December 1989

Yakima/Klickitat Natural Production and Enhancement Program

Annual Report 1989

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Environment, Fish and Wildlife Division
P.O. Box 3621
905 N.E. 11th Avenue
Portland, OR 97208-3621

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Division of Fish and Wildlife - PJ
P.O. Box 3621
Portland, OR 97208

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Annual Report FY 1989

Prepared by

David E. Fast
Joel D. Hubble
Thomas B. Scribner
Mark V. Johnston
William R. Sharp

Yakima Indian Nation
Fisheries Resource Management
P.O. Box 151
Toppenish, WA 98948

Prepared For

Tom Clune, Project Manager
U.S. Department of Energy
Bonneville Power Administration
Division of Fish and Wildlife
P.O. Box 3621
Portland, Oregon 97208
Project No. 88-120
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1.0 ACKNOWLEDGEMENTS

We would like to thank all the members of the Yakima Indian Nation Fisheries Resource Management staff for their suggestions and assistance in the field. Thanks also to Joe Jay Pinkham III, William Fiander, and the many other field technicians for maintaining the high quality of data collected in the field.

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2.0 ABSTRACT

Fall chinook spawner surveys were conducted in November and early December, 1988 in the Yakima and Klickitat Basins. Poor visibility was a significant problem in both basins. Of the 203 total redds counted in the mainstem Yakima River, 73% (149 redds) occurred downstream of Prosser Dam. Twelve redds were found in Marion Drain. Boat surveys were the most effective method of the three survey methods used; boat, fixed-wing and helicopter. However, relative counts between methods were comparable. The majority of spawning in the Klickitat River occurred from the WDF hatchery to Leidl Bridge, and dropped off downstream of the bridge.

Steelhead spawner surveys were conducted from February through April, 1989 in the Yakima and Klickitat Basins. In the Yakima Basin a total of 451 redds were observed. A total of 404 redds were found in the Satus Basin, with 129 of these redds occurring in Satus Creek. Redd counts in Dry, Logy, Kusshi and Mule-Dry were 128, 83, 27 and 10 respectively. A total of 47 redds were found in the Toppenish Basin. Of these 37 were found in Toppenish Creek and 10 in Simcoe Creek. Though no surveys were conducted in the Yakima Basin above Roza Dam, 10-20 adults and some redds were observed near the confluence of the West Fork of the Teanaway River in May. Poor visibility limited surveys

in both the Naches system and Klickitat Basin to selected tributaries. No redds were found on surveys conducted in the Naches system and two redds were found in Swale Creek in the Klickitat Basin.

The 1988 fall chinook run of 221 adults at Prosser Dam was the lowest count on record (counts began in 1983). Hatchery fish comprised 2.7% of the total run. Mean run size since 1983 is 570 fish.

The 1988-89 steelhead run count at Prosser Dam was 1,166 adults. This was the lowest run size in the past five years (First complete records begin for the 1984-85 season.). Hatchery fish comprised 7.8% of the total run. Mean run size for the past five years is 2,158 fish.

Monitoring of adult steelhead at Roza Dam began in October, 1988. Of the 71 adults that were estimated to have migrated over Roza Dam, 45.1% passed during March and 40.8% passed during April.

Winter pre-smolt passage at Prosser juvenile trap was monitored from November 23, 1988 through March 31, 1989. Estimated passage for fall chinook and steelhead outmigrants was 39 and 9,996 respectively. Spring smolt passage at Prosser was monitored from April 1 through July 13, 1989. Estimated smolt passage was 47,598 wild fall chinook; 81,176 hatchery fall chinook; 42,062 wild steelhead and 16,060 hatchery steelhead.

Estimated presmolt steelhead outmigration in September and October, and through November 23, 1988 at Wapatox was 721; 2,418 and 2,608 fish respectively. Estimated steelhead smolt outmigration at Wapatox during April, May and June was 7,137; 2,041 and 894 fish respectively. Median passage date was April 18. The mean fork length was 134 mm in April and 151 mm in May.

Roza juvenile trap was operated daily during April and weekly thereafter through the summer. Total raw catch was 446 spring chinook smolts, 5,581 spring chinook fry and 407 steelhead-rainbow.

Electroshocking in the Yakima Basin was conducted during the summer of 1989 in the Satus, Toppenish, Naches and upper Yakima systems. A summary of electroshocking results can be found in Tables 12-15.

Thirty-eight sites were electroshocked in the Klickitat Basin during the summer, 1989. Species present included steelhead-rainbow trout (*Oncorhynchus mykiss*), brook trout (*Salvelinus fontinalis*), spring chinook salmon (*Oncorhynchus tshawytscha*) and coho salmon (*Oncorhynchus kisutch*). Densities ranged from no fish at five locations up to 0.56 (fish/m) in lower Trout Creek.

To date 87 Yakima adult steelhead females have been used to determine the length-fecundity relationship. There appears to be high degree of natural variability in fecundity of Yakima Basin fish. The current fecundity to fork length relationship is as follows:

Y= 179.93 (X) - 6,026. Where Y= the number of eggs and X= the fork length (cm).

The survival rate to Prosser for acclimated Toppenish steelhead smolts was 10.12% vs 1.58% for acclimated Little Naches steelhead smolts. The higher survival rate observed in the Toppenish group may be a result of these fish entering the Yakima River downstream of the Parker Dam to Granger Bridge reach. This reach is supected of incurring a high smolt-to-smolt mortality on outmigrating smolts.

3.0 INTRODUCTION

The purpose of this study is to develop and implement a detailed and comprehensive program for monitoring status and productivity of salmon and steelhead in the Yakima/Klickitat Basins. The procedures will cover all phases in the data gathering process from field work to computer retrievable data files. Sampling locations, sample size, sampling frequencies and methods will be described whenever specific information is available.

This project is complementary to the ongoing Yakima spring chinook program. Although there is an emphasis here on steelhead and anadromous salmonids other than spring chinook the general procedures developed will be applicable to all species. The project will draw very heavily upon the experience gained through the spring chinook program, the masterplanning process, and the Refined Project Goals Report for the Yakima/Klickitat Central Outplanting Facility. Through the master planning and refined goals processes new ideas and approaches have been brought forward, which should have immediate benefits to the Yakima/Klickitat salmonid resources. The procedures developed and implemented under this study will coincide with pre-hatchery requirements of the master plan, however it is anticipated that additional monitoring needs may be identified which are not currently known. Additional monitoring needs or experimental opportunties will be developed and presented in the following years revised annual work plan. Any proposed new projects will be reviewed and approved by the Experimental Design Work Group (EDWG) for the Yakima/Klickitat Production Project. It is a principal objective of this project to be entirely consistent with and supportive of the monitoring and evaluation program of the master plan. This project will address monitoring and evaluation and experimental design issues related to the planned production in the new hatchery facility, and will contribute towards the hatchery needs by applying the approach of adaptive management to the baseline data collection and critical uncertainties in the pre-hatchery situation.

A great deal of learning and experience has been gained from the recent projects completed or in progress in the Yakima Basin. The prospects for improving the health of the salmonid resources in the Basin appear very bright at this time. It seems therefore very appropriate to seize upon the opportunity to view the Yakima system as a model for the development of comprehensive monitoring procedures which may have system wide (Columbia Basin) applicability.

4.0 DESCRIPTION OF STUDY AREAS

4.1 YAKIMA SUBBASIN

The Yakima Subbasin is located in south-central Washington. It drains 6,155 square miles and contains about 1,900 river miles of perennial streams. The subbasin is centered around the city of Yakima and includes most of Yakima and Kittitas counties, as well as a small portion of Benton county. The Yakima Indian Reservation is located in the southwest corner of the subbasin just south of the city of Yakima.

The Yakima River and its tributaries drain the subbasin. The Yakima River heads near the crest of the Cascade Range above Keechelus Lake at an elevation of 6,900 feet and flows 214 miles southeastward to its confluence with the Columbia (RM 335.2). Major tributaries include the Kachess, Cle Elum and Teanaway Rivers in the northern part of the subbasin, and the Naches River in the west (Figure 1). The Naches has four major tributaries, the Bumping, American, Tieton and Little Naches Rivers. Ahtanum, Toppenish, and Satus Creeks join the mainstem Yakima in the lower subbasin.

Six major reservoirs provide irrigation water for the subbasin. The Yakima River flows out of Keechelus Lake (157,800 AF), the Kachess River from Kachess Lake (239,000

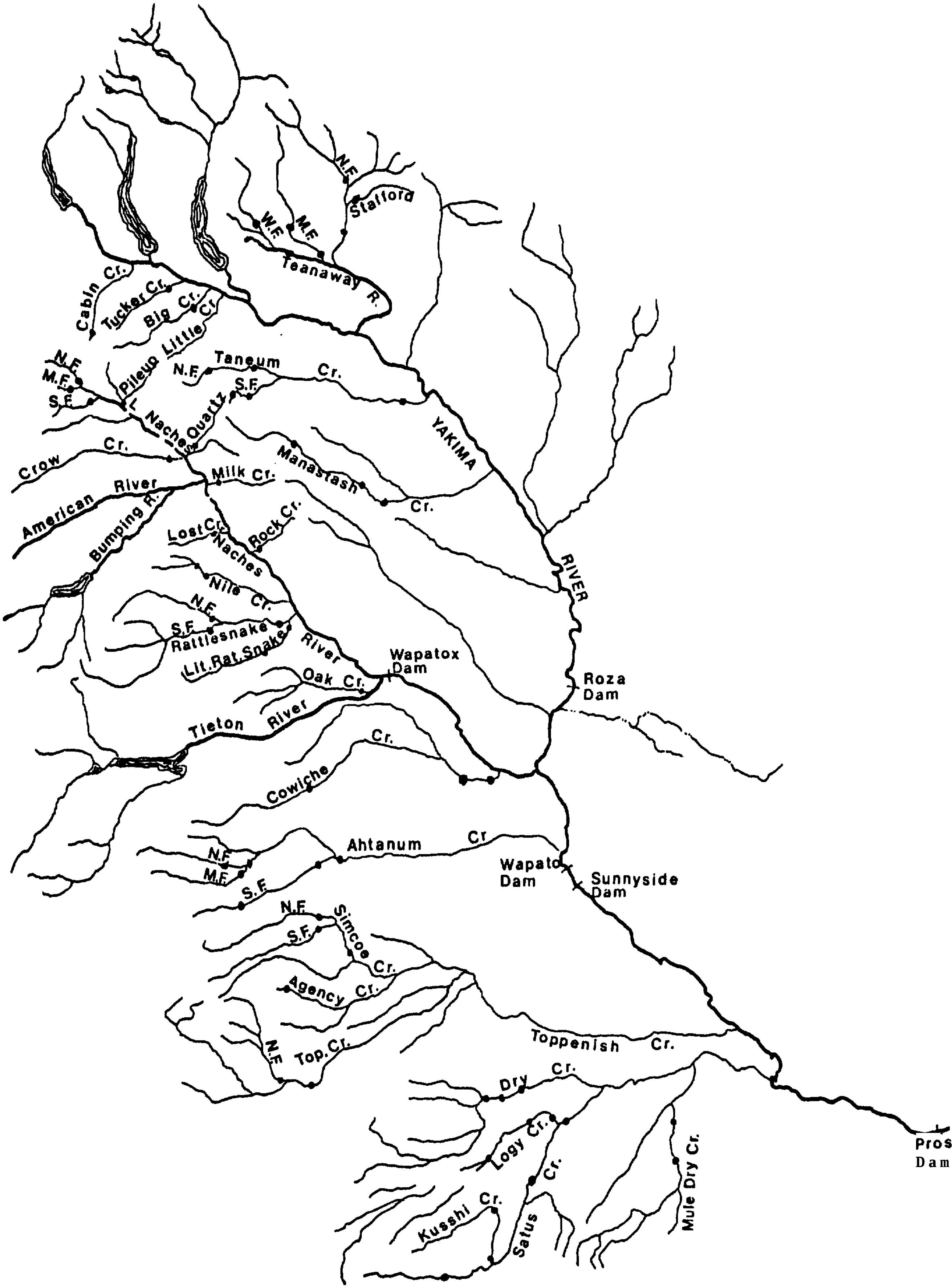


Figure 1. Study area on the Yakima Basin.

AF), the Cle Elum River from Cle Elum Lake (436,000 AF), the Tieton from Rimrock Lake (198,000 AF), the Bumping from Bumping Lake (33,700 AF). The North Fork of the Tieton River connects Clear Lake (5,300 AF) with Rimrock Lake. All reservoirs except Rimrock were natural lakes before impoundment.

There are seven major diversion dams on the mainstem Yakima and several smaller dams on the Naches. From uppermost to lowermost, the Yakima Dams are: Easton (RM 103.8), Town Diversion (RM 161.3), Roza (RM 127.9), Wapato (RM 106.6), Sunnyside (RM 103.8), Prosser (RM 47.1) and Horn Rapids (RM 18.0). The major dams on the Naches are Wapatox (RM 17.1) and Naches Cowiche (RM 3.6).

Topography in the subbasin is characterized by a series of long ridges extending eastward from the Cascades and encircling flat valley areas. Elevations in the subbasin range from about 7,000 feet in the Cascades to about 350 feet at the confluence of the Yakima and Columbia Rivers.

There are seven soil associations in the Yakima subbasin. Four of these associations, (Weirman-Zillah, Renslow-Ritzville, Naches-Woldale and Warden-Shano), comprising about 18% of the subbasin's area, are located in gently sloping areas and are subject to intensive irrigated agriculture. These soil types are fine textured and easily eroded (Anonymous, USDA, 1974). Vegetation in the subbasin is a complex blend of forest, range and cropland. Over one-third of the land in the Yakima subbasin is forested. Rangeland lies between the higher elevation forests and cultivated areas located in the fertile lower valleys. Cropland accounts for about 16 percent of the total subbasin area of which 77 percent is irrigated.

The climate of the Yakima Subbasin ranges from cool and moist in the mountains to warm and dry in the valleys. Annual precipitation near the Cascade crest ranges from 80 to 140 inches, whereas the lower elevations in the eastern part of the subbasin receive 10 inches or less. Summer temperatures average 55 degrees Fahrenheit in the mountains, and 82 degrees Fahrenheit in the valleys. Average maximum winter temperature range from 25 to 40 degrees Fahrenheit, while average minimum winter temperature range from 15 to 25 degrees Fahrenheit. Minimum temperatures of -20 to -25 degrees Fahrenheit have been recorded in most areas.

4.2 KLICKITAT SUBBASIN

The Klickitat River is located on the east slope of the Cascade Range in south-central Washington, and drains an area of 1,350 square miles in Klickitat and Yakima Counties. It enters the Columbia River at rivermile 180.4

(Figure 2). The basin trends north-south toward the Columbia River and is bounded by Mount Adams on the west, the Goat Rocks to the north, and the Simcoe Mountains on the east. Basin topography ranges from rolling hills and plateaus in the south to rugged mountains in the northwest.

There is significant variation in climate within the basin, which is related to elevation and proximity to the Cascade Crest. About three-fourths of the Klickitat subbasin is forested, and forestry and agriculture dominate the subbasin economy.

The Klickitat River heads at an elevation of 4,400 feet near the Goat Rocks in Yakima County and runs for 95.7 miles, dropping to a mean elevation of 74 feet at the Bonneville pool of the Columbia River. Major tributaries include Diamond Fork (RM 76.8), West Fork (RM 63.1), Big Muddy (RM 31.3), Outlet Creek (RM 39.7) and Little Klickitat River (RM 19.8).

Two natural obstacles to upstream fish migration exist in the Klickitat River: Lyle Falls (RM 2.2) and Castile Falls (RM 64.2). Passage improvements have been made at both locations, but difficulties persist. In addition, West Fork has a falls (RM 2.1) that is a blockage to upstream migration.

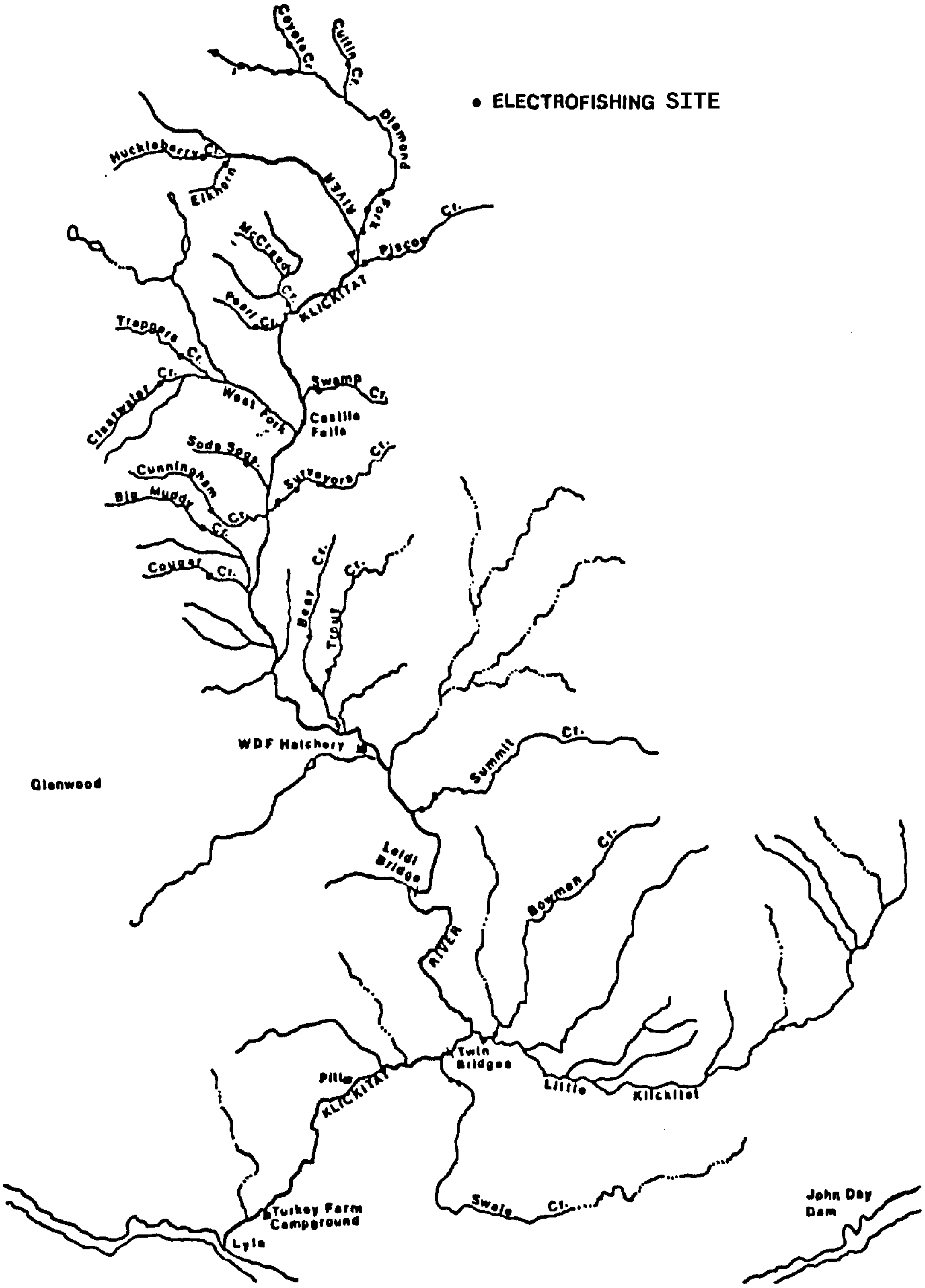


Figure 2. Study area on the Klickitat Basin.

5.0 METHODS AND MATERIALS

5.1 SPAWNER SURVEYS

5.1.1 Fall Chinook

Fall chinook spawner surveys were conducted in both the Yakima and Klickitat Basins during November and December, 1988. One objective of these surveys was to determine if conventional boat and/or aerial survey methods would be feasible to enumerate redds in light of the poor visibility experienced in both river systems, In the Yakima River Basin surveys were conducted in the mainstem from Parker Dam (RM 103.8) to rivermile 2.1. A boat survey was not conducted in the Granger Bridge to Prosser Dam reach because of the limited amount of available spawning area. Each reach, except Parker Dam to Zillah Bridge which was surveyed twice, was survey once during the month of November. Normally each reach was surveyed with two rubber rafts; a raft on each side of the river. Because of the poor water visibilty three rafts were utilized in some of the lower reaches. A fixed-wing survey was conducted November 18, 1988 and a helicopter survey on November 29, 1988 of all reaches. In addition foot surveys were conducted in Marion Drain on December 8, 1988 and the lowest 2 miles of Sulphur Drain, as well as the lower portions of Satus and Toppenish Creeks during last week of

November.

In the Klickitat River a single survey of each reach was conducted (Figure 2), using a single rubber raft on each bank, from the WDF hatchery (RM 42.6) to Turkey Farm Campground (RM 5.0), between November 21 and December 2, 1988.

5.1.2 Summer Steelhead

Spawning ground surveys were initiated in February, 1989 for steelhead spawning in both the Yakima and Klickitat Basins. Poor visiability the entire survey season limited surveys in the Klickitat Basin to selected tributaries. Similar problems were encountered in the Yakima Basin in the Naches system from mid-April through mid-May. Since only 71 adults passed above Roza Dam it was determined that it would be difficult to locate redds in view of the extensive potential spawning area, therefore surveys were not conducted in the upper Yakima River. It's expected that the radio tracking study begining the fall of 1989 will help determine where surveys should be conducted. Extensive surveys were conducted in the Satus and Toppenish Creek Basins from February through mid-April. Satus Creek surveys were conducted from the falls (RM 43.4) to RM 12.5. Dry and Logy Creeks were surveyed from near or at the falls, respectively, to their confluence with Satus Creek. The lower 4.7 RM of Kusshi Creek was surveyed and Mule-Dry

Creek from RM 11.6 to RM 0.8. At present these are considered to be the current spawning reaches in the aforementioned creeks. The upper most survey on Toppenish Creek began at the South Fork (RM 58.2). All survey reaches were conducted on foot and were surveyed one to three times during the coarse of the season depending on the reach.

Because of poor stream conditions surveys in the Naches Basin were limited to the American, Bumping and Little Naches Rivers, and the lower portion of Nile Creek.

Similarly poor river conditions in the Klickitat Basin limited surveys to selected tributaries: Swale, White, Summit and Bowman Creeks.

New redds were flagged with a different colored ribbon each survey and the total number of new redds and live fish were recorded.

