FRI/LSR - 88-12

LOWER SNAKE RIVER COMPENSATION PLAN

LYONS FERRY EVALUATION PROGRAM

1987 ANNUAL REPORT

by

Paul Seidel
Robert Bugert
Paul LaRiviere
Deborah Marbach
Steven Martin
Lance Ross

Washington Department of Fisheries
115 General Administration Building
Olympia, Washington 98504

to

Lower Snake River Compensation Plan Office
U.S. Fish and Wildlife Service
4696 Overland Road, Room 560
Boise, Idaho 83702

Cooperative Agreement 14-16-0001-87512

ABSTRACT

This report provides a synopsis of Fiscal Year 1987 activities by the Washington Department Fisheries' lower Snake River hatchery evaluation studies. This work is funded by the U. S. Fish and Wildlife Service under the Lower Snake River Fish and Wildlife Compensation Plan (LSRCP). Specific programs studied are Lyons Ferry and Tucannon Fish Hatcheries (FH). Mandated adult return objectives for these hatcheries are 18,300 fall chinook salmon, Snake River stock, and 1,152 adult spring chinook salmon, Tucannon River stock.

Fall chinook salmon escapement to Lyons Ferry FH in 1987 was 2,842 adults (age 4+) and 1,015 jacks. Fish were obtained from two sources, voluntary returns to the FH ladder, and fish trapped at Ice Harbor Dam and hauled to Lyons Ferry. Most returns were volunteers. This was the first return of four year old adults to the hatchery, which was built in 1984. Preliminary coded-wire tag (CWT) recovery analysis indicates a high survival of the 1983 brood yearling on-station release. By age 4, 1.22 percent of this release group escaped to the LSRCP project area, and 4.00 percent contributed to high seas and Columbia River fisheries. Of the seven different study groups released to date, all were represented in the 1987 escapement. Fish were spawned from 20 October to 14 December; eggtake was 5,957,976. The 1985 and 1986 broods had minor outbreaks of bacterial kidney disease. In April 1987, the 1986 brood had a major outbreak of gill disease; mortality rate for that month was 7.44 percent. Lyons Ferry FH staff planted 386,919 yearling (1985 brood) fall chinook salmon in April, and 674,047 subyearling (1986 brood) fall chinook salmon in June. We differentially marked (CWT) representative groups of the yearling and subyearling groups for release on-station and for transport below Ice Harbor Dam for release. On-station releases were coordinated with spill at Lower Monumental Dam. We monitored fall chinook natural spawning in the Tucannon, Grande Ronde, and mainstem Snake Rivers and found 16, 7, and 66 redds, respectively.

Spring chinook salmon escapement to the Tucannon River was 251; enumeration was by trapping the adults adjacent to the hatchery, and by snorkel surveys downstream of the trap. We collected 101 adults for broodstock at Tucannon FH. Peak of spawning was 19 September, which coincided well with natural spawners. Eggtake was 196,573. The first release of hatchery reared spring chinook was in 1987; 12,992 smolts were volitionally released on 6 to 10 April. Modal travel time to the downstream migrant trap 38 km downstream of the hatchery was about five days.

We made estimates of Tucannon River spring chinook salmon natural production and survival rates at the egg deposition, late summer parr production, and yearling outmigrant stages. We estimate 302,400 eggs were deposited (1987 brood) by 150 adults.

We quantitatively electrofished 50 sites in three study strata, and found mean rearing densities ranged from 22.69 to 32.60 fish/100m2. These data were used with extensive and intensive habitat surveys to estimate a standing crop of 111,000 fry (1986 brood). We operated a downstream migrant trap from November 1986 through June 1987, and caught 6,239 natural spring chinook smolts, at an average efficiency of 22 percent. We estimate 35,559 (with 95 percent confidence interval of 2,485) natural spring chinook salmon (1985 brood) outmigrated from the Tucannon River. Seven continuous reading thermographs placed in the upper Tucannon River indicated heat loading occurred throughout the HMA study stratum, the reach between Panjab Creek (river kilometer 75) and Big 4 Lake (RK 66) had the most significant temperature increase.

In this report we began documentation and analysis of stock profile characteristics for the endemic fish in our study area. We provide baseline data from electrophoretic analyses of both the Snake River fall chinook salmon and Tucannon River spring chinook salmon. Chi-square contingency tests among 30 loci studied indicated no clear evidence of genetic difference between Snake River stock fall chinook salmon returning to Lyons Ferry FH and those obtained from Kalama Falls FH through the Snake River Fall Chinook Egg Bank Program. A clear evidence of genetic difference was observed between Snake River stock and Columbia River (Priest Rapids) stock fall chinook salmon. Morphometric analysis of juvenile (1986 brood) spring and fall chinook salmon was inititated in FY 1987. Results of these test indicated a difference in body morphometry between Snake River stock fall chinook salmon, Tucannon stock spring chinook salmon reared at Lyons Ferry FH, and Tucannon stock spring chinook salmon reared in the natural environment. Analysis of basic mineral composition for Tucannon River spring chinook salmon was also inititated in FY 1987 and are presented in this report.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

ACKNOWLEDGEMENTS

Many people assisted in all aspects of this study. Technicians Corrine Dedloff and Shane Snow contributed much in the field data collection and logistics. Hatchery managers Carl Ross, Bill Hubbard, and Don Brown offered complete cooperation in the hatchery sampling. Fish culturists Brent Dearing, Morgan Grant, Jeri Bath, Steve Henry, and Jim Fletcher assisted in hatchery sampling and logistics. Eric Anderson of Washington Department of Wildlife (WDW), Andy Appleby, Howard Fuss, and Mark Kimbel of Washington Department of Fisheries (WDF), and several personnel from the Confederated Umatilla Tribe assisted in spring chinook salmon spawning ground and electrofishing surveys. Dr. Jim Shaklee and Steve Phelps of WDF provided the electrophoretic analysis. Dave Seiler of WDF provided much help in designing the downstream migrant trap study. Larry Wimer of Idaho Power and Ken Witty of Oregon Department of Fish and Wildlife participated in, and helped fund, the mainstem Snake River fall chinook salmon redd counts. Glen Mendel of WDW provided help on assessing fall chinook salmon spawning distribution in the Grande Ronde River.

We thank Jerry Harmon and crew from National Marine Fisheries Service (NMFS) for collection of marked fall chinook jacks at Lower Granite Dam, Dr. Gary Winans from NMFS for technical advice and assistance in the morphometrics study, and Ed Calame of the U.S. Forest Service for all aspects of the stream temperature studies. Dr. Ron Hardy and Karl Shearer of NMFS provided the spring chinook salmon elemental composition analysis.

Dan Herrig of the U.S. Fish and Wildlife Service (USFWS) gave invaluable logistical and technical assistance in all aspects of this study. Bob Foster of WDF and Ralph Roseburg of USFWS gave computer programming advice. Dr. Kirk Steinhorst of the University of Idaho provided statistical advice.

LOWER SNAKE RIVER COMPENSATION PLAN

LYONS FERRY SALMON HATCHERY EVALUATION

1987 ANNUAL REPORT

SECTION 1: INTRODUCTION

1.1: Compensation Objectives

Congress authorized the Lower Snake River Fish and Wildlife Compensation Plan (LSRCP) in 1976. As a result of that plan, Lyons Ferry Fish Hatchery (FH) was designed and is currently under operation. The objective of Lyons Ferry FH is to compensate for the loss of 18,300 adult fall chinook salmon, Snake River stock, and 1,152 adult spring chinook salmon, Tucannon River stock (U.S. Army, 1975). An evaluation program was initiated in 1984 to monitor the success of the Lyons Ferry FH in meeting the LSRCP compensation goals and to identify any production adjustments required to accomplish those objectives. A specific list of the evaluation program's objectives is outlined in Appendix A. This report summarizes all activities performed by the Washington Department of Fisheries' (WDF) Lyons Ferry Evaluation Program from the time period 1 April 1987 through 31 March 1988. Section 2 of this report outlines the fall chinook salmon operation and evaluation progress; Section 3 outlines spring chinook salmon operation and evaluation progress.

1.2: Description of Facilities

The Lyons Ferry facility is located at the confluence of the Palouse River with the lower Snake River at river kilometer (RK) 90 (Lower Monumental Pool, Figure 1). Design capacity is 101,800 pounds (9,162,000 subyearling smolts at 90 fish per pound) of fall chinook salmon and 8,800 pounds (132,000 yearling smolts at 15 fish per pound) of spring chinook salmon (Table 1).

Table 1. Fall and spring chinook salmon production objectives for Lyons Ferry and Tucannon Fish Hatcheries.

Facility	Stock	Number produced	Pounds produced	Adult returns	Return rate (%)
Lyons Ferry	Fall	9,162,000	101,800	18,300	0.20
Tucannon	Spring	132,000	8,800	1,152	0.87

The Lyons Ferry facility has a single pass wellwater system through the incubators, two adult holding ponds, and 28 raceways. A satellite facility is maintained on the Tucannon River (RK 61; Figures 1, 2) for collection of spring chinook salmon adults and subsequent release of yearling progeny. It has an adult collection trap and one holding pond. Returning adult spring chinook salmon are trapped and spawned at the Tucannon satellite facility. Progeny are incubated and reared to parr size at the Lyons Ferry facility, then trucked back to the Tucannon satellite for acclimation to river water and release. The first spring chinook salmon smolt release from the Tucannon facility was in 1987. Fall chinook salmon are hatched and reared at the Lyons Ferry facility and either released on station or barged downstream and released. Adult fall chinook salmon return to the fish ladder at the Lyons Ferry facility for broodstock; 1987 was the first year of adult (4+ year old) returns to the hatchery.

SECTION 2: FALL CHINOOK SALMON PROGRAM EVALUATION

2.1: Broodstock Establishment

The Lyons Ferry FH has been building its broodstock since the facility was completed in 1984. Snake River fall chinook salmon broodstock are currently obtained from two sources, returns to the Lyons Ferry FH ladder, and adults trapped at Ice Harbor Dam for transport to Lyons Ferry FH. The third source, transport of eyed eggs from Kalama Falls FH, done as part of the Snake River Egg Bank Program, was completed in 1986.

2.1.1: Returns to Lyons Ferry Fish Hatchery

Numbers of fall chinook salmon returning to the Lyons Ferry FH ladder are increasing each year because on-station releases underway since 1985 are returning as adults. As of 1987, voluntary returns to the hatchery are the primary source of broodstock (Table 2). A total of 1,654 adults and 543 jacks (fish under 61 cm fork length[a]) returned to Lyons Ferry FH in 1987. First adult arrival to the rack was on 18 September; last arrival was on 12 December, six weeks longer than the duration of returns in 1986 (6 October to 14 November).

a

Throughout this report jacks collected in trapping operations and returns to the hatchery rack were distinguished by size, and in some cases revised when coded-wire tag or scale data became available. The length criterion for jacks collected at Ice Harbor Dam and Lyons Ferry FH was 61 cm, the length criterion at Lower Granite Dam was 55 cm.

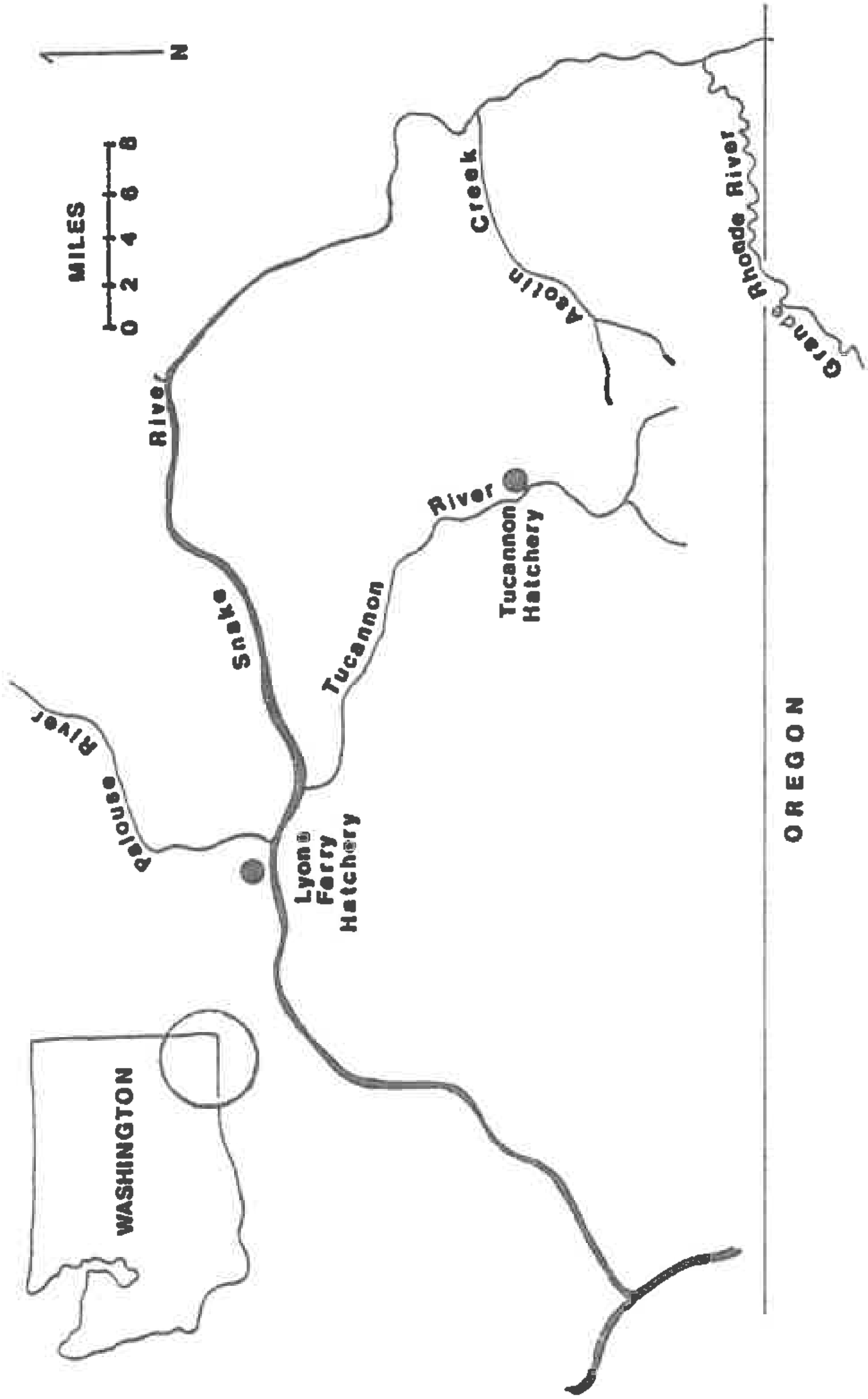


Figure 1. Lower Snake River Basin in southeast Washington, showing location of Lyons Ferry and Tucannon Fish Hatcheries.

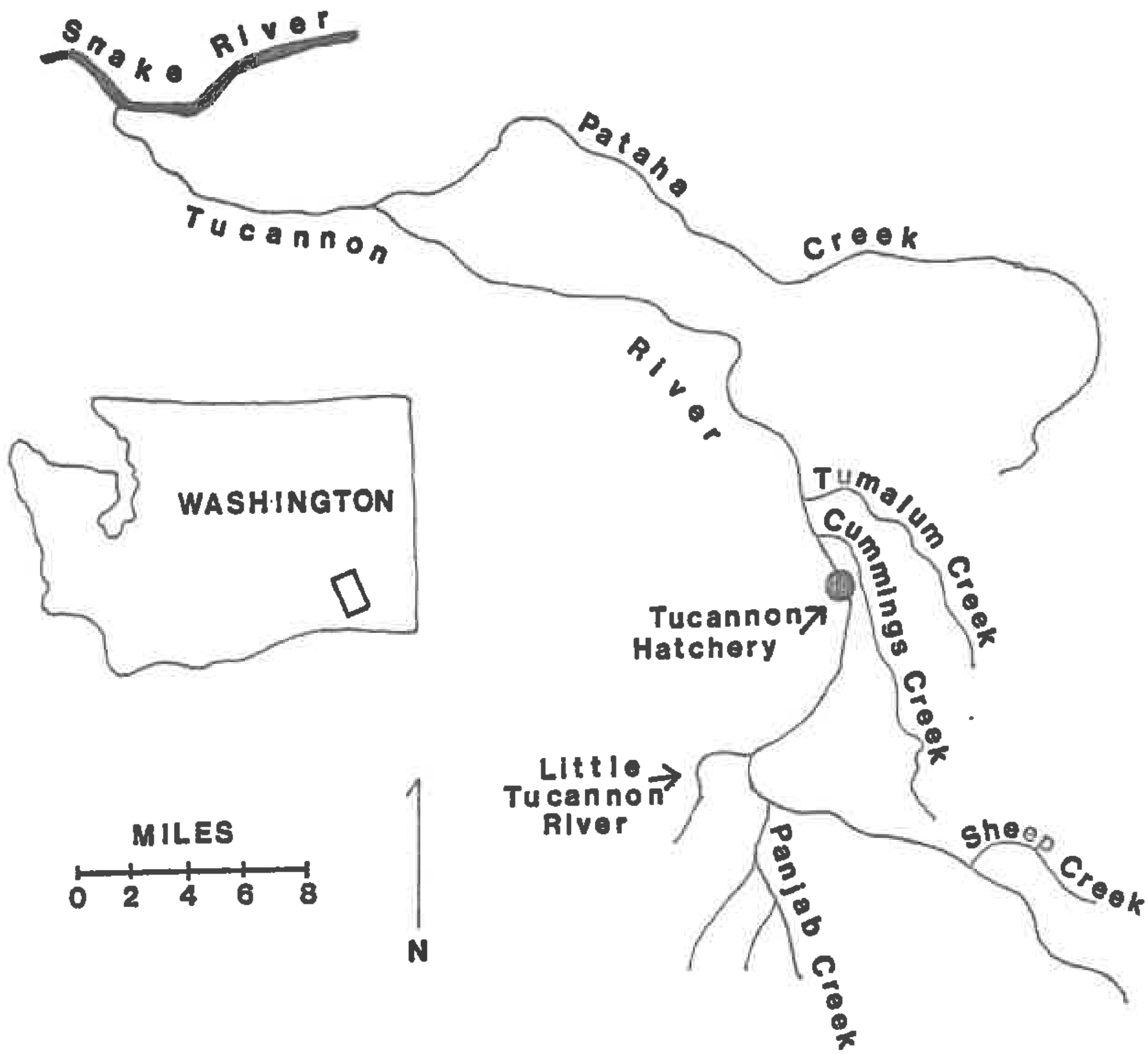


Figure 2. Tucannon River Basin, showing location of Tucannon Fish Hatchery.

Table 2. Contribution of fall chinook salmon adult returns to Lyons Ferry Fish Hatchery (FH) from Ice Harbor Dam, Kalama Falls FH, to the Lyons Ferry FH ladder, and the total count past Ice Harbor Dam during the period 1984 to 1987.

Year	Collection point	Number collected		Ice Harbor Dam count	
		adults	jacks	adults	jacks
1984	Lyons Ferry FH	0	0	1410	642 a
	Ice Harbor Dam	663	97		
	Kalama Falls FH	220	10		
1985	Lyons Ferry FH	6	4070 b	2046	7119
	Ice Harbor Dam	589	90		
	Kalama Falls FH	952	2		
1986	Lyons Ferry FH	245	1125	3152	2665
	Ice Harbor Dam	212	23		
	Kalama Falls FH	576	1		
1987	Lyons Ferry FH	1654	543	6812	1619
	Ice Harbor Dam	1613	47		
	Kalama Falls FH	0	0 c		

a Classification of adults and jacks is based upon size only.

b The first release from Lyons Ferry FH was in 1985 (1983 brood) therefore, first returns of hatchery-reared stock to Lyons Ferry FH were 2 year old jacks in 1985.

c There were no returns of Snake River stock fall chinook salmon to Kalama Falls FH in 1987.

2.1.2: Ice Harbor Dam trapping

Since 1977, returning adult fall chinook salmon have been trapped at Ice Harbor Dam and transported to Dworshak and Tucannon FH in conjunction with the Snake River Fall Chinook Egg Bank Program (Bjornn and Ringe 1988). Since its completion in 1984, Lyons Ferry FH has been receiving the transported fall chinook salmon (Table 3). Over the eleven-year period, numbers of fish transported have averaged 561 adults (range: 212 - 1613) and 56 jacks (range: 0 - 150). In 1987, 1,613 adults and 47 marked jacks were trapped and hauled to Lyons Ferry FH, representing 24 percent of the total run of fall chinook salmon adults past Ice Harbor Dam for that year (Table 2). Actual trap efficiency for the period of operation, however, was 32 percent.

Table 3. Numbers of fall chinook salmon trapped at Ice Harbor Dam and hauled to Lyons Ferry Fish Hatchery, duration of trapping, and peak day of trapping from 1984 through 1987.

Year	Number trapped		Duration of trapping	Peak trapping day	
	adults	jacks		date	number
1984	663	97	1 Sep. - 5 Oct.	11 Sep.	57
1985	589	90	31 Aug. - 30 Sep.	9 Sep.	68
1986	212	23	4 Sep. - 3 Oct.	18 Sep.	24
1987	1613	47	2 Sep. - 11 Oct.	26 Sep.	97

2.1.3: Kalama Falls egg transport

Prior to completion of the Lyons Ferry FH, a portion of the Snake River stock fall chinook salmon adults were collected and reared at the WDF Kalama Falls FH on the lower Columbia River as part of the Snake River Fall Chinook Egg Bank Program. When the Lyons Ferry facility was completed, eyed eggs were transported from Kalama Falls FH to Lyons Ferry for rearing and subsequent release. Hatchery staff transported 219,800 1984 brood eggs, 1,182,000 1985 brood eggs, and 749,355 1986 brood eggs from Kalama Falls FH (Table 2). There were no returns of Snake River stock fall chinook salmon eggtake Kalama Falls FH in 1987. Snake River stock fall chinook salmon have not been released from Kalama Falls FH since spring 1984; all releases since that time have originated at Lyons Ferry FH.

2.2: Coded-Wire Tag Recoveries

2.2.1: Preliminary analysis of returns

In 1987, seven separate treatment (release) groups returned to the Lyons Ferry FH rack: 1) the 1983 brood yearling (age 1+) on-station release, 2) the 1984 brood yearling on-station release, 3) the 1984 brood subyearling (age 0) on-station release, the 1985 brood subyearling 4) on-station and 5) transport groups, and the 1985 brood yearling 6) on-station and 7) transport groups. Each release group was differentially marked with coded-wire tags (CWT, Table 4).

