with the increase in discharge which began on April 21. The majority of the remaining branded chinook salmon moved by the Snake River trap during this peak in discharge. Only 4X of the branded chinook salmon captured at Snake River trap were collected after May 1 and 81% of these were from the South Fork Salmon River release. Thirteen and one-half percent of the South Fork Salmon River brands collected at the Snake River trap were captured during May. No branded chinook salmon were collected in the Snake River trap after May 25.

Steelhead trout. There were two freeze-branded groups of steelhead trout smolts released in the Salmon River, one in the Snake River below Hells Canyon Dam, two groups in the Imnaha River, three groups in the Wallowa River, and three groups in the Grande Ronde River (Table 12). Marked groups contained between 13,200 and 52.300 smolts. The Snake River trap captured 205 freeze-branded steelhead trout smolts. representing 11 brand group cf the 14 groups that were released. Most of the recaptures (72%) came frcm the Hells Canyon and three of the Grande Ronde releases. Migration statistics for freeze-branded steelhead trout captured at the Snake River trap are reported in Table 12. The Hells Canyon steelhead trout group past the trap first (median passage date = May 1) followed by all the Grande Ronde, Wallowa and Imnaha groups (median passage dates

Table 11. Migration statistics for freeze-branded chinook salmon smolts from release sites to the Snake River trap, 1984 through 1986.

Release site	Year	Median release date	Median passage date	Number captured	Travel time (days)	Migration rate (km/day)	Mean Q (kcfs) Salmon R.	Snake R.	Lower Granite Dam
Rapid R. Hatchery	1986	3/27	4/10	237	14	16.3	15.4	82.9	
	1985	4/2	4/12	320	10	22.8	10.6	67.6	
	1984	4/1	4/18	197	17	13.4	10.1	79.3	
Snake R. @ Hells Canyon Dam	1986	3/26	4/3	269	8	21.6	-	83.8	
	1985	3/19	4/3	544	14	12.4	-	43.0	
	1984	3/20	3/29	704	9	19.2	-	81.4	
S. Fk. Salmon River	1986	3/28	4/23	229	26	15.8	16.5	78.6	
	1985	4/2	4/17	76	15	27.1	14.0	71.0	
	1984	4/10	4/24	238	14	29.0	14.5	91.7	
Salmon R. @ Sawtooth Hatchery	1986	3/17	4/14	49	28	24.9	13.6	81.4	
	1985	3/27	4/14	165	18	38.7	9.6	60.1	
	1984	3/28	4/21	136	24	29.0	11.8	84.0	
Lookingglass Creek	1986	4/2	4/5	114	3	62.3	-	82.1	
	1985	- - - - - - - - - NO MARKED RELEASE GROUP - - - - - - - - -							
	1984	- - - - - - - - - NO MARKED RELEASE GROUP - - - - - - - - -							