5.2 ADULT RETURNS

5.2.1 Prosser Dam

Prosser adult fish counting station is monitored year-round for steelhead, fall and spring chinook and coho salmon. The brood year for steelhead begins July 1 and extends through June 30 of the following year. The fall chinook run extends from August 15 through November and the coho run goes from September through November.

Adult counts at Prosser Dam are monitored using a video camera at the right bank ladder and a fish counting board at the left bank ladder. The newly constructed center ladder began operation on April 24, 1989 and was monitored using a video camera.

5.2.2 Roza Dam

The Roza adult fish counting station is monitored year-round for steelhead and spring chinook. A video camera was installed at the counting window at Roza Dam October 31, 1988 and monitored adult movement through May 15, 1989 (except from 11/06/88 to 12/07/88 when the fish ladder was dewatered for repairs and from March 13-15, 1989 when poor visibility prevented enumeration). After May 15, 1989 counts were conducted using the fish counting board (primarily for spring chinook) under the BPA Spring Chinook Enhancement Study.

Fork lengths are recorded by measuring fish on the video tape. The window has been calibrated by placing a pre-measured board in front of the viewing window where most fish pass. The length of this board was then measured on the video monitor and the calibration factor determined. Fish that were obviously not parallel to the window were not measured.

5.3 JUVENILE COUNTING FACILITIES

5.3.1 Prosser

Prosser smolt trap was operated from November 23, 1988 to July 13, 1989. Prosser trap operates from a bypass pipe that shunts fish from rotary drum screens in Chandler Canal back to the mainstem Yakima River. In 1984, 1985, 1986 and 1987 trapping efficiency (the percentage of outmigrants passing Prosser Dam diverted into the trap) was calculated via a series of releases of marked fish. The statistical methodology for efficiency calculations was evaluated by Douglas Chapman of the University of Washington Center of Quantitative Science. A detailed description of the evaluation process can be found in Appendix B of the 1986 Spring Chinook Enhancement BPA annual report. The basic procedure was as follows. Once each week, fish captured in the trap during the night were cold-branded. Two groups were branded differently, with one group released two miles upstream of the canal intake, and the other in the canal. Efficiency (E_i) was based on the recapture rate of branded fish as follows:

$$E_i = \frac{C_{ri}}{R_{ri}\ (C_{ci}\ /\ R_{ci})}$$

where E_i = fraction of fish diverted into the canal in the ith experiment;

R_{ci} = number released directly into the canal in the ith experiment;

R_{ri} = number released directly into the river in the ith experiment;

C_{ci} = number recaptured from the canal release in the ith experiment; and

C_{ci} = number recaptured from the river release in the ith experiment.

During the 1984, 1985, 1986 and 1987 smolt outmigrations a total of 68 separate efficiency tests were performed using spring and fall chinook and steelhead smolts. A relationship was developed between the combined 1984-87 efficiency data and river discharge. This relationship was then used to estimate the total number of juvenile fish passing Prosser Dam in each of the years the trap was operating. In 1990 the use of pit tags implanted in smolts will refine the efficiency relationship. The confidence intervals for the calculated total smolt passage for each year was estimated from a linearized form of the logistic equation Y = 1/1+E (-A+BX). Lengths, weights and scales were taken from random samples of all species and release groups on a daily basis. In addition unbranded ad-clipped hatchery fall chinook were sacrificed for coded wire tag analysis on a daily basis.

Length frequencies and scale analysis were used to differentiate spring and fall chinook outmigrants.

Explicitly, the number of wild fall chinook migrating past Prosser Dam in a given week was estimated as follows:

$$Nj \sum_{i=a}^{i=b} [\, Li,j)\ \ (Fi,j)] = Nf,j \quad \text{equation 1.}$$

where a and b are length increment bounds, with "a" representing "less that 40 mm, ", "b" representing "greater than 199 mm," and with intervening steps of mm--(40-44, 45-49,..., 195-199);

Li,j = the percent of sampled wild chinook in week j falling in length interval i;

Fi,j = the percent of fish in length interval i in week j determined from scale analysis to fall chinook, i.e., 0-age;

Nj = the estimated outmigration of all wild chinook in week j; and

Jf,j = the estimated number of wild fall chinook in week j.

5.3.2 Wapatox

The purpose of Wapatox smolt trap is to monitor salmonid smolt outmigration in the spring and pre-smolt outmigration the remainder of the year from the Naches Basin. Species monitored include spring chinook salmon, steelhead and rainbow trout and other resident trout species. Wapatox smolt trap is located on the Naches

River at RM 17, just downstream from the confluence of the Tieton and Naches Rivers (Figure 1). The trap is constructed on the Wapatox fish-bypass ditch. Fish entering the canal are shunted into a by-pass pipe by a series of rotating drum screens across the diversion canal.

The 1988 fall monitoring season was initiated September 1 and ended November 23 when the screens in the canal were removed for the winter. The canal was dewatered for repairs from October 17 through November 4. Wapatox smolt trap began operation on April 1, 1989 when the rotary drum screens were installed into the canal. Monitoring of the spring smolt outmigration extended through the month of June. Three periods of high river flow (4/14-25, 5/05-15 and 6/05-15) rendered the trap inoperable. During these periods daily catch estimates were determined based on a linear regression of the mean daily catch 7 days preceeding and following these events. Since estimated trap efficiency has not been experimentally determined for steelhead, the percent discharge diverted into the canal was used to estimate daily catch.

The trap was normally checked at least 4 times per week and more often during peak migration periods. Only salmonid species were enumerated. Fish were anesthetized with MS-222, fork lengths and weights were recorded, and scale samples were taken from steelhead and spring chinook smolts.

5.3.3 Roza

Roza juvenile trap was operated on a experimental basis begining April 1, 1989 and continuing through the summer. A primary objective was to determine its effectiveness to monitor juvenile salmonid outmigration from the upper Yakima River. An incline plane trap was fished in the fish bypass passage on a 24 hr basis. Fish are directed into the fish bypass system by a series of rotary screens in the forebay. Except for two periods (4/14-19 and 4/28-30) the trap was monitored daily during the month of April. Begining in May the trap was normally fished one day per week for a 24 hr period. Fish were removed from the livebox on a hourly basis and anesthetized with MS-222. After fish were identified according to species, fork lengths and scale samples were taken from a portion of each day's catch. When possible steelhead smolts and resident rainbow trout were separated based on coloration of fins and body. No attempt was made this initial year to establish a flow to entrainment relationship. This will be investigated next spring (1990).

5.4 DISTRIBUTION STUDIES

5.4.1 Yakima Basin

Summer electroshocking surveys were conducted throughout the Yakima Basin in selected tributaries (Figure 1). In the Yakima Basin sampling was conducted in the following watersheds: Satus, Toppenish, Naches, and the mid and upper Yakima. One hundred meter sections were generally selected, representive of the surrounding stream habitat. In most cases the Zippen two-pass removal method (Zippen, 1958) was used to determine salmonid population size. In cases where a high number of fish were collected on the second pass, a third pass was made and the Leslie and Davis method (Leslie and Davis, 1939) was used to calculate population size. To minimize mortality to fry no attempt was made to capture all fish present. Stop nets were used to block downstream movement, while a natural barrier was used to prevent upstream movement. Sampling was conducted in a downstream direction starting at the upstream barrier. A Smith-Root Type-VII electroshocker and dip nets were used to capture the fish. Salmonids collected were anesthetized with MS-222. Data collected included species identification, number of fish per pass, fork lengths and scale samples.

5.4.2 Klickitat Basin

Watersheds sampled in the Klickitat Basin were above Castile Falls (upstream to RM 87), below Castile Falls and the Little Klickitat. Similar sampling procedures used in the Yakima Basin were employed in the Klickitat Basin.

5.5 STEELHEAD LENGTH-FECUNDITY MODEL

Since 1987 length-fecundity information has been recorded from wild steelhead broodstock collected for the YIN-WDW hatchery broodstock program. Both the fork and mid-eye to hypural plate lengths were recorded, as well as the number of eggs collected. Any fish with a partially green or otherwise damaged skein was not included in the analysis. Up until 1989 estimated fecundity was determined by the weight method (Mandis and Harris, 1984). This method involves dividing the mean weight of four samples, consisting of 100 eggs each, into the total weight of eggs and multiplying by 100. Since 1989 the Von Bayer method (Mandis and Harris, 1984) has been used after it was determined that equivalent estimates could be obtained to reduce potential stress to the eggs.

5.6 HATCHERY STEELHEAD RELEASES

Hatchery steelhead smolts released into the Yakima Basin were divided into four groups, two acclimation and two non-acclimated. Releases were made into Toppenish Creek at the WIP Diversion Dam (RM 44.2) and the Little Naches River at the Quartz Creek confluence (RM 3.4).

The experimental design purpose was three-fold, firstly, to evaluate the survival rate to Prosser between acclimated and non-acclimated smolts and to compare the smolt survival rate to Prosser between fish released from each of the two acclimation sites. Secondly, to outplant steelhead into currently underseeded areas. Thirdly, to evaluate survival and homing of adults.

Toppenish and Little Naches acclimated fish were released into their respective acclimation sites on March 29 and March 25. The Toppenish site consisted of an enclosed area between the trash racks and fish screens in the WIP diversion canal; while a beaver pond was used at the Little Naches site. At the Toppenish site a small portion of the fish were inadvertently released between the trash rack and canal headgate. These fish were able to escape into the river by swimming under the headgate, however, the water velocity under the headgate appeared quite high and was probably a barrier for most fish. On March 28 it was discovered that otters had moved into the beaver pond at the Little Naches site and it was decided to release the fish that evening. Within 48 hours nearly 100% of the fish had outmigrated. Toppenish acclimated fish were allowed to volitionally release April 14. Because of high stream flows in Toppenish Creek the flow in the fish bypass pipe was neutral or negative for about 10 days after being volitionally released. This may have extended the outmigration time of fish from the canal because of little or no attraction flow out of the canal. Non-acclimated smolts were released directly into Toppenish Creek April 14 and into the Little Naches April 13.

Through the reading of branded hatchery steelhead smolts at Wapatox juvenile trap it was discovered that an unknown number of Toppenish non-acclimated fish were released into the Little Naches. Possible explainations for this are; 1) that a portion of the non-acclimated Toppenish fish were trucked to the wrong release site, 2) that a portion of the non-acclimated Toppenish fish were branded and released back into the wrong pond, or 3) that the wrong brand code was applied to a portion of the non-acclimated Toppenish fish.

6.0 RESULTS AND DISCUSSION

6.1 SPAWNER SURVEYS

6.1.1 Fall Chinook

Fall chinook redd surveys in the Yakima Basin were conducted during the months of November and early December (Table 1). Fall chinook spawning in the Yakima River occurs from Parker Dam (RM 103.8) to rivermile 2.1. Spawning also occurs in Marion Drain which enters the Yakima River at Granger (RM 82.6). A total of 12 redds were found in Marion Drain. No spawning was observed in the lower reaches of Toppenish and Satus Creeks and Sulphur Drain. In the mainstem Yakima the majority of spawning occurred below Prosser Dam (RM 47.1). Of the 203 total redds counted (boat surveys), 73% (149 redds) occurred downstream of Prosser Dam. The highest redd density occurred in the Benton to Horn Rapids Dam reach with 5.8 redds per mile.

Water clarity was a significant problem in all reaches except those on Marion Drain and Satus and Toppenish Creeks. Visibility into the water was less than two feet and visibility adjacent to the observer was generally under ten feet. Redds were generally

Table 1. Fall chinook spawning ground rurvcys in the Yakima Basin, 1988.

Survey Reach	Rivermiles	Redd counts for each rurvey method					
		Survey date	Boat/a foot/b	Survey date	Fixed-wing	Survey date	Heli-copter
MAINSTEM							
Parker Dam to Zillah Bridge	13.3	03-Nov	0/a	18-Nov	1	29-Nov	4
	13.3	14-Nov	14/a				
Zillah Bridge to Granger Bridge	7.5	03-Nov	40/a	18-Nov	8	29-Nov	24
Granger Bridge to Prosser Dam	35.9	not surveyed		18-Nov	3	29-Nov	13
Prosser Dam to Benton	17.3	16-Nov	32/a	18-Nov	18	29-Nov	21
Benton to Horn Rapids Dam	11.8	14-Nov	69/a	18-Nov	23	29-Nov	32
Horn Rapids Dam to Richland Bridge	15.9	15-Nov	48/a	18-Nov	19	29-Nov	58
							1
TRIBUTARIES							
Lower Satus Cr.	2.9	23-Nov	0/b				
						29-Nov	
Lower Toppenirh Cr	2.4	23-Nov	0/b				
Sulphur Crain	2.0	29-Nov	0/b				
Marion Drain	17.2	08-Dec					
Lateral C to Highway 97	12.0		10/b				
Highway 97 to confluence	7.0		12/b				

deposited, when observable, in water depths of 2.5 to 3.0 ft. For these reasons its highly likely that the total number of redds deposited was underestimated.

A comparison between survey methods; boat, fixed-wing and helicopter indicate that the boat surveys were most effective. Nearly twice as many redds were counted with boat surveys as with the helicopter survey, which was next best (Table 1). Since the helicopter survey was conducted about two weeks later than the boat surveys it is possible that some redds were begining to algae-over and thus reduce the number of observable redds. However, observers on both the helicopter and fixed-wing surveys noted that visibility was poor because of poor water clarity and glare on the water surface (which was more pronounced due to the low angle of the sun during late fall). Battelle Northwest biologists who have conducted aerial surveys in the lower Yakima River for the past several years have encountered similar difficulties on their fall chinook surveys (Watson 1988, Personal Communication). However, relative redd densities between reaches were comparable between the three methods.

Surveys on the Klickitat River (Table 2) were conducted in late November and early December, from the WDF hatchery (RM 42.6) to Turkey Farm Campground (RM 5.0). The greatest concentration of redds occurred in the hatchery to Leidl Bridge reach (5.5 redds/mi). Redd

Table 2. Fall chinook spawning ground surveys in the Klickitat Basin, 1988.

Survey reach	Survey date	Rivermiles	Redd count	Live Count
Boat Surveys				
MAINSTEM				
WDF hatchery to Leidl Bridge	21-Nov	10.6	58	4
Leidl Bridge to Twin Bridges	22-Nov	13.7	21	0
Twin Bridges to Pitt	01-Dec	8.0	2	0
Pitt to Turkey Farm cmpgr.	02-Dec	3.5	1	0

density progressively decreased below Leidl Bridge. Survey conditions in the Klickitat River were generally poor due to limited visibility into the water.

6.1.2 Summer Steelhead

A total of 404 redds were counted in the Satus Creek Basin (Tables 3 and 4), with 129 of these occurring in the Satus mainstem. Redd counts in Dry, Kusshi, Logy and Mule-Dry, major tributaries to Satus Creek were 128, 27, 83 and 10 respectively. Redd density in the Satus mainstem (upstream from rd 23, RM 12.5) was 4.2 redds/mi. Highest redd density occurred in Logy Creek with 7.5 redds/mi; followed by Kusshi, Dry and Mule-Dry with 5.7, 5.5 and 1.0 redds/mi respectively. Peak spawning throughout the basin occurred from mid-March to mid-April. Only 1 redd was found before March.

The majority of spawning in Satus Creek occurred upstream of the second crossing (RM 23.7), with the highest concentration occurring in the last crossing (RM 39.2) to High Bridge (RM 32.4) reach. Reasons for this are the higher stream gradient upstream to High Bridge, which is more conducive to steelhead spawning and the overall better rearing conditions, in terms of water temperature and summer flow, that exist upstream from

Table 3. Satus Creek and tributary steelhead redd counts for the 1988-89 season.

Stream/Reach	Reach length (RM)	Date	Redds	Live
Satus Creek				
falls to Highuay 97	4.4	01-Feb	0	0
		21-Mar	16	13
		II-Apr	15	2
section total			31	15
Highway 97 to county bridge	2.8	01-Feb	0	0
		El-Mar	9	4
		II-Apr	17	6
section total			26	10
county bridge to high bridge	3.7	02-Feb	0	0
		21-Mar	4	7
		II-Apr	26	3
section total			30	10
high bridge to Holwegner	3.9	02-Feb	0	0
		21-Mar	9	11
		12-Apr	â	0
section total			17	11
Holwegner to second Satus	4.8	02-Feb	1	0
		22-Mar	7	6
		II-Apr	11	1
section total			19	7
second Satus to gauge station	6.7	06-Feb	0	0
		22-Mar	0	0
		12-Apr	5	0
section total			5	0
gauge station to Road 23	4.7	17-Feb	0	0
		12-Apr	1	0
section total			1	0
STREAM TOTAL			129	
Shinando Creek (Lowest 0.5 mi)	0.5	08-Feb	0	0
		II-Apr	0	0
STREAM TOTAL			0	0
Wilson Charley Creek	1.9	09-Feb	0	0
		05-Apr	12	0
		11-Apr	3	3
STREAM TOTAL			15	3
Bull Creek (lowest 1.4 mi)	1.4	oa-Feb	0	0
		14-Apr	12	0
STREAM TOTAL			12	0
Kusshi Creek (Lowest 4.7 mi)	4.7	oa-Feb	0	0
		23-Mar	8	7
		13-Apr	19	3
STREAM TOTAL			27	10

Table 4. Logy, Dry and Mule-Dry Creeks steethead redd counts for the 1988-89 season.

Stream/Reach	Reach length (RM)	Date	Redds	Live
Logy Creek				
Falls to Spring Creek	2.7	14-Apr	11	0
			15	0
section total			26	0
Spring Creek to third crossing	5.8	Oa-Feb	0	0
		04-Apr	28	10
		14-Apr	19	0
section total			47	10
third crossing to confluence	2.5	Oa-Feb	0	0
		06-Apr	10	1
section total			IO	1
STREAM TOTAL			a3	
Dry Creek				
south fork to saddle	3.6	07-Feb	0	0
		31-Mar	22	3
		13-Apr	19	3
section total			41	6
saddle to elbow crossing	4.8	07-Feb	0	0
		31-Mar	30	9
		13-Apr	14	4
section total			44	13
elbow crossing to road 75	7.7	07-Feb	0	0
		03-Apr	17	7
		14-Apr	a	1
section total			25	a
road 75 to powerlines	5.4	07-Feb	0	0
		03-Apr	12	2
		14-Apr	2	0
section total			14	2
powerlines to confluence	1.6	09-Feb	0	0
		31-Mar	4	2
section total			4	2
STREAM TOTAL			128	
Mule-Dry Creek				
Yakima Chief Rd. to C.B. crossing		28-Apr	1	0
section total			1	0
C.B. crossing to fence tine		24-Mar	6	1
		17-Apr	3	0
section total			9	1
STREAM TOTAL			IO	
Satus Basin Total			404	

this point. In Dry Creek the majority of spawning occurred upstream of Seattle Creek (RM 11.7). Reasons for this are both the moderate water temperatures and perennial flow that exists upstream from Seattle Creek for juvenile rearing. Below this point extremely poor stream flows and high water temperatures persist from late spring through summer. In fact the creek generally becomes intermittent or dry from Road 75 (RM 7.0) to its confluence by July 1. A survey of lower Dry Creek in July revealed that emergent fry were rearing in several isolated pools and intermittent reaches. However, it appears unlikely that many of these fry are able to survive to smolt and ultimately return to spawn in these lower reaches.

Spawning was found to occur up to RM 4.6 in Kusshi Creek and spawning was equally distributed from this point to the confluence.

The majority of spawning in Logy Creek occurred upstream from RM 2.5, with the highest redd density (9.6 redds/mi) found from Logy Falls (RM 11.0) to Spring Creek (RM 8.3).

The 10 redds found in Mule-Dry Creek were all found, with the exception of one, between RM 4.0 and RM 8.4. Similar to Dry Creek the low number of redds is a reflection of the limited amount of summer rearing area.

A total of 47 redds were counted in the Toppenish

Creek Basin, with 37 of these occurring in Toppenish Creek and the remaining 10 in Simcoe Creek (Table 5). The highest redd density (4.8 redds/mi) in Toppenish Creek occurred between the North Fork (RM 55.4) and Willy Dick Creek (RM 48.5). Most of the remaining redds were located downstream from Willy Dick Creek to the WIP Dam (RM 44.2). Though one redd was found below the Signal Peak Road crossing (RM 40.2) little suitable spawning habitat exists downstream from this point for steelhead. With the exception of two redds in the North Fork, all the redds found in Simcoe Creek occurred from the North Fork and South Fork confluence (RM 18.9) to White Swan (RM 8.1). Little suitable spawning habitat exists for steelhead below White Swan.

Estimated adult escapement was 502 into the Satus Basin and 58 into the Toppenish Basin, or 43% and 5% of the total estimated escapement above Prosser Dam respectively. This is based upon an estimate of 1.2 females per redd and an estimated female-to-male sex ratio of 1.5:1.0 in the Yakima Basin (Watson, 1988). The significantly lower escapement observed in the Toppenish Basin compared with the Satus Basin is most likely a result of poor passage conditions that both currently and previously existed. Prior to 1987 there

Table 5. Toppenish Creek Basin steelhead redd counts for the 1988-89 season.

Stream/Reach	Reach Length (RM)	Date	Redds	Live
Toppenish Creek				
North Fork (RM 4.5 to concluence)	4.5	15-Feb 31-Mar	8	0 2
section total			0	2
South Fork (rd 199 to rd 195)	1.5	15-Feb	0	0
South Fork to North Fork	2.7	15-Feb 31-Mar	0 2	0 0
section total			2	0
North Fork to Willy Dick Creek	5.8	10-Feb 30-Mar	0 28	18
section total			28	19
Wilty Dick Creek to WIP dam	4.0	09-Feb 30-Mar	8	0 4
section total			6	4
WIP dam to Signal Peak Road	3.7	10-Feb 29-Mar	8	0 0
section total			0	0
Signal Peak Rd to Shaker Church Rd	2.7	10-Feb 29-Mar	0 1	0 1
section total			1	1
STREAM TOTAL			37	
Hill Creek				
upper section		16-Feb	0	0
Lower section		17-Feb	0	0
STREAM TOTAL			0	
Simcoe Creek				
North Fork		13-Feb 28-Mar	0 2	0 1
section total			2	1
South Fork		13-Feb 28-Mar	0 0	0 0
section total			0	0
forks to UIP Dam	4.5	1 -Feb 23-Mar	0 4	0 1
section total			4	1
WIP Dam to White Swan	3.5	14-Feb 27-Mar 30-Apr	0 2 2	0 2 0
section total			4	2
STREAM TOTAL			IO	
Agency Creek				
crossing to Job Corps	2.8	14-Feb 28-Mar	0 0	0 0
section total			0	0
Job Corps to mill	5.3	14-Feb	0	0
section total			0	0
STREAM TOTAL			0	
Wahtun Creek (Lowest 1.0 mi)	1.0	16-Feb	0	0
Toppenish Basin Total			47	

was no fish ladder at the WIP Dam on Toppenish Creek and thus adult passage was limited to periods when flow conditions were conducive to passage. There was also no fish screen at this facility thus the loss of smolts through entrainment adversely impacted the number of returning adults. At the South Satus pump station on Toppenish Creek (RM 3.5) the tainter gates are lowered into the creek at the onset of the irrigation season blocking upstream migration. A newly constructed fish ladder in 1988 rectified this problem. Steelhead smolt outmigrants are currently lost at the WIP Mud Lake pump station on Toppenish Creek (RM 26.5) which lacks screened pump intakes. There currently exists a migratory blockage at the WIP diversion on Simcoe Creek (RM 13.9) at certain low flows (though passage at this facility was improved in 1989); fish screens are also lacking to prevent entrainment of smolts into the canal.