To date, 1.21 percent of the 1983 brood has returned to Lyons Ferry FH as two, three, and four year olds (Table 5). If we include fish trapped at Lower Granite Dam (Section 2.2.3), 1.22 percent has returned to the LSRCP project area (above Ice Harbor Dam). Currently, 13,399 tagged fish from this release group were caught in various fisheries, for a 4.00 percent contribution rate. The overall survival rate for the 1983 brood (fishery contribution and returns to the LSRCP project area) is 5.23 percent. To date, 0.05 and 0.06 percent of the 1984 brood subyearling on-station release have returned to Lyons Ferry FH and contributed to various fisheries, respectively; the overall survival rate is 0.11 percent. For the 1984 brood subyearling transport group, 0.06 and 0.18 percent have returned to Lyons Ferry FH and contributed to fisheries, respectively; the overall survival rate is 0.22 percent. Both release groups have returned as two and three year olds. These estimates are preliminary, and will be revised when CWT recoveries from all year classes are available. A breakdown of CWT recoveries by tag code is presented in Appendix B.

Table 4. Numbers released and proportion marked (coded-wire tag) for Lyons Ferry fall chinook salmon, compared by brood year and release group.

Brood year release group	Number marked	Number unmarked	Mark rate	Total released
1983				
yearling on-station	334,442	315,858	0.5143	650,300
1984				
subyearling on-station	234,985	304,407	0.4356	539,392
yearling on-station	258,355	223,595	0.5361	481,950
1985				
subyearling on-station	246,625	1,295,543	0.1904	1,542,168
subyearling transport	245,561	1,831	0.9926	247,392
yearling on-station	152,479	77,934	0.6618	230,413
yearling transport	156,036	470	0.9970	156,506
1986				
subyearling on-station	251,646	86,139	0.7450	337,785
subyearling transport	255,998	80,264	0.7613	336,262

Table 5. Preliminary estimates of contributions to various fisheries (based upon coded wire tag expansions), returns to the Lyons Ferry hatchery rack, and fish trapped at Lower Granite Dam for 1983, 1984, and 1985 broods Lyons Ferry fall chinook salmon. Results are compared by type of release and year of recovery (see Appendix B).

Brood year release group	Year recovered	Fishery contribution	Hatchery returns	Lower Granite Dam
1983				
yearling on-station	1985	157	1,929	51
	1986	2,839	663	40
	1987	10,403	1,444	1 [a]
	Total	13,399	4,036	92
1984				
subyearling on-station	1986	88	34	56
	1987	328	108	1
	Total	416	142	57
yearling on-station	1986	4	48	4
	1987	142	89	3
	Total	146	137	7
1985				
subyearling on-station	1987	0	18	17
subyearling transport	1987	0	6	0
yearling on-station	1987	0	131	15
yearling transport	1987	0	110	3

[a] Only jacks (less than 55 cm fork length) were collected at Lower Granite Dam, providing an accurate estimate for returns as two or three year olds only.

2.2.2: Lyons Ferry Hatchery returns

All release groups from the 1983, 1984 and 1985 broods were represented in returns to the Lyons Ferry FH in 1987 (Table 6). The 1983 brood yearling release comprised the majority of the escapement in 1985, 1986, and 1987. Actual age distributions of returning fall chinook salmon to Lyons Ferry FH based upon scale and coded-wire tag (CWT) analyses indicate the predominance of the strong 1983 year class (Table 7).

Table 6. Number (and percent) of coded-wire tag recoveries by treatment (release) group and return year at Lyons Ferry Fish Hatchery.

Brood year release group	Number marked	Coded-wire tags recovered 1985	1986	1987	Total
1983					
yearling on-station	334,442	1,891 (0.57)	663 (0.20)	1,444 (0.43)	3,998 (1.20)
1984					
subyearling on-station	234,985	--	34 (0.01)	108 (0.05)	142 (0.06)
yearling on-station	258,355	--	48 (0.02)	89 (0.03)	137 (0.05)
1985					
subyearling on-station	246,625	--	--	18 (0.01)	18 (0.01)
subyearling transport	245,561	--	--	6 (0.01)	6 (0.01)
yearling on-station	152,479	--	--	131 (0.09)	131 (0.09)
yearling transport	156,036	--	--	110 (0.07)	110 (0.07)

Table 7. Comparison of age composition (and percent of total) for fall chinook salmon broodstock since Lyons Ferry Fish Hatchery began operation in 1984. Numbers include both voluntary returns to the hatchery and fish trapped at Ice Harbor Dam.

Year	Age 2	Age 3	Age 4	Age 5	Total
1984	0 (0)	278 (37)	401 (54)	67 (9)	746 (100)
1985	4,147 (87)	71 (2)	442 (9)	95 (2)	4,755 (100)
1986	157 (10)	1,344 (83)	63 (4)	41 (3)	1,605 (100)
1987	563 (14)	453 (12)	2,823 (73)	18 (1)	3,857 (100)

2.2.3: Fishery contribution

To date, three release groups have contributed to catches in commercial and sport fisheries: 1) the 1983 brood yearling on-station release, 2) the 1984 brood yearling on-station release, and 3) the 1984 brood subyearling on-station release (see Appendix B). These groups were represented in a wide geographic distribution, ranging from California to Alaska.

2.2.4: Lower Granite Dam trapping

At our request, National Marine Fisheries Service (NMFS) personnel sampled coded wire tagged fall chinook salmon jacks (less than 55 cm fork length) at the Lower Granite Dam trapping facility. The purpose of this collection was to determine the origin of marked fall chinook salmon jacks and to quantify stray rates from Lyons Ferry FH.

Marked fall chinook salmon jacks were observed at the trapping facility from 27 August through 8 December 1987, compared to 11 September through 30 November in 1986. Seventy-nine marked jacks were observed, and 42 (53 percent) were collected for CWT analysis, compared to 112 in 1986. Coded-wire tag analysis by the WDF tag recovery lab indicated 40 of the 42 were Lyons Ferry stock. Stray rates varied by age and location of release (Table 8).

2.2.5: Snake River sport fishery

In 1987, WDF adopted a fall chinook salmon jack (less than 61 cm) sport fishery in the Snake River from Lower Monumental Dam upstream to the mouth of the Palouse River (adjacent to Lyons Ferry FH). This fishery was based upon analysis of the large escapement of 1983 brood Lyons Ferry jacks in 1985 and 1986. No coded-wire tags were recovered from this fishery; it appears that little exploitation occurred (Fiscus, personal communication). This fishery will continue in 1988, and the length restriction will be increased to 71 cm.

2.3: Lyons Ferry Hatchery Practices

2.3.1: Spawning and rearing

Duration of 1987 fall chinook salmon spawning was from 20 October through 14 December (Table 9), compared to 22 October through 16 December in 1986. Peak of spawning was 17 November, compared to 19 November in 1986, and 16 November in 1985. Eggtake was 5,957,976, with a mortality rate of 3.82 percent, compared with egg mortality rates of 3.98 percent in 1986 and 3.99 percent in 1985.

Table 9. Collection and spawning summary for 1987 fall chinook salmon broodstock at Lyons Ferry Fish Hatchery.

Week ending	Arrivals adult	Arrivals jacks	Mortality M	Mortality F	Mortality J	Spawned M	Spawned F	Estimated egg take
09/05/87	87							
09/12	174							
09/19	408							
09/26	747							
10/03	542		3	2				
10/10	400		3	1				
10/17	136		2	3				
10/24	89		6	11	1		3	13,500
10/31	78		6	17	1	10	18	81,000
11/07	196		9	31			82	328,500
11/14	55		46	46	2	10	192	841,500
11/21	114		111	120	14	58	506	2,223,000
11/28	160		188	36	3	155	377	1,647,000
12/05	28		220	42	3	223	296	1,314,000
12/12	24		92	15	4	118	92	414,000
12/19	3		18	3		69	19	63,000
Total	3241[a]	616[a]	704	327	28	643	1585	6,925,500

[a] Classification of adults and jacks at time of arrival was based on size only. Coded-wire tag and scale impression data revised escapement to 2,842 adults and 1,015 jacks.

2.3.2: Disease incidence

The 1985 and 1986 broods fall chinook salmon had minor outbreaks of bacterial kidney disease (Table 10). Monthly mortality rates for the 1986 and 1987 broods during the 1987 study period averaged 0.59 percent (range: 0.11 - 1.55, n=12) and 1.49 percent (range: 0.11 - 3.74, n=3), respectively. In the 1986 study period, monthly mortality rates for the 1985 and 1986 broods averaged 0.76 percent (range: 0.10 - 3.27), and 0.30 percent (range: 0.14 - 0.41), respectively. In the initial study period, 1985, monthly mortality rates for the 1984 brood averaged 0.40 percent (range: 0.07 - 1.24). The overall mortality rate (egg to smolt) for the 1984 brood yearling release group was 5.88 percent. The overall mortality rate for the 1985 brood subyearling release group was 11.73 percent and 16.18 percent for the yearling release group. The overall mortality rate for the 1986 brood subyearling release group was 19.23 percent.

In April 1987, the 1986 brood had a major outbreak of gill disease in one pond. Mortality rate was 7.44 percent for the month the incident occurred. This phenomenon has recurred every spring since completion of Lyons Ferry FH.

2.3.3: Water quality investigations

Washington Department of Fisheries' pathologists are conducting a pond-loading study at Lyons Ferry FH to gain a better understanding of the recurring problem of gill lamellar hyperplasia in the subyearling fall chinook salmon. This phenomenon occurs each spring and often secondarily leads to bacterial gill disease. Since 1985, pathologists have observed the presence of manganese oxide particles in the rearing ponds and often lodged in the gill lamellae of moribund fish. Mortalities have been minimized by maintaining low loading densities and reducing the flows to increase the settling rate of the suspended particles.

In January 1988, the 1987 brood fall chinook salmon were ponded under three nested treatment groups: 1) incremental loading densities, 2) addition of crushed limestone to the ponds to increase water pH and hardness, and 3) variable diets. The study is tentatively scheduled for two years. Results of this study will be released separately by WDF pathologists.

Table 10. Incidence, date, location, and treatment of diseases for 1985, 1986, and 1987 broods fall chinook salmon contracted at Lyons Ferry Fish Hatchery. Data are summarized by calendar year.

Brood year	Date	Disease	Pond numbers	Treatment
1985	01/87	Bacterial kidney	15 to 26, 29	Gallimycin
	02/87	Bacterial kidney	15 to 26, 29	Gallimycin
	03/87	Bacterial kidney	13	Gallimycin
	04/87	Bacterial kidney	14	Gallimycin
1986	01/87	Fungus	Incubation room	Formalin
	03/87	Bacterial kidney	3 to 7	Gallimycin
	04/87	Bacterial kidney	5 to 10	Gallimycin
	04/87	Bacterial gill	3	Diquat
	07/87	Bacterial kidney	11 to 19	Gallimycin
1987	11/87	Fungus	Incubation room	Formalin
	12/87	Fungus	Incubation room	Formalin

2.4: Smolt Releases

Hatchery staff planted 386,919 yearling (1985 brood) fall chinook salmon in April 1987 and 674,047 subyearling (1986 brood) fall chinook salmon in June 1987 (Table 11). Our experimental design for fall chinook salmon releases is a 2x2 factorial treatment of yearlings and subyearlings released both on-station and transported by barge to be released immediately downstream of

Ice Harbor Dam (Seidel and Bugert 1988). In the first three years of operations at Lyons Ferry FH, (1984 to 1986) we did not have sufficient eggtakes to meet minimum CWT sample size to perform all treatment groups (Table 4). In 1987, we had enough smolts to perform all four treatments. Of the yearling group, 230,413 fall chinook salmon were released from Lyons Ferry FH, and 156,506 were transported for release. We released 337,785 subyearling fall chinook salmon on-station and transported 336,262 subyearlings below Ice Harbor Dam.

2.4.1: Yearling releases

On-station group Mean length and coefficient of variation for the yearling (1985 brood) fall chinook salmon released at Lyons Ferry FH were 180.3 mm and 5.0, respectively (Figure 3). The day of release (14 April) was coordinated with the Corps of Engineers for a controlled spill (100 percent of instantaneous discharge) at Lower Monumental Dam from 2000 to 0400 hours nightly from 15 to 17 April. Snake River water temperature at time of release was 11.7 degrees C.

Transport group Fish were loaded into the barge on 16 April and were released adjacent to the lower navigation wing wall at Ice Harbor Dam the following day. Water temperature was 11.7 degrees C. during transport. Water was continuously pumped through the barge during the transport to aid fish in olfactory acclimation to the Snake River. Mean length and coefficient of variation for the yearling transport release were 178.0 mm and 5.8, respectively (Figure 4).

2.4.2: Subyearling releases

On-station group Mean length and coefficient of variation for the subyearlings (1986 brood) released from Lyons Ferry FH were 87.1 mm and 8.3, respectively (Figure 5). Date of release was 1 June. Snake River water temperature during release was 12.2 degrees C.

Transport group Fish were loaded into the barge on 2 June and were released adjacent to the lower navigation wing wall at Ice Harbor Dam the following day. Water temperature at Ice Harbor Dam at time of release was 15.0 degrees C. Water was continuously pumped through the barge during the transport to aid fish in olfactory acclimation to the Snake River. Mean length and coefficient of variation for the subyearling transport release were 82.7 mm and 9.6, respectively (Figure 6).

Table 11. Summary of 1985 and 1986 broods fall salmon chinook releases from Lyons Ferry Fish Hatchery in 1987. Data are summarized by release site, number and weight of fish planted, coded-wire tag (CWT) or freeze brand and marks, number of fish per pound (FPP), mean length (mm), coefficient of variation (CV) and condition factor (Kfactor) at time of release.

Age brood year	Release site	Number planted	Pounds planted	Tag code and marks	FPP	Length	CV	Kfactor
Subyearlings	On-station	125,570	2,616	Ad + CWT 63 42/61 [a]	48.0	95	6.07	1.09
1986 brood	On-station	126,076	2,627	Ad + CWT 63 42/59 [a]	48.0	95	6.07	1.09
	On-station	5,655	118	Ad only	48.0	95	6.07	1.09
	On-station	80,484	1,059	Brand LA/S/1 [b]	76.0	80	10.07	1.11
subtotal		337,785	6,420					
	Ice Harbor	128,283	1,807	Ad + CWT 63 44/01 [a]	71.0	85	10.12	1.01
	Ice Harbor	127,715	1,799	Ad + CWT 63 42/62 [a]	71.0	85	10.12	1.01
	Ice Harbor	2,064	29	Ad only	71.0	85	10.12	1.01
	Ice Harbor	78,200	745	Unmarked	105.0	75	7.99	1.01
subtotal		336,262	4,380					
Total 1986 brood		674,047	10,800					
Yearlings	On-station	152,479	25,413	Ad + CWT 63 41/56 [c]	6.0	187	4.31	1.14
1985 brood	On-station	1,075	179	Ad only	6.0	187	4.31	1.14
	On-station	39,906	4,245	Brand LA/7N/1 [b]	9.4	167	6.34	1.11
	On-station	653	69	PIT tagged [d]	9.4	167	6.34	1.11
	On-station	36,300	3,862	Unmarked	- -	- -	- -	- -
subtotal		230,413	33,768					
	Ice Harbor	156,036	22,614	Ad + CWT 63 41/59 [c]	6.9	178	5.80	1.01
	Ice Harbor	470	68	Ad only	6.9	178	5.08	1.01
subtotal		156,506	22,682					
Total 1985 brood		386,919	56,450					

[a] Six unique codes were given within this tag code to provide statistical replication.

[b] Freeze branded fish were released on-station in conjunction with the Fish Passage Center to assess travel time through lower Snake and Columbia River sampling stations.

[c] Three unique codes were given within this tag code to provide statistical replication.

[d] PIT (Passive integrated transponder) tagged fish were released on-station in conjunction with National Marine Fisheries Service to assess travel time through lower Snake and Columbia River sampling stations.

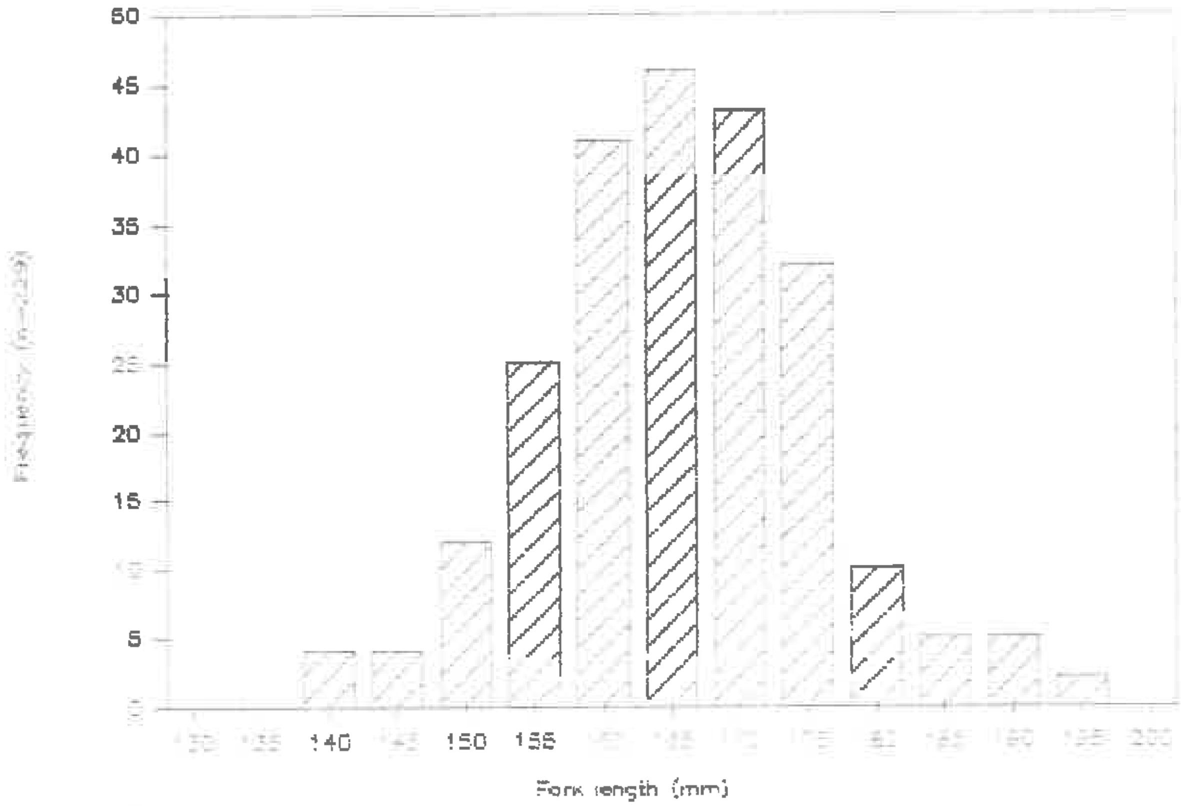


Figure 3. Length frequency distribution of yearling fall chinook salmon released at Lyons Ferry Fish Hatchery in April 1987.

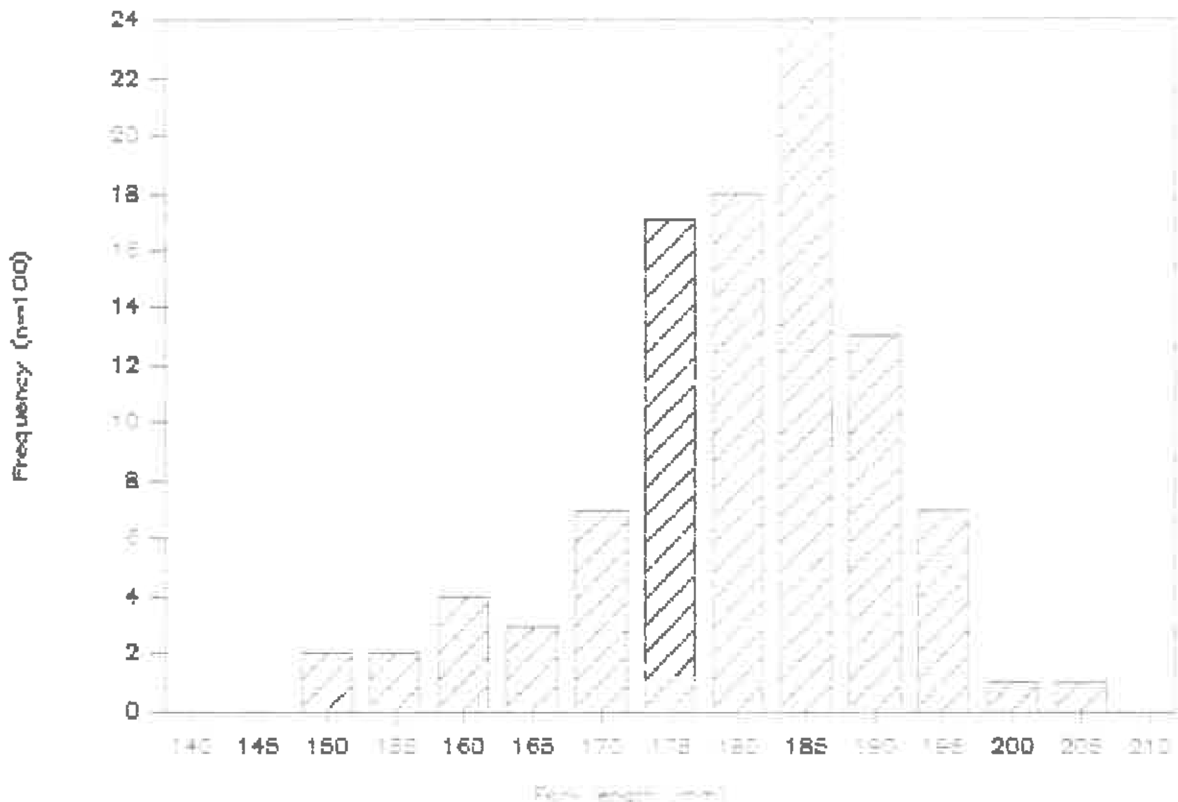


Figure 4. Length frequency distribution of yearling fall chinook salmon transported below Ice Harbor Dam in April 1987.