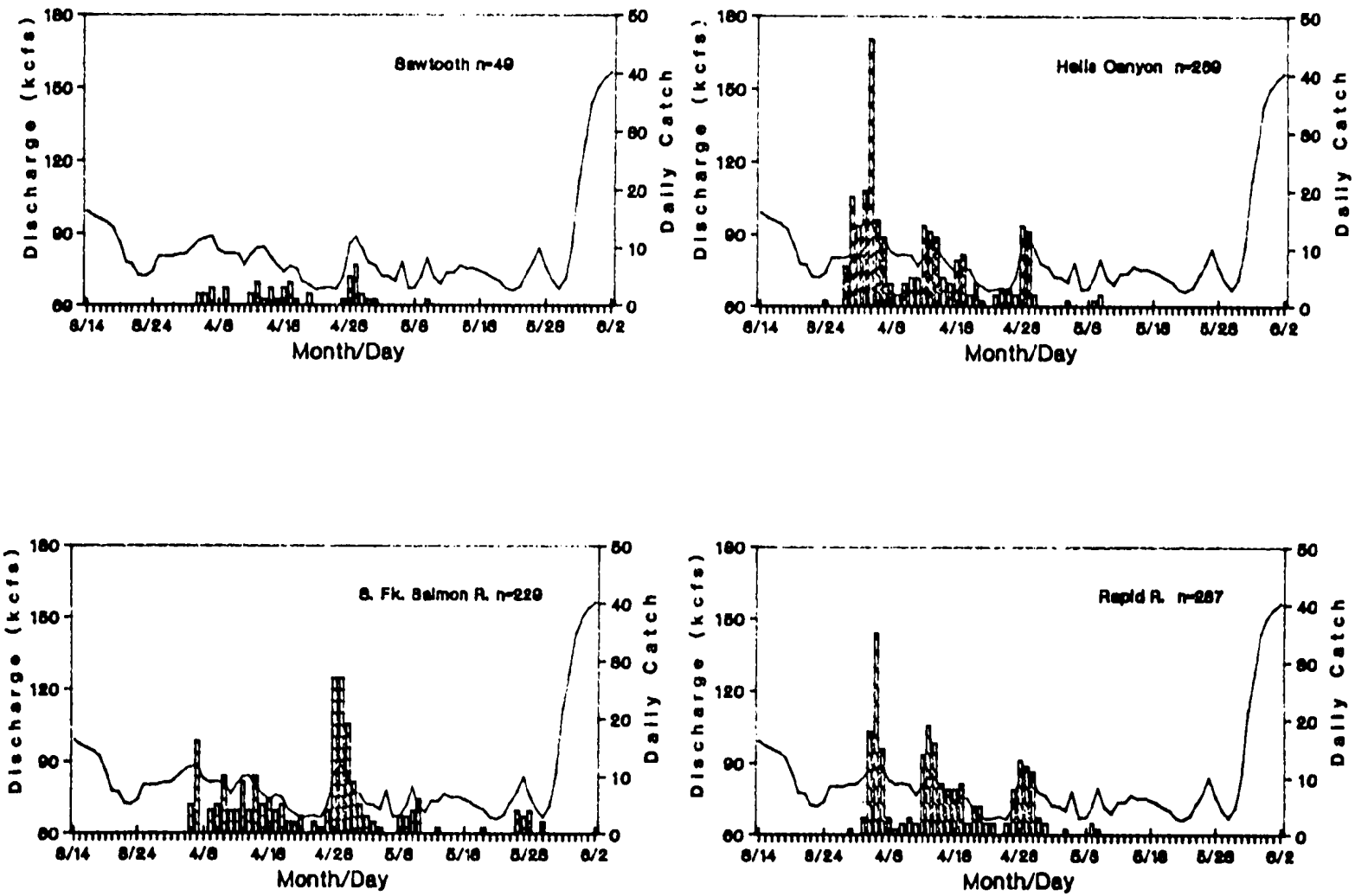
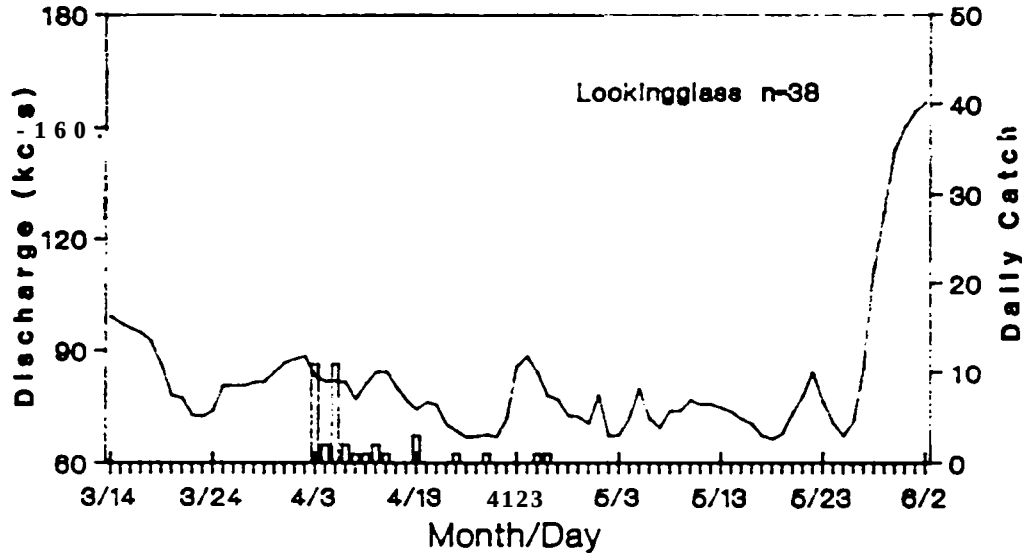


Figure 7. Daily catch of six unique hatchery chinook salmon brand groups at the Snake River trap overlaid with Snake River discharge, 1986.



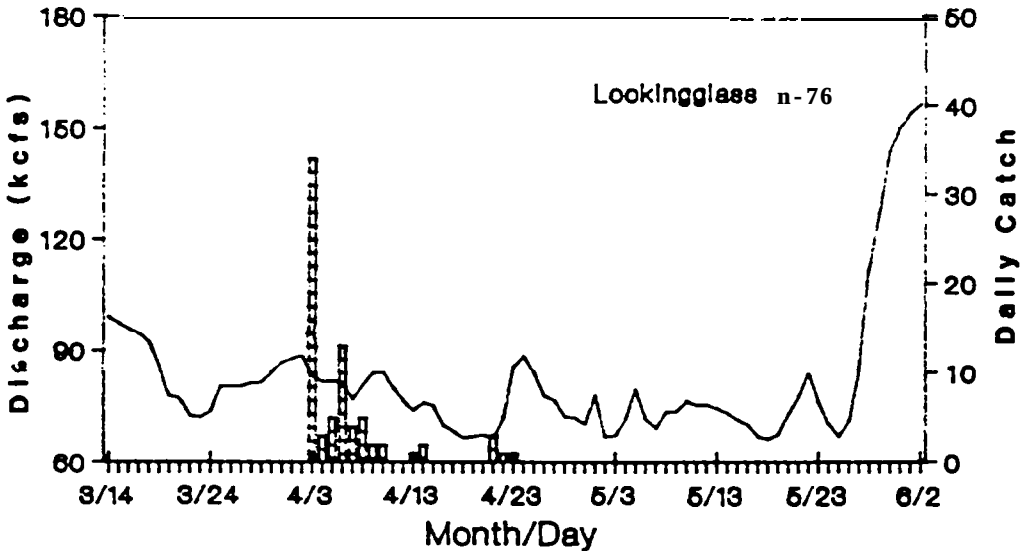


Figure 7. Continued.