Surveys conducted in the Naches Basin tributaries: lower Little Naches, Bumping and American Rivers were all plagued by high flows and marginal visibility. The monthly mean flow recorded in the upper Naches River was 1,869 cfs; the highest monthly mean since records have been kept in 1977. Surveys on the mainstem Naches River were not attempted for similar reasons. Of the surveys conducted no redds were located. However, the poor conditions are likely the reason for this. No spawning was found in the lower 4.0 RM of Nile Creek.

Though no formal surveys were conducted in the upper Yakima Basin, 10-20 adults, as well as some redds were sighted in the West Fork of the Teanaway River, 1/4 mi above the confluence, on May 15 (Bambrick 1989, Personal Communication).

Unusually poor river conditions precluded conducting any surveys on the mainstem Klickitat River the entire season. No redds were found during foot surveys conducted on the lower reaches of White, Summit and Bowman Creeks.Two redds were located in the middle reach of Swale Creek in mid-February.

6.2 ADULT RETURNS

6.2.1 Prosser Dam

A summary of the fall chinook counts from 1983-87 is presented in Appendix Tables A.1-5. The highest estimated run size occurred in 1984 with 1,332 returning adults and the lowest occurred in 1988 when only 221 returning adults were counted (Table 6). The mean adult return since 1983 is 570 fish. Migration past Prosser extends from mid-August through November 30. Out of the five complete years the median passage date (Figure 3) has occurred as early as September 14 (1985) and as late as October 8 (1987). Hatchery fall chinook have comprised between 0.3% (1986) and 4.7% (1987) of the total fall chinook run past Prosser since 1986.

A summary of adult steelhead counts at Prosser from the 1984-85 run through the 1987-88 run is presented in Appendix Tables B.1-4. Steelhead counts past Prosser ranged from a low of 1,166 adults during the 1988-89 season (Table 7) to a high of 2,693 adults during the 1987-88 season. The mean run size for the last 5 seasons is 2,158 adults. The steelhead run in the Yakima River is bimodel with a peak migration occurring in the fall, followed by a period of minimal movement in the winter, followed by another period of increased migration in the spring (Figures 4 and 5). However, the median passage

Table 6. Weekly total passage of fall chinook at Prosser Dam, 1988.

Date	Daily count			Cumulative count		
(week ending) (date)	Wild	Hatchery	Combined	Wild	Hatchery	Combined
17-Aug	0	0	0	0	0	0
24-Aug	0	0	0	0	0	0
31-Aug	1	0	1	1	0	1
07-Sep	5	1	6	6	1	7
14-Sep	22	3	25	28	4	32
21-Sep	20	0	20	48	4	52
28-Sep	31	1	32	79	5	84
05-Oct	65	0	65	144	5	149
12-Oct	21	0	21	165	5	170
19-Oct	41	0	41	206	5	211
26-Oct	5	0	5	211	5	216
02-Nov	1	0	1	212	5	217
09-Nov	2	1	3	214	6	220
16-Nov	1	0	1	215	6	221
23-Nov	0	0	0	215	6	221
30-Nov	0	0	0	215	6	221
07-Dec	0	0	0	215	6	221
14-Dec	0	0	0	215	6	221
21-Dec	0	0	0	215	6	221
28-Dec	0	0	0	215	6	221
Totals	215	6	221			

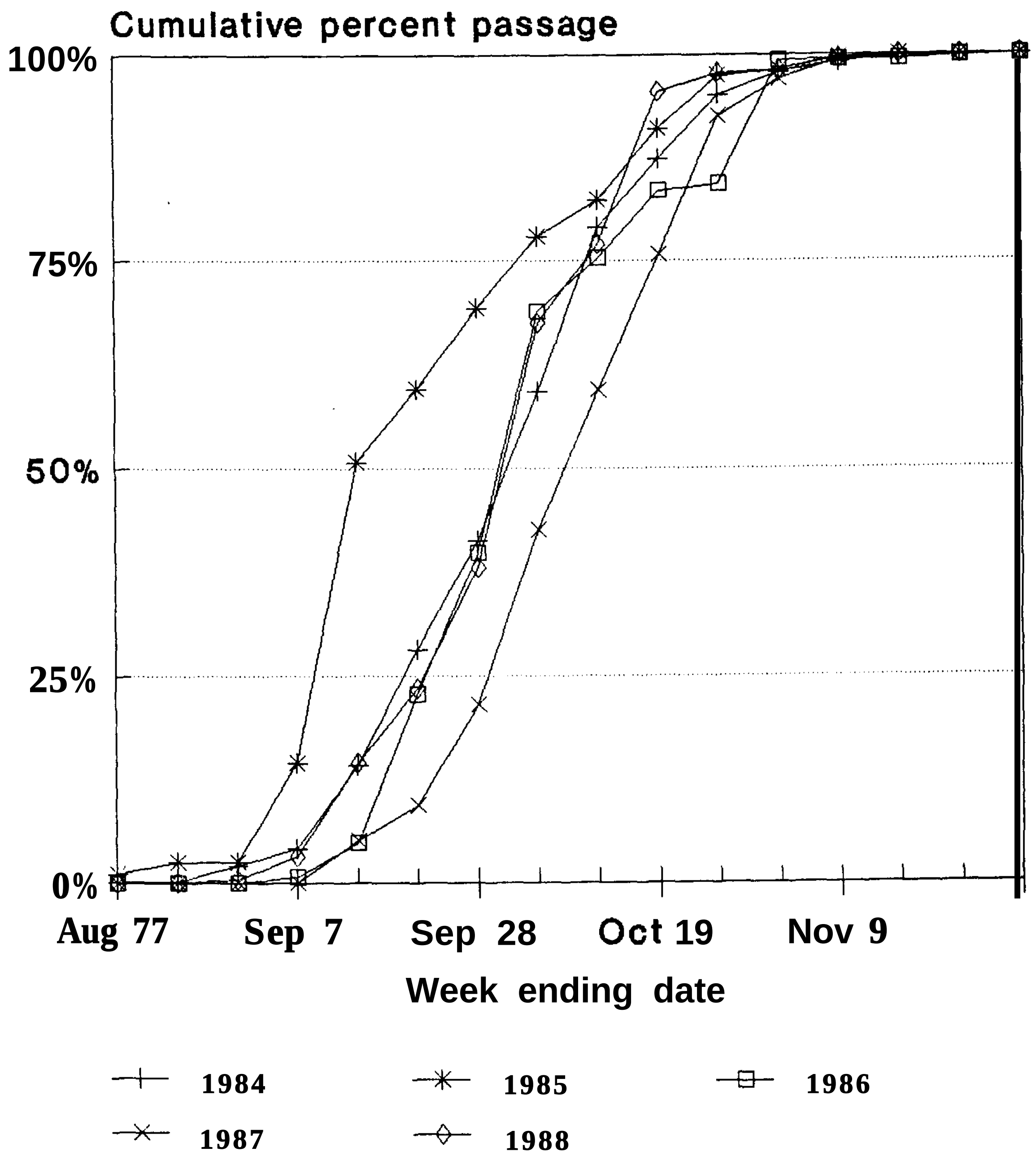


Figure 3. Cumulative percent passage of adult fall chinook past Prosser, 1984-89.

Table 7. Weekly total steelhead passage at Prosser Dam, 1988-89 season.

Date	Daily count			Cumulative count		
(week ending) (date)	Wild	Hatchery	Combined	Wild	Hatchery	Combined
07-Jul	0	0	0	0	0	0
14-Jul	0	1	1	0	1	1
21-Jul	0	0	0	0	1	1
28-Jul	0	0	0	0	1	1
04-Aug	0	0	0	0	1	1
11-Aug	0	0	0	0	1	1
18-Aug	0	0	0	0	1	1
25-Aug	0	0	0	0	1	1
01-Sep	0	0	0	0	1	1
08-Sep	0	0	0	0	1	1
15-Sep	13	1	14	13	2	15
22-Sep	77	4	81	90	6	96
29-Sep	31	2	33	121	8	129
06-Oct	68	10	78	189	18	207
13-Oct	27	8	35	216	26	242
20-Oct	76	21	97	292	47	339
27-Oct	30	5	35	322	52	374
03-Nov	25	2	27	347	54	401
10-Nov	25	3	28	372	57	429
17-Nov	29	1	30	401	58	459
24-Nov	21	0	21	422	58	480
01-Dec	20	6	26	442	64	506
08-Dec	3	0	3	445	64	509
15-Dec	18	0	18	463	64	527
22-Dec	0	0	0	463	64	527
29-Dec	0	0	0	463	64	527
05-Jan	10	0	10	473	64	537
12-Jan	13	0	13	486	64	550
19-Jan	20	1	21	506	65	571
26-Jan	0	0	0	506	65	571
02-Feb	32	0	32	538	65	603
09-Feb	0	0	0	538	65	603
16-Feb	0	0	0	538	65	603
23-Feb	0	0	0	538	65	603
01-Mar	190	9	199	728	74	802
08-Mar	23	0	23	751	74	825
15-Mar	47	2	49	798	76	874
22-Mar	147	11	158	945	87	1,032
29-Mar	57	4	61	1,002	91	1,093
05-Apr	10	0	10	1,012	91	1,103
12-Apr	9	0	9	1,021	91	1,112
19-Apr	5	0	5	1,026	91	1,117
26-Apr	9	0	9	1,035	91	1,126
03-May	16	3	19	1,051	94	1,145
10-May	9	0	9	1,060	94	1,154
17-May	7	0	7	1,067	94	1,161
24-May	1	0	1	1,068	94	1,162
31-May	0	0	0	1,068	94	1,162
07-Jun	0	0	0	1,068	94	1,162
14-Jun	0	0	0	1,068	94	1,162
21-Jun	4	0	4	1,072	94	1,166
28-Jun	0	0	0	1,072	94	1,166
Totals	1,072	94	1,166			

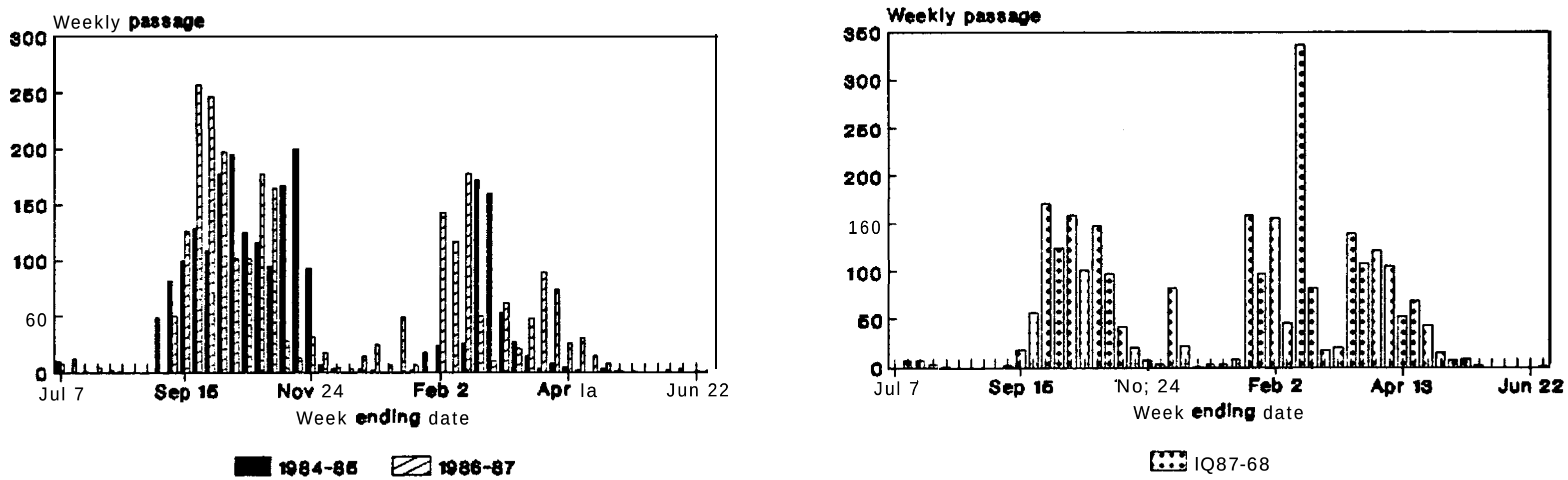


Figure 4. Summary of weekly adult steelhead passage at Prosser for the 1984-85, 1986-87 and 1987-88 seasons.

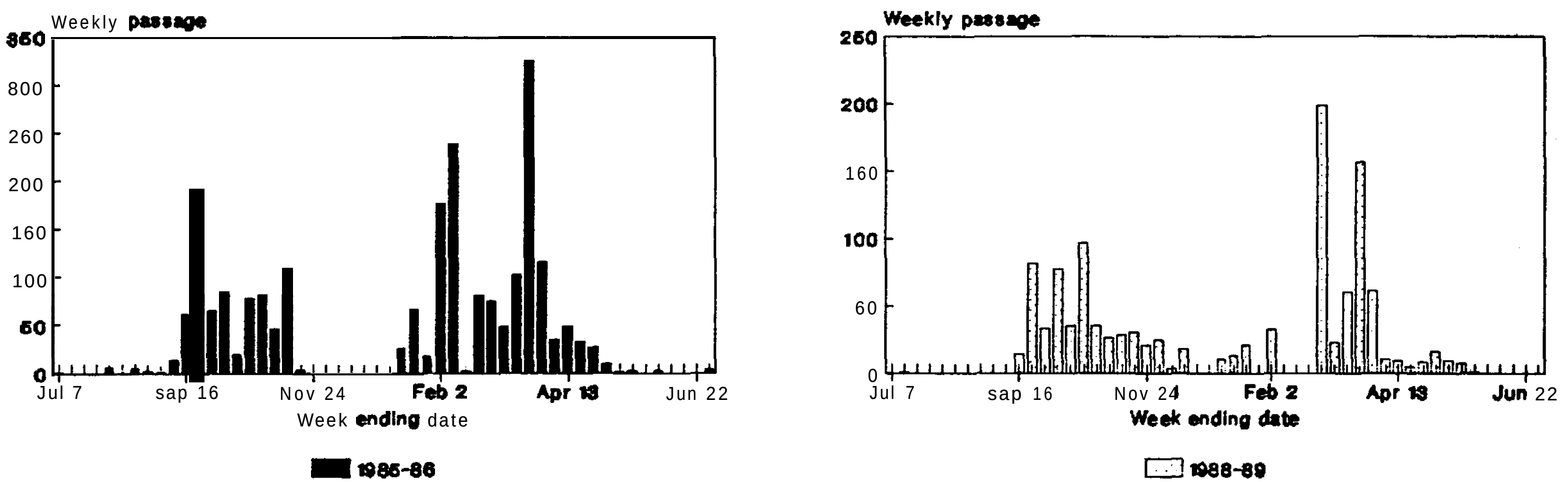


Figure 5. Summary of weekly adult steelhead passage at Prosser for the 1985-86 ad 1988-89 seasons.

date (Figure 6) has not been consistent. The median passage date occurred October 27 for the 1984-85 and 1986-87 seasons, January 26 for the 1987-88, February 1 for the 1988-89 season, and February 4 for the 1985-86 season. Records for hatchery fish migrating past Prosser have been kept since the 1986-87 season. For the past two seasons (1987-88 and 1988-89) the hatchery contribution to the total run has averaged 8.2%; during the 1986-87 season it was only 1.6%.

6.2.2 Roza Dam

With the completion of the redesigned fish ladder in the winter of 1988 steelhead adults were able to migrate beyond Roza Dam throughout the entire season. Prior to this the ladder was nonfunctional at various times during the migration period; usually in October (after the irrigation season), during periods of severe river ice, and again in March prior to the next irrigation season. Monitoring began October, 1988 and extended through the remainder of the 1988-89 season. Some difficulty has been encountered in distingishing large resident rainbow trout around 51.0 cm (20 in) from small adult steelhead. Figure 7 presents the length distribution of rainbow trout and steelhead (approximately 20 rainbow trout known to be less than

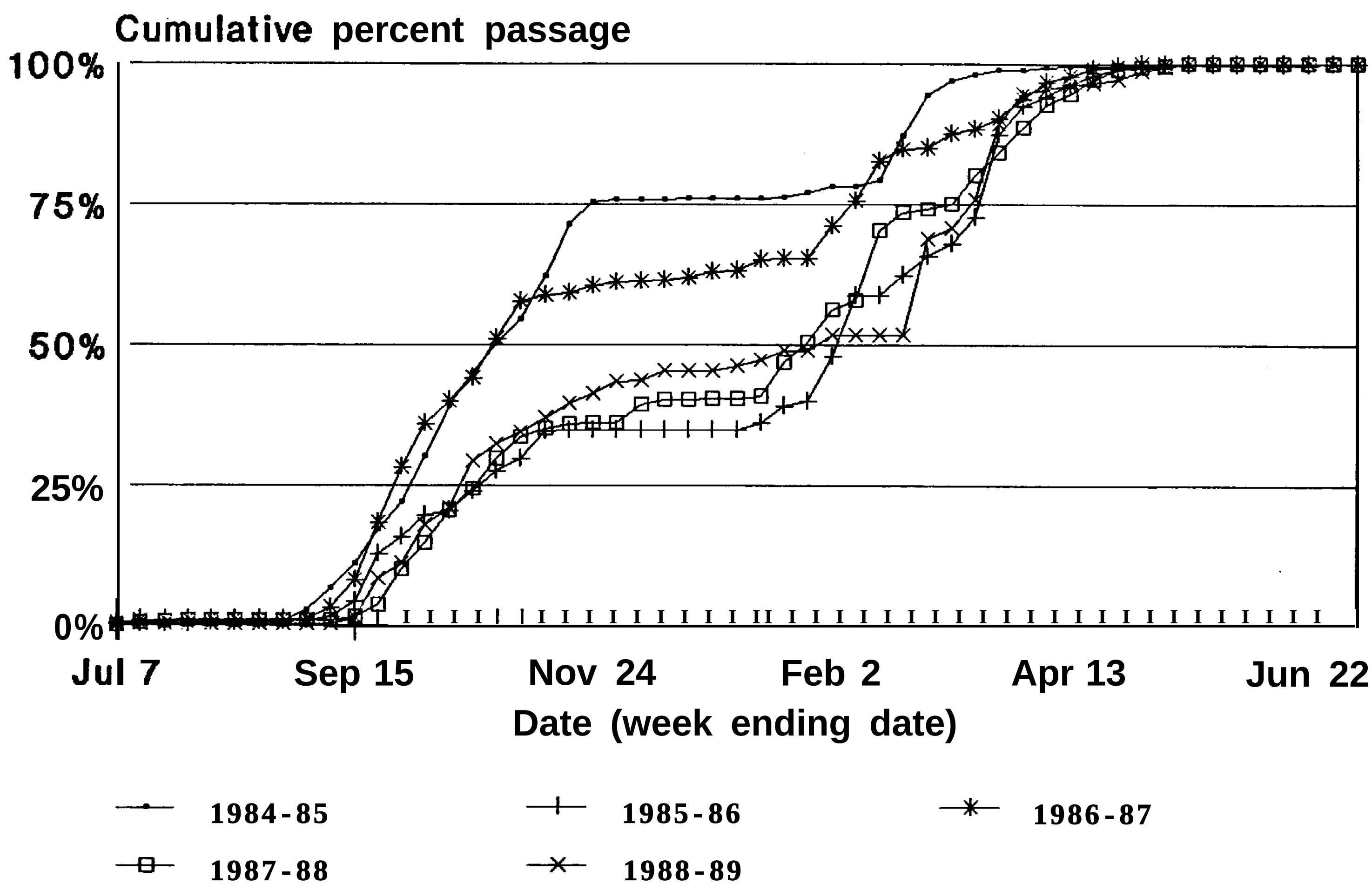


Figure 6. Cumulative percent of adult steelhead at Prosser, 1984-85 through 1988-89.