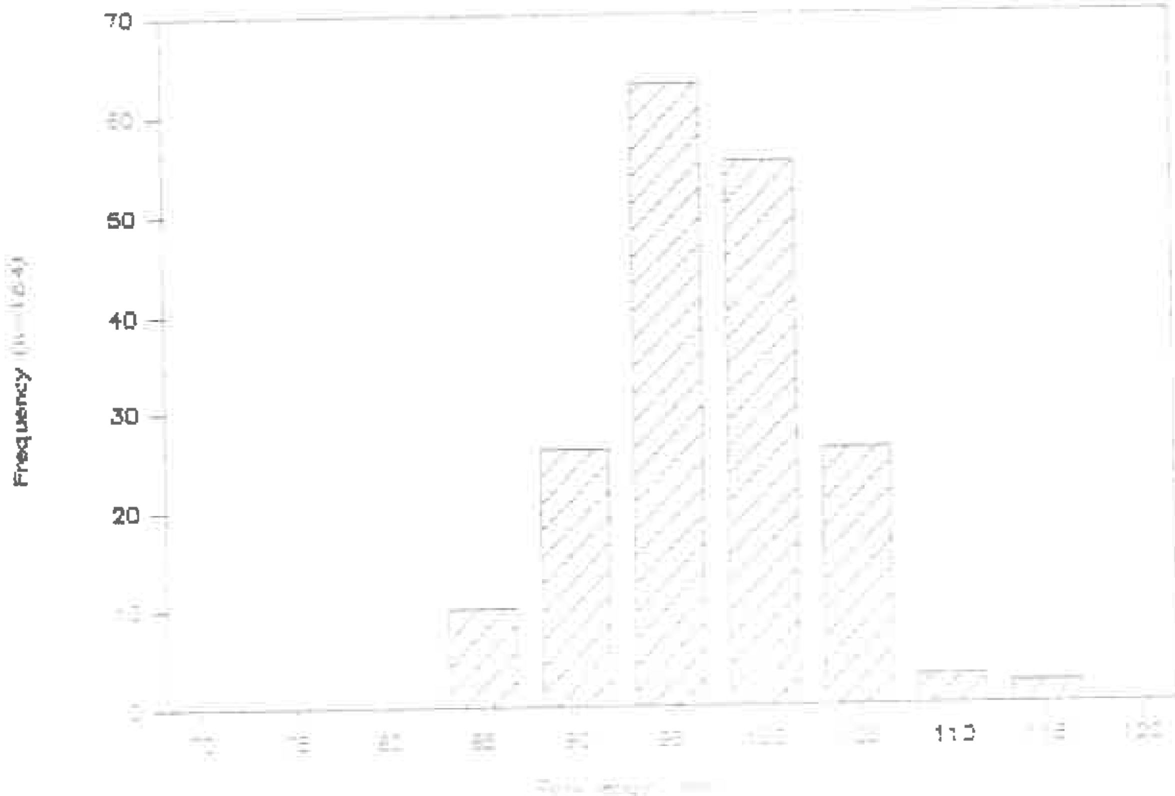


Figure 5. Length frequency distribution of subyearling fall chinook salmon released from Lyons Ferry Fish Hatchery in June 1987.

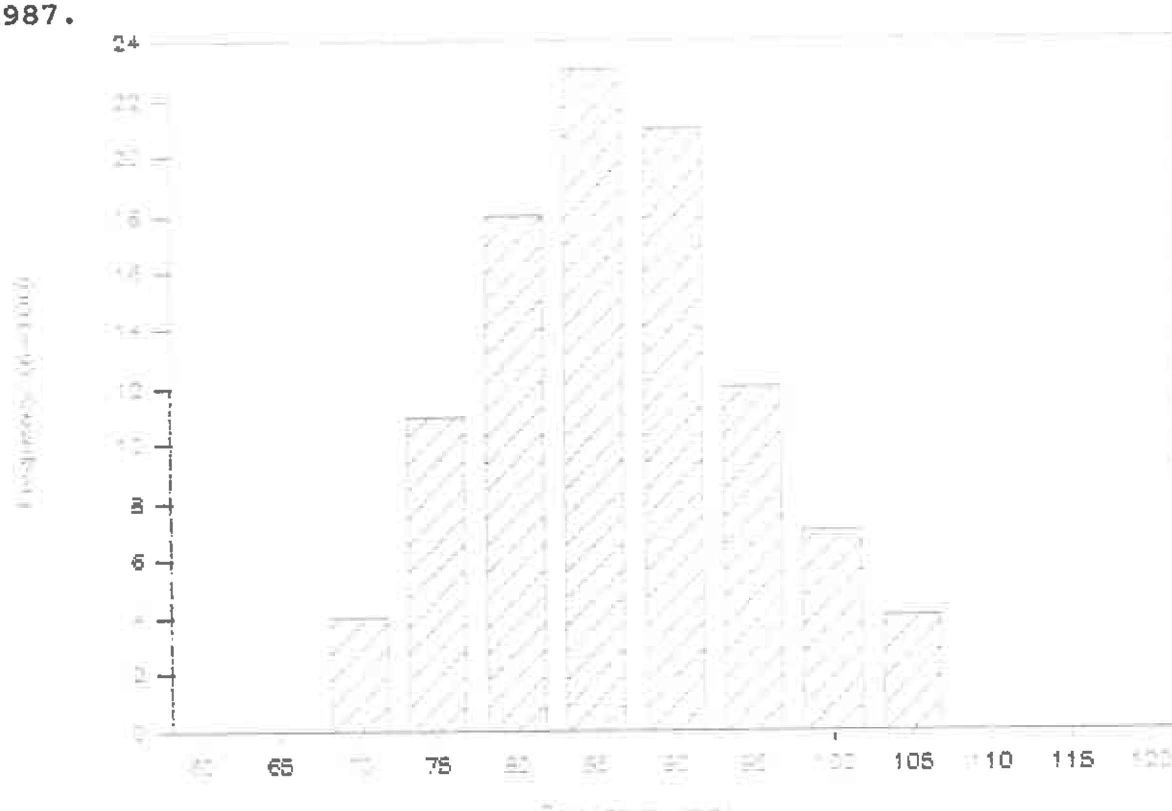


Figure 6. Length frequency distribution of subyearling fall chinook salmon transported below Ice Harbor Dam in June 1987.

2.4.3: Fish passage

Yearling on-station release The 1985 brood fall chinook salmon released from Lyons Ferry FH on 14 April first arrived at the Lower Monumental Dam gatewell collections on 19 April and were observed passing the dam through 29 May; peak day of passage was 30 April. One percent (394 of 39,906) of the branded yearlings released from Lyons Ferry FH were observed at Lower Monumental Dam; most of which (361) were seen within 16 days of release (Appendix C). During this period spills were occurring nightly at Lower Monumental Dam at flows ranging from 8 to 18 percent of average daily Snake River discharge. We found no correlation between the daily number of yearling fish collected and either Snake River discharge or spill at Lower Monumental Dam ($p<0.05$, Table 14, Figure 7). This lack of correlation may be confounded, however, with variable success in gatewell dipping efficiency during spill. Average travel time for yearling fall chinook salmon from Lyons Ferry FH to McNary Dam was 21 days (7.1 km/day). Travel time from McNary Dam to Bonneville Dam was seven days (33.6 km/day; Fish Passage Center, 1988).

Subyearling on-station release The 1986 brood fall chinook salmon released from Lyons Ferry FH on 1 June first arrived at the Lower Monumental Dam gatewell collections within 48 hours and were observed through 25 July, the final day of trapping operations. Two percent (1,599 of 80,484) of the branded subyearlings released from Lyons Ferry FH were observed at Lower Monumental Dam; most of which were seen in July (Appendix C). We found no correlation between the daily number of fish collected and either Snake River discharge or spill at Lower Monumental Dam ($p<0.05$, Table 12, Figure 7). Average travel time for subyearling fall chinook salmon from Lyons Ferry FH to McNary Dam was 39 days (3.7 km/day; Fish Passage Center 1988). Branded 1986 brood subyearling fall chinook salmon were observed in the March 1987 gatewell dippings at Lower Monumental Dam, nine months after release. Lengths of these fish ranged up to 250 mm (Basham, personal communication).

Table 12. Lower Monumental Pool river conditions in the ten day period after Lyons Ferry Fish Hatchery 1985 and 1986 broods fall chinook salmon on-station releases in 1987.

Release group date	Mean discharge (kcfs)	Mean spill (kcfs)	Mean water temperature (degrees C)
Yearlings			
14-23 April	103.2	48.8	9.4
Subyearlings			
1-10 June	121.6	51.4	15.1

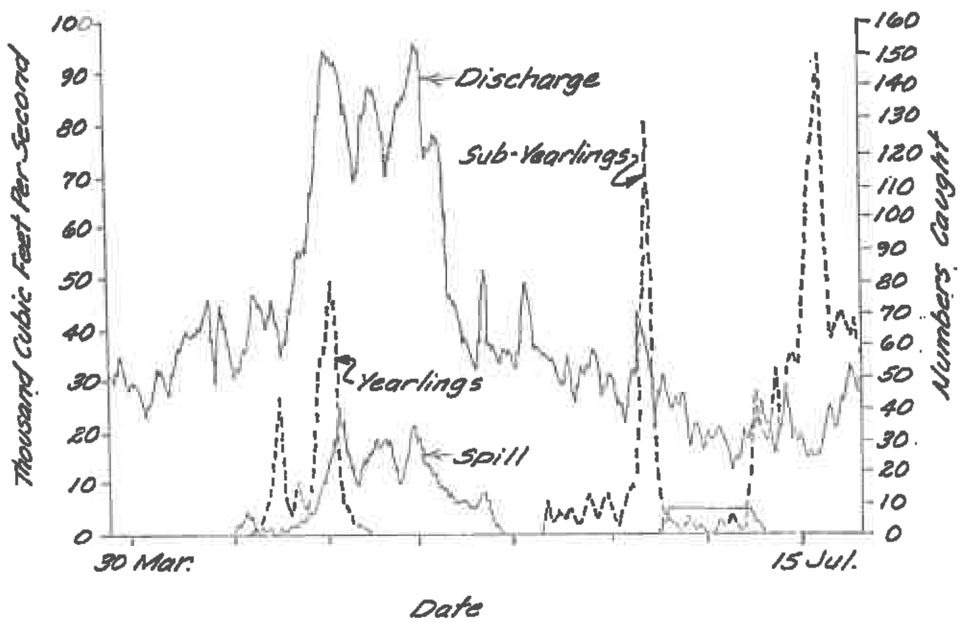


Figure 9. Numbers of branded yearling (1985 brood) and subyearling (1986 brood) Lyons Ferry stock fall chinook salmon collected at Lower Monumental Dam, compared with Snake River daily discharge and spill at Lower Monumental Dam in 1987.

2.6: Natural Production

Program staff surveyed fall chinook salmon spawning grounds in the lower 22.6 km of the Tucannon River on 18 November, 1 December, and 15 December 1987. We increased the scope of surveys (number and distance covered) from previous years. Sixteen redds were seen in the three surveys (Table 15); all were within the lower 9.2 kilometers of the river. Spawning ground density was 1.74 redds/km. No fall chinook salmon carcasses or redds were found above the 1.3 m high irrigation diversion dam at RK 9.4. The dam may be a passage impediment. Visibility was poor for all three surveys because of water turbidity.

We observed redds on our initial survey, and concluded that spawning takes place before 18 November. The last observed redd was deposited between 1 and 15 December. We inferred the duration of spawning to be at least 27 days. We estimate the peak of spawning to be 25 November, compared to 17 November at Lyons Ferry FH. We found 12 carcasses (ten female, two male), three of the females were recovered for CWT processing. Of the three recoveries, two were untagged and one was a 1983 brood yearling release from Lyons Ferry FH.

We surveyed fall chinook salmon spawning grounds in 1985 and 1986, but did not observe any fish or redds. Fall chinook salmon carcasses were seen in the Tucannon River in 1986 (Basham, personal communication), but no spawning activity was documented.

Table 13. Number of fall chinook salmon redds observed and carcasses recovered by survey date and location on the Tucannon River in 1987.

Survey date	River kilometer	Number of redds	Carcasses recovered females	males
18 November	22.6 - 9.4	-	-	-
	9.4 - 6.1	1	1	-
	6.1 - 0.0	8	1	-
1 December	11.6 - 9.4	-	-	-
	9.4 - 6.1	4	-	-
	6.1 - 0.0	2	2	-
15 December	11.6 - 9.4	-	-	-
	9.4 - 6.1	1	1	-
	6.1 - 0.0	-	5	2
Total		16	10	2

Program staff conducted two fall chinook salmon spawning ground counts in the southeast Washington/northern Oregon region. On 9 November, we sighted 31 redds in the mainstem Snake River from Hells Canyon dam to Asotin (166 km). On 23 November, an additional 35 redds were counted for a total of 66. Spawning ground density was 0.40 redds/km. Thirteen live adults were seen in the 23 November survey (Appendix D). By the 9 November count, 864 fall chinook salmon adults and 374 jacks passed Lower Granite Dam.

On the 9 November count, we surveyed the Imnaha River from the confluence upstream to Cow Creek (6.5 km) and saw no spawning activity. We surveyed the Grande Ronde River from the confluence to Joseph Creek (3 km) on 9 November and saw no redds or adults. On 23 November we surveyed the Grande Ronde River from the confluence upstream to Wenatchee Creek (54 km), and found one redd. Washington Department of Wildlife (WDW) biologist Glen Mendel, however, observed an additional six fall chinook salmon redds, two live adults, and two carcasses in the Grande Ronde River from the confluence to Shumaker Creek (RK 25) on 24 November (personal communication).

At our request, Idaho Power Company lowered and stabilized discharge from Hells Canyon Dam, providing us with good conditions for counting fall chinook salmon redds in the mainstem Snake River. Average flow was maintained at 13,813 (range: 10,230 - 18,910) and 15,848 (range: 10,460 - 18,460) cubic feet per second for the 9 and 23 November surveys, respectively. Snake River secchi disk readings taken within 24 hours of the November 9 and 23 counts were 9 feet and 10 feet, respectively. Counts were made with a Hiller 12E helicopter.

SECTION 3: SPRING CHINOOK SALMON PROGRAM EVALUATION

3.1: Broodstock Establishment

Evaluation and hatchery personnel operated an adult trap adjacent to the Tucannon satellite facility to collect the spring chinook salmon broodstock at Lyons Ferry FH. On a random basis, we collected one fish for every one allowed to pass through the rack for natural spawning. The first adult arrived at the rack on 26 April; the last adult arrived on 12 June. Peak day of arrival was 15 May, compared to 27 May in 1986. We collected 101 adults to fulfill broodstock requirements, and passed 108 adults upstream (Table 14), giving a total escapement to the rack of 209, compared to 247 in 1986. Prior to removal of the rack, we counted 42 adults by snorkel surveys in the 6.4 km of stream immediately downstream of the rack. This adjusts the total Tucannon River spring chinook salmon escapement to 251.

Table 14. Escapement, collection, and spawning summary for 1987 spring chinook salmon broodstock at Tucannon Fish Hatchery.

Week ending	Escapement to the rack	Number passed	Number collected	Mortality M	Mortality F	Spawned M	Spawned F
05/02	2	2	0				
05/09	0	0	0				
05/16	71	44	27	2			
05/23	22	1	21				
05/30	40	26	14				
06/06	34	16	18				
06/13	28	19	9	1			
06/20	3	0	3				
06/27	3	0	3		1		
07/04							
07/11				1			
07/18					2		
07/25				1	1		
08/01							
08/08					1		
08/15							
08/22					1		
08/29							1
09/05					1		5
09/12							14
09/19							19
09/26				4	1	15	9
10/03				1		20	0
Total	203[a]	108	95[a]	10	8	35	48

[a] Weekly escapements were estimated; numbers were corrected at end of spawning. Actual numbers were 209 escaped to the rack, of which 101 were collected for broodstock.

3.2: Lyons Ferry/Tucannon Hatchery Practices

3.2.1: Spawning and rearing

Tucannon River spring chinook salmon were spawned at the Tucannon FH; unfertilized gametes were immediately transported to Lyons Ferry FH for fertilization, incubation, and rearing. Spawning went from 25 August to 22 September, with peak of spawning on 19 September, compared with 17 September in 1986 (Table 14). Eggtake was 196,573 with 28,286 lost (14.39 percent). This high loss is mainly attributable to destruction of the pool of eggs from three females (one of which tested positive for incidence of the infectious hematopoietic necrosis virus, IHNV). Excluding egg destruction, percent loss in eggtake was 8.14.

3.2.2: Disease incidence

The 1987 adult spring chinook salmon were injected with Erythromycin prior to spawning for treatment of bacterial kidney disease (BKD). The 1986 brood was periodically fed Gallimycin and Romet as prophylaxis for BKD (Table 15). Monthly mortality rates averaged 0.21 percent (range: 0.00 - 1.32, n=12) for the 1985 brood and 0.29 percent (range: 0.40 - 0.98, n=12) for the 1986 brood. Average monthly mortality rate for the 1987 brood was 0.21 (range: 0.06 - 0.37, n=4). Overall mortality rate (egg to smolt) for the 1985 brood spring chinook salmon was 12.94 percent.

Table 15. Incidence, date, location, and treatment of diseases for 1986 and 1987 broods spring chinook salmon contracted at Lyons Ferry Fish Hatchery. Data are listed by calendar year.

Brood year	Date	Disease	Pond numbers	Treatment
1986	02/87	Bacterial kidney	1, 2	Gallimycin
	03/87	Bacterial kidney	1, 2	Gallimycin
	07/87	Bacterial kidney	1 to 10	Gallimycin
	10/87	Bacterial kidney	1 to 10	Romet
	11/87	Bacterial kidney	1 to 10	Romet
1987	08/87	Fungus	Incubation room	Formalin
	09/87	Fungus	Incubation room	Formalin
	10/87	Fungus	Incubation room	Formalin
	11/87	Fungus	Incubation room	Formalin

3.3: Smolt Releases

Lyons Ferry FH staff transported the 1985 brood spring chinook salmon to the adult holding pond at Tucannon FH on 10 December 1986 for acclimation to river water prior to release. Smolts volitionally emigrated from 6 to 10 April, 1987. Mean size and coefficient of variation of the 12,922 smolts at release was 183.0 mm, and 14.2, respectively (Figure 8). All were coded-wire tagged and adipose-fin clipped.

Program staff monitored travel time of the smolts from the hatchery to the main downstream migrant trap located 38 km downstream (refer to section 3.5.11 for methods). Thirty-five hatchery-reared smolts were collected at the trap; we observed the first arrival on 10 April, the last one was seen on 29 April. Modal travel time for the hatchery-reared spring chinook salmon was about five days for the 38 km distance.

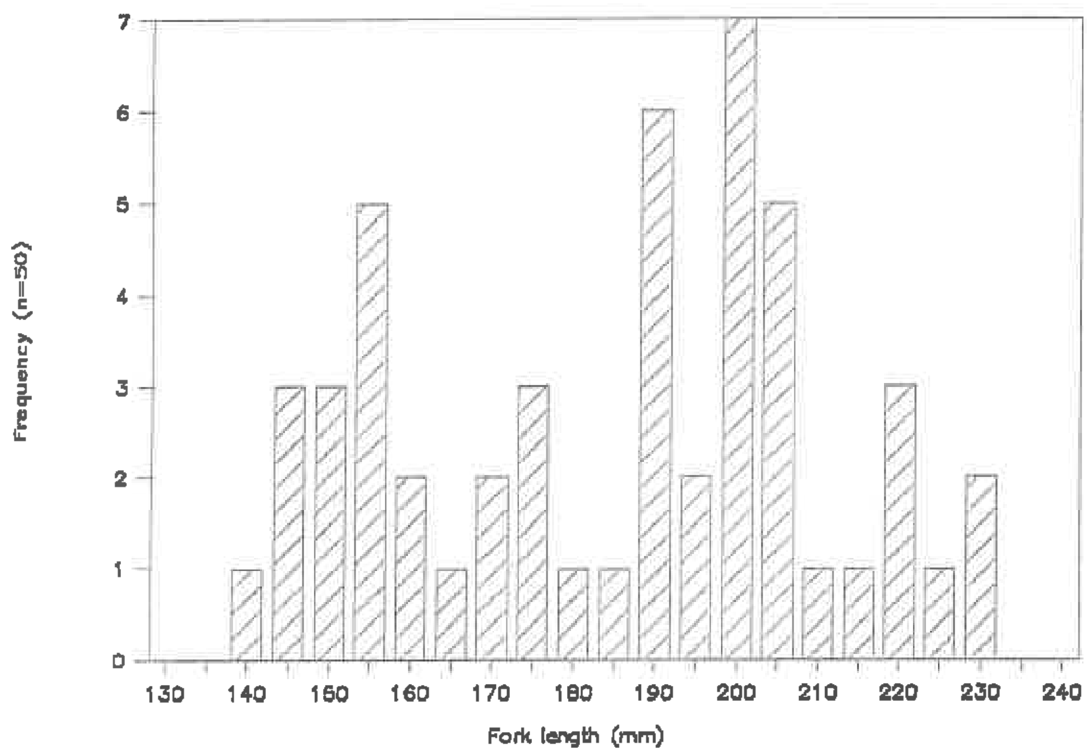


Figure 8. Length frequency distribution of 1986 brood spring chinook salmon released from the Tucannon Fish Hatchery in April 1987.

3.4: Natural Production

The Tucannon River flows through varied habitat conditions that restrict distribution of salmonids in the watershed. To compare differences in spring chinook salmon production within the Tucannon River, we designated 5 strata, based upon the predominant land use adjacent to the stream:

Lower (RK 0.0 - RK 17.9)
Marengo (RK 18.0 - RK 42.1)
Hartsock (RK 42.2 - RK 54.8)
HMA (RK 54.9 - RK 75.1)
Wilderness (RK 75.2 - RK 85.3)

The Lower, Marengo, and Hartsock strata are within agricultural bottomland which receives limited water diversion for summer irrigation. Sections of the stream within these strata have a poorly defined or braided stream channel. Banks are often unstable with limited riparian areas. Water temperatures often exceed the upper threshold of spring chinook salmon tolerance. The upper reach of the Hartsock Stratum has tolerable water temperatures for spring chinook salmon during most of the summer rearing period. The HMA Stratum is within WDW and U.S. Forest Service (USFS) owned and managed land that is forested, has relatively stable banks, and maintains water temperatures tolerable for spring chinook salmon at all stages in the life cycle. The Wilderness Stratum is in the Wenaha-Tucannon Wilderness Area, a part of the Umatilla National Forest. Total watershed area is about 132,000 hectares. Stream elevation rises from 150 m at the mouth to 1,640 m at the headwaters. Annual precipitation ranges from 25 cm in the lower reaches to 100 cm in the higher elevations.