Table 12. Migration statistics for freeze-branded steelhead trout smolts from release sites to the Snake River trap, 1984 and 1986.

Release site	Year	Median release date	Median passage date	Number captured	Travel time (days)	Migration rate (km/day)	Mean Q (kcfs) Salmon R.	Mean Q (kcfs) Snake R.
Salmon R. @ Sawtooth Hatchery	1986	4/9	5/21	11	42	16.6	24.0	73.4
	1985	4/9	5/7	-	28	24.9	19.5	62.6
E. Fk. Salmon River	1986	4/8	5/24	9	45	14.6	24.7	73.9
	1985	4/17	5/1	-	22	30.0	20.6	56.4
Snake R. @ Hells Canyon Dam	1986	4/29	5/1	38	2	86.4	-	69.1
	1985	4/30	5/3	-	3	57.6	-	52.9
Spring Creek	1986	5/1	5/27	14	26	9.3	-	72.9
		4/30	-	1	-	NOT ENOUGH RECAPTURES @ SNAKE R. TRAP		
		4/3	-	2	-	NOT ENOUGH RECAPTURES @ SNAKE R. TRAP		
	1985	5/9	5/19	-	10	24.2	-	46.4
Cottonwood Creek	1986	4/28	5/5	110	13	13.0	-	72.3
		4/28	5/6	29	8	12.0	-	72.2
		4/28	5/5	42	7	13.0	-	72.3
	1985	- - - - - - - - - - - - NO MARKED RELEASE GROUP - - - - - - - - - - -						
Little Sheep Creek	1986	4/28	5/8	16	10	12.0	-	72.1
		4/27	-	2	-	NOT ENOUGH RECAPTURES @ SNAKE R. TRAP		

occurred between May 5 and May 8) except one group released in the Wallowa River which did not pass until May 27 (median passage date). With the exception of the Wallowa group, the upper Salmon River releases were the last to pass the trap (median passage dates occurred between May 21 and May 23). Ninety-five percent confidence intervals around the median passage date were generally below $\pm$ 4 days and ranged from 2.2 to 8.2 days.

Steelhead trout released in the Snake River at Hells Canyon Dam migrated at the fastest rate (86 km/day). This was considerably faster than the migration rate of 58 km/day for the 1985 Snake River at Hells Canyon Dam release group. Mean discharge for the migration period in 1986 was 16,000 cfs greater than in 1985, which may be one factor contributing to the increase in rate of movement. The difference between 1985 and 1986 Hells Canyon steelhead trout movement is not that great when travel time is considered. In 1985, the steelhead trout brand groups' median travel time was three days and in 1986 it was two days.

Average migration rate for Salmon River and Grande Ronde River steelhead trout release groups was considerably less (12 km/day: $n = 6$, $s = 2.4$) than the Hells Canyon group (Table 12). This compares to an average migration rate for Salmon and Grande Ronde river steelhead trout groups in 1985 of 27 km/day. There were not enough branded steelhead trout captured in 1984 to calculate migration rates. In all instances mean, discharge during the migration period was greater in 1986. although the discharge fluctuations were not as great as in 1985.

The daily number of steelhead trout, by brand group, captured at the Snake River trap was graphed for four brand groups and overlaid with Snake River discharge (Figure 8). The majority of the branded steelhead trout **smolts** passed by the Snake River trap and was associated with two peaks in discharge which began on April 30 and May 6. Sixty-six percent of the branded steelhead trout were captured at the Snake River trap during a 15-day period between April 30 and May 14. For the four branded groups represented in Figure 8, 76X passed the Snake River trap during this 15-day period. Trap operation was temporarily terminated from May 29 until June 15 due to high discharge. Branded steelhead trout were still being collected on May 28, the day prior to trap shutdown, and it is expected that steelhead trout smolt movement increased with the increase in discharge. No branded steelhead trout **smolts** were collected at the Snake River trap after operation began again on June 16.

Except for a few of the earliest arriving fish from the Hells Canyon steelhead trout brand group and late arriving fish from the South Fork Salmon River chinook salmon brand group, there was little seasonal overlap in the passage of branded yearling chinook salmon and steelhead trout smolts at the Snake River trap. Movement of steelhead trout smolts did not appear to be as dependent on increases in discharges as was seen with chinook salmon smolts. but the steelhead trout did appear to move during periods of high discharge.