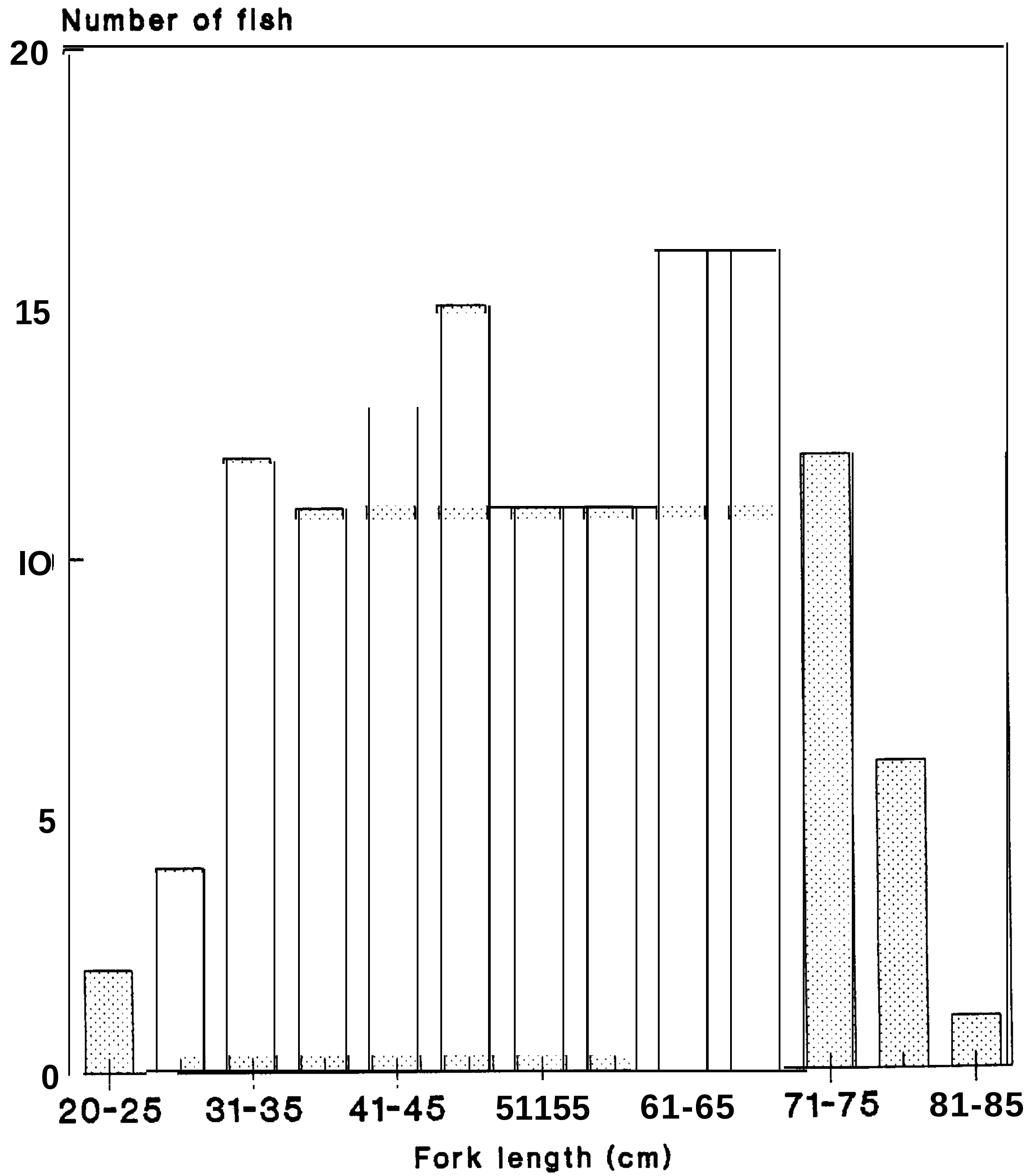


Figure 7. Length frequency distribution of adult steelhead and rainbow trout (not all lengths were recorded on fish under 51.0 cm) at Roza during the 1988-89 season.

51.0 cm are not included in the figure). If the standard 51.0 cm length determinate is used a total of 71 adults passed Roza Dam. Mean steelhead fork length was 64.9 cm (25.6 in). Fish ranged in length from 51.0 cm to 80.6 cm (31.7 in). Little migration past Roza was observed prior to March. Of the total run counted at Roza 45.1% passed during March and 40.8% passed during April.

6.3 JUVENILE COUNTING FACILITIES

6.3.1 Prosser

Smolt outmigration was estimated from a logistic relationship between percent river diversion and percent entrainment (Fast et. al., 1985). A logistic relationship was fit to data from test releases made in 1984, 1985, 1986 and 1987. This relationship (Appendix B of the 1986 Spring Chinook Enhancement BPA annual report) was used to estimate 1989 outmigration. Test releases will be made throughout the duration of the project. The diversion-entrainment relationship will be refined and the outmigration of previous years re-estimated.

6.3.1.1 Winter Movement

The Prosser smolt trap was operated from November 23, 1988 through March 31, 1989 to monitor the winter outmigration of juvenile salmonids. The total estimated outmigration of salmonids is presented in Table 8. Estimated outmigration of wild steelhead was 9,996 with 93.5% passing between March 8 and March 21, 1989. Estimated outmigration of wild fall chinook (fry) was 39, hatchery coho and wild coho were 26 and 1 respectively.

Table 8. Estimated outmigration of juvenile salmonids at Prosser Dam November 23, 1988 through March 31, 1989.

Period of Estimation	Total steelhead	Total fall chin. fry	Total wild coho	Total hatchery coho
11/23/88-11/30/89	30	0	0	0
12/01/89-12/07/89	17	0	0	0
12/08/89-12/14/89	8	0	0	0
12/15/89-12/21/89	7	0	0	0
12/22/89-12/31/89	19	0	0	0
01/01/89-01/07/89	11	0	0	0
01/08/89-01/14/89	22	0	0	0
01/15/89-01/21/89	11	0	0	0
01/22/89-01/31/89	20	0	1	0
02/01/89-02/07/89	7	0	0	0
02/08/89-02/14/89	21	0	0	0
02/15/89-02/21/89	36	0	0	0
02/22/89-02/28/89	42	6	0	0
03/01/89-03/07/89	102	0	0	0
03/08/89-03/14/89	6,605	0	0	0
03/15/89-03/21/89	2,740	15	0	0
03/22/89-03/31/89	298	18	0	26
Total	9,996	39	1	26

Estimated passage based on interoplations: 12/15-20, 1/5-6, 2/2-22 and 3/10-16.

6.3.1.2 Spring Movement

A total of 411,566 salmonids were estimated to have passed Prosser Dam from April 1 through July 13, 1989. Total outmigration of wild steelhead and fall chinook smolts was 43,062 and 47,598 respectively (Table 9). Estimated outmigration of hatchery fall chinook, steelhead and coho was 81,176, 16,060 and 224,670 respectively. A small number of coho were naturally produced but accurate estimates are not possible because nearly 90% of hatchery coho were not adipose clipped.

The weeks of peak wild steelhead and fall chinook smolt outmigration occurred May 1-7 and June 1-7 respectively (Figure 8). The date of median passage was May 1 and June 5, 1989 for wild steelhead and fall chinook.

6.3.2 Wapatox

The estimated outmigration of steelhead parr in September and October, 1988 was 721 and 2,418 fish respectively (Table 10). The estimate for October may be too high because daily counts had to be interpolated from October 17 through November 4 when the canal was dewatered. The estimated passage from November 1 through November 23, when the screens were removed from the canal, was 2,608 fish. Mean fork length in September, October and November was 133 mm, 108 mm and 179 mm

Table 9. Estimated outmigration of juvenile salmonids at Prosser Dam April 1 through July 13, 1989.

Period of Estimation	Wild steelhead	Hatchery steelhead	Wild fall chinook	Hatchery fall chinook	Hatchery coho
04/01/89-04/07/89	595	63	31	0	881
04/08/89-04/14/89	3,879	685	942	0	16,672
04/15/89-04/21/89	5,998	905	634	0	16,916
04/22/89-04/30/89	7,933	4035	1,600	0	25,707
05/01/89-05/07/89	9,455	6772	1,774	0	93,086
05/08/89-05/14/89	5,469	1898	697	0	46,300
05/15/89-05/21/89	3,441	888	1,085	0	20,642
05/22/89-05/31/89	2,542	427	5,412	0	3,951
06/01/89-06/07/89	996	83	16,847	18,694	484
06/08/89-06/14/89	901	162	11,554	31,781	27
06/15/89-06/21/89	555	83	3,427	10,266	4
06/22/89-06/30/89	217	27	3,010	17,343	0
07/01/89-07/07/89-	63	20	518	2,584	0
07/08/89-07/13/89	18	12	67	508	0
Total	42,062	16,060	47,598	81,176	224,670

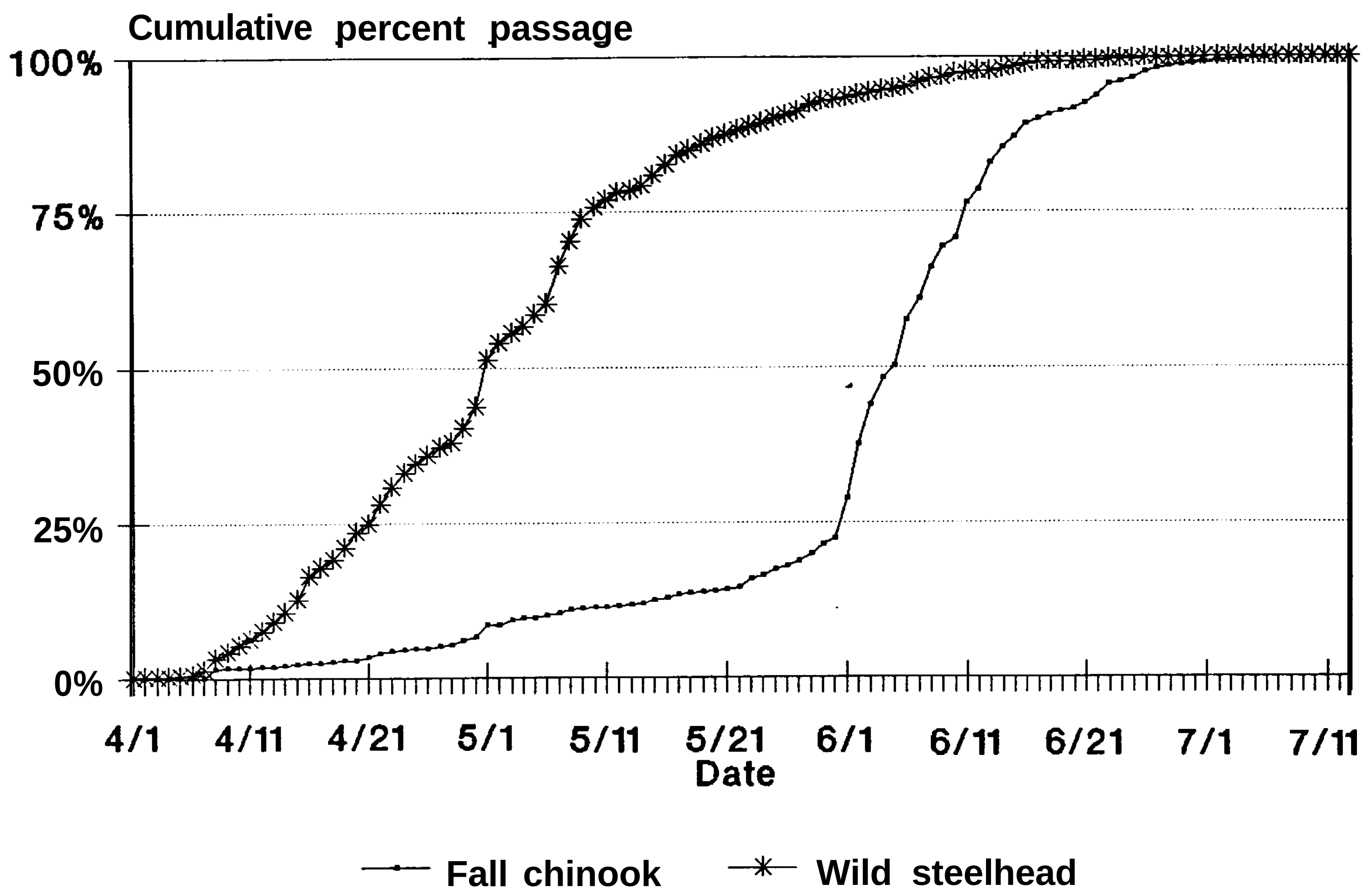


Figure 8. Cumulative percent passage of fall chinook and steelhead smolts at Prosser in 1989.

Table 10. Estimated weekly and monthly catches of steelhead at Wapatox for fall, 1988 and spring, 1989.

Date (week ending) (date)	Weekly count	Cummulative count
Fall, 1988		
08-Sep	17	17
15-Sep	278	295
22-Sep	251	546
29-Sep	154	700
06-Oct	149	849
13-Oct	233	1,082
20-Oct	548	1,630
27-Oct	875	2,505
03-Nov	1,203	3,708
10-Nov	1,649	5,357
17-Nov	256	5,613
24-Nov /a	147	5,760

	Sep.	Oct.	Nov. /b
Fall totals	721	2,418	2,608

Date (week ending) (date)	Weekly count	Cummulative count
Spring, 1989		
07-Apr	695	695
14-Apr	2,972	3,667
21-Apr	2,178	5,845
28-Apr	1,204	7,049
05-May	347	7,396
12-May	464	7,860
19-May	628	8,488
26-May	348	8,836
02-Jun	468	9,304
09-Jun	344	9,648
16-Jun	202	9,850
23-Jun	128	9,978
30-Jun	94	10,072

	April	May	June	Season
Spring totals	7,137	2,041	894	10,072

/a Was operated only six days this week.
/b November 23 was the last day of operation.

respectively (Figure 9). It appears that fall outmigrants comprised 3 age classes; young-of-the-year (66 mm to 115 mm), 1+ fish (136 mm to 200 mm), and 2+ fish (greater than 240 mm). Enumeration of the salmonid smolt outmigration commenced April 1 when the screens were installed into Wapatox Diversion Canal. A monthly summary of the steelhead smolt outmigration is presented in Table 10. The estimated outmigration of wild steelhead in April, May and June was 7,137; 2,041 and 894 respectively. The season total for wild steelhead was 10,072 smolts. Peak smolt outmigration occurred April 8-14 with an estimated passage of 2,972 smolts or 29.5% of the total outmigration; while the median passage date was April 18 (Figure 10). The mean wild steelhead smolt fork length during April and May was 134 mm and 151 mm respectively (Figure 11). Previous scale analysis of Prosser smolts (Watson, 1989) indicated that only 5% were 3+ fish. Based on this information the two length frequencies observed at Wapatox are probably 1+ (60 mm to 125 mm) and 2+ (126 mm to 230 mm) smolts (however, some of the small fish observed in the 1+ age class could be resident rainbow trout).

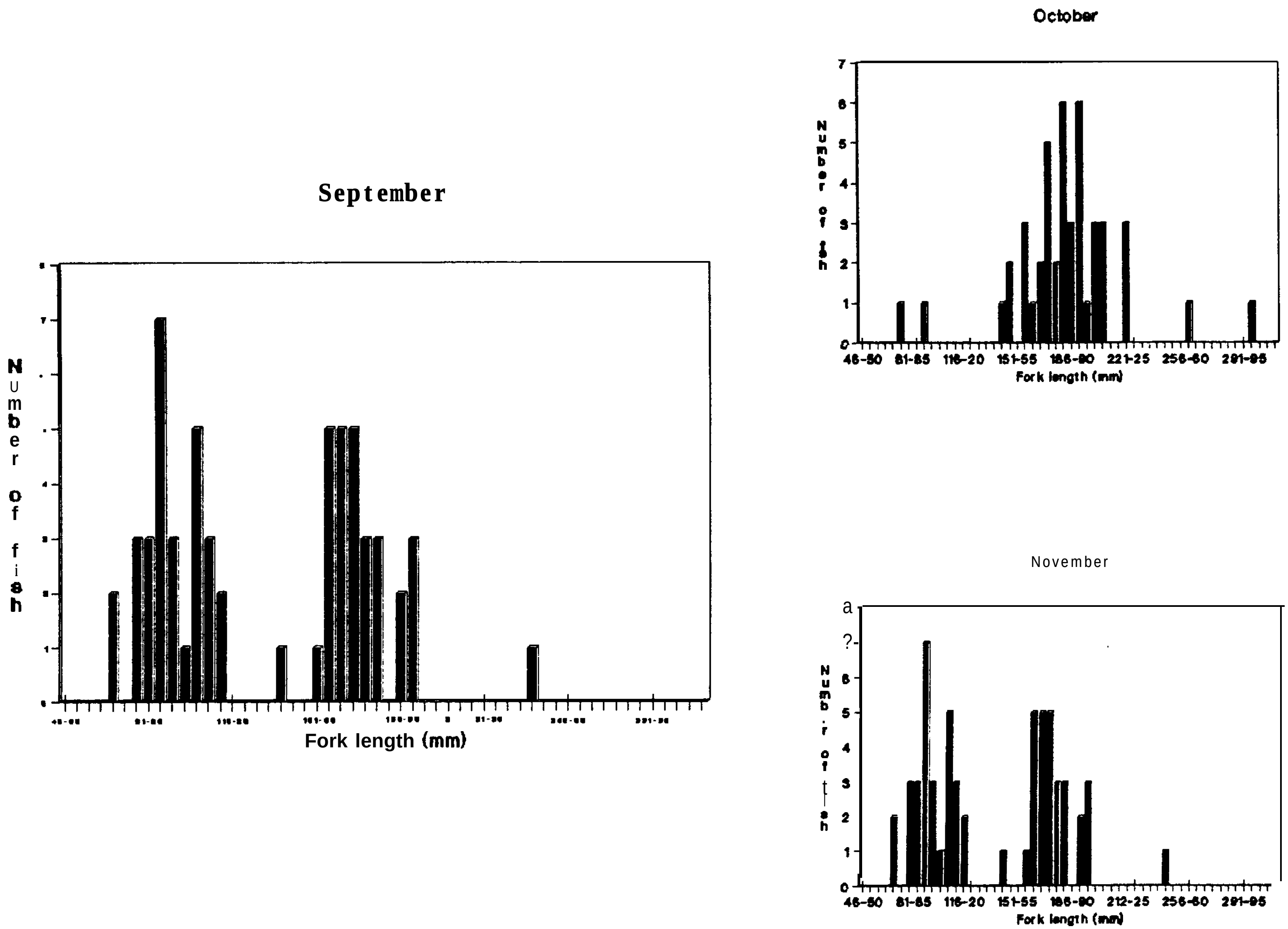


Figure 9. Length frequency distribution of juvenile steelhead at Wapatox in September, October and November, 1988.

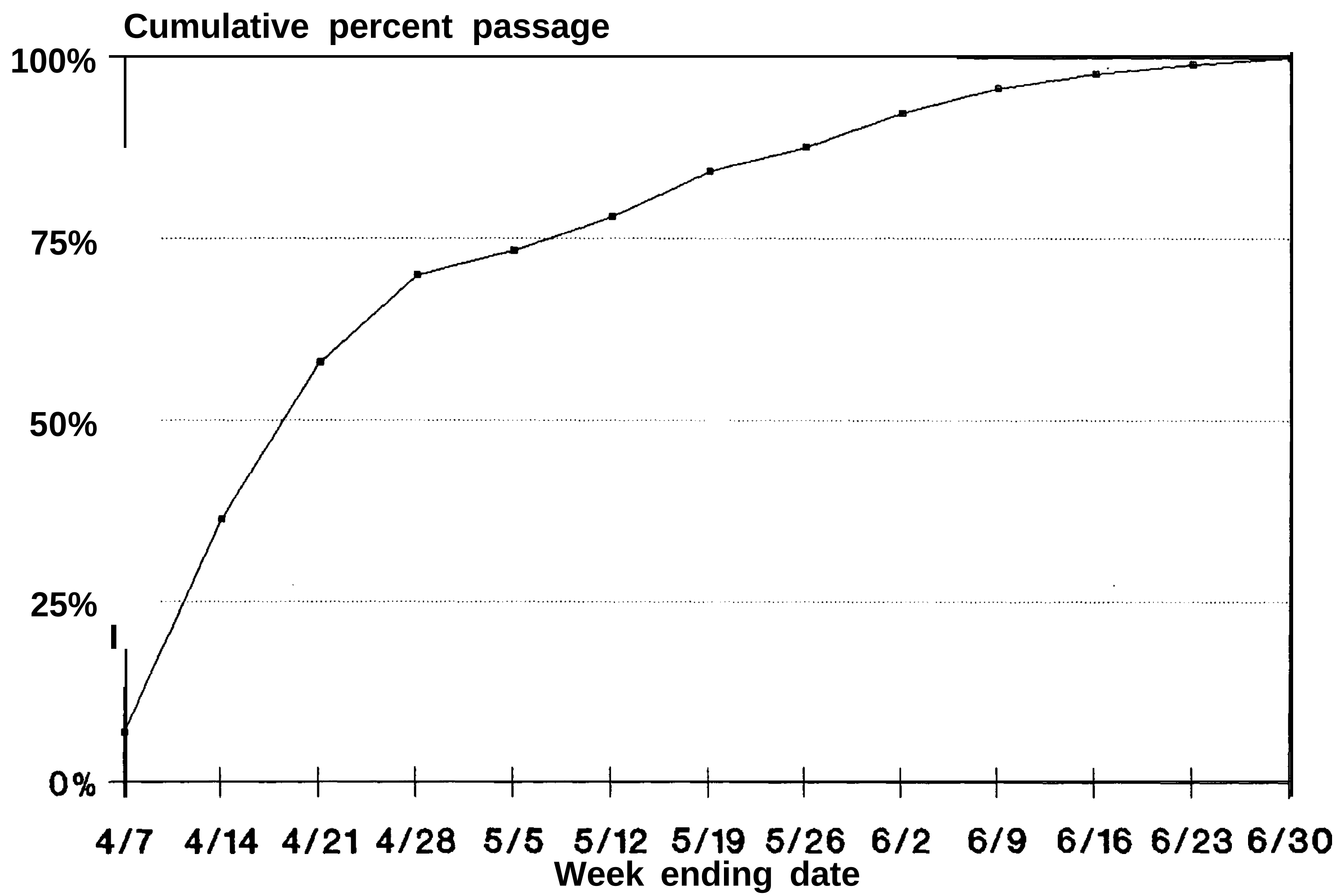


Figure 10. Cumulative percent passage of steelhead smolts at Wapatox April 1 through June 30, 1989.