We conducted electrofishing surveys from 27 July through 8 October; our priority was to evaluate production in the Hartsock Stratum. The priorities in the 1985 and 1986 survey seasons were to evaluate production in the Wilderness Stratum and HMA Stratum respectively. Within each stratum, we designated several sample units as index sites, which are monitored yearly to determine trends in juvenile salmonid production. Selection of index sites was based upon logistics, minimum sample sizes required for statistical comparison, and whether a site represents the stream in general. We used the depletion method for population estimation of all salmonids (Zippin, 1958) and analyzed the data using the Burnham Maximum Likelihood method (Van Deventer and Platts, 1983). We complemented electrofishing data by snorkeling and observing the number of chinook salmon and steelhead parr in chosen index sites. We used the habitat terminology suggested by Helm (1985), and evaluated habitat quality within each electrofishing index area using a modified version of the rating system suggested by Platts et al. (1983; Appendix F). Parr production data for trouts, char, and whitefish may be published separately.

3.4.1: Wilderness Stratum parr production

Methods Site selection and sample design for electrofishing surveys in the Wilderness Stratum were the same as those used by program staff in 1985 (Seidel et al. 1985). These sites are sampled yearly to serve as indicators of relative parr abundance. In 1987, we sampled 11 of the 24 sites established.

Results Mean density and biomass of spring chinook salmon parr for the 10.1 km long Wilderness Stratum were 32.18 fish/100m2 and 197.53 grams/100m2, respectively (Tables 16, 17). Spring chinook salmon densities averaged 53.97 fish/100m2 in the pools (n=6), 15.65 fish/100m2 in the runs (n=1), and 3.63 fish/100m2 in the riffles (n=4). We sampled a cumulative 125 meters (or 1.2 percent) of the stream within the Wilderness Stratum. We did linear regression analyses on the Wilderness sites for gradient vs. density and gradient vs. biomass, and found no significant correlation (p=0.05) for either. Density differences between 1985, 1986 and 1987 were inconclusive (Table 18).

Table 16. Comparison of spring chinook salmon rearing densities and biomass (with sample size, mean, and standard deviation) by stratum, Tucannon River, Washington, 1987.

Stratum	Sample size	Density (fish/100m2)		Biomass (grams/100m2)	
		mean	S.D.	mean	S.D.
Wilderness	11	32.18	32.51	197.53	213.07
HMA	30	32.60	25.13	126.85	84.35
Hartsock	9	22.69	14.10	116.49	81.43

Table 17. Comparison of spring chinook salmon rearing densities and biomass within the Wilderness Stratum, Tucannon River, Washington, 1987.

Habitat type	Site	1987 Density (fish/100m2)	1987 Biomass (grams/100m2)
Riffle	Wild 1	1.36	8.18
	Wild 12	7.64	49.34
	Wild 13	4.57	25.57
	Wild 14	0.96	11.66
Run	Wild 10	15.65	101.12
Pool	Wild 2	40.48	254.12
	Wild 3	40.60	196.02
	Wild 5	79.06	655.52
	Wild 7	97.68	511.41
	Wild 11	46.76	252.91
	Wild 19	19.21	106.96

Table 18. Comparison of 1985, 1986, 1987 spring chinook salmon rearing densities, in selected index sites in the Wilderness Stratum, Tucannon River, Washington.

Habitat type	Site	1985 density (fish/100m2)	1986 density (fish/100m2)	1987 density (fish/100m2)
Riffle	Wild 14 (4.2)	0.72	1.81	0.96
Run	Wild 3 (2.2)	34.51	96.65	40.60
Pool	Wild 5 (2.4)a	45.01	41.22	79.06
	Wild 10 (3.3)	12.92	37.48	15.65
	Wild 11 (3.4)	47.39	80.72	46.76
	Wild 19 (7)	5.20	6.14	19.21

a 1985 number designation

3.4.2: HMA Stratum parr production

Methods We used a random systematic sampling design to identify and electrofish five distinct habitat types within the HMA Stratum: riffles, runs, pools, side channels, and boulder sites. The latter habitat type is a series of artificial placements (average boulder size is 0.50 m3) built by WDW to improve resident rainbow trout rearing habitat (Hallock and Mendel, 1985). Sampling originated at a randomly determined location near the downstream boundary of the stratum. We sampled six replicates of each habitat type, which were selected every 1000 m from the starting point and alternated in a random systematic order. The 1987 sampling design for the HMA Stratum was the same as the 1986 design (Seidel and Bugert 1986). Some or all of these sites will be monitored yearly.

Results Tucannon River spring chinook salmon parr abundance is highest in HMA Stratum; mean density and biomass for the 20.2 km reach of stream were 32.60 fish/100m2 and 126.85 grams/100m2, respectively (Table 16); densities decreased from summer 1986 (Table 19). Densities and biomass differed significantly among habitat types within the HMA Stratum (Freidman's two-way ANOVA $p<0.05$). We used Wilcoxon sign-rank pairwise comparisons (Daniel 1978) to compare densities by habitat type. Riffles had lower rearing densities than pools, runs, or side channels ($p<0.05$). Boulder sites had lower rearing densities than pools or runs ($p<0.05$) We found no correlation between rearing density or biomass with gradient or habitat score ($p<0.05$).

Table 19. Comparison of 1986 and 1987 spring chinook rearing density and biomass estimates for riffles, runs, pools, boulder sites, and side channels within the HMA Stratum, Tucannon River, Washington.

Habitat type	Site	1986 density (fish/100m2)	1987 density (fish/100m2)	1986 biomass (grams/100m2)	1987 biomass (grams/100m2)
Riffle	HMA 1	23.37	19.77	73.85	83.94
	HMA 5	24.10	12.79	84.35	45.80
	HMA 9	11.77	10.33	39.55	32.97
	HMA 13	17.35	9.74	63.67	45.03
	HMA 18	13.87	7.91	41.89	27.69
	HMA 20	18.37	18.19	58.05	83.71
Run	HMA 3	24.75	45.09	82.91	197.08
	HMA 6	19.91	6.78	80.64	28.45
	HMA 10	20.72	65.54	51.18	251.13
	HMA 14	96.68	56.43	322.91	201.83
	HMA 19	48.94	37.43	318.11	161.29
	HMA 24	92.45	45.48	277.35	245.37
Pool	HMA 4	12.14	4.43	23.55	14.25
	HMA 8	10.53	47.53	46.12	195.56
	HMA 12	38.73	33.04	154.53	187.68
	HMA 16	67.43	46.80	262.98	177.22
	HMA 21	60.89	31.40	281.92	109.97
	HMA 22	126.26	71.64	807.87	299.93
Boulder sites	HMA 2	8.95	7.48	31.95	37.34
	HMA 7	13.68	37.48	41.31	121.25
	HMA 11	12.99	9.00	35.07	34.10
	HMA 15	12.79	34.87	44.25	126.57
	HMA 17	22.96	20.53	94.37	82.96
	HMA 23	17.73	15.39	47.87	64.28
Side channel	HMAS-1	75.44	36.89	110.14	116.17
	HMAS-2	23.79	123.60	87.07	309.39
	HMAS-3	41.22	49.07	139.74	216.48
	HMAS-4	35.23	23.33	148.67	114.87
	HMAS-5	122.11	19.41	333.36	94.10
	HMAS-6	53.20	30.21	185.14	99.14

3.4.3: Hartsock Stratum parr production

Methods We used a stratified random sampling design to identify and survey three distinct habitat types within the Hartsock Stratum: riffles, runs, and pools. Some or all of these sites will be used for annual electrofishing surveys to monitor relative changes in parr production. Two of these sites (Hart 2 and 6) were used in the electrofishing surveys of 1985 and 1986. One other site was used (Hart 8) in the electrofishing surveys of 1986.

Results Mean spring chinook salmon density and biomass for the Hartsock Stratum were 22.69 fish/100m2 and 126.85 grams/100m2, respectively, (Table 16); densities increased from 1986 (Table 20). Densities and biomass did not differ significantly among habitat types within the Hartsock Stratum (one-way ANOVA with unequal sample size, $p<0.05$). Spring chinook salmon densities averaged 28.38 fish/100m2 in the pools (n=2), 23.42 fish/100m2 in the runs (n=4), 17.93 fish/100m2 in the riffles (n=3, Table 21).

Table 20. Comparison of 1985, 1986, and 1987 spring chinook salmon rearing densities in selected index sites in the Hartsock Stratum, Tucannon River, Washington.

Habitat Type	Site	1985 density (fish/100m2)	1986 density (fish/100m2)	1987 density (fish/100m2)
Riffle	Hart 8 (4)[a]	- -	9.13	21.16
Riffle	Hart 5	- -	13.91	10.67
Run	Hart 2	3.48	12.56	34.83
Run	Hart 6 (3)	10.30	21.48	16.41

[a] 1985, 1986 number designation

Table 21. Comparison of spring chinook salmon rearing densities and biomass in the Hartsock Stratum, Tucannon River, Washington, 1987.

Habitat type	Site	1987 density (fish/100m2)	1987 biomass (grams/100m2)
Riffle	Hart 3	21.95	55.98
	Hart 5	10.67	92.72
	Hart 8	21.16	99.93
Run	Hart 1	24.63	141.35
	Hart 2	34.83	177.04
	Hart 6	16.41	82.06
	Hart 10	17.80	74.14
Pool	Hart 4	4.26	26.53
	Hart 7	52.49	298.68

3.4.4: Tucannon tributaries parr production

We electrofished index sites on three tributaries of the Tucannon River: Sheep Creek (confluence with Tucannon at RK 83), Panjab Creek (RK 76), and Cummings Creek (RK 58). Index sites were the same selected and electrofished in 1985 and 1986. Densities of spring chinook salmon in Panjab Creek and Cummings Creek increased from summers of 1985 and 1986 (Table 22). We did not see rearing spring chinook salmon in Sheep Creek in 1986 and 1987. For the three years' surveys, we have not found juvenile spring chinook salmon in these tributaries farther than 400 m upstream from the confluence with the mainstem Tucannon River. Platts and Partridge (1978) found similar results in the South Fork Salmon River.

Table 22. Comparison of spring chinook salmon rearing densities for electrofishing sites on Tucannon River tributaries, 1985, 1986, and 1987.

Stream	Site	1985 density (fish/100m2)	1986 density (fish/100m2)	1987 density (fish/100m2)
Sheep Creek	1	3.48	0.00	0.00
	2	10.30	0.00	0.00
Panjab Creek	1	13.40	1.13	31.26
	2	6.88	0.00	24.62
Cummings Creek	1	9.00	5.70	9.63
	2	0.00	2.79	10.88

The length frequency distribution of the 1861 fish captured and measured during the 1987 electrofishing surveys indicated a predominant age class of subyearlings (Figure 9). We obtained scales from three fish within the 90th percentile of fork lengths (100, 105, and 110 mm) and determined them to be yearlings.

3.4.5: Tucannon River snorkel surveys

We snorkeled 19 electrofishing index sites: 15 in the HMA Stratum, and two each in the Wilderness and Hartsock Strata. Surveys were conducted by one person doing multiple passes within the index site parallel to shore. The snorkeler counted all salmonids within an equal distance on each side of each pass. Number of passes were determined by the size of the index sight and ranged from three to five passes. We found a general linear relationship between the number of spring chinook salmon parr counted in the snorkel surveys in a given site and the number collected during a multiple-pass electrofishing depletion survey (least squares $p<0.05$, Table 23). In most sites, the population estimate from the snorkel survey was lower than from the electrofishing survey.

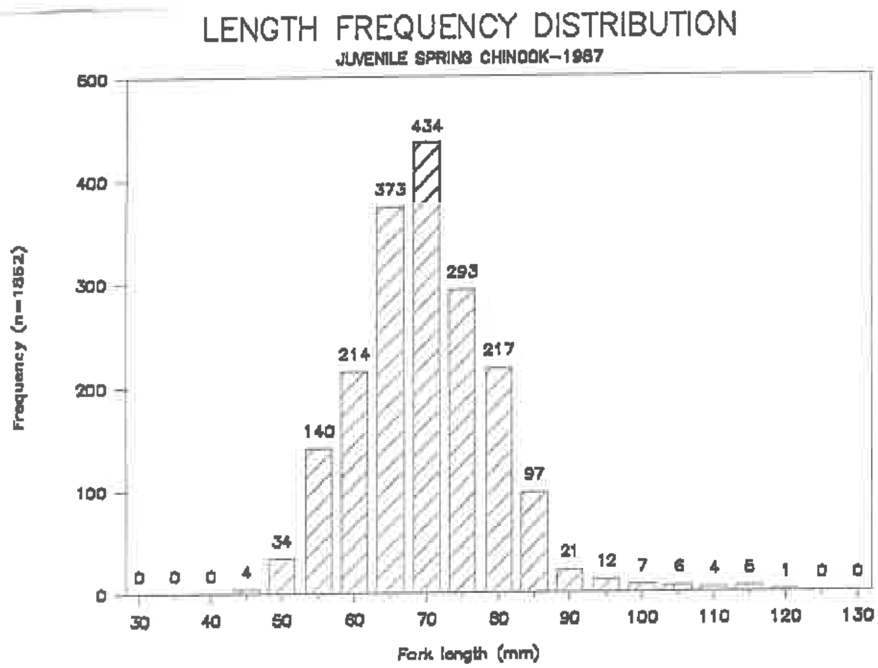


Figure 9. Length frequency distribution of spring chinook salmon measured in Tucannon River electrofishing surveys, 1987.

Table 23. Comparison of number of spring chinook salmon parr observed in snorkel surveys with number collected in multiple-pass electrofishing depletion surveys, Tucannon River, 1987.

Stratum Site	Habitat type	Snorkel surveys	Electrofishing surveys
Wilderness			
WILD2	Pool	35	34
WILD11	Pool	13	62
HMA			
HMA1	Riffle	12	40
HMA3	Run	8	62
HMA4	Pool	22	5
HMA7	Boulder	49	46
HMA8	Pool	46	63
HMA9	Riffle	18	22
HMA10	Run	49	112
HMA11	Boulder	13	21
HMA12	Pool	29	50
HMA13	Riffle	9	19
HMA15	Boulder	16	46
HMA16	Pool	74	87
HMA19	Run	54	44
HMA21	Pool	23	33
HMA22	Pool	77	109
Hartsock			
HART4	Pool	4	4
HART7	Pool	61	55

3.4.6: Extensive stream habitat inventory surveys

Program staff inventoried stream habitat types in the HMA and Hartsock Strata, Tucannon River, from 16 June to 13 July 1987. Inventory data for the Wilderness Stratum were taken in 1985 (Seidel et al. 1985). We collected data in a random systematic order at 30 m intervals from RK 42.2 to 85.3. Inventory data included wetted width (measured to 0.1 m precision), gradient (percent), habitat type (riffle, run, pool, and in the HMA Stratum, boulder placement sites). We used the habitat terminology suggested by Helm (1985). Each site was scored by quality of rearing habitat (Appendix E). We identified and evaluated 1732 sites in the three strata. The riffle:run: pool ratio for the Wilderness Stratum is 74:15:11 (333 sites inventoried). The riffle:run:pool: boulder ratio for the HMA Stratum is 51:37:3:9 (667 sites inventoried). The riffle:run: pool ratio in the Hartsock Stratum is 68:30:2 (732 sites inventoried). These ratios concur with the results of the 1980 survey by Kelley and Associates (1982). Mean wetted widths and gradients are presented in Table 24. In 1987 we inventoried side channels and feeder springs in the HMA and Hartsock Stratum. Methods were the same as those used in the mainstem survey, but intervals were at 15 m. We evaluated 283 and 217 sites in the HMA and Hartsock Strata, respectively (Table 25). We located 37 feeder springs in the HMA Stratum (32 flow into the mainstem, 5 into the side channels), and 38 feeder springs in the Hartsock Stratum (35 in mainstem, 3 in side channels).

Table 24. Mean wetted width and gradient by river kilometer in the Tucannon River, Washington, 1987.

Stratum River kilometer	Wetted width (m)	Gradient (percent)
Hartsock		
42.2-42.9	12.5	0.8
43.0-45.6	12.8	0.8
45.7-50.1	12.9	0.8
50.2-54.0	12.1	1.1
54.1-54.8	11.3	1.0
HMA		
54.9-59.5	11.4	0.7
59.6-63.8	12.1	1.3
63.9-66.6	11.6	1.5
66.7-69.2	12.5	1.3
69.3-73.5	11.7	1.1
73.6-75.1	10.5	1.5
Wilderness		
75.2-85.3	8.1	1.4

Table 25. Number, total length, and mean wetted width of side channels located in the Hartsock and HMA Strata, Tucannon River, in 1987.

Stratum river kilometer	Side channels number	total length (m)	mean width (m)
Hartsock			
42.2-44.0	61	915	3.3
44.1-47.9	94	1,410	4.1
48.0-54.8	62	930	3.0
HMA			
54.9-59.5	31	465	4.1
59.6-66.6	59	885	4.2
66.7-69.2	47	705	4.4
69.3-73.5	56	840	4.2
73.6-75.1	90	1,350	6.0

3.4.7: Intensive stream habitat evaluation surveys

Program staff evaluated spring chinook salmon spawning, incubation, and rearing habitat on twelve randomly located reaches on the Tucannon River from 14 to 25 July 1987. Six sites were in the HMA Stratum, and three each were located in the Hartsock and Wilderness Strata. All sites were 200 m long. We designed these surveys to perform two functions: 1) provide a means to calibrate the extensive habitat inventory surveys, which encompassed all areas spring chinook salmon use, with an intensive evaluation of habitat quality on a few selected sites, and 2) develop a detailed description of spring chinook salmon habitat quality on a universal system, which would allow us to compare Tucannon River habitat parameters with those of other streams in the upper Columbia River Basin.

Within each 200 m intensive study area, we systematically analyzed 20 transects placed perpendicular to stream flow. On those transects, we collected the same data as that used for the extensive habitat inventory surveys (wetted width, habitat type, and score). We analyzed the same transects using a more intensive method (Appendix F). Techniques for collection of these habitat variables were based upon Platts et al. (1987). The habitat inventory data from each transect is then compared to the more intensive evaluation data. We consider the extensive habitat quality scores gathered in the inventory surveys to be tentative, and may be revised upon comparison with the intensive habitat evaluation. This comparison will be published separately at a later date.

We used the Habitat Suitability Index (HSI) modeling procedure (Terrell et al. 1982, Raleigh and Miller 1985) to describe spring chinook salmon spawning, incubation, and rearing habitat in the Wilderness, HMA, and Hartsock Strata. Low percentage of pools and maximum summer temperatures were the two factors deemed by this method to limit production (Appendix G). Kelley and Associates (1982) listed four constraints to salmonid production in the Tucannon River: 1) water temperature, 2) substrate embeddedness, 3) high water velocities, and 4) lack of pools.

Data from both habitat surveys will serve two functions: 1) provide a baseline to monitor changes in habitat quality through time, and 2) form a framework to estimate spring chinook salmon carrying capacity when sufficient production data is available.

3.4.8: Stream temperature studies

Program staff deployed six continuous-reading thermographs on the Tucannon River to monitor heat loading throughout the summer. The thermographs recorded daily maximum and minimum water temperatures from mid-April through mid-September. Locations of the thermographs were as follows:

1) 300 m downstream of the Sheep Creek confluence (RK 83)
2) 300 m downstream of the Panjab Creek confluence (RK 75)
3) near the downstream outlet of Big 4 Lake (RK 66)
4) near the downstream outlet of Beaver-Watson Lakes (RK 64)
5) near the downstream outlet of Deer Lake (RK 61)
6) 100 m downstream of the Cummings Creek confluence (RK 57)

The thermograph at the Beaver-Watson Lakes sampling location did not provide complete information, so we omitted those data from our analysis. In general, stream temperatures increased in varying increments from the furthest upstream location to the furthest downstream (Table 26). The most significant temperature increase occurred between the Panjab Creek and Big 4 Lake thermographs. The daily record for the five thermographs are presented in Appendix H.

Table 26. Mean monthly ranges (minimum to maximum) water temperatures at selected Tucannon River sampling locations in 1987. Data are listed in degrees Celsius.

Month	Sheep Creek	Panjab Creek	Big 4 Lake	Deer Lake	Cummings Creek
April	1.8- 3.8	3.2- 6.4	4.7- 8.6	5.5- 9.5	4.7- 8.6
May	3.6- 5.9	5.1- 7.6	6.4-10.6	7.5-10.6	6.9-10.6
June	6.9-10.0	7.5-11.4	9.0-14.3	10.2-15.5	9.8-14.0
July	8.2-10.9	8.4-11.9	10.5-15.4	11.6-16.8	11.0-14.9
August	7.5-10.4	7.7-11.5	9.9-15.3	10.9-16.7	10.4-14.8
September	6.4- 8.2	7.4-10.6	- - [a]	10.4-15.9	9.8-13.6

[a] The Big 4 thermograph recorded data only until 23 August.

3.4.9: Spawning ground surveys

Tucannon River We surveyed spring chinook salmon spawning grounds on the upper Tucannon River and tributaries to determine the temporal and spatial distribution of spawning and to assess the abundance and density of spawners. Spawning grounds were surveyed on 26 August, and 2, 9, 16, 23, and 30 September. Person-days required for the surveys were 1, 8, 8, 5, 5, and 5, respectively. The 16 and 23 September surveys encompassed all known spring chinook salmon spawning areas within the Tucannon River.

Total number of redds in the Tucannon River in 1987 was 185 (Table 27). The number of redds sighted in the Tucannon River increased from the estimated previous 5 year average of 143 redds and 20 year average of 121 redds, but is most likely a result of the additional stream area covered by a larger survey crew than in years prior to this study. We found no redds in the Tucannon River tributaries Sheep, Panjab, or Cummings Creeks.

Table 27. Results of Tucannon River spring chinook salmon spawning ground surveys, 1987.

Stratum	River kilometer	Number of redds	Carcasses recovered female	Carcasses recovered male
Wilderness	87 - 76	15	0	0
HMA	76 - 69	66	22	26
	69 - 64	44	16	8
	64 - 55	30	10	11
Hartsock	55 - 48	23	10	10
	48 - 43	7	0	0
Total		185	58	55

From the six counts on the Tucannon River, we concluded that the peak spawning date for spring chinook salmon varied by river kilometer. Peak of spawning was 5 September for the farthest upstream reach (Wilderness Stratum), 16 September for the HMA Stratum, and 23 September for the Hartsock Stratum. Two adults had spawned by the 26 August survey, and ten new redds were deposited the week of the 30 September count, indicating the duration of spawning to be at least 35 days.

Fifteen redds were sighted in the Wilderness Stratum of the Tucannon River, which has 10.1 km of stream, resulting in a density of 1.49 redds/km. This density is considerably lower than we found in 1985 (8.32 redds/km), and 1986 (5.25 redds/km). We sighted 140 redds in the 20.2 km HMA Stratum, indicating a 6.93 redds/km density, which is an increase from the 1985 density

(5.33 redds/km) and 1986 density (5.79 redds/km). Thirty redds were sighted within the 12.7 km Hartsock Stratum resulting in a density of 2.36 redds/km, which is similar to the 1986 density (2.28 redds/km). Tucannon River spring chinook salmon spawning ground densities are comparable to those found in other upper Columbia River Basin streams (Table 28).