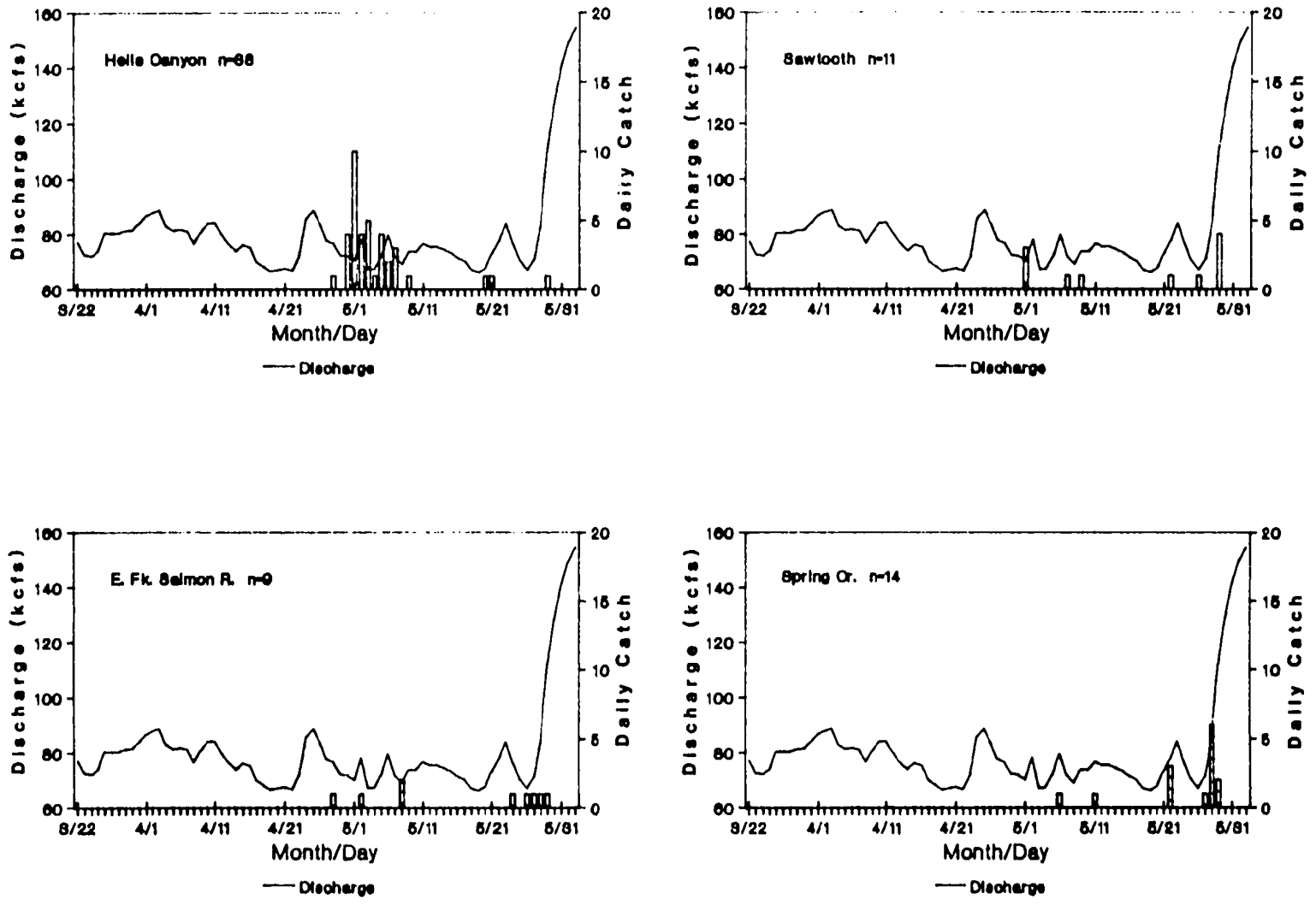


Figure 8. Daily catch of eight unique hatchery steelhead trout brand groups at the Snake River trap overlaid with Snake River discharge, 1986.