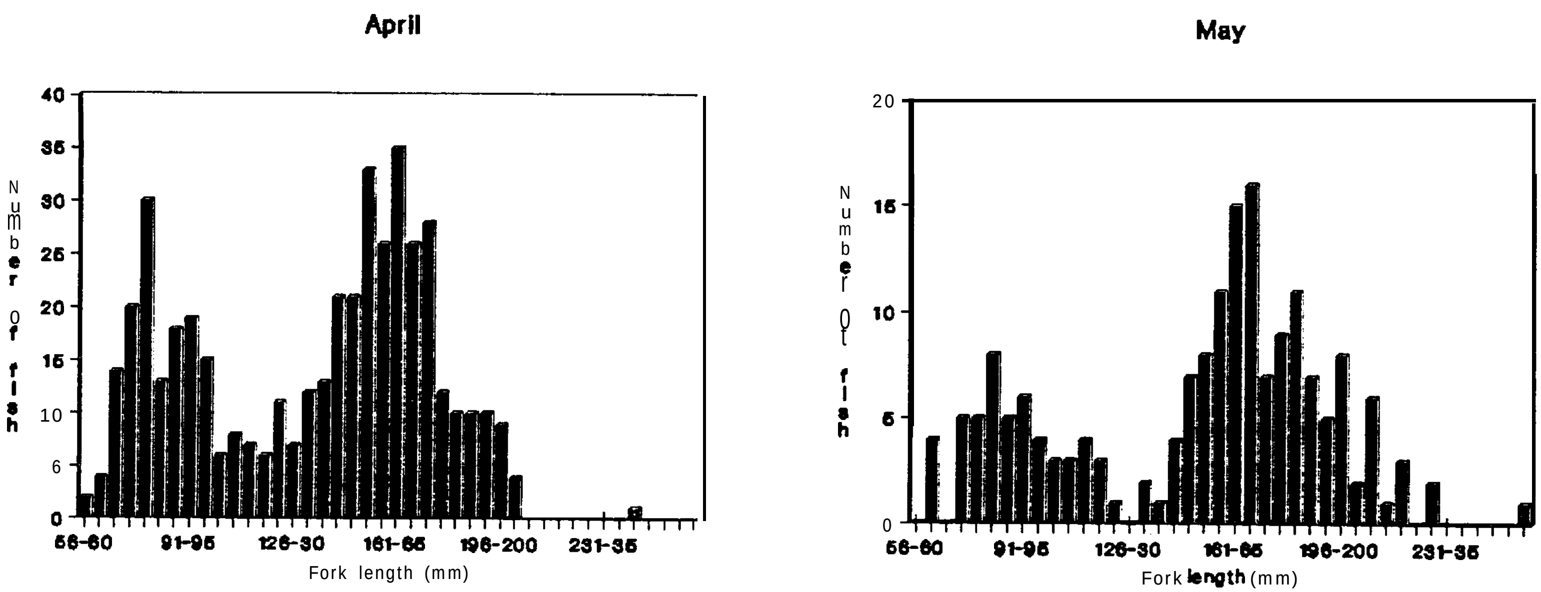


Figure 11. Length frequency distribution of steelhead smolts at Wapatox in April and May, 1989.

6.3.3 Roza

Because the flow to entrainment relationship has yet to be established only a qualitative analysis of the data is possible. A catch summary is presented in Table 11. Total catches from April through August were 446 spring chinook smolts, 5,581 spring chinook young-of-the-year and 407 steelhead-rainbow. Spring chinook smolts were captured from April 1 through the remaining smolt season. Mean fork length for spring chinook smolts in April was 115 mm, and for pre-smolts it was 83 mm in July and 89 mm in August (Figure 12). Spring chinook fry were first collected April 6 and outmigration continued throughout the summer. Both the mean fork length and date of capture indicate that newly emergent fry are outmigrating past Roza Dam from the upper Yakima River. Redd capping data in 1985 (BPA 1985 Annual Report) found date of 50% emergence to range from April 1 to May 17 for redds capped in the upper Yakima River (RM 195). The nearest redd in 1988 was located upstream near RM 140 indicating that fry are moving a considerable distance shortly after emergence. The fact that young-of-the-year spring chinook were captured throughout the summer supports evidence collected from distribution studies in 1983-85 (Fast et. al., 1985) that juvenile spring chinook continuously migrate downstream from spawning areas

Ttblt 11. Summary of salmonid catch at Roza Dam juvenile trap April through August, 1989.

DATE	Spring chinook smolt	Spring chinook fry	Steelhead/	Rainbuu
01-Apr	25	0	2	0
02-Apr	8	0	1	0
03-Apr	7	0	0	0
04-Apr	9	0	3	0
0S-Apr	2	0	2	0
06-Apr	61	197	19	3
07-Apr	31	325	14	0
08-Apr	18	379	31	1
09-Apr	23	1109	36	1
I0-Apr	29	1032	30	2
II-Apr	23	497	23	2
12-Apr	8	200	32	2
13-Apr	15	113	9	1
20-Apr	3	43	2	0
21-Apr	10	83	14	0
22-Apf	2	58	9	0
25-Apr	28	190	19	0
26-Apr	17	97	7	0
27-Apr	37	114	23	1
05-May /a	19	0	7	0
18-flay /b	11	116	19	0
25-May /c	22	25	36	0
01-Jun	38	7	16	0
15-Jun		60	9	0
22-Jun		429	1	0
29-Jun		120	0	0
06-Jul		202	8	0
13-Jul		30	0	0
20-Jul		18	0	0
27-Jul		36	0	0
03-Aug		10	5	0
04-Aug		44	9	0
I0-Aug		15	9	0
17-Aug		16	1	0
24-Aug		8	9	0
31-Aug		2	2	0
Totals	446	5,581	407	13

/a Start tint was 1100, the 5th, and end time was 1700 the 5th.
/b Start time was 1300 the 18th.
/c Start time was 1730 the 25th, and end time was 0945 tht 26th.

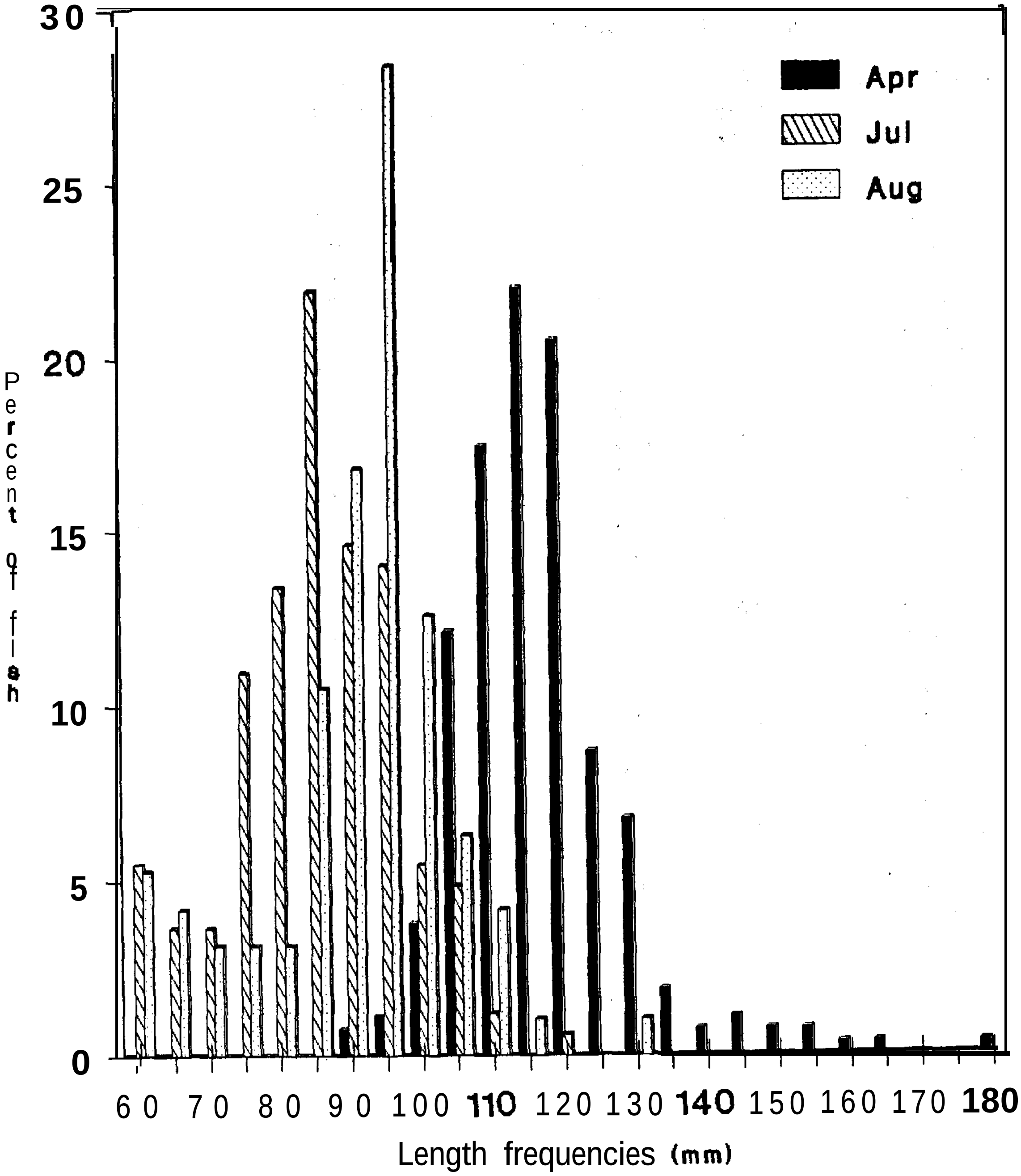


Figure 12. Length frequecy distribution of spring chinook at Roza in April, July and August, 1989.

into the Yakima Canyon.

Steelhead-rainbow were collected on all but a few sampling dates, begining on April 1. Length-frequency data (Figure 13) suggests that the majority of fish outmigrating in April and May were steelhead smolts, as few fish under 90 mm were collected. The mean fork length was 138 mm. However, in July and August no steelhead-rainbow over 95 mm were captured and no determination is really possible as to whether these smaller fish are resident rainbow trout or steelhead.

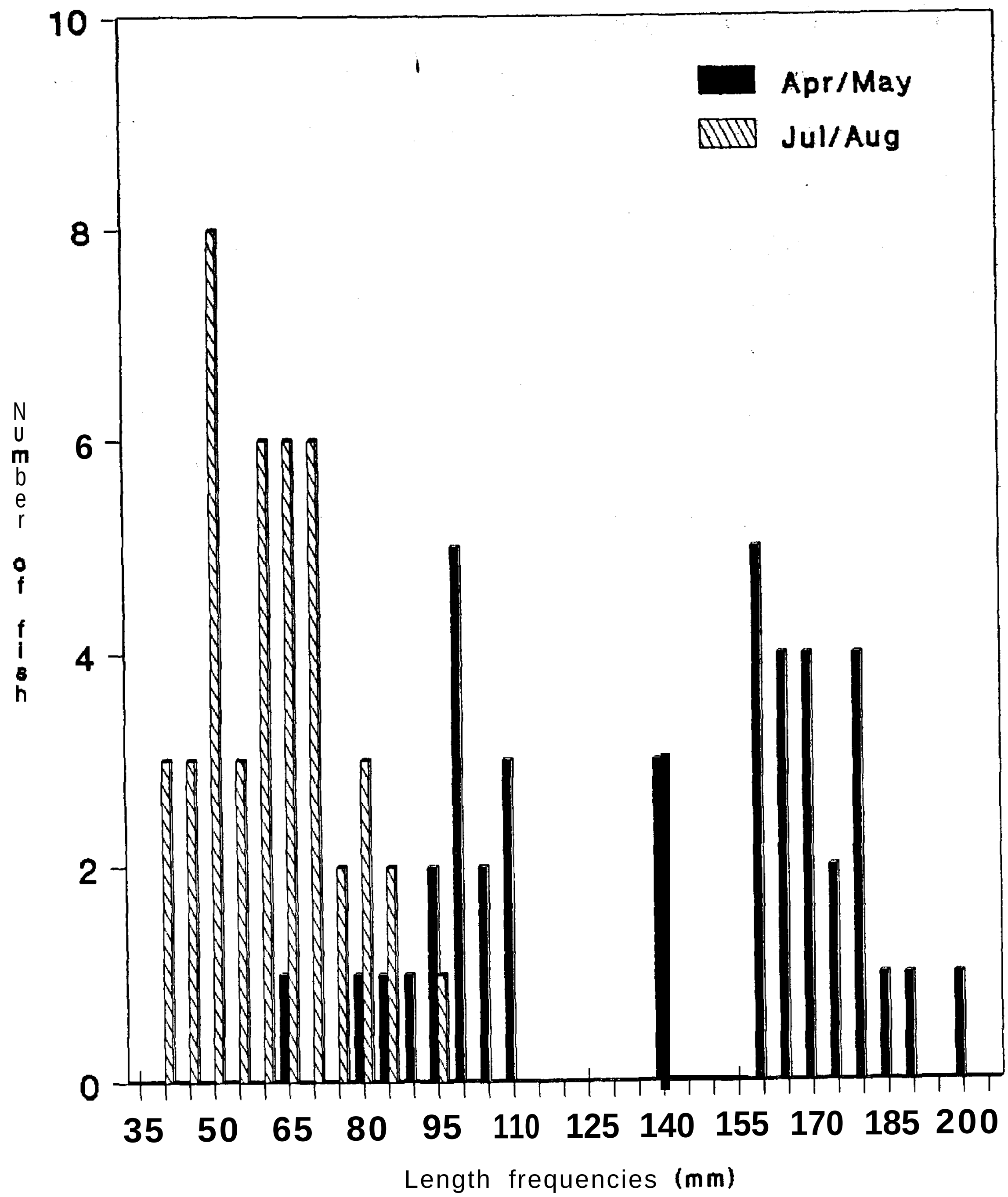


Figure 13. Length frequency distribution of steelhead-rainbow at Roza for April/May and July/August, 1989.

6.4 DISTRIBUTION STUDIES

6.4.1 Yakima Basin

A summary of summer electroshocking in the Yakima Basin is presented in Tables 12-15 and sampling locations are delineated in Figure 1. A more complete summary of electroshocking surveys in the basin will be forthcoming; as surveys were being conducted at the time of this writing. Steelhead was the only species found in the Satus Basin, however, sampling was confined downstream of anadromous blockages (e.g. the falls on Satus, Logy and Dry Creeks). Eastern Brook trout are known to reside in substaintal numbers upstream of Logy Creek falls and Dry Creek falls (Hubble, 1980). In Satus Creek parr density levels were highest in the upper reaches (0.16 fish/m^2) and lowest in the middle and lower reaches. High levels of fry were also observed at the upper sites on Satus Creek. This is expected as the majority of steelhead spawning occurs in the upper reaches. Generally high stream temperatures and minimal flow account for the low fish densities in middle and lower Satus Creek.

Steelhead parr densities in Dry Creek were highest in the upper reaches (0.32 fish/m^2) with few fish in the middle and lower (which was nearly dry by July 1)

Table 12. Summary of electroshocking data for salmonids in the Satus system in June and July, 1989.

Stream	Date	Location	Steelhead fry: Presence level/a	Steelhead parr: Density (fish/m2)	Steelhead parr: Mean fork length (mm)	Steelhead parr: Stan. dev.	Cutthroat: Density (fish/m2)	Cutthroat: Mean fork length (mm)	Cutthroat: Stan. dev.	Brook Trout: Density (fish/m2)	Brook Trout: Mean fork length (mm)	Brook Trout: Stan. dev.	Spring Chinook: Density (fish/m2)	Spring Chinook: Mean fork length	Spring Chinook: Stan. dev.
Dry	6-15-89	Upper	Med.	0.36 (.35-.37)	107	17.01	0.00			0.00			0.00		
Dry/a	6-20-89	Upper	High		lo!	22.86	0.00			0.00			0.00		
Dry	6-16-89	Middle	High	0.10 (.10-.11)	104	14.98	0.00			0.00			0.00		
Kusshi	6-14-89	Middle	Low	0.00			0.00			0.00			0.00		
Kusshi	6-13-89	Lower	High	0.01<	215		0.00			0.00			0.00		
Logy	7-14-69	Lower	High	0.04 (.04-.05)	128	34.2	0.00			0.00			0.00		
Logy	7-17-89	Lower	Low	0.12 (.12-.14)	124	29.85	0.00			0.00			0.00		
Logy	7-17-89	Upper	Med.	0.07 (.06-.07)	94	44.47	0.00			0.00			0.00		
Mule Dry	6-12-89	Lower	Lou	0.26 (.24-.29)	65	3.26	0.00			0.00			0.00		
Mule Dry	6-13-89	Middle	Lou	0.05 (.04-.06)	104	52.21	0.00			0.00			0.03		
Satus	f-13-89	Upper	High	0.16 (.15-.17)	108	27.37	0.00			0.00			0.00		
Satus	6-20-89	Upper	High	0.16 (.15-.18)	116	26.8	0.00			0.00			0.00		
Satus	7-13-89	Middle	Low	0.01 (.01-.01)	204	59.8	0.00			0.00			0.00		

Table 13. Summary of electroshocking data for salmonids in the Toppenish system in June, 1989.

			Steelhead fry	Steelhead parr			Cutthroat			Brook trout			Spring Chinook		
Stream	Date	Location	Presence level/a	Density (fish/m2)	Mean fork length (mm)	Stan. dev.	Density (fish/m2)	Mean fork length (mm)	Stan. dev.	Density (fish/m2)	Mean fork length (mm)	Stan. dev.	Density (fish/m2)	Mean fork length (mm)	Stan. dev.
Agency	6-23-89	Upper	Low	0.11 (.11-.11)	130	23.94	0.00			0.00			0.00		
Simcoe	6-26-89	Upper	Med.	0.05 (.05-.05)	138	20.92	0.00			0.00			0.00		
N.F.Simcoe	b-27-89	Middle	Med.	0.11 (.10-.11)	127	32.81	0.03			0.00			0.00		
S.F.Simcoe	6-27-89	Riddle	Low	0.04 (.03-.05)	171	65.19	0.00			0.00			0.00		
Toppenish	6-29-89	Upper	Med.	0.03 (.02-.04)	112	22.55	0.00			0.00			0.00		
N.F.Toppenish	62889	Lover	High	0.28 (.27-.28)	117	20	0.00			0.00			0.00		

Table 14. Summary of electroshocking data for salmonids in the Naches Basin in July and August, 1989.

			Steelhead fry	Steelhead parr			Cutthroat			Brook Trout			Spring Chinook		
Stream	Date	Location	Presence level/a	Density (fish/m2)	Mean fork length (mm)	Stan. dev.	Density (fish/m2)	Mean fork length (mm)	Stan. dev.	Density (fish/m2)	Mean fork length (mm)	Stan. dev.	Density (fish/m2)	Mean fork length (mm)	Stan. dev.
M.F.L.Naches	8-18-89	Lower	Low	0.00	111		0.02 (.02-.02)	113	25.95	0.00			0.00		
N.F.L.Naches	8-17-89	Louer	Low	0.01 (.01-.02)	145	34.44	0.00			0.00			0.00		
S.F.L.Naches	8-18-89	Lower	Low	0.00			0.04 (.03-.04)	125	31.96	0.00			0.00		
Crow/a	8-16-89	Lower	Low	0.00	142	61.52	0.00			0.00			0.01<	84	21.88
Pile-up	S-18-89	Lower	Low	0.00			0.01<	105	32.92	0.00			0.00		
Quartz	8-16-89	Lower	Low	0.05 (.05-.06)	113	27.18	0.01 (.01-.01)	154	29.48	0.00			0.00		
Rattlesnake	R-4-89	Middle	Low	0.02 (.02-.03)	137	17.73	0.01<	iv5	0	0.03			0.02	83	13.98
Rattlesnake	8-3-89	Lower	Low	0.08 (.06-.11)	150	39.06	0.00			0.00			0.02 (.02-.03)	71	0.47
Rattlesnake	7-27-89	Middle	Low	0.04 (.04-.04)	129	29.38	0.0%	179	26.87	0.00			0.03		
L.Rattlesnake	7-31-89	Lower	Low	0.09 (.09-.10)	125	30.54	0.01<	1%	24.75	0.00			0.01 (.01-.01)	77	10.4
L.Rattlesnake	7-31-89	Upper	Low	0.03	102	26.43	0.15 (.13-.17)	127	34.09	0.00			0.00		
Nile	7-26-89	Upper	Low	0.00			0.59 (.51-.68)	126	28.76	0.00			0.03		
Couiche	7-6-89	Lower	Low	0.01 (.01-.01)	167	39.21	0.00			0.00			0.00		
Cowiche	7-11-89	Middle	Low	0.07 (.07-.08)	123	29.51	0.00			0.00			0.00		
Couiche	7-5-89	Upper	Low	0.13 (.11-.14)	165	34.81	0.01<	160		0.00			0.00		
Lost	8-7-89	Lower	Low	0.17 (.16-.18)	99	16.82	0.00			0.00			0.00		
Milk	aX-89	Lower	Low	0.06 (.06-.06)	124	17.72	0.00			0.00			0.00		
Oak	8-15-89	Lower	Med.	0.50 (.48-.51)	125	34.1	0.00			6.02 (.02-.02)	161	288.84	0.00		
Rock	8-8-89	lower	Low	0.12 (.12-.13)	112	24.31	0.00			0.00			0.01 (.01-.01)	81	6.36

Table 15. **Summary** of **electroshocking** data for **salmonids** in the **Yakima system** in July, **August** and **September,** 1989.

Stream	Date	Location	Steelhead fry: Presence Level/a	Steelhead parr: Density (fish/m2)	Steelhead parr: Mean fork length (mm)	Steelhead parr: Stan. dtv.	Cutthroat: Density (fish/m2)	Cutthroat: bean fork length (mm)	Cutthroat: Stan. dev.	Brook Trout: Density (fish/m2)	Brook Trout: Mean fork length (mm)	Brook Trout: Stan. dev.	Spring Chinook: Density (fish/m2)	Spring Chinook: Mean fork length (mm)	Spring Chinook: Stan. dev.
Ahtanum	7-25-89	Upper	Low	0.03 .03-.04)	147	42.09	0.00	138	8.89	0.00			0.00		
M.F.Ahtanum	7-21-89	Lower	Low	0.00			0.11 .11-.12)	136	38.57	0.00			0.00		
N.F.Ahtanum	7-19-89	Upper	Low	0.00			0.08 .08-.09)	126	42.07	0.00			0.00		
S. F.Ahtanum	7-12-89	Lower	Low	0.00			0.01	176	79.65	0.00			0.00		
S.F.Ahtanum	7-12-89	Upper	Low	0.00						0.00			0.00		
Cabin	9-1-89	Middle	Low	0.00			0.01	161	60.06	0.00			0.00		
Manastash	8-22-89	Middle	Low	0.04 .04-.04)	135	31.24	0.00	174		0.01 .01-.01)	94	32.05	0.00		
Manastash	8-22-89	Lower	Low	0.09 .08-.09)	129	46.4	0.02 .01-.02)	155	33.62	0.00			0.00		
S.F.Manastash	8-22-89	Upper	Low	0.00			0.06 .06-.07)	121	37.24	0.07 (.07-.07)	110	46.05	0.00		
Taneum	W-89	Middle	Low	0.13 .12-.13)	151	31.03	0.00			0.00			0.00		
N . F.Taneum	8-29-89	Upper	Low	0.00			0.12 (.12-.12)	143	32.04	0.05 (.05-.05)	147	40.03	0.00		
N. F.Taneum	8-29-89	Lower	Low	0.02 (.02-.02)	163	25.36	0.03 (.03-.03)	158	56.18	0.01 (.01-.01)	119	32.99	0.00		
S.F.Taneum	8-28-89	Middle	LOU	0.00			0.09 (.08-.10)	118	30.44	0.00	84	15.56	0.00		
M.F.Teanaway	9-6-89	Middle	Med.	0.05 (.05-.05)	123	31.15	0.00			0.00			0.00		
W.F.Teanaway	9-6-89	Middle	Low	0.07 (.07-.08)	132	27.66	0.00	127		0.00			0.00		
Stafford	9-s-89	Lower	Med.	0.05 (.05-.06)	127	21.33	0.00	320		0.00			0.00		

reaches. Higher fish densities in the upper reaches is a reflection of better stream flows and stream temperatures. As previously discussed (section 6.1.2) the lower 7.0 RM of the creek become intermittent begining in June. Newly emerged fry were located in several isolated reaches and the survival of these fish over the summer appears poor.