We did not collect data on spent carcasses because samples taken from spring chinook salmon carcasses trapped at the hatchery rack were of better quality.

Asotin Creek On 3 and 10 September program staff surveyed the North Fork and mainstem Asotin Creek to its confluence with Charlie Creek. In this 9.6 km section we counted 3 redds, for a density of 0.31 redds/km. Peak of spawning was probably 10 September. We counted one redd in this section of Asotin Creek in 1986.

Butte Creek This was the first year we surveyed this tributary of the Wenaha River. The Oregon reach of Butte Creek is usually surveyed by ODFW (Witty, personal communication). On 22 September we observed 8 redds in a 3.2 km reach within Washington for a density of 2.5 redds/km. It appears there is considerably more spawning gravels available. We will expand our coverage of Butte Creek in 1988 to obtain more information on spring chinook salmon spawning duration and range.

Table 28. Comparison of upper Tucannon River spring chinook salmon spawning ground densities and midpoint of spawning to that of other Columbia River Basin streams.

Stream survey area	Citation	Density (redds/km)	Spawning midpoint
Tucannon River	This study		
Wilderness Stratum		1.49	5 Sept.
HMA Stratum		6.93	16 Sept.
Hartsock Stratum		2.36	23 Sept.
Total		4.29	
John Day River[a]	Burck et al. 1979	5.80	7-17 Sept.
Imnaha River[b]	Carmichael, pers. comm.	7.73	26 August
Grande Ronde[b]	Carmichael, pers. comm.		
Wallowa River		1.17	25 August
Upper Minam River		2.85	27 August
Lower Minam River		2.90	28 August
Lostine River		10.88	27 August
South Fork Wenaha River		4.19	3-9 Sept.
Salmon River[c]	Kucera, 1987		
Big Creek		2.48	11 August
Johnson Creek		12.29	26 August
Secesh River		8.22	27 August
Wenatchee River[c]	Easterbrooks, pers. comm.		
Mainstem		2.31	20-25 August
Icicle Creek		9.83	
Nason Creek		13.67	
Methow River[c]	Easterbrooks, pers. comm.	8.87	20-31 August
Yakima River[d]	Fast et al. 1986		
American River		6.29	15 August
Naches River		4.89	6 Sept.

[a] Five-year average, 1974-1978.

[b] Five year average, 1983-1987.

[c] 1987 data.

[d] Six-year average, 1981-1986.

3.4.10: Downstream migrant trap operations

On 18 November 1986, we installed a floating inclined plane downstream migrant trap on the Tucannon River at RK 21. The trap (Figure 10) consists of two 9 m long by 90 cm wide by 90 cm deep pontoons placed 1.5 m apart with decks fore and aft. The trap is located between the pontoons and strains a 1.2 x 1.2 m section of stream flow with the inclined plane fully lowered. Approximately 2.4 cubic meters per second (cms) of water flow through the trap during optimum trapping conditions. Seiler et al. (1981) give a detailed description of floating trap operations. We trapped downstream migrants intermittently from 1 December 1986 to 1 March 1987, and then trapped continuously until 30 June 1987.

Our objectives in downstream migrant trapping are:

1) Estimate the magnitude, duration, periodicity, and peak of spring chinook salmon outmigration.
2) Assess downstream migrant quality at migration (degree of smoltification, descaling, condition factor, and a subjective index of fish health).
3) Provide supplemental data for stream population estimates derived from electrofishing and spawning ground surveys and to assess overwinter survival.
4) Determine travel time for spring chinook salmon smolts released from the Tucannon FH.

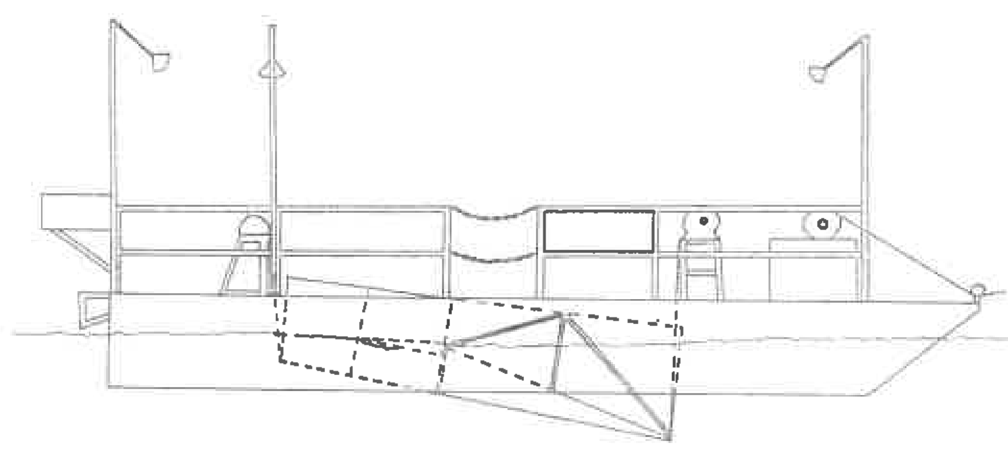


Figure 10. Side view of inclined plane downstream migrant trap.

Methods To calibrate trapping efficiency, we marked (pelvic or caudal fin-tip clipped) captured smolts and transported them in an aerated live box either 250 m, 10 km, or 40 km upstream of the trap for release. Only natural smolts were used. The percent of marked fish captured was used to estimate percent total downstream migrants trapped. With these data, we used a modified form of the standard Peterson mark-recapture method (Chapman, 1948; Steinhorst, personal communication) to estimate spring chinook salmon and steelhead outmigrants from the Tucannon River System. We estimated the number of outmigrants using the equation:

$$p = 1/m \sum_{i=1}^{m} y_i/n_i$$

$$SE(p) = \sqrt{1/m^2 \sum_{i=1}^{m} \frac{p_i q_i}{n_i}}$$

where:

m =number of days fish were marked

p_i =proportion of fish caught that were marked on day i

y_i =number of recaptured fish on day i

n_i =number of fish that were marked on day i

Predetermined groups of fish were marked differentially; date, time, and location of release were recorded for these groups, allowing us to determine both travel time and trap efficiency. Water temperature, flow, velocity, and clarity (determined with a 25 cm Secchi disk), moonphase, and photoperiod were recorded daily to be used as covariates in explaining the variability in smolt migrations. The form used for smolt trap data collection is shown in Appendix J.

We operated a portable downstream migrant trap (aperture opening of 60 cm x 90 cm) 60 km upstream of the main trap at RK 81 to provide ancillary information on spring chinook salmon migration timing and travel speed. We gave unique marks to fish collected at the upstream trap and released them there. Some of these marked fish were subsequently recaptured in the main trap.

In the mid-1950s, Mains and Smith (1955) trapped downstream migrants with two fyke nets, at the mouth of the Tucannon River, and at RK 23. The latter site is the approximate location of our main trap site. The trap was operated from March 1954 through June 1955. Methods for trapping were analogous to this study, allowing us to draw some comparisons.

On most spring chinook salmon collected, we assessed the amount of descaling (Achord et al. no date), fin erosion, and the degree of smoltification. We measured fork lengths of virtually all fish collected and, from 1 March to 30 June, weighed 1,720 (28 percent) of the fish on a random basis.

Results During the period 1 December 1986 to 30 June 1987, we caught and processed 6239 natural and 35 hatchery spring chinook salmon smolts. Peak of outmigration was the period 26 April to 10 May (Figure 11), coinciding well with the peak flow (least squares p<0.05) Mains and Smith (1955) found peaks of outmigration in November, April, and May. Major and Mighell (1969) trapped spring chinook salmon outmigrants in the Yakima River from 1959 to 1963 and found the peak of outmigration to be 14 April to 19 May.

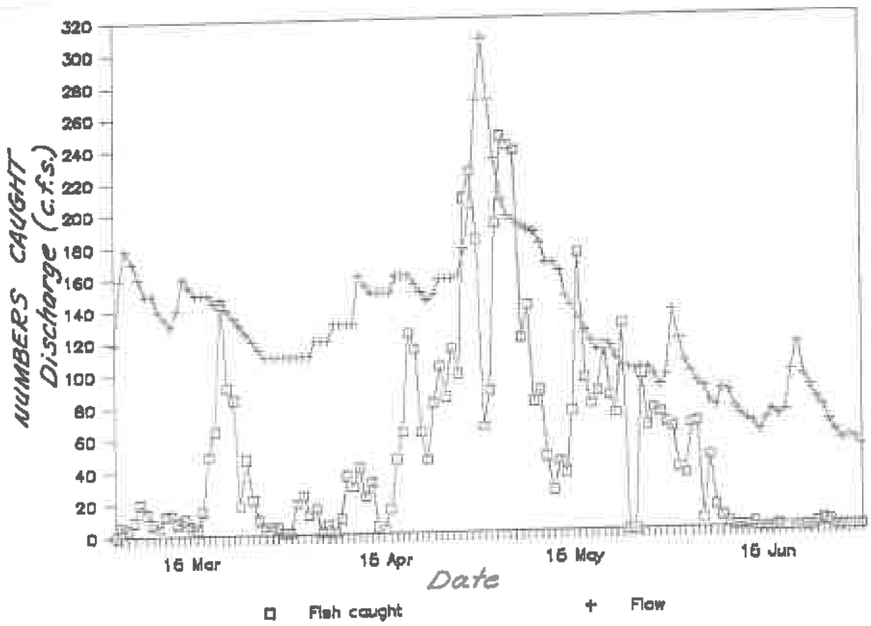


Figure 11. Comparison of daily number of spring chinook salmon caught in the Tucannon River downstream migrant trap with average daily flow.

Average trap efficiency was 22.1 percent (573 of 2,591) for the 250 m release test fish, 17.7 percent (90 of 509) for the 10 km release test fish, 24.0 percent (18 of 75) for the 38 km release test fish, and 40.7 percent (11 of 27) of the fish marked and released from the portable trap 60 km upstream (Appendix J). Overall trap efficiency was 21.6 percent (692 of 3202). We estimate 35,559 (95 percent confidence interval of 2,485) natural spring chinook salmon smolts outmigrated in the 1986/1987 season.

Dates of the 5, 25, 50, 75, and 95 percentiles of cumulative outmigrants caught occurred on 31 January, 19 April, and 2, 15, and 30 May, respectively. We compared Julian date, photoperiod, moonphase, water temperature, flow, and clarity for the period 1

March to 30 June 1987 with a logit transformation of the cumulative catch. Julian date and photoperiod correlated well with the cumulative number of outmigrants caught (least squares $p<0.05$).

Travel time for the natural spring chinook salmon from the 38 km release fish varied from 44 hours to 18 days (n=18). Modal travel time was 3 days, compared to 5 days for the hatchery-reared spring chinook. Travel time for the natural spring chinook salmon released 60km upstream of the trap varied from 20 to 38 days; modal time was 33 days.

Mean length of the 6,221 spring chinook salmon measured was 89 mm, (Figure 15) and varied by month. We found the yearling spring chinook salmon average length increased as the outmigration season progressed (least squares $p<0.10$). Mains and Smith (1955) and Major and Mighell (1969) also saw this relationship. Condition factors of the 1720 fish weighed from 1 March to 30 June also increased through time (March, 1.09; April, 1.10; May 1.19; June, 1.23). Similar results were found by Major and Mighell (1969). Mean condition factors for parr, transitional smolts, and full smolts were 1.32 (n=12), 1.17 (n=388), and 1.12 (n=1,313), respectively.

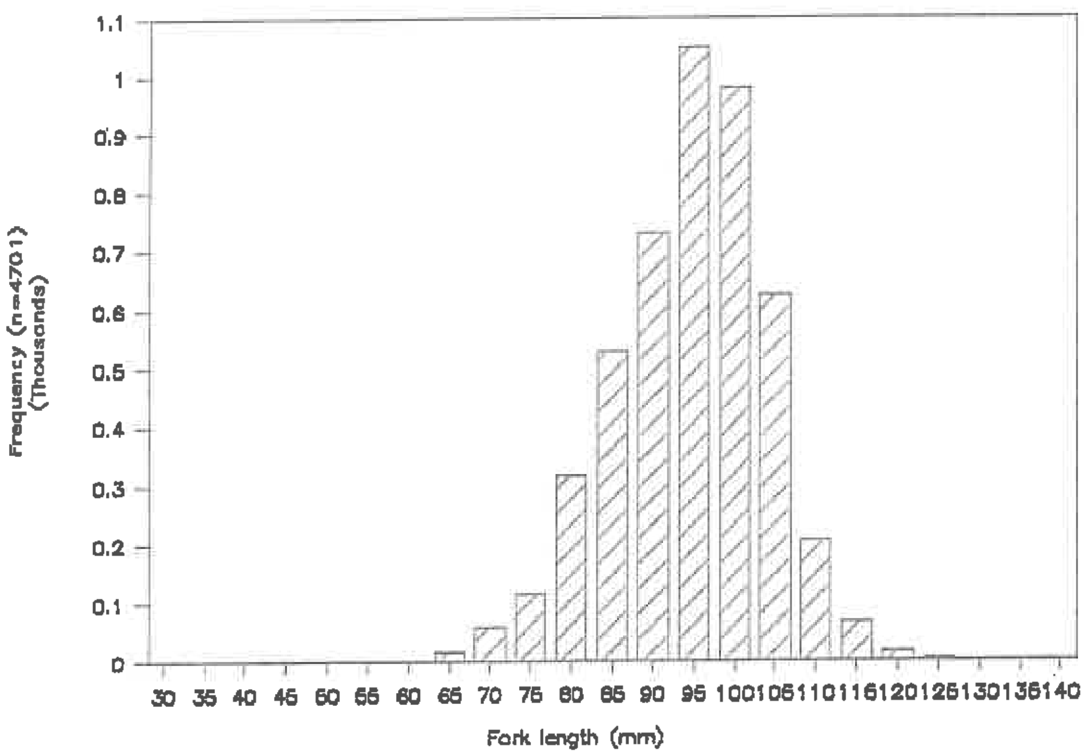


Figure 12. Length frequency distribution of natural spring chinook salmon caught at downstream migrant trap, Tucannon River, 1986/1987.

We assessed the degree of smoltification on 6,178 spring chinook salmon; 76 percent (4,701) were classified as full smolts, 23 percent (1,437) were considered transitional smolts, and one percent (40) were assessed as parr. Most parr were collected in May. We took scale samples of 18 parr in the lower 25th percentile for length (fork lengths ranged from 53 to 71 mm); all were age zero.

Eighty-two percent of the outmigrants were caught between 2201 and 0600 hours, 10 percent were caught between 0601 and 1400 hours, and 8 percent were caught between 1401 and 2200 hours (Table 29). Smith and Mains (1955) found similar results in 1954/1955; they found very few fish migrating, however, during full moon periods. We found no relationship between the number of outmigrants and lunar phase (least squares p=0.10). Major and Mighell (1969) caught 69 percent of Yakima River outmigrants between 2000 and 0800 hours. In western Washington streams, Seiler et al. (1981) caught 96.4 to 97.5 percent of coho salmon outmigrants at night.

Descaling occurred most frequently during rapid increases in discharge when debris load would be the highest. We found an overall 6.9 percent descaling rate (two or more zones each with 40 percent scale loss). Scully and Buettner (1986) found seasonal chinook salmon descaling rates ranging from 1.5 to 4.5 percent in Idaho streams. The higher rate of descaling may be attributed to two factors: 1) depending on discharge, 29 to 92 percent of the total streamflow is strained through the trap, causing it to collect an inordinate amount of debris, and 2) our staff had minimal training in assessment of descaling; some observer errors may have occurred. We saw no difference in descaling, however, between fish captured once and those captured and handled twice (recaptured marked fish).

Table 29. Number of spring chinook salmon caught by time period (hour) and month, Tucannon River downstream migrant trap, 1987.

Month[a]	Day (0601-1400)	Evening (1401-2200)	Night (2201-0600)	Total
March	67	27	581	675
April	211	159	1,560	1,930
May	311	305	2,567	3,183
June	17	14	268	299
Total	606	505	4,976	6,087

[a] From November through February, the trap was operated continuously, but tended only in mornings.

Overall, 39 natural and no hatchery spring chinook salmon died in the trap during the eight month season (0.6 percent). To evaluate the effect of trapping outmigrants on their stress and potential for delayed mortality, we held a one percent sample in a net pen located in a protected area of the stream near the bow of the trap for two days after sampling. No fish showed any obvious signs of stress from the capture and handling.

Steelhead were trapped at a lower overall efficiency than spring chinook salmon, but were caught over a longer period of time. Peak of steelhead outmigration occurred at roughly the same time as spring chinook salmon. Results of the steelhead trapping operations will be presented in detail separately. We also collected large numbers of incidental non-gamefish; Appendix K lists species caught, and their relative abundance.

3.4.11: Standing crop

Natural spring chinook salmon population estimates have been derived for several brood years at the egg deposition, late summer rearing fry, and yearling outmigrant stages of life history. Currently, only the estimate for the 1985 brood is complete for all juvenile life stages, however. Likewise, all estimates are preliminary and are subject to revision as we obtain additional information from ongoing studies.

We estimate the number of eggs deposited by calculating the product of 1) number of adults allowed to pass the hatchery rack for natural spawning (refer to Sections 3.1 and 3.4.9), and 2) the mean fecundity of those fish collected at the rack for spawning in the hatchery (Section 4.1.2). We have two years' data to date (1986 and 1987 broods).

The rearing fry population estimate is the product of 1) electrofishing-survey density estimates (Sections 3.4.1 to 3.4.4), and 2) areal measurements of the stream derived from the extensive habitat inventory survey (Section 3.4.6). Both estimators are stratified by stream reach (Wilderness, HMA, or Hartsock Stratum), habitat type (riffle, pool, run, boulder, or side channel), and habitat quality rating (Appendix E). We have two years' data to date (1985 and 1986 broods).

We currently have one season of reliable smolt trap data (1986/87, Section 3.4.10). Virtually all of the outmigrants from this season were yearlings (1985 brood). We can then derive survival estimates for this brood year by comparing population estimates by life stage (Table 30). Our estimate of spring chinook salmon standing crop in the Tucannon River during the summers of 1986 and 1987 are less than the 1980 estimate of 170,000 by Kelley and Associates (1982). We inferred the spring chinook salmon to have relatively high survival rates between life stages by comparing these data with results from other upper Columbia River Basin spring chinook salmon studies (Table 31).

Table 30. Current estimates of Tucannon River spring chinook salmon abundance by life stage for the 1985, 1986 and 1987 broods.

Brood year	Redds	Adults	Eggs	Fry	Smolts
1985	189 a	138 b	276,000 c	90,000	36,000
1986	200	131	262,400	111,000	- -
1987	185	151	302,400	- -	- -

a Number of adults was extrapolated from average (1986 and 1987) adult to redd ratio (1.37:1.00).

b Average (1986 and 1987) sex ratio of adults trapped for broodstock is 1:1.

c Average fecundity of the 1986 and 1987 broodstocks is 4,005.

The parr production estimates of 1987 were of particular interest to us because we removed essentially half (116 out of 247) of the returning adults for hatchery broodstock in 1986. Since escapement to the rack was similar in 1985 and 1986, changes in standing crop between the two brood years' should manifest the effect of this action. Parr production estimates were similar between the two years, however, and did not show any appreciable effect of the reduction in spawners. Tucannon River spring chinook salmon parr production is comparable to other upper Columbia River Basin streams (Table 32).

Table 31. Comparison of Tucannon River spring chinook salmon survival rates by life stage with estimates derived from other studies.

Stream citation	Dates	Percent survival egg/fry	 fry/smolt	 egg/smolt
Tucannon River This study	1985-87	32.6-42.4	40.0	13.0
Deschutes River Jonasson and Lindsay 1983	1975-81			2.3-10.0
Lemhi River Bjornn 1978	1962-75			4.0-15.9
John Day River Lindsay et al. 1985	1978-82	14.5-24.5	24.7-35.2	3.6- 8.6
Yakima River Major and Mighell 1969	1957-61			5.4-16.4

Table 32. Comparison of 1987 Tucannon River spring chinook salmon density and biomass to other upper Columbia River Basin studies.

Stream study area	Citation	Density (fish/100m2)	Biomass (grams/100m2)
Tucannon River	This study 1987		
Wilderness Stratum		32.2	197.5
HMA Stratum		32.6	126.8
Hartsock Stratum		22.7	116.5
Middle Fork John Day River	Maciolek 1979	5.0	37.0
Red River	Hillman et al. 1987	69.0	70.0
Icicle Creek	Mullan and McIntyre 1987	24.3-46.0	100-310
Wenatchee River	Griffith 1985	1.2-3.5	4.0-52.0
Methow River	Griffith and Hillman 1986	- -	2.0-94.0
Lemhi River	Bjornn 1978	38.3	- -
Yakima River			
Naches River	Fast et al. 1986	25.0	- -
Cowiche Creek		30.0	- -

SECTION 4: STOCK PROFILE INVESTIGATIONS

4.1: Broodstock Characteristics

4.1.1: Snake River fall chinook salmon

From 2 September through 12 December 1987, 3,267 fall chinook salmon adults and 590 jacks (fish less than 61 cm fork length) were collected at Lyons Ferry FH. Duration of returns was considerably longer than in 1986 (5 September to 15 November). Fish were spawned, and scales were sampled from 20 October to 14 December, with a total of 2310 scale samples (60 percent) taken. Age composition was 15 percent 2 year olds, 12 percent 3 year olds, 72 percent age 4, and 1 percent age 5 (Table 33, Figure 13). In 1986, percent age composition for the 2, 3, 4, and 5 year classes was 10, 84, 4, and 3, respectively.

Table 33. Age composition by sex of adult fall chinook salmon sampled at Lyons Ferry Fish Hatchery, 1987.

Sex	Age 2	Age 3	Age 4	Age 5	Total
Male	325	214	634	3	1,176
Female	3	50	1,012	8	1,073
Total	328	264	1,646	11	2,249[a]

[a] Scales from 61 fish regressed or were unreadable, precluding age determination.

Average fecundity for 1987 returning fall chinook salmon adults (3,874) was considerably less than in 1985 (4,622) and 1986 (4,386). Average fecundity of Snake River stock fall chinook salmon since inception of the egg bank program in 1977 is 4,297. The ratio of females to males in 1987 was 1.43:1.00, compared to 0.48:1.00 in 1986, and 1.79:1.00 in 1985. The average female:male ratio since 1977 is 1.33:1.00 (Table 34).