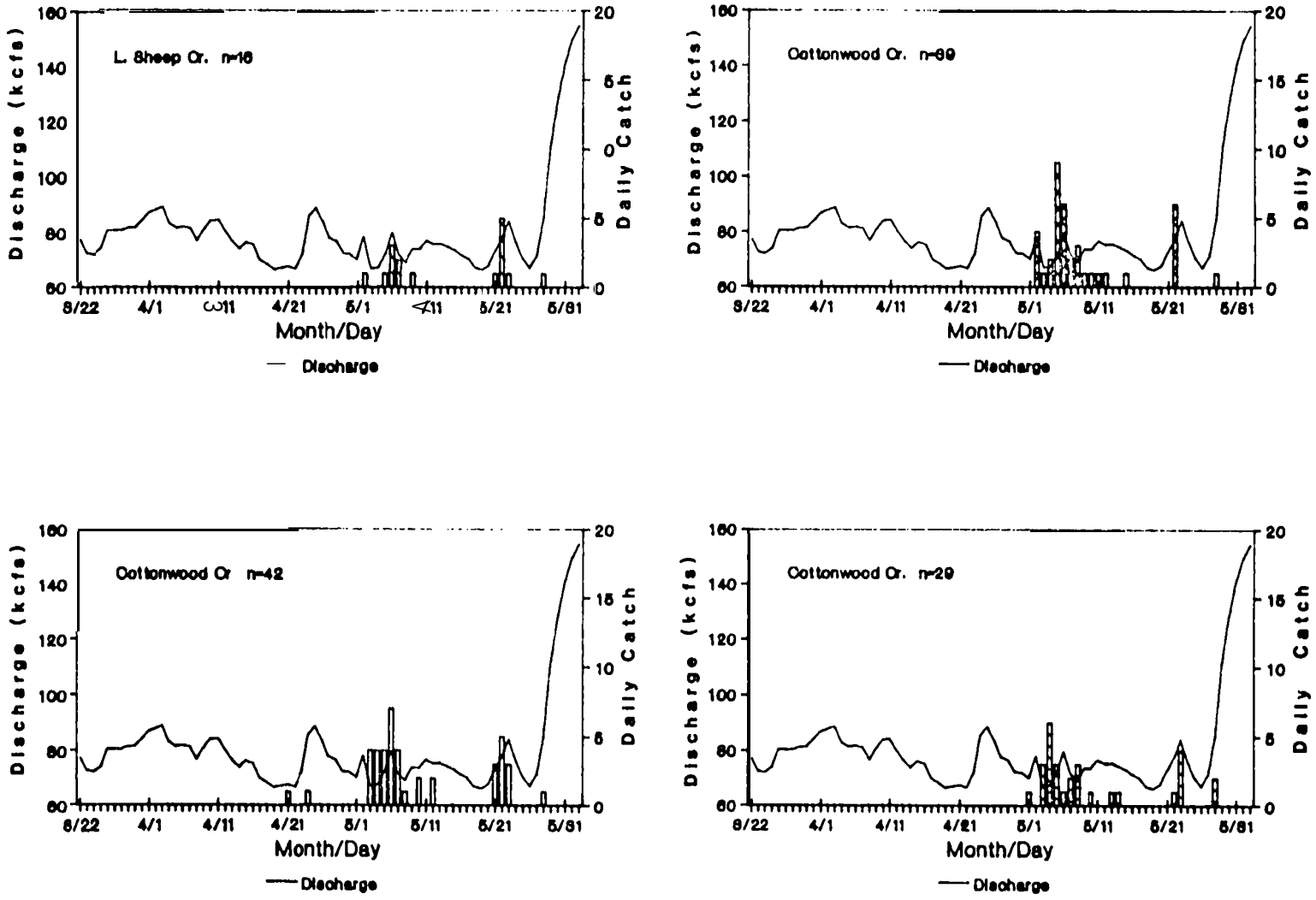


Figure 8. Continued.

Release Site to the Clearwater River Trap

There was one group of branded chinook salmon released April 2 and one of branded steelhead trout released May 7 in the Clearwater River in 1986. Both were released at Dworshak NFH 57 kilometers upstream from the Clearwater River trap. Median passage at the Clearwater River trap was the day following release for each group (Figure 9). A peak in river discharge of 29.700 cfs occurred the day the chinook salmon brand group was released. River discharge was also 29.700 cfs and dropping when the steelhead trout brand group was released.

Snake River Trap to Lower Granite Dam

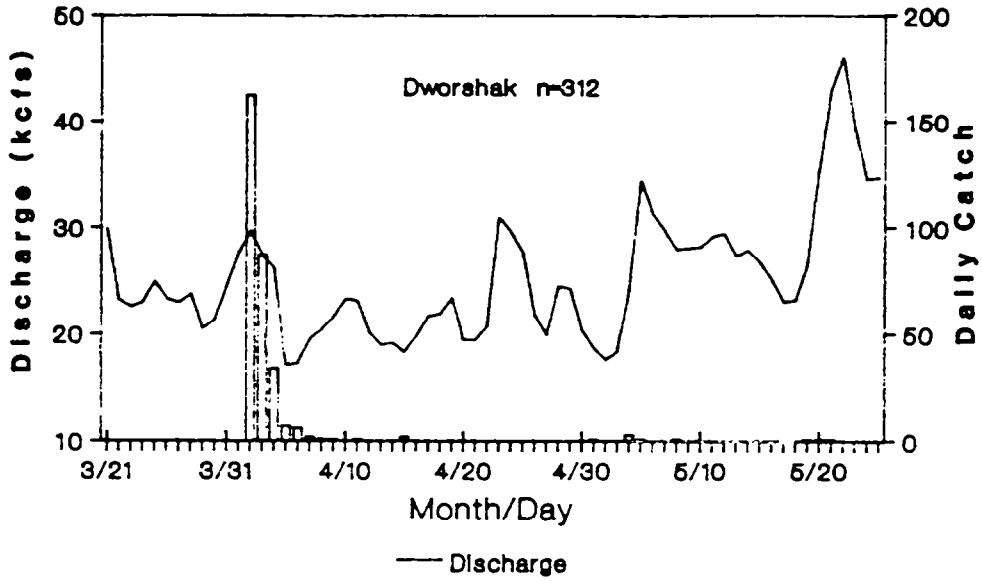
Chinook salmon. In 1986. nine chinook salmon brand groups were marked and released from the Snake River trap to determine travel time and migration rate through Lower Granite Reservoir. In addition, median passage date at the Snake River trap was calculated for six branded chinook salmon groups released from hatcheries. Travel time and migration rate through Lower Granite Reservoir were calculated for these six groups also (Tables 13 and 14).