Steelhead parr densities in Logy Creek ranged from 0.04 fish/m^2 up to 0.12 fish/m^2. The overall lower densities seen in Logy Creek compared to Dry Creek may be misleading. Good stream flow occurs throughout the summer in Logy Creek and fish are less likely to become concentrated as the wetted area decreases, as seen in Dry Creek, and give falsely higher density levels.

Few steelhead parr were found in Kusshi Creek, however, young-of-the-year steelhead were abundent in the lower reach where better flow exists (though still intermittent).

Steelhead parr densities in lower and middle Mule-Dry Creek were 0.26 and 0.05 fish/m^2 respectively. The high density level found in the lower reach is probably higher than earlier in the season because of increased intermittent conditions. Preliminary data (being worked up at the time of this writing) indicate that steelhead parr reside throughout the summer in isolated pools and riffles that are fed by moderately cool (15^o C) subsurface flow.

Steelhead parr densities in the Toppenish Basin ranged from a low of 0.04 fish/m^2 in middle South Fork of Simcoe Creek up to 0.28 fish/m^2 in lower North Fork of Toppenish Creek. Few parr were seen in the mainstem of upper Toppenish (0.03 fish/m^2) and Simcoe (0.05 fish/$m^{2)}$ Creeks where spawning was known to occur.

The major tributaries electroshocked in the Naches Basin were the Little Naches River, and Rattlesnake and Cowiche Creeks. Salmonid densities in the Little Naches system were generally low. Quartz Creek had the highest steelhead (and/or rainbow trout) parr density (0.05 fish/m^2). Cutthroat trout (*Salmo clarki*) were found primarily in the middle and south forks of the Little Naches with densities up to 0.04 fish/m^2. Spring chinook were found only in Crow Creek in very low numbers ($<$ 0.01 fish/m^2).

In the Rattlesnake system steelhead and spring chinook were the primary salmonids found. Steelhead densities ranged from 0.08 fish/m^2 up to 0.20 fish/m^2 and spring chinook densities in the middle and lower Rattlesnake River were 0.02 fish/m^2.

In the Cowiche system steelhead were almost exclusively found and densities ranged from 0.01 fish/m^2 up to 0.13 fish/m^2.

Primary tributaries electroshocked in the Yakima system were Ahtanum, Manastash and Taneum Creeks and the Teanaway River. Cutthroat trout were the primary salmonid species found in the Ahtanum system (0.08 fish/m^2 up to 0.11 fish/m^2).

In the Manastash system steelhead, cutthroat and brook trout were found. Density levels for all species combined ranged from 0.01 fish/m^2 up to 0.09 fish/m^2.

The steelhead parr density in lower Taneum Creek was 0.13 fish/m^2. In the North Fork of Taneum Creek cutthroat and brook trout were the main salmonid species found and densities ranged from 0.01 fish/m^2 up to 0.13 fish/m^2. In the South Fork of Taneum Creek Brook trout were the primary species found (0.09 fish/m^2).

As of this writing electroshocking surveys were still being conducted in the Teanaway system. Thus far steelhead is the dominate salmonid species; densities range from 0.05 fish/m^2 up to 0.07 fish/m^2.

6.4.2 Klickitat Basin

Electroshocking surveys were conducted in selected tributaries within the Klickitat Basin during the summer of 1989 to determine abundance and distributions of salmonids (Table 16). The Klickitat system was divided into three sections, above Castile Falls, mid-basin and lower basin (Summit Creek and below). The highest concentrations of steelhead-rainbow above Castile Falls

Table 16. Summary of electroshocking data for salmonids in the Klickitat Basin, July and August, 1989.

			Steelhead f	Steelhead parr			Brook Trout			Spring Chinook			Coho		
Stream	Date	Location	Presence level/a	Density (fish/m2)	Mean fork length (mm)	Stan. dev.	Density (fish/m2)	Mean fork length (mm)	Stan. dev.	Density (fish/m2)	Mean fork length (mm)	Stan. dev.	Density (fish/m2)	Mean fork length (mm)	Stan. dev.
Above Castile Falls															
Elkhorn/a	8-2-89	Lower	Low	0.12 (.10-.15)	83	36.66	0.03			0.00			0.00		
Huckleberry	8-14-m	Lower	Low	0.06 (.05-.07)	118	22.12	0.00			0.00			0.00		
Piscoe	7-5-89	Lower	Med	0.31 (.26-.36)	90	35.61	0.00			0.00			0.00		
Piscoe	7-5-89	Middle	Low	0.14 (.12-.15)	93	24.86	0.00			0.00			0.00		
Klickitat R.	8-15-m	Upper	Low	0.05 (.05-.06)	99	31.82	0.00			0.00			0.00		
Diamond	7-24-89	Lower	Low	0.09 (.09-.10)	88	19.63	0.00			0.09 (.09-.10)	88	19.63	0.00		
Diamond	7-24-89	Lower	Low	0.14 (.14-.15)	107	35.06	0.01<	102		0.00			0.00		
Diamond	8-15-B	Middle	Low	0.13 (.12-.13)	109	31.31	0.01 (.01-.01)	116		0.00			0.00		
Diamond	8-10-S	Middle	Low	0.25 (.23-.26)	111	33.66	0.02 (.02-.02)	133		0.00			0.00		
Diamond	8-8-89	Upper	Low	0.03 (.02-.03)	87	30.1	0.01 (.01-.01)	ICE		0.00			0.00		
Diamond	8-9-89	Upper	Low	0.25 (.23-.27)	99	27.49	0.12	138	43.74	0.00			0.00		
Coyote	8-10-89	Upper	Low	0.06 (.06-.07)	127	29.45	0.00			0.00			0.00		
Cuitin	B-9-83	Middle	None	0.00			0.00			0.00			0.00		
Hid Klickitat Basin															
Pearl	8-1-89	Middle	Low	0.17 (.12-.22)	109	24.39	0.01			0.00			0.00		
Soda Springs	8-6-B	Middle		0.00			0.00			0.00			0.00		
Bear	7-21-89	Lower	Low	0.17 (.16-.18)	106	20.65	0.00			0.00			0.00		
Bear	7-11-B	Middle	Low	0.13 (.11-.14)	102	21.65	0.00			0.00			0.00		
Trout	7-31-89	Lower	Low	0.56 (.54-.58)	5'5	19.2	0.00			0.03 (.03-.04)	68	7.13	0.00		
Trout	7-21-89	Middle	Low	0.14 (.13-.14)	118	26.35	0.00			0.00			0.00		
Trout	7-11-89	Upper	Low	0.26 (.23-.28)	106	19.27	0.00			0.00			0.00		
Surveyors	7-18-89	Lower	Low	0.07 (.07-.08)	114	22.32	0.00			0.00			0.00		
Surveyors	7-18-89	Middle	Low	0.09 (.08-.11)	120	26.34	0.00			0.00			0.00		
Big Muddy	7-12-89	Lower	None	0.00			0.00			0.00			0.00		
Cunningham	E-7-89	Lower	None	0.03			0.00			0.00			0.00		
Surveyors	7-28-89	Upper	Low	0.25	108	25.18	0.00			0.00			0.00		
Lower Klickitat Basin															
Summit	7-10-89	Lower	High	0.23 (.22-.24)	99	24.09	0.00			0.00			0.15 (.14-.15)	63	7.52
Summit	8-17-89	Middle	Low	0.31 (.30-.32)	84	26.99	0.00			0.00			0.04 (.04-.04)	74	4.11
Litttle Klickitat	8-25-89	Lower	Low	0.09 (.08-.10)	82	18.12	0.00			0.01<	65		0.01<	54	
Little Klickitat	8-23-89	Middle	Low	0.12 (.10-.14)	174	70.99	0.00			0.00			0.00		
Little Klickitat	8-24-89	Upper	Low	0.12 (.11-.14)	131	54.41	0.00			0.00			0.00		
Swale	7-19-B	Lower	Med	0.30 (.28-.32)	64	17.9	0.00			0.03 (.02-.03)	71		0.00		
Swale Pool	7-19-89	Lower	Low	0.07	79		0.00			0.00			0.20	124	
Bowman	7-19-89	Lower	Low	0.26 (.24-.28)	94	40.85	0.00			0.00			0.00		

/a Combined fry and parr estimate.

were found at Piscoe Creek (0.31 fish/m^2) and in the upper end of Klickitat Meadows in the Diamond Fork (0.25 fish/m^2), and the uppermost site on the Diamond Fork (0.25 fish/m^2). The lowest concentrations were found in Huckleberry Creek (0.06 fish/m^2) and in the lower end of Klickitat Meadows in the Diamond Fork (0.03 fish/m^2). Brook trout were also found in the Diamond Fork system averaging 0.04 fish/m^2. Hatchery planted spring chinook were recorded at the lower most site on the Diamond Fork with a density of 0.09 fish/m^2.

In the mid-Klickitat section (Castile Falls to above Summit Creek) anadromous fish passage is limited to a few tributaries, because of steepness in lower reaches as they enter the Klickitat canyon. In this section Trout Creek had a high of 0.56 fish/m^2 at the lowest site. In addition the only occurrence of chinook in this portion of the basin was recorded with a density of 0.03 fish/m^2. The lowest densities were observed at the lower site on Surveyors Creek at 0.07 fish/m^2. In the lower basin the highest densities for rainbow-steelhead were found in Summit Creek (0.31 fish/m^2) with coho salmon averaging 0.10 fish/m'. No sampling was done above the impassable falls at RM 2.5. The lowest densities for rainbow-steelhead were observed at Swale Pool with 0.07 fish/m^2 while coho salmon were found at 0.20 fish/m'. A 100 meter section below this pool had rainbow-steelhead at

0.30 fish/m^2 and chinook salmon at 0.03 fish/m^2.

6.5 STEELHEAD LENGTH-FECUNDITY MODEL

To date a total of 87 adult females have been used in calculating the length-fucundity model (Figure 14). Thus far a wide range in the number of eggs vs fork length has been observed (r squared = 0.51). The major source of variability in fecundity appears to be natural. Initially the weight method (Mandis and Harris, 1984) was used to calculate fecundity. On several occassions during this time the Von Bayer (Mandis and Harris, 1984) was used as a comparsion. In most instances the two methods were in close agreement, therefore it appears unlikely that sampling method or technique is a significant contributor to the observed variance.

The current fecundity to fork length relationship is as follows: Y= 179.93 (X) - 6,026. Where Y= the number of eggs and X= the fork length (cm).

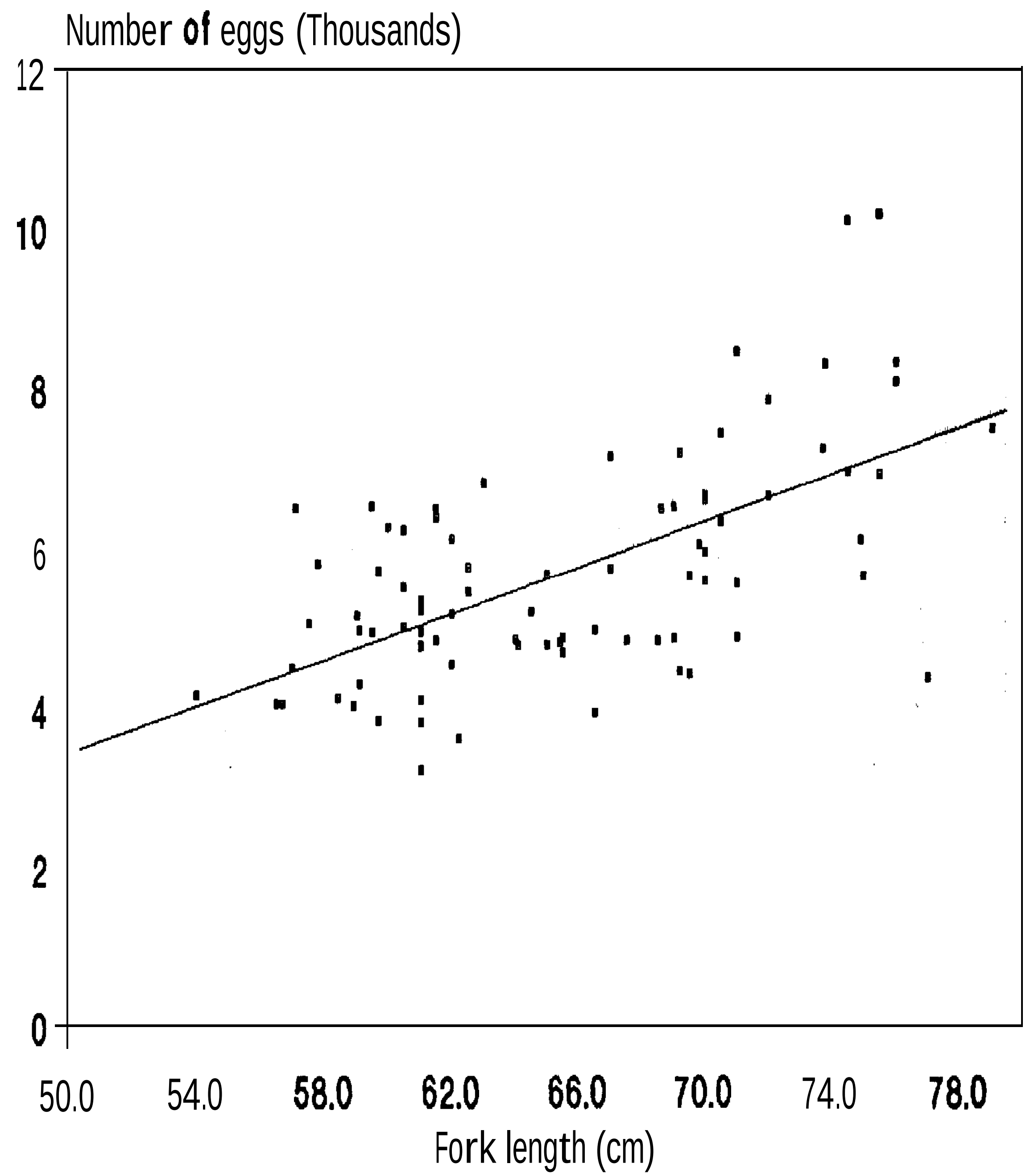


Figure 14. Length fecundity relationship of Yakima River steelhead broodstock.

6.6 HATCHERY STEELHEAD RELEASES

Results from the four hatchery steelhead smolt releases, acclimated vs non-acclimated made in both Toppenish Creek and the Little Naches River were confounded by the aforementioned events (section 5.6). The survival rate to Prosser for the acclimated Toppenish and Little Naches groups was 10.12% and 1.58% respectively. Though not conclusive, the much higher survival of the Toppenish group may be the result of smolts entering the Yakima River downstream of the Parker Dam (RM 103.8) to Granger (RM 83.0) reach. Previous experimental releases conducted with hatchery coho smolts in the Yakima Basin (Fast et. al., 1988) suggest that this particular reach is responsible for a high percentage of smolt-to-smolt mortality, due to sub-optimal flows which frequently exist during the smolt outmigration period. An unknown level of mortality was incurred by both Toppenish groups as a result of unscreened pump intakes at the WIP Mud Lake pump station, which was unknown to staff members prior to making these releases. Despite this occurrence the Toppenish acclimation group had higher survival to Prosser than the Little Naches group which may indicate the severity of the outmigration problem upstream of Granger. The unexpected higher survival of Little Naches nonacclimated group vs acclimated is probably explained by the acclimated group being acclimated for only 72 hrs and possible stress induced by the presence of otters in the pond.

Median passage date to Prosser for the Toppenish and Little Naches acclimated smolts were May 3 and May 14 respectively (Figure 15). Median travel rate to Prosser for the Toppenish and Little Naches smolts were 4.1 RM/day and 2.5 RM/day respectively.

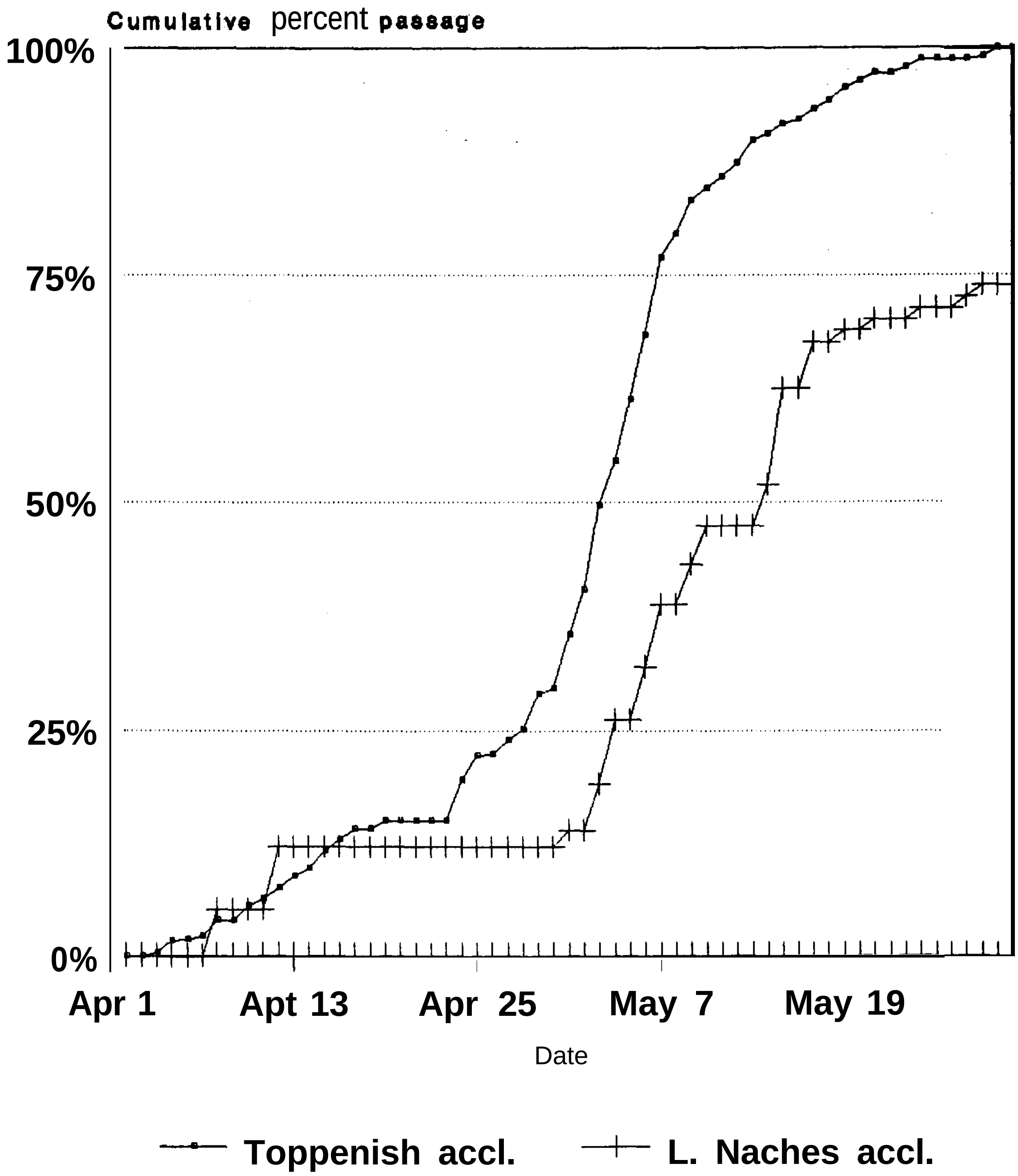


Figure 15. Cumulative percent passage of acclimated Toppenish and Little Naches hatchery steelhead smolt releases at Prosser in 1989.

6.7 WAPATO CANAL FISH-REARING PEN STUDY

Overview

In 1986 and 1987, while conducting a technical review of the Yakima Hatchery Master Plan (Measure 703 (f) (3) (A) of the Northwest Power Planning Council's Fish & Wildlife Program), a new experimental method of rearing fall chinook was proposed and discussed by participating fisheries personnel. The idea would be to use the ample water supply of the Wapato Irrigation Canal to rear and acclimate upriver bright fall chinook. Rearing pens would be constructed and anchored to the retaining wall immediately upstream of the new Wapato Canal fish screens, where a pool created by the reduced flow requirements at the screen/water interface seemed highly suitable for a pen type operation.

Besides testing the biological feasibility of rearing fall chinook in the pens, the experiment would also show the impact of the pens on flow in the canal, specifically across the face of the screens where the approach velocity is critical (0.5 ft/sec max.). If as a result of this experiment it were deemed feasible and practical to pen rear fall chinook in the Wapato Irrigation Canal, the water available in the study area has the potential to accommodate the total production of 3 million smolts outlined in the production profiles of the Master Plan for the proposed Yakima Outplanting Facility.

Pen Design

Several pen configurations-circular, octagonal, rectangular and square-were considered by the YIN and engineers from NMFS who were experienced in pen design and who volunteered to draw detailed blueprints. However, in order to begin the experiment as quickly as possible, it was decided to use a square pen structure because of its simplicity in design and construction. In early June, 1987, after a couple of Wapato Canal site visits by NMFS personnel, final blueprints were drawn up. The estimated cost for constructing the three 16' square pens was $19,000.00 each. O & M costs would be kept low because the natural flow of water through the canal would eliminate the need for a water intake/delivery or pumping system. The major structural components were wood planks and beams, perforated aluminum plate, styrofoam, and corrugated aluminum roofing (Figure 16).