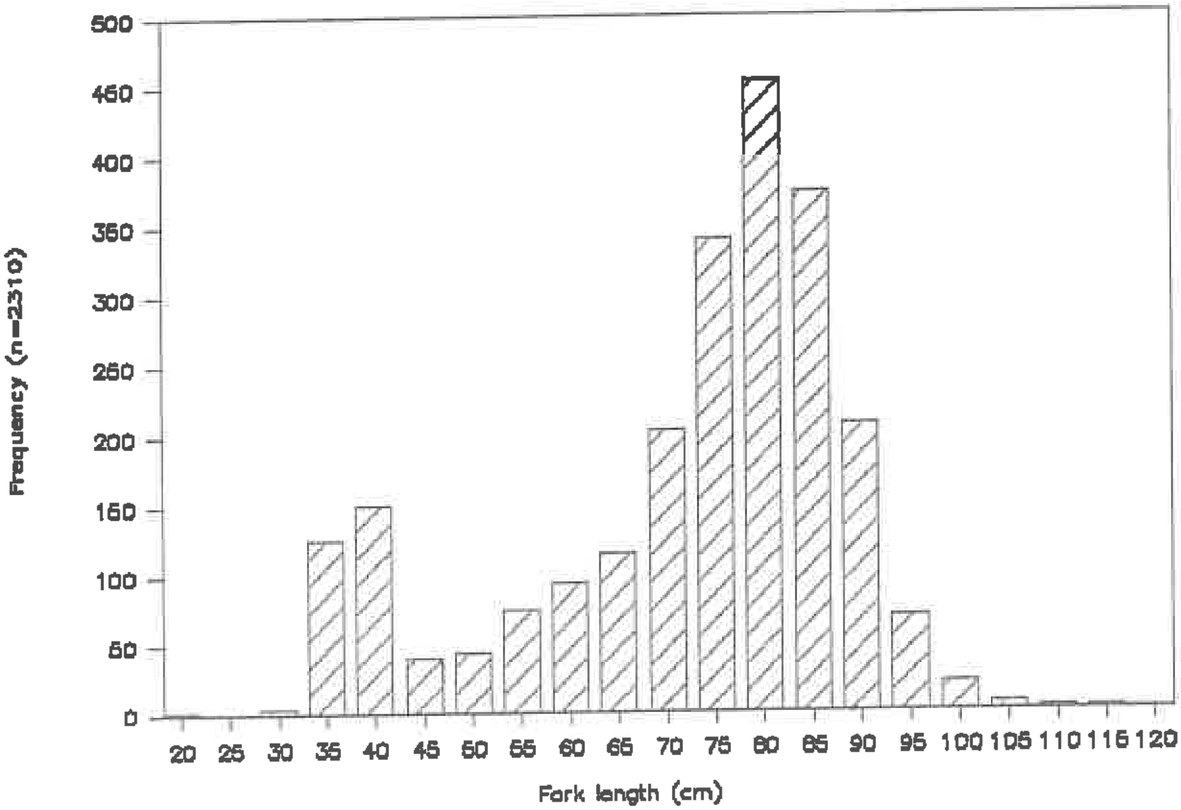


Figure 13. Length frequency distribution of fall chinook salmon spawned at Lyons Ferry Fish Hatchery in 1987.

Table 34. Comparison of fecundity, egg size, and sex ratios of Snake River fall chinook salmon from 1977 through 1987.

Return year	Fecundity	Egg size (number/lb.)	Sex ratio (female:male)
1977	4,533	- -	1.55:1.00
1978	3,936	- -	1.05:1.00
1979	4,526	- -	1.60:1.00
1980	4,302	- -	2.83:1.00
1981	4,339	- -	1.49:1.00
1982	4,282	- -	0.32:1.00
1983	4,271	- -	0.73:1.00
1984	4,191	- -	2.09:1.00
1985	4,622	1,312	1.79:1.00
1986	4,386	1,720	0.48:1.00
1987	3,874	1,539	1.43:1.00

4.1.2: Tucannon River spring chinook salmon

Average fecundity for the Tucannon River spring chinook salmon was 4,095, compared to 3,916 in 1986. Mean fork length was 76.4 cm (n=98; Figure 14). Spring chinook salmon spawned at the Tucannon FH were mostly 4 years old, with two years of their life in the ocean (4/2), one three year jack (3/2) was recovered, and the remainder were 5 year olds having spent 3 years in the ocean (5/2; Table 35). We found the mean length of age 4 returning adults (71.1 cm) to be significantly less than age 5 adults (90.8 cm; unpaired t-test $p<0.05$). Mean length by age class differed little from spring chinook adults returning in 1985 and 1986 (Table 36). For the three year classes, 80 cm is a consistent breakoff between four and five year olds using one standard deviation (SD).

Table 35. Sex, mean fork length (cm), and age (from scale impressions) of spring chinook salmon spawned at the Tucannon Fish Hatchery, 1987.

Sex	Fork length (SD, n) at given age 3_2	4_2	5_2	Total number
Female	- -	71 (4.6, 29)	85 (4.7, 25)	54
Male	47 (-, 1)	71 (4.8, 32)	91 (5.4, 11)	44
Total	1	61	36	98
Percent	1	62	37	100

Table 36. Comparison of fork length (cm), by age of 1985, 1986, and 1987 spring chinook salmon spawned at the Tucannon Fish Hatchery.

Return year	Age 3 (x, SD, n)	Age 4 (x, SD, n)	Age 5 (x, SD, n)
1985	--	74.5, 5.7, 19	86.6, 2.9, 8
1986	63, --, 2	72.3, 4.1, 89	86.9, 3.7, 13
1987	47, --, 1	70.9, 4.7, 61	86.7, 5.6, 36

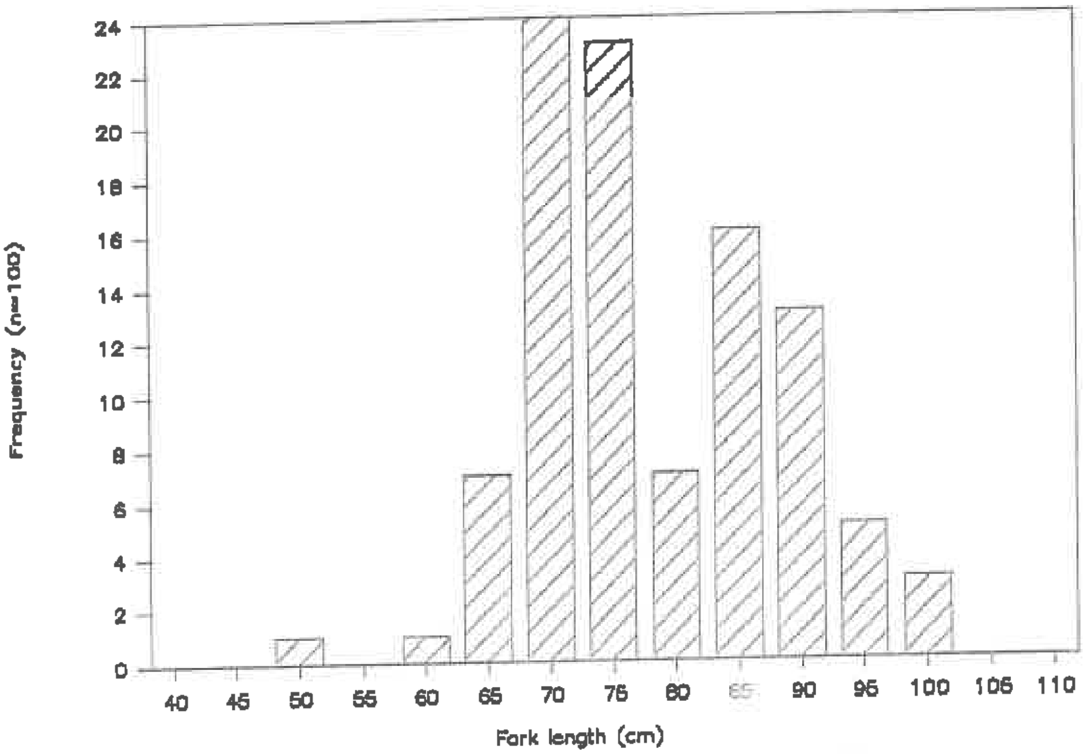


Figure 14. Length frequency distribution of spring chinook salmon adults collected at the Tucannon Hatchery in 1987.

4.2: Electrophoretic Analysis

Program staff collected 100 electrophoretic samples of adult fall chinook salmon returns to Lyons Ferry FH and 100 samples from mid-Columbia River "bright" adults at the Priest Rapids FH. In addition, electrophoretic samples were taken from 88 adult spring chinook salmon trapped at the Tucannon FH, and 98 juveniles (1986 brood) by electrofishing. Samples from adults include eye, liver, heart, and skeletal muscle tissue. Samples were maintained at -80 degrees C prior to processing at the Genetic Stock Identification (GSI) Laboratory in Olympia, Washington. We have made these collections since the program's inception (1985). By combining collections from both juveniles and adults, we currently have baseline genetic data on six sequential brood years from the Tucannon River spring chinook stock and five sequential brood years from the Snake River (Lyons Ferry) fall chinook stock.

Data from the electrophoretic analysis provide the following information:

1) compilation of a data base of genetic polymorphism among chinook salmon stocks within the Snake River Basin.

2) discernment of genetic differences between lower Snake River and middle Columbia River fall chinook salmon stocks.

3) a data base to observe any potential long-term genotypic changes in a wild chinook salmon stock receiving hatchery enhancement.

4.2.1: Genetic variation

Fifty-eight loci were screened for genetic variation in 1987-88 (see Appendix L, Table 1). Of these, 27 loci including duplicate isoloci *Aat1,2 and Mdh1,2* counted as two loci each) were monomorphic (homozygous for the same allele in a population) in the four 1987 collections analyzed in this study. Twelve of these monomorphic loci (*mAh2, mAh3, Ak, Ck1, Ck2, Ck3, EstD, Idh1, Ldh3, PepC, Tpi1, and Tpi2*) are essentially invariant in all chinook stocks analyzed coastwide. Allele frequencies at the 31 variable loci (duplicate isoloci *Mdh3,4* counted as two loci) are presented in Appendix L, Table 2.

4.2.2: Comparisons among years

Patterns of genetic variation in the Tucannon River stock have now been analyzed for the past four years (1985-1988). In each year, new loci and alleles have been recognized and added to the growing database (Appendix L, Table 3). As a result of the changing status of the database, comparisons among years are difficult because the data are not comparable among years (in almost all cases, the data for the two most recent years are more complete than those for the first two years). Therefore, detailed statistical analyses were conducted on the data sets from 1987 and 1988 only. The results of these tests are summarized below.

4.2.3: Hardy-Weinberg tests

Twenty-seven loci exhibiting genetic variation in any of the four collections from 1987 or the five collections from 1986 were tested for agreement with Hardy-Weinberg equilibrium expectations (loci listed in Appendix L, Table 1 which were not tested were: *GpiH; Mdh3,4; and Tapep2*). Of the 181 tests where variation was observed, 22 involved only a single variant and were thus trivial. Another 13 tests exhibited "significant" deviations which were attributable to one or more cells having an expected value of 3 or less. Thus, out of 146 tests, significant deviations from expectation occurred only three times:

Locus	Probability	Collection	Observation
Aat4	$p<0.000$	87 Tucannon adults	heterozygote deficiency
Sod2	$p<0.000$	87 Tucannon adults	heterozygote deficiency
Sod2	$p<0.000$	86 Snake River	heterozygote deficiency

These results are interpreted as indicating that the data are in general agreement with Hardy-Weinberg expectations.

4.2.4: Contingency Chi-square tests

Several pairwise contingency chi square tests were conducted to examine the inter-relationships of specific collections. These tests involved 30 loci; all loci listed in Appendix L, Table 1, except *mAat-1 and mAat-2* (which could not be included because of incomplete data for some collections), and *Ada-2*. The results of these analyses are summarized below:

Fall chinook salmon collections tested	Result for all loci	Significant loci	
86 Snake River/Lyons Ferry vs. 86 Snake River/Lyons Ferry via Kalama egg bank	p=0.31907	*mAh4*	p=0.02909
		Mpi	p=0.03893

Conclusion: No evidence of genetic difference between fish returning to the Snake River and Lyons Ferry Hatchery and those derived from the Snake River/Lyons Ferry egg bank program at Kalama Falls Hatchery and returning to that hatchery.

Fall chinook salmon collections tested	Result for all loci	Significant loci	
86 Priest Rapids vs. 86 Snake River/Lyons Ferry	p<0.01000	*Idh4*	p=0.02822
		PepLT	p=0.02020
		Sod2	p=0.00098
		Tapep1	p=0.00367

Conclusion: Clear evidence of significant genetic differences between the Priest Rapids Hatchery stock and the Snake River/Lyons Ferry Hatchery stock.

Fall chinook salmon collections tested	Result for all loci	Significant loci	
87 Priest Rapids vs. 87 Snake River/Lyons Ferry	p<0.00000	*Idh4*	p=0.00661
		MdhP1	p=0.00187
		PepLT	p=0.00010
		Sod2	p=0.00013
		Tapep1	p=0.00004

Conclusion: Clear evidence of significant genetic differences between the Priest Rapids Hatchery stock and the Snake River/Lyons Ferry Hatchery stock.

Fall chinook salmon collections tested	Result for all loci	Significant loci	
87 Snake River/Lyons Ferry vs. 86 Snake River/Lyons Ferry	p=0.24461	*Gpi2*	p=0.00408

Conclusion: No significant allele frequency differences between 1986 and 1987 in the Snake River/Lyons Ferry Hatchery stock. The difference at Gpi2 is likely due to differences in scoring of this locus between years.

Fall chinook salmon collections tested	Result for all loci	Significant loci	
87 Priest Rapids vs. 86 Priest Rapids	p=0.24651	*Gpi2*	p=0.00241
		MdhP1	p=0.01702

Conclusion: No significant allele frequency differences between 1986 and 1987 in the Priest Rapids Hatchery stock. The difference at Gpi2 is likely due to differences in scoring of this locus between years.

Spring chinook salmon collections tested	Result for all loci	Significant loci	
87 Tucannon adults vs. 86 brood Tucannon smolts	p=0.00297	*Mpi* *Tapep1*	p<0.00000 p=0.02209

Conclusion: Significant difference at Mpi between adults from the Tucannon River Hatchery and wild smolts from the Tucannon River.

86 Tucannon adults vs. 85 brood Tucannon smolts	p=0.12047	*Tapep1*	p=0.02892

Conclusion: No evidence of genetic difference between Tucannon River hatchery adults and wild smolts.

87 Tucannon adults vs. 86 Tucannon adults	p=0.04590	*Gpi2* *Sod2*	p=0.02999 p=0.03149

Conclusion: No clear evidence for genetic differences between the 1986 and 1987 collections of adults at the Tucannon River Hatchery.
The difference at *Gpi2* is likely due to differences in scoring of this locus between years.

86 brood Tucannon smolts vs. 85 brood Tucannon smolts	p=0.00030	*Gpi-2* *MdhP1* *Mpi* *Tapep1*	p=0.01047 p=0.01110 p=0.00209 p=0.00278

Conclusion: Significant allele frequency differences between '85-brood and '86-brood smolts collected in the Tucannon River. The differences at *Mpi and Tapep1* are not currently explainable. The difference at *Gpi2* is likely due to differences in scoring of this locus between years.

4.2.5: Genetic distances among collections

Nei's genetic distance (Nei, 1978) was calculated for all pairs of collections and a dendrogram generated using the UPGMA method of Sokal and Rholf (1981, Figure 15). The same 30 loci used in the contingency chi square tests were used in the calculations of genetic distance. This analysis emphasizes the major genetic differences which separate the Tucannon River spring chinook salmon (represented by both adult and smolt collections in 1986 and 1987) and the fall chinook salmon stocks from the upper Columbia River (Priest Rapids Hatchery) and lower Snake River (Snake River/Lyons Ferry Hatchery). To a lesser degree, the dendrogram also shows the differentiation of Columbia River/Priest Rapids from Snake River/Lyons Ferry. Finally, the differences between the 1986 brood smolts and other collections from the Tucannon River are evident in this analysis.

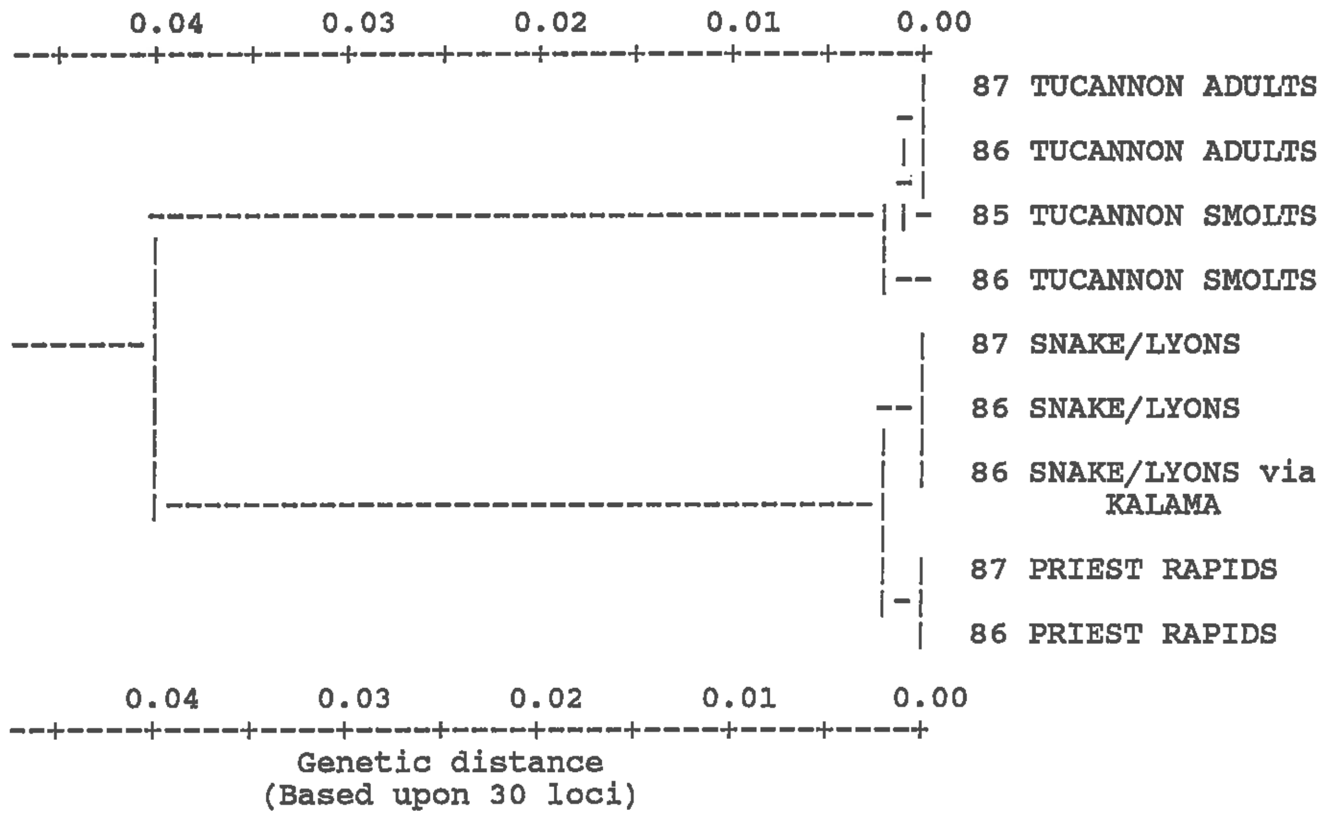


Figure 15. Dendrogram of "genetic distance" (Nei, 1978) relationships among collections of chinook salmon using 29 loci. (The loci used in this analysis were: *Aat1,2; Aat3; Aat4; Ada1; Ada2; Ah1; mAh4; Dpep1; Gpi2; Gpi3; GpiH; Gr; Hagh; Idh3; Idh4; Ldh5; Mdh3,4; mMdh2; Mpi; Pdpep2; PepLT; Pgk2; Sod1; Sod2; mSod1; Tapep1; and Tpi4*.)

4.2.6: Notable observations

Most of the variation observed in the present study occurs in at least some of the other stocks in the coast-wide chinook GSI baseline. Noteworthy observations from the present study include:

Aat1,2 — This isolocus pair is invariant in the Columbia River Basin (including the Snake River and its tributaries) except for two collections from the Salmon River (Johnson and Valley Creeks in the Snake River Drainage in Idaho) where frequencies of 0.02-0.04 for the 85 allele have been reported.

mAat2 — The -90 allele generally ranges in frequency from 0.02 to 0.15. The absence of this allele in the Tucannon River adult collection is unusual but not unique (it was also absent from collections of both the Green River Hatchery and Trask Hatchery fall-run stocks.

Ada2 The 105 allele at this locus has not been reported for any stocks from the Columbia River Basin (including the Snake River and its tributaries); although it occurs in stocks from coastal Washington, Puget Sound, and Canada.

Ck4 The [103] allele is only known for stocks in the upper Columbia River Basin (including the Snake River and its tributaries) at present.

Dpep1 The 86 allele, which has only been recognized for the past year, is only known to occur in stocks in the Columbia River Basin (including the Snake River and its tributaries) (where its frequency is less than 0.05).

Gpi-2 This year's data for the 60 allele were derived from the scoring of both heterozygous and homozygous variants. Data from past years were obtained from scoring homozygous variants only (and calculating allele frequencies by taking the square root of the observed frequency of homozygous variants).

Hagh The 65 allele is new this year and was only observed in the Priest Rapids collection (and in a collection of Skagit River Hatchery fall-run fish). With the exception of one collection from Canada (Deep Creek), frequencies of greater than 0.04 for the 143 allele are only known for collections from the Columbia River Basin (including the Snake River and its tributaries).

Idh3 Frequencies of greater than 0.10 for the 74 allele are restricted to collections from the upper Columbia River Basin (including the Snake River and its tributaries). The 129 allele appears to be absent from the Columbia River Basin (including the Snake River and its tributaries) and from Oregon and California although it often occurs at frequencies of 0.05-0.10 in Puget Sound stocks.

Idh4 The absence of the 127 allele from the Tucannon River collections is somewhat unusual as this allele occurs at frequencies of 0.01-0.05 in most stocks. (The 66 allele has only been recognized this year. It is easily confused with the 74 allele of Idh3.)