A t-test was calculated to determine if there was a significant difference between migration rates of chinook salmon smolts marked at the Snake River trap and those groups released from hatcheries. No significant difference was observed between these groups at the 0.05 level of significance.

The hatchery-released chinook salmon brand groups from 1985 were added to the data from 1986, and a Duncan's New Multiple Range test was applied to determine if there was a difference in travel time through Lower Granite Reservoir between the groups from 1985 and 1986 and the chinook salmon marked at the trap in 1986. There was no difference at the 0.05 level of significance. The three sets of data were pooled to run a linear regression analysis to determine if discharge affected migration rate in Lower Granite Reservoir. This data indicate there is very little relationship between chinook salmon travel time through Lower Granite Reservoir and discharge (r^2= 0.095).

It is unrealistic to believe migration rate is not related to discharge. Possibly this data does not show a relationship because of the narrow range of discharges over which the samples were observed. Ninety-six percent of the samples fell within a discharge range of 79,000 to 100.000 cf s measured at Lower Granite Dam. The discharge range is narrow because of the inability to collect enough chinook salmon early and late in the migration period for adequate sized freeze brand groups. Also, discharges during 1985 and 1986 chinook salmon migration periods were similar.

Steelhead trout. In 1986, two treatments of branded steelhead trout groups were used to calculate travel time through Lower Granite Reservoir. One treatment was branded at the hatcheries for release with the production release. Median passage dates at the Snake River trap were calculated for these brand groups and used as a start date for their



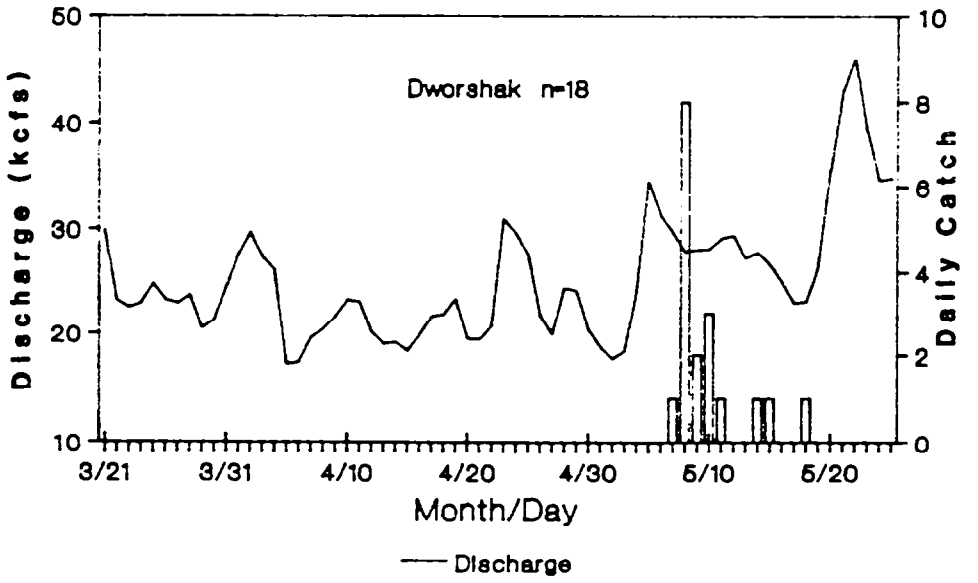


Figure 9. Daily catch of one unique hatchery chinook salmon and one unique hatchery steelhead trout brand group at the Clearwater River trap overlaid with Clearwater River discharge, 1986.

Table 13. Chinook salmon smolt travel time and migration rate to Lower Granite Dam from the head of Lower Granite pool using fish branded at the Snake River trap, 1986.

	Snake River Trap		Lower Granite Dam		Travel time (days)	Migration rate (km/day)	Mean Q (kcfs) at LGD
Brand	Release date	Numbers branded	Median arrival date	Numbers collected			
RDK-1	4/3	2,793	4/16	57	13	4.1	99.5
RDK-2	4/6	1,596	4/24	63	18	2.9	94.6
RDK-3	4/11	2,743	4/24	50	13	4.0	92.7
RDK-4	4/15	1.392	No recaptures				
RAK-1	4/24	2,863	5/1	23	7	7.4	99.3
RAK-2	4/26	2,421	5/7	25	11	4.7	93.7
RAK-3	5/7	1,227	5117	27	10	5.1	98.7
RAK-4	5/16	45	No recaptures				
LDK-1	5/24	421	6/2	5	8	6.4	176.6

Table 14. Chinook salmon smolt travel time and migration rate to Lower Granite Dam trom the head of Lower Granite pool using fish passing the Snake River Trap from upriver release sites, 1985 and 1986.