Coordination with Wapato Irrigation Project and Bureau of Reclamation

The Wapato Irrigation Project (WIP) controls the water within Wapato Canal, and the Bureau of Reclamation (BOR) is responsible for maintaining the fish screens adjacent to the pens. An agreement was drawn up between these agencies and the YIN to allow the tribe to use the

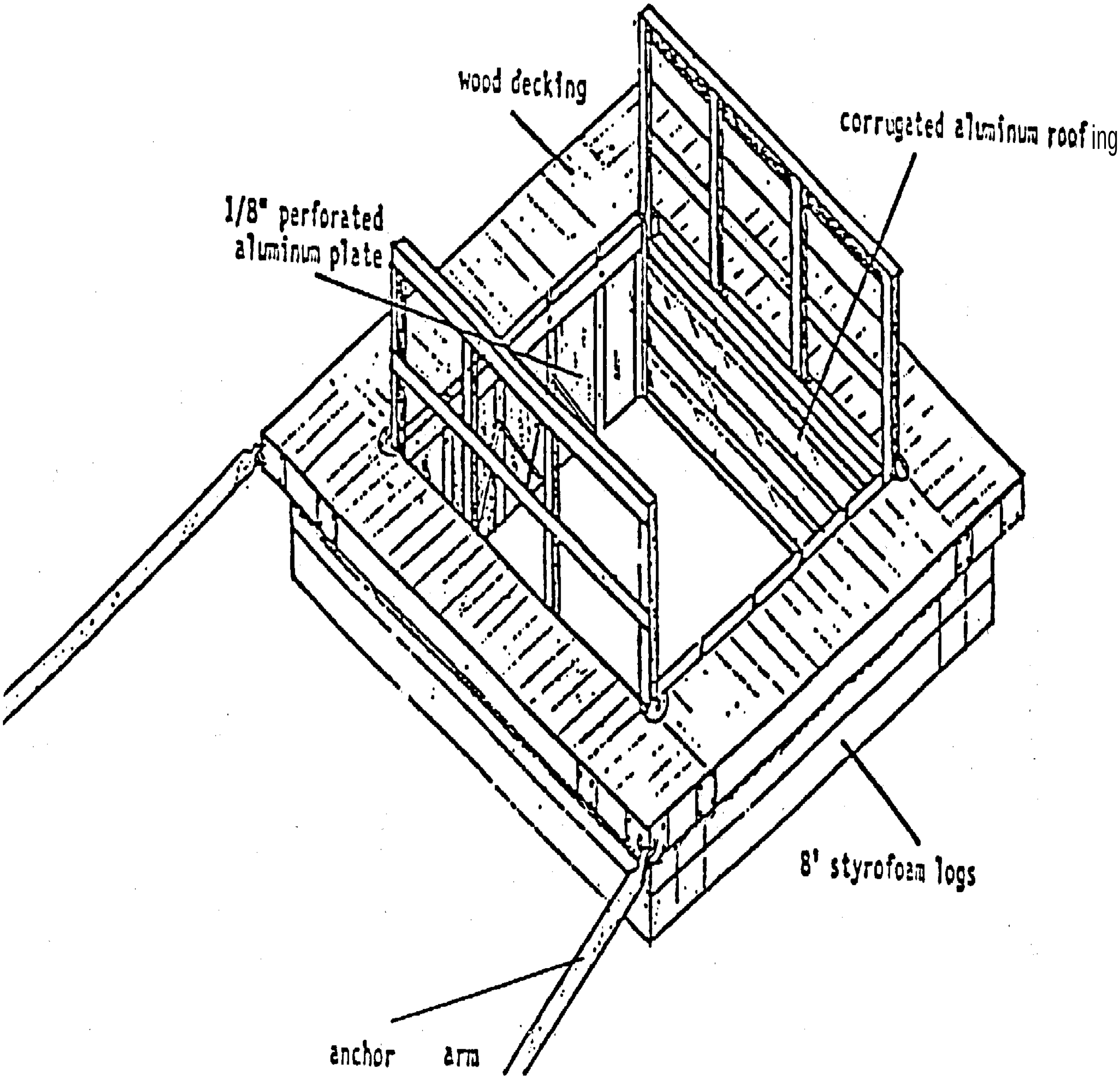


Figure 16. Schematic of Wapato fall chinook rearing pens,

area immediately upstream from the screens on the east bank of the Canal (Figure 17).

Coordination with Hydraulic Engineers and Biologists from Yakima River Water Enhancement Project (YRWEP)

In 1987 and 1988, concerns over the potential impacts of the pens on the function and efficiency of the Wapato fish screens were expressed by the screens' designers, Ken Bates of WDF and Bob Pierce of NMFS. Following discussions within the YRWEP technical work group, it was agreed that the YIN would monitor flows across the face of the screens to assure that the currents at the water/screen interface were not being altered. This task was performed the previous two years.

During the same time period another monitoring of water flows adjacent to the new fish screens in the Wapato and Sunnyside Diversions Canals was undertaken by Battelle Northwest of Richland. This study was funded by the BPA through the BOR office in Yakima. The water flow measurements by Battelle were done with equipment more sophisticated and sensitive than the YIN's flow meter. Though Battelle's focus was to determine whether the flows adjacent to the screens met the design criteria, their work served to duplicate and "check " our flow measurements and thus to confirm our findings as to possible water flow interruptions from the pens.

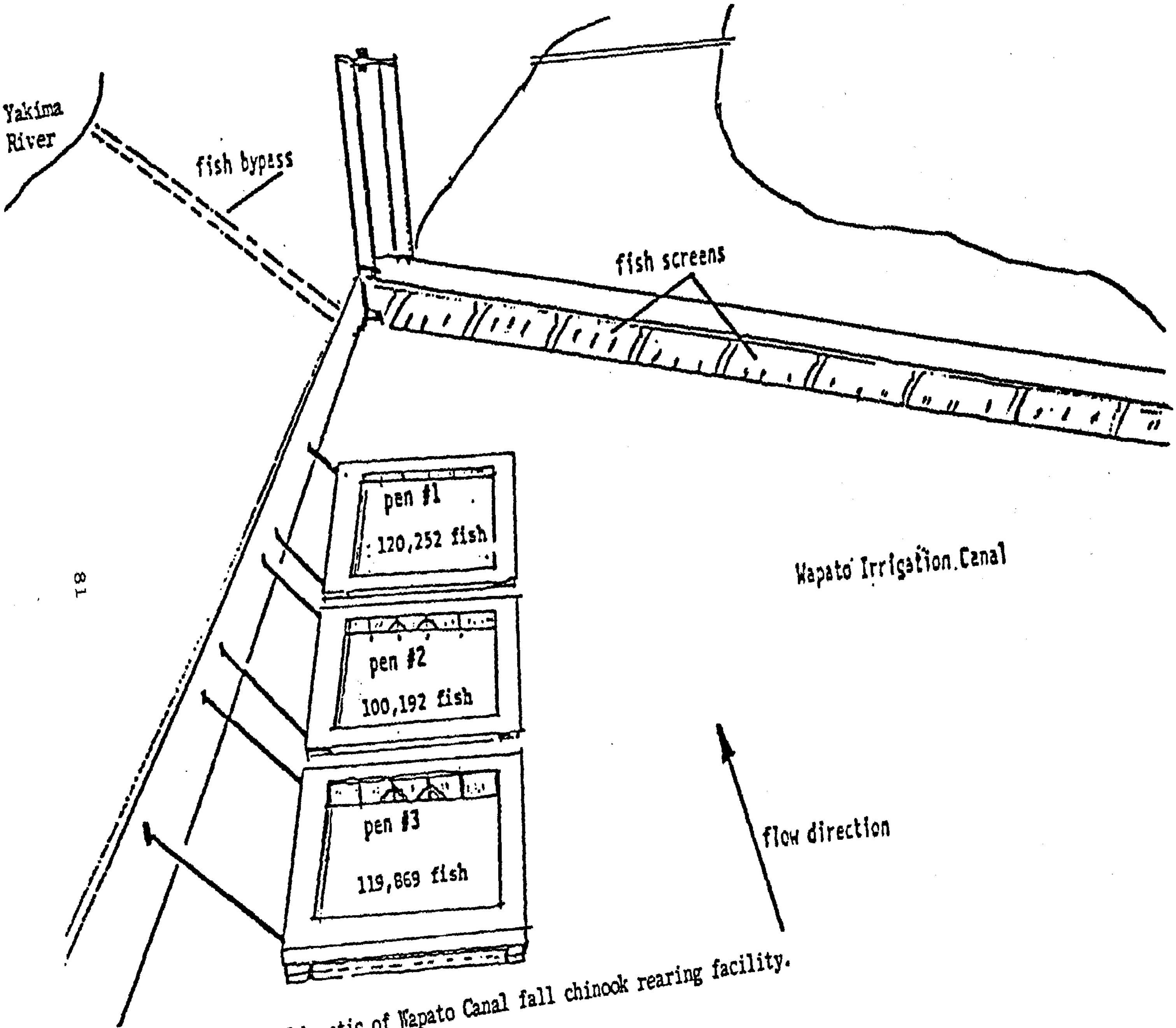


Figure 17. Schematic of Wapato Canal fall chinook rearing facility.

Battelle felt the 1988 study contained biased data due to different flow regimes in the Wapato Canal when measurements were taken with the pens in the canal as opposed to after their removal. They planned to repeat their experiments in 1989 with the results of their study expected to be published in early 1990.

Experimental Design, Disease Implications, and Marking of Fall Chinook at Little White National Fish Hatchery

As in the 1988 study, the upriver bright fall chinook used in the study were from Little White National Fish Hatchery in the lower Columbia River. The fish selected were from virus-free parents and were periodically checked for virus throughout their early rearing cycle. They were not coded-wire tagged until early April because of their slow growth due to the low water temperatures at the hatchery.

After consultation with Lars Mobrand, biometrician consultant for the Yakima/Klickitat Production Project, it was decided that the most statistically significant data could be collected on the effectiveness of the pen rearing concept if all three pens contained the same densities. This approach would allow replication. Therefore, unlike the 1988 pens experimental design which had three separate densities, in 1989 each pen was programmed to rear 120,000 fall chinook.

Because of a misunderstanding between myself and the U.S. Fish and Wildlife Service (agency responsible for coded wire tagging the experimental fish) only 85% or 306,000 of 360,000 of the total fish were marked. The population was divided equally into 3 separate groups of 102,000 and tagged. Because our density goal was 120,000 per pen, approximately 18,000 were added to each experimental population at the time of trucking to the Wapato site.

The fall chinook to be reared in experimental Pen 1 were tagged with a half tag code of 5-1-1-2-4 from April 7 to April 11. A total of 102,319 were tagged with a retention rate of 94%. The Pen 2 group were tagged from April 5 to April 7 with a code of 5-1-1-2-3. A total of 102,392 were tagged with a retention rate of 94%. The final group for pen 3 (102,125) were tagged from April 3 to April 5 with a code and retention rate of 5-1-1-2-2 and 95% respectively.

After certification by the U.S. Fish and Wildlife Service that they were disease-free, the experimental fall chinook were trucked to the Wapato Canal pen site on April 21. Upon arrival the fish were acclimated to canal water in the transport tanks and then released into the pens. Pen 3, the farthest upstream pen, contained 101,790 marked fish and 18,079 unmarked (119,869 total) with a size of 276 and 291 fish/lb respectively. Pen 2, the middle pen, began with fewer fish due to an estimated 20,000 fish loss at the time of pen introduction. The cause of loss was a malfunction of the transport tank discharge tube. Therefore, it was estimated to contain 85,113 marked chinook at 275 fish/lb and 15,079 unmarked fish at 291 fish/lb. The total beginning number of fall chinook in Pen 2 was therefore estimated to be 100,192. The final population of chinook were put into Pen 1, just downstream of Pen 2. This pen contained 102,173 marked chinook and 18,079 unmarked at 282 and 292 fish/lb respectively. The total beginning population for Pen 1 was 120,252 chinook (Figure 17).

Technical Maintenance of the Pens

A tribal technician was assigned to tend the pens. Using a biomoist diet from Bioproducts, the attempt was to feed all fish in the three pens the same percent of estimated body weight daily. Each week the daily ration per pen was calculated anew, based on water temperature and on each pen's estimated biomass. Pen biomass was determined by multiplying the average weight of three sample sub-groups. Feed amounts for each pen were adjusted after each weekly size measurement (Tables 17-19).

Pen maintenance consisted mainly of a daily cleaning of the perforated aluminum screens and the removal of mortalities. The design of the pens allowed maintenance

Table 17. Upriver bright fall chinook grouth data at Wapato Canal pen one.

Week	Water Temp (F)	Food Fed (#)	#/lb	Hortality	Number Remaining
4/21-4/22	52	21.0	258	3	120,249
4/23-4/29	47	81.0	221	3	120,246
4/30-5/6	52	107.0	175	18	120,228
5/7-5/13	50	149.0	159	11	120,217
5/14-5/20	51	201.0	141	8	120,209
5/22-5/27	51	230.0	98	26	120,183
5/28-5/30	52	123.0	72	9	120,174
		--m---D--			
		912.0			

Begining number	120,252
Begining biomass	424.00
Total food	912.00
Total mortality	78
Biomass gained	1245.00
feed conversion	1.37

Table 18. Upriver bright fall chinook growth data at Wapato Canal pen two.

Week	Water Temp (F)	Food Fed (#)	#/Lb	Hortality	Number Remaining
4/21-4/22	52	20.0	217	4	100,188
4/23-4/29	47	74.0	196	3	100,185
4/30-5/6	52	101 .0	141	8	100,177
5/7-5/13	50	141.0	135	3	100,174
5/14-5/20	51	190.0	129	5	100,169
5/22-5/27	51	212.0	92	9	100,160
5/28-5/30	52	117.0	66	7	100,153
		855.0			

Begining number	100,192
Begining biomass	432.00
Total food	855.00
Total mortality	39
Biomass gained	1085.00
feed conversion	1.27

Table 19. Upriver bright fall chinook growth data at Wapato Canal pen three.

Week	Water Temp (F)	Food Fed (#)	#/Lb	Mortality	Number Remaining
4/21-4/22	52	22.0	261	5	119,864
4/23-4/29	47	81.0	226	10	119,854
4/30-5/6	52	107.0	177	19	119,835
5/7-5/13	50	149.0	153	10	119,825
5/14-5/20	51	201.0	137	17	119,808
5/22-5/27	51	230.0	104	8	119,800
5/28-5/30	52	123.0	75	6	119,794
		913.0			

Begining number	119,869
Begining biomass	430.00
Total food	913.00
Total mortality	75
Biomass gained	1167.00
feed conversion	1.28

to be relatively simple with minimal labor.

Flow measurements within and adjacent to each pen were taken two times throughout the study (Tables 20-21). The purpose was to measure the expected slowing of the water from Pen 3 to Pen 1 due to the pens and the fish themselves acting as obstructions to the flow. The perforated aluminum screens are rated to be 47% efficient at water passage.

Release of the Fish from the Pens

The fish were reared in the pens for five weeks 4/21/89 to 5/30/89. Around May 20th was determined to be the optimal time of release for the experimental fish. This release schedule would have coincided with smolt flushing flows released by BOR from the reservoirs to allow quick migration out of the Yakima to the Columbia River. It was also prior to elevated water temperatures in the lower Yakima River, the critical migration corridor of the experimental chinook. The experimental fish were released over a week later due to a disease certification problem with Washington Department of Fisheries and U.S. Fish and Wildlife Service. Just prior to our intended release, IHN virus was detected in the original population of fish at Little White National Fish Hatchery of which the experimental chinook were a sub-population (See Letter 5/18/89 in Appendix). A quick virus sample was cultured from May 19 - May 24 which

Table 20. Net pen flow data taken on April 25, 1989.

		Surface	3 ft depth	6 ft depth
Lower pen Pen #1	Front	0.1	0.1	0.4
	Middle	0.1	0.0	0.5
	Back	0.0	0.0	0.7
Middle pen Pen #2	Front	0.1	0.2	0.5
	Middle	0.1	0.2	0.4
	Back	0.2	0.0	0.9
Upper pen Pen #3	Front	0.5	0.7	0.9
	Middle	0.2	0.2	0.3
	Back	0.0	0.1	0.4

Location where measurements were taken:

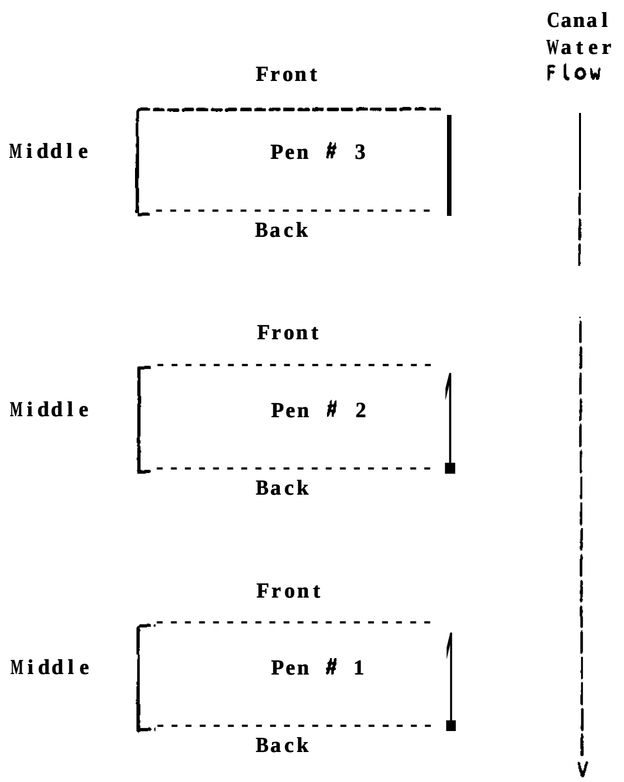
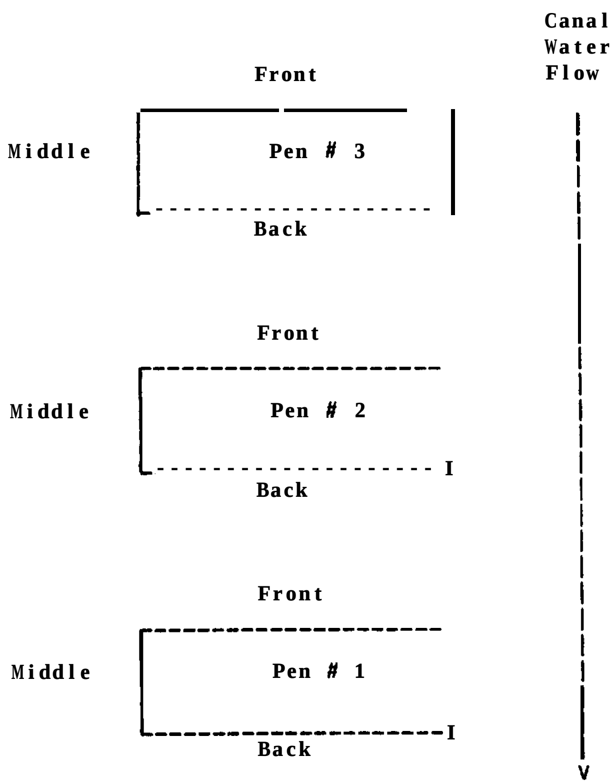


Table 21. Net pen flow data taken on Hay 17, 1989.

		Surface	3 ft depth	6 ft depth
Louer pen Pen #1	Front	0.2	0.2	0.3
	Middle	0.5	0.5	0.6
	Back	0.0	0.0	0.6
Hiddle pen Pen #2	Front	0.1	0.1	0.8
	Middle	0.7	0.8	1.2
	Back	0.0	0.0	0.4
Upper pen Pen #3	Front	0.0	0.2	0.9
	Middle	0.4	0.6	0.8
	Back	0.0	0.0	0.7

Location where measurements were taken:



revealed no infection in any of the pens. The chinook smolts were released May 30 by simply removing the 1/8" thick perforated screens on the downstream side of each of the pens. The release was timed for the evening to avoid, if possible, excessive predation. The location of the pens was such that the experimental chinook would pass down the canal for only a short distance (50 meters maximum) before being shunted to the Yakima River mainstem via the fish bypass associated with the new fish screens (Figure 17).

Tag Recoveries of Released Experimental Fish

The experimental fall chinook began showing up within a few days of release at the Prosser Juvenile Trap, where 25 tags per day were sampled. To date, evaluation of the tag information has not been completed. Tags will also be monitored at the Prosser Adult Trap when the experimental chinook return in 1 to 4 years.

Re-Design of Pens

Following three years of experience in utilizing the pens as rearing vessels, it was determined that the pens' effective rearing area could be increased substantially with minimal re-design of the infrastructure. Therefore, after release of the 1989 experimental chinook and the Battelle water flow study, each of the pens was "remodeled" to increase the rearing capacity. Basically, the width of each pen was expanded out from inside the walkway to the outside edge of the walkway. This increased the width of the rearing area by about four feet on each side of each pen or 30% (Figure 18).

General Discussion

A preliminary determination from last year's Wapato Pen density study indicated that there was little difference between the 3 densities in survival to the Prosser Juvenile Trap. Therefore, it was decided by biometricians associated with the Yakima/Klickitat Production Project that the highest density from 1988 be used in 1989 (1.1 lb/cu.ft) with 2 replicates. Statistically, results of the biological feasibility of utilizing the pens for rearing quality fall chinook smolts plus their value in the over all management scheme of the YKPP could be better evaluated.

Another phase of this year's pen study was to generally compare the survival to the Prosser Smolt trap and eventual adult survival of the fall chinook smolts (100% cwt) released at Sunnyside Dam after direct trucking from Little White National Fish Hatchery and the Wapato Canal experimental chinook. Twenty-five fall chinook were sampled daily at the Prosser Trap for later evaluation.