Ldh5 The 84 allele is only known from the Tucannon River stock (which lacks the 90 allele). Studies conducted prior to 1986-87 did not distinguish between the 90 and 84 alleles which have indistinguishable mobilities on high pH buffers.

mMdh-2 This locus was called mMdh-1 in last year's report. It exhibits variation in many stocks but the frequency of the 200 allele seldom exceeds 0.05 except in the

Columbia River Basin (including the Snake River and its tributaries). Frequencies greater than 0.10 are only known for the Tucannon River (although no other Snake River stocks have been screened for this locus yet).

MdhP-1 The 105 allele has not been observed in the Columbia River Basin (including the Snake River and its tributaries) although it occurs at frequencies up to 0.07 in Puget Sound stocks. With the exception of the Trask Hatchery fall chinook salmon stock, upper Columbia River Basin (including the Snake River and its tributaries) stocks are the only chinook known to have frequencies of the 92 allele greater than 0.70.

Mpi The frequency of the 109 allele observed in this year's Tucannon River smolt sample is exceptionally high when compared to all other collections from the Tucannon River. The explanation for this unusual frequency is unclear although gel scoring does not seem responsible as the locus was double scored in both heart and eye samples.

PepLT This is a difficult system to score. Frequencies at the four collection sites in the past two year's samples have been very similar and are thought to be accurate. However, scores from earlier studies are likely to be unreliable.

Pgk2 The 74 allele is new this year; it is known from a single fish from the Priest Rapids collection.

Sod1 The 580 allele is unknown in stocks from the Columbia River Basin (including the Snake River and its tributaries) stocks (except last year's Priest Rapids collection and the 1985 Eagle Creek/McKenzie collection where it was reported to occur at a frequency of 0.01). The -175 allele has only been observed in the Snake River/Lyons Ferry stock (once this year and once in 1985).

Sod2 This system is difficult to score in adults (heart) and impossible to score in smolts. There is a tendency for a deficiency of heterozygotes at this locus which may reflect inaccurate scoring.

Tapep2 The [108] allele is new this year and was only observed in the Priest Rapids collection (N=2).

4.3: Morphometric analysis

In the 1987 study period, program staff began a baseline analysis of morphometric variation among fish stocks (Taylor, 1986). We collected 100 samples each of: 1) 1986 brood Snake River stock fall chinook salmon parr from Lyons Ferry FH, 2) hatchery-reared 1986 brood Tucannon River stock spring chinook salmon parr from Lyons Ferry FH, and 3) 1986 brood Tucannon River stock spring chinook salmon reared naturally in the Tucannon River.

Methods Fish were immediately frozen and retained for measurement at a convenient date. We thawed individual specimens to room temperature, and gently teased the fins into extended positions on a 10 cm x 15 cm card. We marked 15 selected fin and body locations of the fish onto the cards with pins; this method was based upon the techniques of Winans (1984). We recorded fork length, stock (fall or spring chinook salmon), and origin (hatchery or natural) for each fish. Cards were then taken to the NMFS laboratory in Seattle Washington for measurement of Euclidean distances between each of the 15 coordinates (31 distances total). We also collected otoliths from 58 Lyons Ferry fall chinook salmon adults and 88 Tucannon spring chinook adults to be retained for supplementary stock identification in the future (Neilson et al. 1985). This is the third year of otolith collection for these study groups.

We performed multivariate analyses of variance (MANOVA) with a canonical discriminant analysis (CANDISC) to discriminate and categorize the three study groups based upon Euclidean distances. All analysis was done with the Statistical Analysis System (SAS) program (SAS Institute Inc. 1982).

Results We found an overall significant difference in body morphometry between hatchery-reared Tucannon stock spring chinook salmon, natural-reared Tucannon stock spring chinook salmon, and hatchery-reared Snake River stock fall chinook salmon (Wilks' lambda $p<0.0001$). Canonical discriminant analysis showed a class separation by study group based upon two canonical coefficients. The first coefficient explained 78 percent of the variability among study groups; the second canonical coefficient explained the remaining 22 percent (Figure 15). Table 38 lists standardized canonical coefficients for the 31 Euclidean distances.

Both hatchery- and natural-reared Tucannon stock spring chinook salmon parr were progeny of a common broodstock. From these tests, we found overall differences among the two study groups, and infer an environmental influence upon morphological development. We will use these results as part of the baseline stock profile characteristics, and will continue morphometric database development annually.

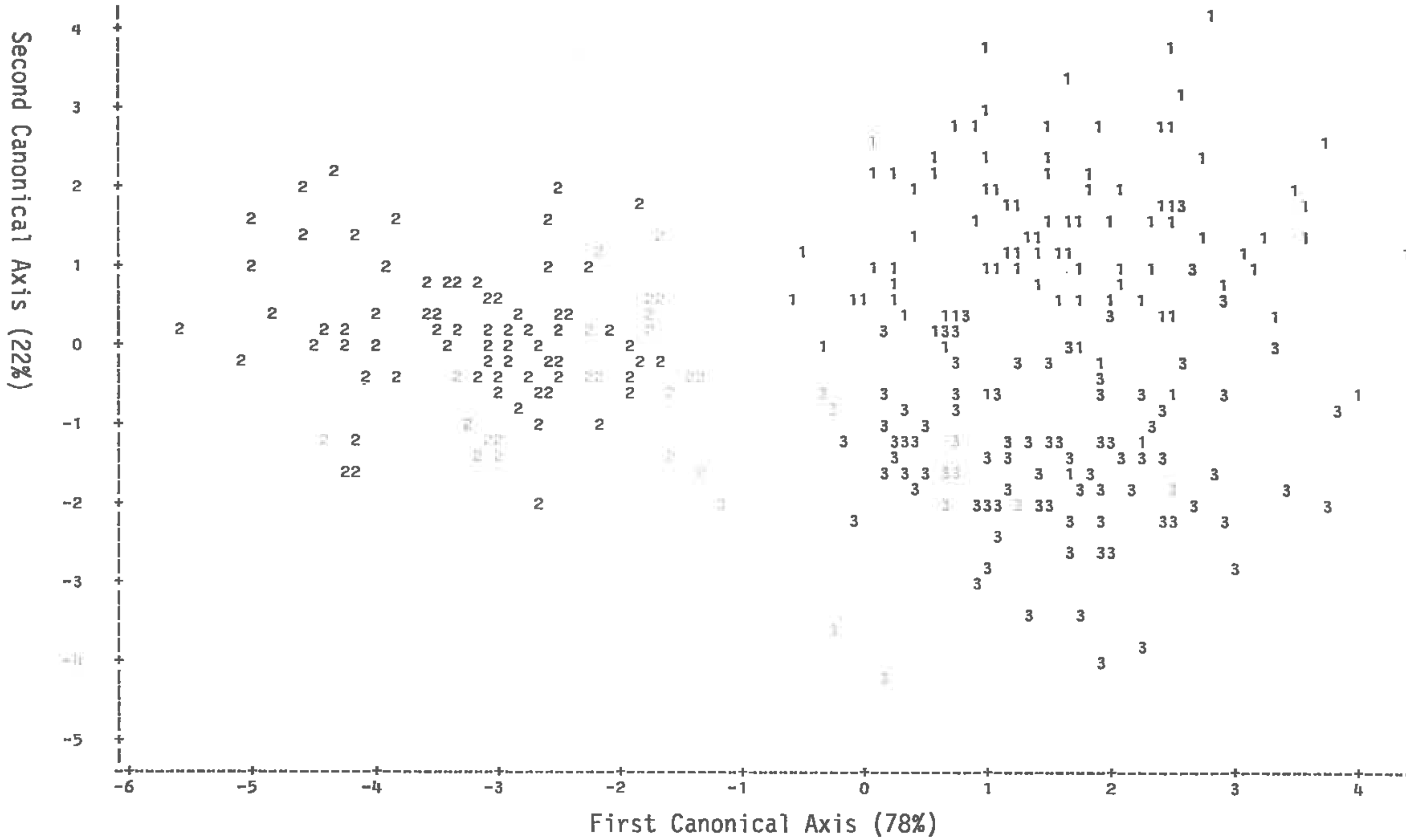


Figure 16. Plot of canonical coefficients protraying morphometric differences between 1) hatchery-reared Tucannon stock spring chinook salmon, 2) natural-reared Tucannon stock spring chinook salmon, and 3) hatchery-reared Snake River stock fall chinook salmon

Table 37. Standardized canonical coefficients for Euclidean (morphometric) distances classified by three study groups: 1) hatchery-reared Tucannon stock spring chinook salmon, 2) natural-reared Tucannon stock spring chinook salmon, and 3) hatchery-reared Snake River stock fall chinook salmon. All were 1986 brood studied at the parr stage.

Euclidean (morphometric) distance	First canonical coefficient	Second canonical coefficient
Nose-maxillary	-0.2464	1.9718
Maxillary-pectoral	-0.5091	1.5972
Nose-pectoral	0.8353	-5.4536
Head-maxillary	1.2560	-0.2875
Nose-head	-0.7732	-1.0191
Head-pectoral	-2.0608	-0.5344
Pectoral-pelvic	-2.9562	-4.2364
Head-pelvic	5.0569	6.4924
Pectoral-dorsal	2.0589	6.5470
Head-dorsal	-1.7261	-4.8737
Pelvic-dorsal	-1.5639	-6.8185
Pelvic-vent	-0.5524	6.8322
Vent-dorsal	0.5518	3.8352
Pelvic-back	-0.6739	-1.4307
Dorsal-back	-0.7531	-5.8729
Vent-back	-0.7481	-1.2876
Vent-anal	-0.6160	3.4347
Anal-back	1.5025	1.0297
Adipose-vent	-0.4859	-1.0513
Adipose-back	-1.8218	1.1782
Anal-adipose	-1.5786	4.0195
Anal-caudal	-2.6983	-5.9084
Anal-peduncal	3.8644	-5.7671
Adipose-peduncal	-2.1425	4.9268
Caudal-peduncal	-2.6591	3.4876
Caudal-bottom caudal	-0.3927	1.8128
Peduncal-bottom caudal	1.8416	-1.9321
Caudal-top caudal	1.8532	-2.7663
Peduncal-top caudal	-1.4524	3,2990
Top caudal-bottom caudal	-1.2367	1.0768
Nose-hypural (fork length)	4.8408	-0.3159

4.4: Elemental Composition

In the 1987 study period, program staff began a study to evaluate stock characteristics of the Tucannon stock spring chinook salmon based upon elemental and proximal composition of individual fish. Fish were taken at parr and smolt stages of their life cycle, and at Lyons Ferry FH (well water), Tucannon FH (river water), and those fish reared in the river naturally. We collected 15 samples from each group for this analysis. Results are presented in Table 39. These data will provide part of the baseline stock characteristic profile for Tucannon stock spring chinook salmon.

Table 38. Elemental composition of Tucannon River spring chinook salmon, comparing 1985 brood natural origin fish, 1986 brood natural origin fish, and 1986 brood hatchery origin fish. Hatchery fish were sampled when rearing at Lyons Ferry and Tucannon Fish Hatcheries. Values are presented without units as means (with standard deviations).

Element	F value [a]	Treatment Group [b] 1		2		3		4	
Ca	11.5	5525	(663)	4838	(132)	4327	(245)	4531	(302)
Co	4.8	0.15	(0.04)	0.05	(0.06)	0.11	(0.02)	0.14	(0.07)
Cr	7.1	0.09	(0.03)	1.50	(3.80)	0.15	(0.10)	6.20	(4.20)
Cu	2.0	0.64	(0.17)	0.73	(0.13)	0.65	(0.23)	0.85	(0.13)
Fe	4.4	40.0	(13.0)	22.0	(14.9)	30.4	(13.9)	49.5	(17.9)
K	5.6	3131	(196)	3268	(190)	3326	(198)	2941	(175)
Mg	9.4	356	(16)	325	(9)	348	(14)	361	(13)
Mn	8.1	2.7	(0.9)	1.1	(0.4)	2.7	(1.0)	2.1	(0.4)
Na	3.0	1167	(39)	1152	(39)	1078	(82)	1191	(61)
P	11.7	4729	(287)	4569	(87)	4387	(171)	4165	(147)
Sr	25.6	3.91	(0.5)	4.40	(0.2)	3.20	(0.3)	4.60	(0.4)
Zn	12.2	34.9	(5.1)	40.8	(6.4)	26.9	(3.1)	30.8	(2.2)
Fish weight (gm)	218	7.6	(2.0)	48.8	(5.2)	8.4	(2.1)	10.4	(4.0)
Solids	3.3	19.1	(1.2)	21.4	(2.0)	21.9	(3.9)	23.2	(2.0)
Protein		14.39		15.86		16.58		14.23	
Fat		1.78		2.99		3.76		6.70	
Ash		2.58		2.35		2.25		2.18	

[a] Values greater than 6.60 are statistically significant at p=0.05; n=7.

[b] Sample groups are as follows: 1= natural 1986 brood collected in March 1988, 2= hatchery reared 1986 brood collected in March 1988 at Tucannon Fish Hatchery, 3= natural 1985 brood collected in May 1987, and 4= hatchery reared 1986 brood collected at Lyons Ferry Fish Hatchery.

REFERENCES

Achord, S., G.M Mathews, and T.E. Ruehle. No date. Descaling of salmonid smolts: a review of effects and a standardized method of measurement for large samples. Unpublished draft, National Marine Fisheries Service, Pasco, Washington, USA.

Basham, L. Fish Passage Center, Portland, Oregon, USA.

Bjornn, T.C. 1978. Survival, production, and yield of trout and chinook salmon in the Lemhi River, Idaho. Bulletin Number 27, College of Forestry, Wildlife, and Range Sciences, University of Idaho, Moscow, Idaho, USA.

Bjornn, T.C., and R.R. Ringe. 1988. Fall chinook trapping at Ice Harbor Dam in 1987. Completion Report, Cooperative Agreement Number 14-16-0009-1559, Research Work Order Number 15 to U.S. Fish and Wildlife Service, Washington, D.C., USA.

Burck, W.A., R.B. Lindsay, B.J. Smith, and E.A. Olsen. 1979. Spring chinook studies in the John Day River. Federal Aid to Fisheries Progress Report, Contract Number DE-AC79-80BP18234, Oregon Department of Fish and Wildlife, Portland, Oregon, USA.

Carmichael, R. Oregon Department of Fish and Wildlife, LaGrande, Oregon, USA.

Chapman, D.G. 1948. A mathematical study of confidence limits of salmon populations calculated from sample tag ratios. International Pacific Salmon Fisheries Commission, Bulletin II, pages 67-85.

Daniel, W. W. 1978. Applied nonparametric statistics. Houghton Mifflin Company, Boston, Massachusetts, USA.

Easterbrooks, J. Washington State Department of Fisheries, Yakima, Washington, USA.

Fast, D.E., J.D. Hubble, and B.D. Watson. 1986. Yakima River spring chinook enhancement study. Yakima Indian Nation Annual Report, project number 82-16 to U.S. Department of Energy, Bonneville Power Administration, Portland, Oregon, USA.

Fiscus, H. Washington State Department of Fisheries, Battleground, Washington, USA.

Fish Passage Center. 1988. Migrational characteristics and survival of Columbia Basin salmon and steelhead trout, 1987. Smolt monitoring program annual report, project number 87-127 to U.S. Department of Energy, Bonneville Power Administration, Portland, Oregon, USA.

Griffith, J.S. 1985. Analysis of fish populations in the Wenatchee River, Washington. A report to U.S. Fish and Wildlife Service, Fisheries Assistance Office, Leavenworth, Washington, USA.

Griffith, J.S., and T.W. Hillman. 1986. Analysis of fish populations in the Methow River, Washington.

Hallock, D. H., and G. Mendel. 1985. Instream habitat improvement in southeast Washington. 1984 Annual Report. Washington State Department of Game, Olympia, Washington, USA.

Helm, W.T. (ed.) 1985. Glossary of stream habitat terms. Habitat Inventory Committee, Western Division, American Fisheries Society, Department of Fisheries and Wildlife, Utah State University, Logan, Utah, USA.

Hillman, T.W., J.S. Griffith, and W.S. Platts. 1987. Summer and winter habitat selection by juvenile chinook salmon in a highly sedimented Idaho stream. Transactions of the American Fisheries Society 116:185-195.

Jonasson, B.C., and R.B. Lindsay. 1983. An ecological and fish cultural study of Deschutes River salmonids. Annual Progress Report F-88-R-13, Oregon Department of Fish and Wildlife, Portland, Oregon, USA.

Kelley, D.W., and Associates. 1982. Ecological investigations on the Tucannon River Washington. Report to U.S. Department of Agriculture, Soil Conservation Service, Spokane, Washington, USA.

Kucera, P.A. 1987. Chinook salmon spawning ground survey in Big Creek, Johnson Creek, Secesh River, and Lake Creek, Salmon River Subbasin, Idaho. Technical Report 87-3, Department of Fisheries Management, Nez Perce Tribe, Lapwai, Idaho, USA.

Lindsay, R.B, W.J. Knox, M.W. Flesher, B.J. Smith, E.A. Olsen, and L.S. Lutz. 1986. Study of wild spring chinook salmon in the John Day River System. Oregon Department of Fish and Wildlife Final Report, Contract Number DE-A179-83BP39796, Project Number 79-4, to U. S. Department of Energy, Bonneville Power Administration, Portland, Oregon, USA.

Maciolek, K. 1979. Eastern Oregon habitat study. Final report, Fish research project 79-ABC-00113. Oregon Department of Fish and Wildlife, Portland, Oregon, USA.

Mains, E.M., and J.M. Smith. 1955. Determination of the normal stream distribution, size, time, and current preferences of downstream migrating salmon and steelhead trout in the Columbia and Snake Rivers. Contract Report DA35026-ENG-20571, U.S. Army Engineer District, Walla Walla, Washington, USA.

Major, R.L., and J.L. Mighell. 1969. Egg-to-migrant survival of spring chinook salmon (Oncorhynchus tshawytscha) in the Yakima River, Washington. Fishery Bulletin, 67(2):347-359.

Mendel, G. Washington State Department of Wildlife, Clarkston, Washington, USA.

Mullan, J.W., and J.D. McIntyre. 1986. Growth and survival of salmon and steelhead in a controlled section of Icicle Creek. Information Report FRI/FAO-86-14. U.S. Fish and Wildlife Service, Leavenworth, Washington, USA.

Myers, J.L. 1979. Fundamentals of experimental design. Allyn and Bacon, Incorporated, Boston, Massachusetts, USA.

Nei, M. 1978. Estimation of average heterozygosity and genetic distance from a small number of individuals. Genetics: vol. 89 pages 588-590.

Neilson, J.D., G.H. Geen, and B. Chan. 1985. Variability in dimensions of salmonid otolith nuclei: implications for stock identification and microstructure interpretation. Fishery Bulletin 83(1):81-89.

Platts, W.S., W.F. Megahan, and G.W. Minshal. 1983. Methods for evaluating stream, riparian, and biotic conditions. General Technical Report INT-138. U.S. Forest Service, Intermountain Forest and Range Experiment Station, Ogden, Utah, USA.

Platts, W.S., and F.E. Partridge. 1978. Rearing of chinook salmon in tributaries of the South Fork Salmon River, Idaho. U.S. Forest Service. Research Paper INT-205. Intermountain Forest and Range Experiment Station, Ogden Utah, USA.

Platts, W.S., C. Armour, G.D. Booth, M. Bryant, J.L. Bufford, P. Culpin, S. Jensen, G.W. Lienkaemper, G.W. Minshall, S.B. Monsen, R.L. Nelson, J.R. Sedell, and J.S. Tuhy. 1987. Methods for evaluating riparian habitats with applications to management. General Technical Report INT-221. U.S. Forest Service, Intermountain Forest and Range Experiment Station, Ogden, Utah, USA.

Raleigh, R.F., and W.J. Miller. 1985. Habitat suitability index models: chinook salmon. U. S. Fish and Wildlife Service Draft Report, Washington D.C., USA.

SAS Institute, Inc., 1982. SAS User's Guide: Statistics. Cary, North Carolina, USA.

Scully, R.J., and E. Buettner. 1986. Smolt condition and timing of arrival at Lower Granite Reservoir. Idaho Department of Fish and Game Annual Report, Contract Number DE-A179-83BP11631, Project Number 83-323B, to U.S. Department of Energy, Bonneville Power Administration, Portland, Oregon, USA.

Seidel, P., R. Bugert, R.S. Kirby, and L. Ross. 1985. Annual Report, Lower Snake River Compensation Plan, Lyons Ferry Evaluation Program, to U.S. Fish and Wildlife Service, Cooperative Agreement 14-16-0001-85072. Washington Department of Fisheries, Olympia, Washington, USA.

Seidel, P., and R. Bugert. 1986. Annual Report, Lower Snake River Compensation Plan, Lyons Ferry Evaluation Program, to U.S. Fish and Wildlife Service, Cooperative Agreement 14-16-0001-86521. Washington Department of Fisheries, Olympia, Washington, USA.

Seidel, P., and R. Bugert. 1988. Lower Snake River Compensation Plan, Lyons Ferry Evaluation Program, Five-Year Plan 1988-1992. Washington Department of Fisheries, Olympia, Washington, USA.

Seiler, D., S. Neuhauser, and M. Ackley. 1981. Upstream/ downstream salmonid trapping project, 1977-1980. Progress Report Number 144. Washington State Department of Fisheries, Olympia, Washington, USA.

Sokal, R.R.,and F.G. Rohlf. 1981. Biometry, 2nd edition. W.H. Freeman. San Fransico, California. 766 pages.

Steinhorst, R.K. Department of Mathematics and Applied Statistics, University of Idaho, Moscow, Idaho, USA.

Taylor, E.B. 1986. Differences in morphology between wild and hatchery populations of juvenile coho salmon. The Progressive Fish Culturist 48:171-176.

Terrell J.W., T.E. McMahon, P.D. Inskip, R.F. Raleigh, and K.L. Williamson. 1982. Habitat Suitability Index Models: Appendix A. Guidelines for riverine and lacustrine applications of fish HSI models with the habitat evaluation procedures. FWS/OBS-82/10.A Habitat Evaluation Procedures Group, Western Energy and Land Use Team, U.S. Fish and Wildlife Service, Fort Collins, Colorado, USA.

U.S. Army Corps of Engineers, June 1975. Special Report: Lower Snake River Fish & Wildlife Compensation Plan. Walla Walla, Washington, USA.

Van Deventer, J.S., and W.S. Platts. 1983. Sampling and estimating fish populations from streams. Transactions of the North American Wildlife and Natural Resources Conference. 48: 349-354.

Winans, G.A. 1984. Multivariate morphometric variability in Pacific salmon: technical demonstration. Canadian Journal of Fisheries and Aquatic Science 41:1150-1159.

Witty, K. Oregon Department of Fish and Wildlife. Enterprise, Oregon, USA.

Zippin, C. 1958. The removal method of population estimation. Journal of Wildlife Management. 22(1):82-90.