			Snake-Clearwater R. Trap		Lower Granite Dam				Mean Q (kcfs)
Year	Brand	Release site	Median passage date	Number captured	Median arrival date	Number collected	Travel time (days)	Migration rate (km/day)	at LGD
1985	RDR-1	Salmon R. @ Sawtooth	4/14	165	5/4	4,313	20	2.6	89
	RDR-3	S. Fk. Salmon River	4/17	76	5/14	4,193	27	1.9	85
	LDR-1	Rapid R.	4/12	370	4/25	9,422	13	4.0	98
	LDR-3	Snake R. @ Hells Canyon	4/3	544	4/13	7,111	10	5.1	88
	LDR-4	Grande Ronde R.	6/4	135	6/23	6,868	19	2.7	79
	RDR-2	Clear-water R. @ DNFH	4/4	248	4/27	6,403	23	2.7	94
1986	RAJ- 1	Lookingglass Creek (fall)	3/25	3	4/11	159	17	3.1	104.9
	RAJ-2	Lookingglass Creek	4/5	38	4/14	3,141	9	5.8	98.7
	RAJ-3	Lookingglass Creek (fall)	4/4	13	4/9	333	5	10.3	99.4
	RAJ-4	Lookingglass Creek	4/5	76	4/21	2,593	16	3.2	94.6
	LDY-1	Rapid River	4/16	237	4/20	10,589	4	12.9	88.0
	LDY-3	Snake R. @ Hells Canyon	4/3	269	4/16	9,898	13	4.0	99.5
	RAY-2	Clearwater R. @ DNFH	4/2	312	4/21	4,703	19	3.2	97.3
	RDY-1	Salmon R. @ Sawtooth	4/14	49	4/23	2,245	9	5.8	88.8
	RDY-3	S. Fk. Salmon R.	4/23	229	5/3	5,921	10	5.1	97.7

migration through Lower Granite Reservoir. The second treatment consisted of four brand groups used for trap efficiency tests at the Clearwater River trap. The 1985 hatchery brand release data were combined with the 1986 data (Table 15). A Duncan's New Multiple Range test was conducted to determine if there was a difference between the three treatments of data at the 0.05 level of significance. There was no significant difference between the three treatments of brand groups so a linear regression was run to determine if steelhead trout travel time through Lower Granite Reservoir was related to discharge. The regression showed no relationship between discharge and migration rate ($r^2 = 0.002$).

SUMMARY

In addition to wild and natural chinook salmon and steelhead trout production, 5,503,726 chinook salmon and 6,608,665 steelhead trout juveniles were reared at hatcheries in Idaho, Oregon, and Washington, for release upriver from Lower Granite Reservoir, contributing to the 1986 outmigration. Of these, 284,547 chinook salmon and 335,118 steelhead trout smolts (5.3% and 5.1% of the total release, respectively) were freeze branded and released in nine unique groups for chinook salmon and 14 unique groups for steelhead trout.

The Snake River trap operated from March 14 through May 28 and from June 16 through June 26. The period May 29 to June 15, the trap did not operate due to excessively high river discharge. The Snake River trap captured 27,568 yearling chinook salmon, 220 subyearling chinook salmon, 1.211 wild steelhead trout, 5.059 hatchery steelhead trout, and 224 sockeye salmon. Approximately 0.4% (914) of the hatchery-branded chinook salmon smolts and 0.07'1 (205) of the hatchery-branded steelhead trout smolts released in the Snake River drainage upstream from the Snake River trap were captured by the Snake River trap.

Average migration rate from point of release to the Snake River trap for hatchery-branded chinook salmon in 1986 was slower than observed in 1984 and 1985 (19.7 km/day, 22.7 km/day, and 25.3 km/day, respectively). Average migration rate for branded chinook salmon from the Snake River trap to Lower Granite Dam in 1986 was faster than 1985 (5.5 km/day in 1986 and 3.2 km/day in 1985). Chinook salmon smolt movement through Lower Granite Reservoir in 1986 was five times slower than in the free-flowing river. Average migration rate from point of release to the Snake River trap for hatchery-branded steelhead trout smolts was slower in 1986 than in 1985 (21.0 km/day and 34.2 km/day. respectively). Average migration rate from the Snake River trap to Lower Granite Reservoir in 1986 took twice as long as it did in 1985 (6.6 km/day in 1986 and 12.5 km/day in 1985). Two branded steelhead trout groups released in the Grande Ronde River in 1986 greatly skew the data. If the average migration rates are calculated without these two groups, the 1986 movement is slightly faster than 1985. 6.6 km/day in 1986 and 5.9 km/day in 1985. Freeze branded steelhead trout smolts move approximately three to four times faster in the free-flowing river section than they do in Lower Granite Reservoir.

Table 15. Steelhead trout smolt travel time and miqration rate to Lower Granite Dam from the head of Lower Granite pool, 1985 and 1986.