Results and Summary

This first couple of years of the study showed that upriver bright fall chinook are capable of being cultured

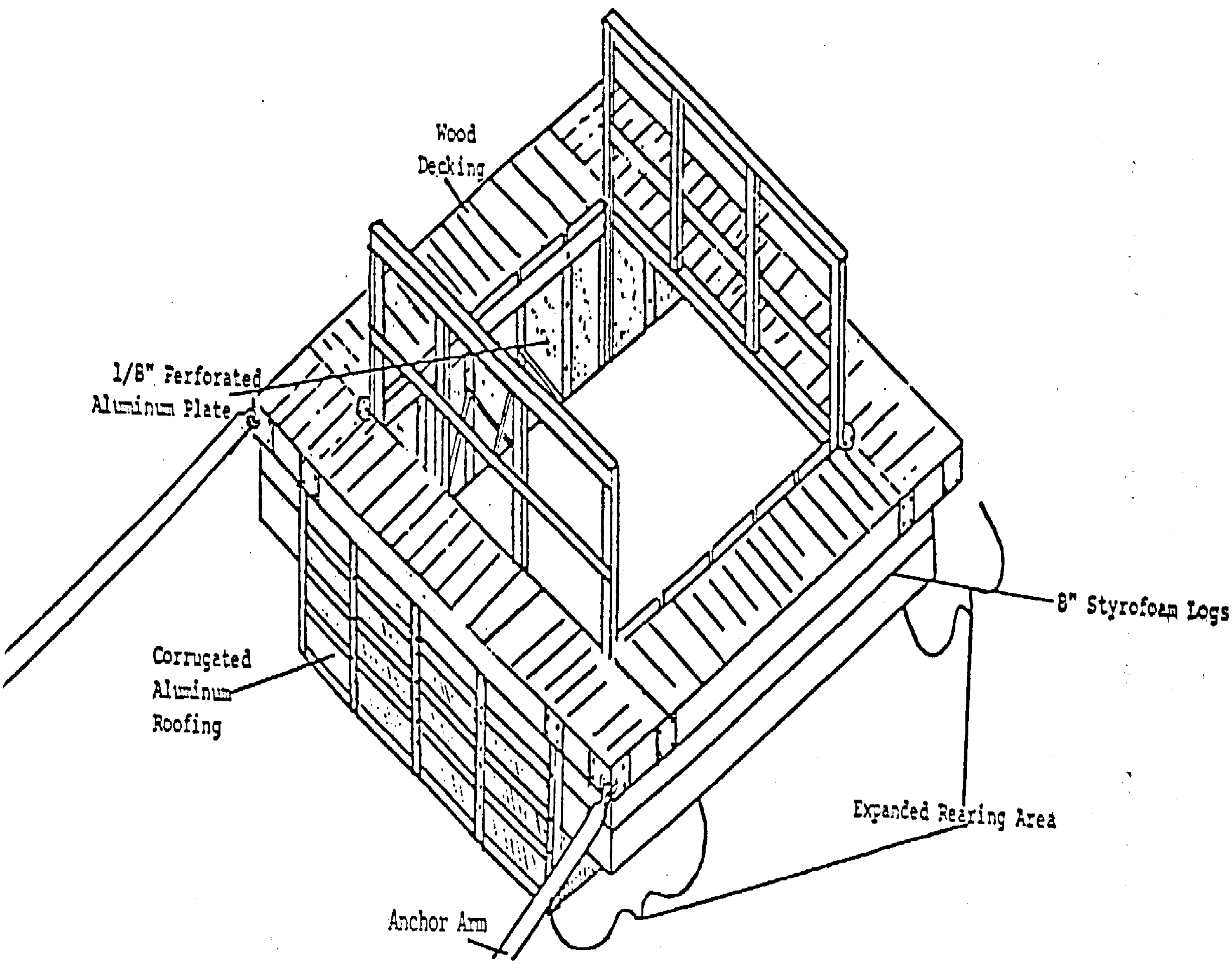


Figure. 18. Schematic of pen structure after modification,

in a pen environment in the irrigation canal. In the 1989 study, the chinook grew at a normal rate from approximately 280 fish/lb to 72, 66, and 75 fish/lb in pens 1, 2, and 3 respectively. There was no significant difference in growth rates between the 3 different densities. Thus, feed conversions were all similar (pen 1 - 1.37, pen 2 - 1.27, pen 3 - 1.28) (Tables 17-19). The feed conversions were better that those recorded at the Little White N.F.H. (1.68) with their 1989 fall chinook rearing program. The observed mortalities in the three pens were insignificant, averaging less that 0.001% suggesting that there was no serious pathological problems in the fish populations. At the end of the pen-rearing period, the chinook in all pens were physically in good shape with no apparent scale loss or fin erosion.

When the 1988-1989 tags sampled at the Prosser Juvenile Trap are read, the CWT data, besides indicating potential in-river survival differences between the three pens, should also determine any difference in survival between the 200,000 upriver bright fall chinook smolts trucked and released directly into the Yakima River one mile downstream from the study site and the experimental pen fish. The 1988-1989 survival data to Prosser will be incorporated into the 1990 Wapato Canal report because the data has not been analyzed.

The measurements of the rate of water flow upstream, within and downstream at each pen indicated that, in deed, the flow decreased moving downstream from one pen to the next. However, even with the steadily lower flows and reduced water exchanges along the downstream progression from Pen 3 to Pen 1, the condition and health of the fish along the same progression seemed unaffected (Tables 20-21).

In summary, this study indicated considerable potential of rearing upriver bright fall chinook in an existing irrigation canal. The experiment also suggested that for any given pen in a series of pens, the fish may be introduced and reared at a density that can be adjusted according to anticipated variations in water flow and exchange rates to keep the pen within a critical carrying capacity.

Because of the success of this experimental study, next year the YIN is proposing to increase the number of pens to six or nine in order to allow treatment replication. Results from replication will have better statistical validity. However, this expansion of the scope of work will occur only if the Battelle study confirms the YIN findings as to the negligible impacts of the pens on water flows to the fish screens.

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8.0 Appendices

Appendix A.

Adult fall chinook counts at Prosser Dam.

Appendix Tabtt A.1. Weekty totat passage of fall chinook at Prosscr Dam, 1983.

Date (week ending) (date)	Daily count Wild	Hatchery	Combined	Cumulative count Wild	Hatchery	Combined
17-Aug	-- /a	--	--	--	--	--
24-Aug	--	--	--	--	--	--
31-Aug	--	--	--	--	--	--
07-Sep	--	--	--	--	--	--
14-Sep	--	--	--	--	--	--
21-Sep	24	0	24	24	0	24
28-Sep	14	0	14	38	0	38
05-Oct	15	0	15	53	0	53
12-Oct	56	0	56	109	0	109
19-Oct	89	0	89	198	0	198
26-Oct	91	0	91	289	0	289
02-Nov	50	0	50	339	0	339
09-Nov	18	0	18	357	0	357
16-Nov	17	0	17	374	0	374
23-Nov	3	0	3	377	0	377
30-Nov	0	0	0	377	0	377
07-Dec	0	0	0	377	0	377
14-Dec	0	0	0	377	0	377
21-Dec	0	0	0	377	0	377
28-Dec	0	0	0	377	0	377
Totals	377	0	377			

1a Counting began the week ending September 21.

Appendix **Table A.2.** Weekly tots-l passage of fall chinook at **Prosser Dam,** 1984.

Date (week ending) (date)	Daily count Wild	 Hatchery	 Combined	Cumulative count Wild	 Hatchery	 Combined
17-Aug	2	0	2	2	0	2
24-Aug	0	0	0	2	0	2
31-Aug	26	0	26	28	0	28
07-Sep	27	0	27	55	0	55
14-Sep	134	0	134	2	0	189
21-Sep	186	0	186	0	0	375
28-Sep	115	0	175	26	0	550
05-Oct	237	0	237	27	0	787
12-Oct	265	0	265	134	0	1,052
19-Oct	110	0	110	186	0	1,162
26-Oct	104	0	104	175	0	1,266
02-Nov	37	0	37	237	0	1,303
09-Nov	17	0	17	265	0	1,320
16-Nov	9	0	9	110	0	1,329
23-Nov	3	0	3	104	0	1,332
30-Nov	0	0	0	37	0	1,332
07-Dec	0	0	0	17	0	1,332
14-Dec	0	0	0	9	0	1,332
21-Dec	0	0	0	3	0	1,332
28-Dec	0	0	0	0	0	1,332
Totals	1,332	0	1,332			

Appendix Table A.3. Weekly total passage of fall chinook at Prosser Dam, 1985.

Date	Daily count			Cumulative count		
(week ending) (date)	Wild	Hatchery	Combined	Wild	Hatchery	Combined
17-Aug	3	0	3	3	0	3
24-Aug	4	0	4	7	0	7
31-Aug	0	0	0	7	0	7
07-Sep	33	0	33	40	0	40
14-Sep	100	0	100	3	0	140
21-Sep	24	0	24	4	0	164
28-Sep	27	0	27	0	0	191
05-Oct	24	0	24	33	0	215
12-Oct	12	0	12	100	0	227
19-Oct	24	0	24	24	0	251
26-Oct	18	0	18	27	0	269
02-Nov	2	0	2	24	0	271
09-Nov	4	0	4	12	0	275
16-Nov	1	0	1	24	0	276
23-Nov	0	0	0	18	0	276
30-Nov	0	0	0	2	0	276
07-Dec	0	0	0	4	0	276
14-Dec	0	0	0	1	0	276
21-Dec	0	0	0	0	0	276
28-Dec	0	0	0	0	0	276
Totals	276	0	276			

Appendix Table A.4. Weekly total passage of fall chinook at Prosser Dam, 1986.

Date	Daily count			Cumulative count		
(week ending) (date)	Wild	Hatchery	Combined	Wild	Hatchery	Combined
17-Aug	0	0	0	0	0	0
24-Aug	0	0	0	0	0	0
31-Aug	0	0	0	0	0	0
07-Sep	5	0	5	5	0	5
14-Sep	29	1	30	0	1	35
21-Sep	131	0	131	0	1	166
28-Sep	123	0	123	0	1	289
05-Oct	211	0	211	5	1	500
12-Oct	47	0	47	30	1	547
19-Oct	59	0	59	131	1	606
26-Oct	6	0	6	123	1	612
02-Nov	109	1	110	211	2	722
09-Nov	1	0	1	47	2	723
16-Nov	0	0	0	59	2	723
23-Nov	3	0	3	'6	2	726
30-Nov	1	0	1	110	2	727
07-Dec	0	0	0	'1	2	727
14-Dec	0	0	0	0	2	727
21-Dec	0	0	0	3	2	727
28-Dec	0	0	0	1	2	727
Totals	725	2	727			

Appendix Table A.5. Weekly total passage of fall chinook at Prosser Dam, 1987.

Date	Dai ly count			Cunulat i ve count		
(week ending) (date)	Uild	Hatchery	Combined	Wild	Hatchery	Combined
17-Aug	0	0	0	0	0	0
24-Aug	0	0	0	0	0	0
31 -Aug	0	0	0	0	0	0
07-Sep	0	0	0	0	0	0
14-Sep	27	0	27	0	0	27
21-Sep	23	0	23	0	0	50
28-Sep	59	5	64	0	5	114
05-Oct	105	6	111	0	11	225
12-Oct	83	5	88	27	16	343
19-Oct	a3	4	87	23	20	400
26-Oct	86	3	89	64	23	489
02-Nov	22	2	24	111	25	513
09-Nov	13	0	13	88	25	526
16-NOV	3	0	3	87	25	529
23-Nov	0	0	0	89	25	529
30-Nov	0	0	0	24	25	529
07-Dec	0	0	0	13	25	529
14-Dec	0	0	0	3	25	529
21-Dec	0	0	0	0	25	529
28-Dec	0	0	0	0	25	529
Totals	504	25	529			

8.0 Appendices

Appendix B.

Adult steelhead counts at Prosser Dam.

Appendix Table B.1. Weekly total passage of steelhead at Prosser Dam, 1984-85.

Date	Daily count			Cumulative count		
(Week ending) (date)	Wild	Hatchery	Both	Wild	Hatchery	Both
	10	0	10	10	0	10
14-Jul	0	0	0	10	0	10
21-Jul	0	0	0	10	0	10
28-Jul	0	0	0	10	0	10
04-Aug	0	0	0	10	0	10
11-Aug	1	0	1	11	0	11
18-Aug	0	0	0	11	0	11
25-Aug	0	0	0	11	0	11
01-Sep	49	0	49	60	0	60
08-Sep	82	0	82	142	0	142
IS-Sep	100	0	100	242	0	242
22-Sep	129	0	129	371	0	371
29-Sep	109	0	109	480	0	480
06-Oct	178	0	178	658	0	658
13-Oct	195	0	195	853	0	853
20-Oct	126	0	126	979	0	979
27-Oct	116	0	116	1,095	0	1,095
03-Nov	95	0	95	1,190	0	1,190
IO-Nov	167	0	167	1,357	0	1,357
17-Nov	200	0	200	1,557	0	1,557
24-Nov	93	0	93	1,650	0	1,650
01-Dee	6	0	6	1,656	0	1,656
08-Dec	3	0	3	1,659	0	1,659
15-Dec	0	0	0	1,659	0	1,659
22-Dec	3	0	3	1,662	0	1,662
29-Dec	2	0	2	1,664	0	1,664
05-Jan	0	0	0	1,664	0	1,664
12-Jan	0	0	0	1,664	0	1,664
19-Jan	2	0	2	1,666	0	1,666
26-Jan	18	0	18	1,684	0	1,684
02-Feb	24	0	24	1,708	0	1,708
09-Feb	0	0	0	1,708	0	1,708
16-Feb	26	0	26	1,734	0	1,734
23-Feb	172	0	172	1,906	0	1,906
02-Mar	160	0	160	2,066	0	2,066
09-Mar	53	0	53	2,119	0	2,119
16-Mar	27	0	27	2,146	0	2,146
23-Mar	15	0	15	2,161	0	2,161
30-Mar	3	0	3	2,164	0	2,164
06-Apr	8	0	a	2,172	0	2,172
13-Apr	4	0	4	2,176	O	2,176
20-Apr	2	0	2	2,178	O	2,178
27-Apr	0	0	0	2,178	0	2,178
04-Hay	3	0	3	2,181		2,181
II-May	1	0	1	2,182	8	2,182
18-May	0	0	0	2,182	0	2,182
25-Hay	0	0	0	2,182	0	2,182
01-Jun	0	0	0	2,182	0	2,182
08-Jun	2	0	2	2,184	0	2,184
15-Jun	3	0	3	2,187	O	2,187
22-Jun	O	0	O	2,187	O	2,187
29-Jun	1	0	1	2,188	0	2,188
	0	0	0	2,188	0	2,188
Totals .	2,188	0	2,188			

Appendix fable B.2. Weekly total passage of steelhead at Prosser Dam, 1985-86.

Date	Daily count			Cumulative count		
(Week ending) (date)	Wild	Hatchery	Both	Wild	Hatchery	Both
07-Jul	1	0	1	1	0	1
14-Jul	0	0	0	1	0	1
21-Jul	0	0	0	1	0	1
28-Jul	0	0	0	1	0	1
04-Aug	6	0	6	7	0	7
II-Aug	0	0	0	7	0	7
18-Aug	5	0	5	12	0	12
25-Aug	2	0	2	14'		14
01-stp	1	0	1	15	8	15
08-Sep	14	0	14	29	0	29
IS-stp	62	0	62	91	0	91
22-stp	192	0	192	283	0	283
29-stp	65	0	65	348	0	348
06-Oct	86	0	86	434	0	434
13-Oct	20	0	20	454	0	454
20-Oct	76	1	77	530	1	531
27-Oct	80	1	81	610	2	612
03-Nov	45	1	46	655	3	658
10-Nov	111	0	111	766	3	769
17-Nov	4	0	4	770	3	773
24-Nov	0	0	0	770	3	773
01-Dec	0	0	0	770	3	773
08-Dec	0	0	0	770	3	773
15-Dec	0	0	0	770	3	773
22-Dec	0	0	0	770	3	773
29-otc	0	0	0	770	3	773
05-Jan	0	0	0	770	3	773
12-Jan	26	0	26	796		799
19-Jan	67	0	67	863	5	866
26-Jan	18	0	18	881	3	884
02-Feb	177	0	177	1,058	3	1,061
09-Feb	240	0	240	1,298	3	1,301
16-Feb	2	0	2	1,300	3	1,303
23-Ftb	81	0	81	1,381	3	1,384
02-Mar	76	0	76	1,457	3	1,460
09-Mar	49	0	49	1,506	3	1,509
16-Mar	103	0	103	1,609	3	1,612
23-Mar	326	0	326	1,935	3	1,938
30-Mar	117	0	117	2,052	3	2,055
06-Apr	36	0	36	2,088		2,091
13-Apr	49	0	49	2,137	5	2,140
20-Apr	33	0	33	2,170		2,173
27-Apr	28	0	28	2,198	5	2,201
04-May	10	0	10	2,208	3	2,211
II-Hay	1		1	2,209		2,212
18-May	2	8	2	2,211	5	2,214
25-May	0	0	0	2,211	3	2,214
01-Jun	2	0	2	2,213	3	2,216
08-Jun	0	0	0	2,213	3	2,216
IS-Jun	0	0	0	2,213	3	2,216
22-Jun	0	0	0	2,213	3	2,216
29-Jun	3	0	3	2,216	3	2,239
	2	0	2	2,218	3	2,221
Totals	2,218	3	2,221			

kpptndix Table 8.3. Weekly total passage of steelhead at Prosstr Dam, 1986-87.

Date	Daily count			Cuaulative count		
(Week ending) (date)	Uild	Hatchery	Both	Wild	Hatchery	Both
07-Jul	8	0	8	8	0	8
14-Jul	12	0	12	20	0	20
21-Jul	1	0	1	21	0	21
28-Jul	4	0	4	25	0	25
04-Aug	2	0	2	27	0	27
II-Aug		0	0	27	0	27
18-Aug	8	0	0	27	0	27
25-Aug	0	0	0	27	0	27
01-stp	0	0	0	27	0	27
08-Sep	50	0	50	77	0	77
IS-stp	127	0	127	204	0	204
22-stp	257	0	257	461	0	461
29-stp	247	0	247	708	0	708
06-Oct	197	0	197	905	0	905
13-Oct	102	0	102	1,007	0	1,007
20-Oct	100	2	102	1,107	2	1,109
27-Oct	160	17	177	1,267	19	1,286
03-Nov	150	15	165	1,417	34	1,451
IO-Nov	28	0	28	1,445	34	1,479
17-Nov	13	0	13	1,458	34	1,492
24-Nov	29	3	32	1,487	37	1,524
01-otc	18	0	18	1,505	37	1,542
08-Dec	4	0	4	1,509	37	1,546
15-Dec	3	0	3	1,512	37	1,549
22-Dec	14	0	14	1,526	37	1,563
29-Dec	25	0	25	1,551	37.	1,588
05-Jan	6	0	6	1,557	37	1,594
12-Jan	49	0	49	1,606	37	1,643
19-Jan	6	0	6	1,612	37	1,649
26-Jan	0	0	0	1,612	37	1,649
02-Ftb	143	0	143	1,755	37	1,792
09-Ftb	117	0	117	1,872	37	1,909
16-Feb	175	2	177	2,047	39	2,086
23-Feb	50	0	50	2,097	39	2,136
02-Mar	10	0	10	2,107	39	2,146
09-Mar	60	2	62	2,167	41	2,208
16-Mar	21	0	21	2,188	41	2,229
23-Mar	48	0	48	2,236	41	2,277
30-Mar	90	0	90	2,326	41	2,367
06-Apr	74	0	74	2,400	41	2,441
13-Apr	26	0	26	2,426	41	2,467
20-Apr	31	0	31	2,457,	41	2,498
27-Apr	15	0	15	2,472	41	2,513
04-May	8	0	8	2,480	41	2,521
11-May	1	0	1	2,481	41	2,522
18-May	1	0	1	2,482	41	2,523
25-May	0	0	0	2,482	41	2,523
01-Jun	0	0	0	2,482	41	2,523
08-Jun	0	0	0	2,482	41	2,523
15-Jun	0	0	0	2,482	41	2,523
22-Jun	1	0	1	2,483	41	2,524
29-Jun		0	0	2,483	41	2,524
	8	0	0	2,483	41.	2,524
Totals	2,483	41	2,524			

Appendix Table 8.4. Weekly totat ptssagt of stttlhtad at Prosser Dam, 1987-88.

Date (Week ending) (date)	Daily count Wild	Hatchery	Both	Cumulative count Wild	Hatchery	Both
07-Jul	0	0	0	0	0	0
14-Jul	7	0	7	7	0	7
21-Jul	8	0	8	15	0	15
28-Jul	3	0	3	18	0	18
04-Aug	1	0	1	19	0	19
11-Aug	0	0	0	19	0	I?
18-Aug	0	0	0	19	0	19
25-Aug	0	0	0	19	0	19
01-Sep	0	0	0	19	0	19
08-Sep	0	2	2	19	2	21
IS-Stp	18	0	18	37	2	39
22-Stp	55	2	57	92	4	96
29-Stp	141	30	171	233	34	267
06-Oct	103	22	125	336	56	392
13-Oct	116	42	158	452	98	550
20-Oct	92	10	102	544	108	652
27-Oct	118	30	148	662	138	800
03-Nov	83	15	98	745	153	898
IO-Nov	39	4	43	784	157	941
17-Nov	18	3	21	802	160	962
24-Nov	6	1	7	808	161	969
01-Dtc	3	0	3	811	161	972
OS-Ott	83	0	83	894	161	1,055
IS-Dtc	23	0	23	917	161	1,078
22-Oec	1	0	1	918	161	1,079
29-Oec	4	0	4	922	161	1,083
OS-Jan	4	0	4	926	161	1,087
12-Jan	9	0	9	935	161	1,096
19-Jan	159	0	159	1,094	161	1,255
26-Jan	96	2	98	1,190	163	1,353
02-Ftb	149	7	156	1,339	170	1,509
09-Ftb	47	0	47	1,386	170	1,556
16-Feb	321	16	337	1,707	186	1,893
23-Ftb	78	5	83	1,785	191	1,976
02-Mar	16	2	18	1,801	193	1,994
09-Mar	21	0	21	1,822	193	2,015
16-Mar	133	7	140	1,955	200	2,155
23-Mar	94	15	109	2,049	215	2,264
30-Mar	113	9	122	2,162	224	2,386
06-Apr	101	5	106	2,263	229	2,492
13-Apr	52	1	53	2,315	230	2,545
20-Apr	69	1	70	2,384	231	2,615
27-Apr	42	2	44	2,426	233	2,659
04-May	14	1	15	2,440	234	2,674
II-Hay	7	0	7	2,447	234	2,681
18-May	9	0	9	2,456	234	2,690
25-Hay	2	0	2	2,458	234	2,692
01-Jun	0	0	0	2,458	234	2,692
08-Jun	0	0	0	2,458	234	2,692
15-Jun	0	0	0	2,458	234	2,692
22-Jun	0	0	0	2,458	234	2,692
29-Jun	1	0	1	2,459	234	2,693
	0	0	0	2,459	234	2,693
Totals	2,459	234	2,693			

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