Year	Brand	Release site	Snake-Clearwater R. Trap: Median passage date	Snake-Clearwater R. Trap: Number captured	Lower Granite Dam: Median arrival date	Lower Granite Dam: Number collected	Travel time (days)	Migration rate (km/day)	Mean Q (kcfs) at LGD
1985	RDY-1	Salmon R. @ Sawtooth	5/7	23	5/28	3,510	21	2.4	92
	RDY-3	E. Fk. Salmon R.	5/9	22	5/28	2,454	19	2.7	93
	LDY-1	Snake R. @ Hells Canyon Dam	5/3	44	5/11	2,821	8	6.4	88
	RA17-1	Cottonwood Creek	5/20	36	5/22	12,110	2	25.7	102
	RA17-3	Cottonwood Creek	5/19	31	5/21	12,022	2	25.7	95
	LDY-2	Clearwater R. @ DNFH	4/29	88	5/4	6,699	5	12.2	83
1986	RAIJ-1	Cottonwood Creek	5/5	39	5/21	4,468	16	3.2	98
	RAIJ-3	Cottonwood Creek	5/5	43	5/22	5,151	17	3.1	100
	RAIJ-4	Cottonwood Creek	5/6	29	5/18	4,114	12	4.3	99
	LAJ-1	Spring Creek	5/26	1	5/30	808	-- NOT ENOUGH RECAPTURES @ SNAKE R. TRAP		
	LAJ-3	Spring Creek	5/5	2	6/1	458	-- NOT ENOUGH RECAPTURES @ SNAKE R. TRAP		
	RAJ-I	Sprinq Creek	5/27	14	5/26	1,628	-- MEDIAN ARRIVAL DATE @ LGD 1 DAY BEFORE MEDIAN PASSAGE DATE @ SNAKE R. TRAP		
	RAJ-2	Little Sheep Creek	5/5	2	6/2	734	-- NOT ENOUGH RECAPTURES @ SNAKE R. TRAP		
	RAJ-3	Sprinq Creek	5/8	2	5/30	1,326	-- NOT ENOUGH RECAPTURES @ SNAKE R. TRAP		
	RAJ-4	Little Sheep Creek	5/8	16	5/30	1,340	22	2.4	114
	LDT-2	Salmon R. @ Sawtooth	5/21	11	5/29	3,772	8	6.4	120
	LDT-4	E. Fk. Salmon R.	5/23	9	5/29	1,552	6	8.5	119
	RDT-2	Snake R. @ Hells Canyon Dam	5/1	38	5/8	5) 033	7	7.4	94
	RDT-4	Clearwater R. @ DNFH	5/8	18	5/17	7,194	9	6.8	99
		Releases made in Clear-water River 15 km upstream from confluence with Snake River							
	LD4-1	Clearwater R. Trap	5/8		5/14	1,003	6	11.1	100
	LD4-3	Clearwater R. Trap	5/13		5/22	869	9	7.4	98
	RD4-1	Clear-water R. Trap	4/16		4/23	371	7	9.5	103
	RD4-3	Clearwater R. Trap	5/1		5/8	751	7	9.5	94

There was little temporal overlap in the passage of yearling chinook salmon smolts and steelhead trout smolts at the Snake River trap. The majority of the chinook salmon past in April and most of the steelhead trout in May.

The Clearwater River trap operated from March 21 to May 26 and captured 9,509 yearling chinook salmon smolts, 965 hatchery steelhead trout smolts, and 123 wild steelhead trout smolts. Freeze-branded chinook salmon and steelhead trout smolts released form Dworshak NFH had an average migration rate to the Clearwater River trap of one day (migration rate = 57 km/day).

The Salmon River trap was not operated in 1986 due to the above normal snowpack reported in the March forecast.

No correlation between discharge and trap efficiency was detected at either the Snake River or Clearwater River traps. Mean trap efficiency for yearling chinook salmon and steelhead trout smolts at the Snake River trap was 1.202 and 0.67%. respectively. Mean trap efficiency for yearling chinook salmon and steelhead trout smolts at the Clear-water River trap was 1.25X and 0.099. respectively.

Average classical descaling rates for yearling chinook salmon smolts were 3.8X at the Snake River trap, 0.7% at the Clear-water River trap, and 3.5% at the collection facility at Lower Granite Dam. Average classical descaling for hatchery steelhead trout at both the Snake River and Clearwater River traps showed an increase over previous years. Descaling of hatchery steelhead trout smolts was much greater than that seen in wild steelhead trout smolts at both traps.

Descaling of chinook salmon and steelhead trout smolts at hatcheries was approximately one percent. The rate of descaling for both increased less than one percent at off-hatchery release sites.

LITERATURE CITED

Mason, J.E. 1966. The Migrant Dipper: A Trap for Downstream Migrating Fish. Progressive Fish Culturist. 28:96-102.

Mighell. J.L. 1969. Rapid Cold-Branding of Salmon and Trout with Liquid Nitrogen. Journal of Fishery Research Board of Canada. 26:2765-2769.

Ott, L. 1977. An Introduction to Statistical Methods and Data Analysis. Duxbury Press, North Scituate, Massachusetts.

Raymond, H.L., and G.B. Collins. 1974. Techniques for Appraisal of Migrating Juvenile Anadromous Fish Populations in the Columbia River Basin. IN: Symposium on Methodology for the Survey, Monitoring and Appraisal of Fishery Resources in Lakes and Large Rivers, May 2-4, 1974. Aviemore, Scotland. Food and Agricultural Organization of the United Nations, European Inland Fisheries Advisory Commission. EIFAC/74/I/Symposium-24, Rome, Italy.