APPENDIX A

The following is an outline of WDF objectives for the LSRCP Lyons Ferry Hatchery Evaluation Program. These objectives are interrelated in scope, and are not set in priority.

1) **Document juvenile fish output for Lyons Ferry and Tucannon FH.** Records will be compiled and summarized by numbers of fish produced at each facility, categorized by stock, size, weight, and planting location. Fish condition and survival rates to planting will be noted.

2) **Maintain records of adult returns to the Snake River Basin for each rearing program, categorized by stock and brood year.** Data are collected at hatchery racks and spawning grounds by program staff.

3) **Document contributions of each rearing program to the various fisheries through coded-wire tag returns.** Pacific Coast states, Federal, and Canadian agencies cooperate in returning tags and catch data to the agency of origin. We will attempt to tag sufficient fish to represent each rearing program.

4) An initial objective was to **document downstream survival to National Marine Fisheries Service (NMFS) sampling points on the lower Columbia River for each rearing program.** However, this type of sampling has been discontinued by NMFS. We hope that cooperating agencies will continue monitoring survival of downstream migrants. As this type of information becomes available, program staff will retrieve and summarize data for the Lyons Ferry/Tucannon facilities and for basin-wide fall chinook salmon. Survival rate comparisons for each rearing program will be made. This data could then be used to improve downstream migrant survival.

5) **Quantify genetic variables that might be subject to alteration under hatchery production strategies.** Utilizing and maintaining native stocks is an important element of the LSRCP. We plan to identify and quantify as many genetic variables as possible in all available Snake River chinook salmon populations. Similar data for other chinook populations which may overlap with Snake River chinook in the lower Columbia River will also be developed. These data include qualitative loci analysis through electrophoresis, and quantitative analysis of such factors as adult size, run timing, and disease susceptibility.

6) **Determine the success of any off-station enhancement projects, and determine the impact of hatchery fish on wild stock.** Data gathered from objective 5 could allow us to develop genetic marks (qualitative or quantitative) which could provide techniques for evaluating interactions of wild and hatchery fish in the Tucannon River system.

7) Evaluate and provide management recommendations for major hatchery operational practices, including:

A. Optimum size and time-of-release data will be sought for both spring and fall chinook salmon. Existing size, time and return data for other Columbia River Basin programs will be reviewed to determine the experimental possibilities which would have the most likelihood of success. Continual experimentation may be necessary in some cases.

B. Selection and maintenance of brood stock will be done in conformance with LSRCP goals. Criteria will be developed to program genetic management as determined by objective 5.

C. Disease investigations or other special treatments on experimental hatchery practices often require mark-release-return groups to facilitate evaluation. Program staff will coordinate the development of experimental designs, direct the marking, and analyze the results.

8) Evaluate and provide management recommendations for Snake River fall chinook salmon distribution programs basin-wide. As Lyons Ferry FH goals are reached, egg-taking needs for off-site distribution to supplement natural production will be specified along with priorities for off-site distribution. Evaluation and updating the distribution plan will be an on-going process.

9) Coordinate research and management programs with hatchery capabilities. Advance notice to the hatchery for specific study groups of marking programs will allow a more efficient use of hatchery facilities and reduce handling and stress on the fish. Research and management programs will be reviewed to determine if the hatcheries will have the capabilities to meet program goals.

APPENDIX B

Contribution of 1983 and 1984 broods Lyons Ferry stock fall chinook salmon to commercial, Indian, and sport fisheries, escapement to the hatchery rack and Lower Granite Dam. Data are based upon coded-wire tag recoveries in 1985, 1986, and 1987.

Table 1. Recoveries of 1983 brood yearlings released on-station in April 1985. Tagcode was 633218. Mark rate was 51.43 percent (83,611 out of 162,575). Size of fish at release was 10.0 fpp.

Year Fishery	Status	Observed recoveries	Estimated contribution
1985			
Columbia River sport	F a	1	9
Columbia River net	F	2	7
OSU Experimental ocean purse seine	F	8	8
West coast sport (21, 23-27) b	F	3	
Lyons Ferry FH returns	F	494	504
Lower Granite Dam trap	F	16	16
1985 Totals:		524	544
1986			
Oregon ocean troll	F	25	63
Oregon ocean sport	F	6	12
Columbia River net	F	69	268
Oregon estuary sport	F	4	15
Puget Sound sport	P	5	31
Puget Sound net	P	1	4
Wash. ocean sport (charter boat)	P	13	29
Wash. ocean sport (kicker boat)	P	9	26
Wash. ocean troll (Indian)	P	2	12
SE Alaska commercial (unk. gear)	P	1	
SE Alaska commercial (seine)	P	1	1
NW Vancouver Island troll (25-27)	P	7	35
SW Van. Island troll (21,23,24)	P	9	55
Northern troll (1-5)	P	2	8
Northern net (1-5)	P	1	3
Johnstone Strait net (12,13)	P	1	2
Central net (6-11)	P	10	27
Juan de Fuca net (20)	P	9	35
Central sport (6-12, 30)	P	2	
West coast sport (21, 23-27)	P	8	8
Georgia Strait sport (13-20, 28-29)	P	3	11
Lyons Ferry FH returns	P	156	156
1986 Totals:		344	802

a Preliminary estimates are designated "P", "F" designates final estimates.
b Numbers in parentheses designate statistical harvest area.

Appendix B, Table 1, continued.

Year Fishery	Status	Observed recoveries	Estimated contribution
1987			
California ocean troll	P [a]	30	180
Calif. ocean sport (charter boat)	P	1	3
NW Vancouver Island troll (25-27)[b]	P	36	143
SW Van. Island troll (21,23,24)	P	147	776
Northern troll (1-5)	P	11	48
Northern net (1-5)	P	1	5
Oregon ocean troll	P	327	950
Oregon ocean sport	P	17	35
Oregon estuary sport	P	25	67
Washington ocean troll	P	68	188
Puget Sound net	P	1	1
Wash. ocean sport (charter boat)	P	85	183
Wash. ocean sport (kicker boat)	P	30	109
Wash. ocean troll (Indian)	P	31	81
SE Alaska commercial troll	P	11	19
SE Alaska sport	P	1	
Johnstone Strait net (12, 13)	P	1	3
West coast sport (21, 23-27)	P	6	
North central troll (6-9, 30)	P	3	10
South central troll (10-12)	P	12	39
Lyons Ferry FH returns	P	358	358
1987 Totals:		1202	3199
Totals for tag code 633218:		2070	4546

a Preliminary estimates are designated "P", "F" designates final estimates.

b Numbers in parentheses designate statistical harvest area.

Appendix B, continued.
Table 2. Recoveries of 1983 brood yearlings released on-station in April 1985. Tagcode was 632152. Mark rate was 51.43 percent (250,831 out of 487,725). Size of fish at release was 10.0 fpp.

Year Fishery	Status	Observed recoveries	Estimated contribution
1985			
Oregon ocean sport	F a	5	11
Columbia River sport	F	2	19
Columbia River net	F	22	78
OSU experimental ocean purse seine	F	18	18
Wash. ocean sport (charter boat	F	1	2
Groundfish observer (CA/OR/WA)	F	1	2
Wash coast sport (21, 23-27) b	F	7	
Lyons Ferry FH returns	F	1397	1425
Lower Granite Dam trap	F	35	36
1985 Totals:		1488	1589
1986			
California ocean sport	P	1	3
Oregon ocean troll	F	86	272
Oregon ocean sport	F	11	21
Columbia River net	F	202	933
Oregon estuary sport	F	10	38
Puget Sound sport	P	21	115
Puget Sound net	P	4	16
Wash. ocean sport (charter boat)	P	31	68
Wash. ocean sport (kicker boat)	P	29	83
Wash. ocean troll (day boat)	P	3	7
Wash. ocean troll (trip boat)	P	1	2
Wash. ocean troll (Indian)	P	8	60
SE Alaska sport	P	1	
NW Vancouver Island troll (25-27)	P	10	47
SW Van. Island troll (21,23,24)	P	41	207
Northern troll (1-5)	P	2	7
Northern net (1-5)	P	3	11
Johnstone Strait net (12, 13)	P	2	9
Central net (6-11)	P	36	90
Juan de Fuca net (20)	P	31	126
SW Vancouver Island net (21-24)	P	2	4
West coast sport (21, 23-27)	P	37	52
Georgia Strait sport (13-20, 28-29)	P	5	21
Lyons Ferry FH returns	P	507	507
1986 Totals:		1084	2700

a Preliminary estimates are designated "P", "F" designates final estimates.
b Numbers in parentheses designate statistical harvest area.

Appendix B, Table 2, continued.

Year Fishery	Status	Observed recoveries	Estimated contribution
1987			
California ocean troll	P a	82	513
Calif ocean sport (charter boat)	P	3	14
Calif. ocean sport (skiff)	P	8	36
NW Vancouver Island troll (25-27)b	P	136	586
SW Van. Island troll (21,23,24)	P	365	1918
Northern troll (1-5)	P	14	67
Northern net (1-5)	P	1	3
Oregon ocean troll	P	810	2382
Oregon ocean sport	P	58	153
Oregon estuary sport	P	34	93
Washington ocean troll	P	220	567
Puget Sound sport	P	9	54
Puget Sound net	P	6	12
Wash. ocean sport (charter boat)	P	211	449
Wash. Ocean sport (kicker boat)	P	86	310
Wash. ocean troll (Indian)	P	77	198
SE Alaska commercial troll	P	18	55
SE Alaska commercial seine	P	1	3
Johnstone Strait net (12, 13)	P	2	4
Central net (6-11)	P	1	4
Juan de Fuca (20)	P	2	8
West coast sport (21, 23-27)	P	9	
Georgia strait sport (13-20, 28-29)	P	2	11
North Central troll (6-9, 30)	P	11	39
South Central troll (10-12)	P	23	82
Lyons Ferry FH returns	P	1086	1086
1987 Totals:		3275	8648
Totals for tag code 632152:		5847	12937

[a] Preliminary estimates are designated "P", "F" designates final estimates.

[b] Numbers in parentheses designate statistical harvest area.

Appendix B, continued.

Table 3. Recoveries of 1984 brood yearlings released on-station in April 1986. Tagcode was 632841. Mark rate was 58.49 percent (258,355 out of 441,676). Size of fish at release was 8.0 fpp.

Year Fishery	Status	Observed recoveries	Estimated contribution
1986			
Columbia River net	F [a]	1	4
Lyons Ferry FH returns	P	48	48
1986 Totals:		49	52
1987			
NW Vancouver Island troll (25-27)[b]	P	4	8
SW Van. Island troll (21,23,24)	P	1	21
Oregon ocean troll	P	1	3
Oregon ocean sport	P	3	8
Puget Sound sport	P	3	19
Puget sound net	P	1	4
Wash. ocean sport (charter boat)	P	1	2
Wash. ocean sport (kicker boat)	P	4	12
Johnstone Strait net (12, 13)	P	1	2
Central net (6-11)	P	8	22
Juan de Fuca net (20)	P	3	10
Central sport (6-12, 30)	P	2	
West coast sport (21, 23-27)	P	1	
Georgia Strait sport (13-20, 28-29)	P	1	23
South Central troll (10-12)	P	2	9
Lyons Ferry FH returns	P	89	89
1987 Totals:		125	231
Totals for tag code 632841:		174	283

[a] Preliminary estimates are designated "P", "F" designates final estimates.

[b] Numbers in parentheses designate statistical harvest area.

Appendix B, continued.
Table 4. Recoveries of 1984 brood subyearlings released on-station in June 1985. Tagcode was 633228. Mark rate was 43.58 percent (78,504 out of 101,636). Size of fish at release was 67.0 fpp.

Year Fishery	Status	Observed recoveries	Estimated contribution
1986			
Columbia River net	F a	3	10
Johnstone Strait net (12, 13)b	P	1	5
Central net (6-11)	P	2	4
Juan de Fuca net (20)	P	2	9
Lyons Ferry FH returns	P	9	9
1986 Totals:		17	37
1987			
NW Vancouver Island troll (25-27)	P	4	20
SW Van. Island troll (21,23,24)	P	7	33
Northern troll (1-5)	P	1	3
Oregon ocean troll	P	11	25
Wash. ocean troll	P	4	16
Wash. ocean sport (kicker boat)	P	1	2
SE Alaska commercial troll	P	3	5
SE Alaska sport	P	1	
North Central troll (6-9, 30)	P	1	3
Lyons Ferry FH returns	P	40	40
1987 Totals:		73	147
Totals for tag code 633228:		90	184

a
Preliminary estimates are designated "P", "F" designates final estimates.
b
Numbers in parentheses designate statistical harvest area.

Appendix B, continued.

Table 5. Recoveries of 1984 brood subyearlings released on-station in June 1985. Tagcode was 633227. Mark rate was 43.56 percent (78,064 out of 179,199). Size of fish at release was 67.0 fpp.

Year Fishery	Status	Observed recoveries	Estimated contribution
1986			
Columbia River net	F [a]	3	14
Central net (6-11) [b]	P	2	3
Juan de Fuca net (20)	P	2	9
Lyons Ferry FH returns	P	12	12
1986 Totals:		19	38
1987			
California ocean troll	P	1	5
NW Vancouver Island troll (25-27)	P	4	15
SW Van. Island troll (21,23,24)	P	2	8
Northern troll (1-5)	P	3	8
Oregon ocean troll	P	7	25
Oregon ocean sport	P	2	4
Oregon estuary sport	P	1	3
Washington ocean troll	P	1	3
Wash. ocean sport (charter boat)	P	1	2
Wash. ocean sport (kicker boat)	P	1	3
SE Alaska commercial troll	P	1	2
Juan de Fuca net (20)	P	1	4
West coast sport (21, 23-27)	P	1	
South Central troll (10-12)	P	2	9
Lyons Ferry FH returns	P	36	36
1987 Totals:		64	127
Totals for tag code 633227:		83	165

[a] Preliminary estimates are designated "P", "F" designates final estimates.

[b] Numbers in parentheses designate statistical harvest area.

Appendix B, continued.

Table 6. Recoveries of 1984 brood subyearlings released on-station in June 1985. Tagcode was 633226. Mark rate was 43.55 percent (78,417 out of 180,053). Size of fish at release was 67.0 fpp.

Year Fishery	Status	Observed recoveries	Estimated contribution
1986			
Columbia River net	F [a]	3	11
Wash. ocean sport (kicker boat)	P	1	3
Northern net (1-5)[b]	P	2	6
Central net (6-11)	P	4	8
Juan de Fuca net (20)	P	2	6
Lyons Ferry FH returns	P	13	13
1986 Totals:		25	47
1987			
NW Vancouver Island troll (25-27)	P	5	19
SW Van. Island troll (21,23,24)	P	6	34
Northern troll (1-5)	P	1	3
Oregon ocean troll	P	10	23
Oregon ocean sport	P	2	5
Oregon estuary sport	P	1	3
Washington ocean troll	P	1	2
Wash. ocean sport (charter boat)	P	3	7
Wash. ocean sport (kicker boat)	P	2	8
Wash. ocean troll (Indian)	P	1	6
SE Alaska commercial troll	P	1	2
SE Alaska commercial gillnet	P	1	
West coast sport (21, 23-27)	P	2	
South Central troll (10-12)	P	5	19
Lyons Ferry FH returns	P	32	32
1987 Totals:		73	162
Totals for tag code 633226:		98	209

[a] Preliminary estimates are designated "P", "F" designates final estimates.

[b] Numbers in parentheses designate statistical harvest area.

APPENDIX C

Travel time and passage indices of Lyons Ferry stock yearling (1985 brood) and subyearling (1986 brood) fall chinook salmon based upon gatewell dipping and brand analysis at Lower Monumental Dam in 1987.

	Yearlings			Subyearlings			
Date	Total caught	Brands caught	Ad-clip caught	Total caught	Brands caught	Ad-clip caught	Flow (kcfs)
03/26	44 ab	0	2	0 a	0	0	29.2
03/27	7	0	0	0	0	0	31.8
03/28	0	0	0	0	0	0	34.9
03/29	2	0	1	0	0	0	27.4
03/30	3	0	2	0	0	0	30.1
03/31	1	0	1	0	0	0	27.4
04/01	7	0	1	0	0	0	21.5
04/02	0	0	0	0	0	0	28.0
04/03	0	0	0	0	0	0	31.5
04/04	2	0	0	0	0	0	31.1
04/05	1	0	0	0	0	0	26.3
04/06	0	0	0	0	0	0	34.2
04/07	7	0	1	0	0	0	36.9
04/08	3	0	0	0	0	0	38.0
04/09	3	0	0	0	0	0	38.3
04/10	1	0	0	0	0	0	40.4
04/11	26	0	1	0	0	0	44.8
04/12	4	0	0	0	0	0	27.5
04/13	18	0	1	0	0	0	44.5
04/14	11	0	0	0	0	0	36.2
04/15	7	0	1	0	0	0	30.9
04/16	5	0	0	0	0	0	32.7
04/17	11	0	4	0	0	0	37.6
04/18	231	0	66	0	0	0	47.0
04/19	206	1	67	0	0	0	42.9
04/20	243	8	82	0	0	0	40.0
04/21	579	18	196	0	0	0	45.2
04/22	806	43	397	0	0	0	41.9
04/23	259	10	113	0	0	0	34.3
04/24	176	5	69	0	0	0	44.2
04/25	247	16	129	0	0	0	54.6
04/26	142	7	52	0	0	0	53.9
04/27	148	4	28	0	0	0	55.6
04/28	1584	54	456	0	0	0	71.1
04/29	1776	56	533	0	0	0	74.1
04/30	3628	79	717	0	0	0	94.8
05/01	4808	60	599	0	0	0	94.0
05/02	1947	9	230	0	0	0	92.0
05/03	964	7	91	0	0	0	89.6
05/04	350	2	36	0	0	0	69.7

Appendix C continued.

Date	Yearlings Total caught	Yearlings Brands caught	Yearlings Ad-clip caught	Subyearlings Total caught	Subyearlings Brands caught	Subyearlings Ad-clip caught	Flow (kcfs)
05/05	591	2	65	0	0	0	69.8
05/06	1478	2	125	0	0	0	80.7
05/07	1300	3	126	0	0	0	87.6
05/08	1021	2	100	0	0	0	86.4
05/09	1032	1	97	0	0	0	84.2
05/10	475	0	37	0	0	0	69.4
05/11	210	0	27	0	0	0	79.2
05/12	569	0	66	0	0	0	83.6
05/13	422	0	58	0	0	0	85.9
05/14	353	1	36	0	0	0	94.2
05/15	180	0	25	0	0	0	95.9
05/16	196	0	21	0	0	0	73.8
05/17	102	0	13	0	0	0	75.5
05/18	117	0	19	0	0	0	77.4
05/19	75	0	11	0	0	0	46.7
05/20	108	0	14	0	0	0	46.3
05/21	38	1	8	0	0	0	41.8
05/22	37	0	8	0	0	0	40.0
05/23	25	0	5	0	0	0	34.3
05/24	52	0	13	0	0	0	31.6
05/25	238	0	33	0	0	0	51.0
05/26	111	0	12	0	0	0	37.4
05/27	122	2	20	0	0	0	35.3
05/28	113	0	18	0	0	0	33.8
05/29	56	1	15	0	0	0	35.6
05/30	118	0	13	0	0	0	32.5
05/31	156	0	31	0	0	0	31.6
06/01	111	0	15	0	0	0	48.0
06/02	120	0	15	0	0	0	37.6
06/03	146	0	23	5	0	3	35.0
06/04	356	0	50	63	9	19	34.3
06/05	413	0	43	21	3	13	33.7
06/06	185	0	25	21	6	12	30.0
06/07	111	0	20	20	5	12	29.7
06/08	80	0	8	27	7	19	35.0
06/09	74	0	10	29	3	24	25.4
06/10	90	0	11	15	4	8	32.6
06/11	68	0	6	39	12	26	30.7
06/12	39	0	10	61	5	49	35.7
06/13	63	0	8	64	6	22	26.2
06/14	74	0	3	73	13	33	27.9
06/15	115	0	26	51	6	44	30.6
06/16	87	0	7	46	1	44	25.6
06/17	60	0	12	55	10	43	22.0
06/18	64	0	11	64	15	47	30.9
06/19	89	0	13	137	18	115	29.0
06/20	84	0	11	656	127	489	43.8
06/21	98	0	20	346	67	267	18.9
06/22	67	0	11	93	18	73	26.5

Appendix C continued.

Date	Yearlings Total caught	Yearlings Brands caught	Yearlings Ad-clip caught	Subyearlings Total caught	Subyearlings Brands caught	Subyearlings Ad-clip caught	Flow (kcfs)
06/23	18	0	0	31	5	25	29.2
06/24	9	0	1	31	4	25	28.7
06/25	4	0	0	17	3	13	25.1
06/26	17	0	2	12	0	9	26.2
06/27	6	0	2	15	6	9	26.1
06/28	2	0	1	4	1	3	17.8
06/29	20	0	1	39	3	34	21.3
06/30	3	0	0	0	0	0	16.4
07/01	0	0	0	0	0	0	20.6
07/02	20	0	2	25	5	18	19.5
07/03	4	0	0	14	3	11	19.1
07/04	6	0	3	17	7	9	12.5
07/05	1	0	0	9	3	6	12.4
07/06	0	0	0	8	1	7	17.6
07/07	11	0	1	73	12	55	19.5
07/08	46	0	1	195	47	142	19.9
07/09	45	0	2	191	33	153	23.5
07/10	25	0	0	152	29	104	23.1
07/11	39	0	4	239	51	182	18.1
07/12	44	0	1	162	30	121	16.2
07/13	43	0	2	159	53	95	27.6
07/14	46	0	1	212	57	148	18.7
07/15	30	0	0	234	52	173	19.9
07/16	35	0	3	352	112	223	17.8
07/17	50	0	2	353	128	188	14.7
07/18	53	0	0	470	152	271	15.4
07/19	32	0	4	307	95	189	17.0
07/20	26	0	1	151	61	82	23.7
07/21	27	0	0	217	69	131	20.1
07/22	15	0	0	189	68	109	21.1
07/23	18	0	0	163	61	84	25.6
07/24	17	0	0	163	66	81	32.4
07/25	12	0	0	148	47	75	28.7

a We released 230,413 yearlings (39,906 branded LA/7N/1, 153,554 adipose clipped) from Lyons Ferry FH on 14 April and 337,785 subyearlings (80,484 branded LA/S/1, 257,301 adipose clipped) on 1 June 1987.

b Total number caught include all Snake River stocks of spring and fall chinook salmon collected in gatewell dipping, and cannot be discriminated.

APPENDIX D

Location of fall chinook salmon redds and adults observed on Snake River during aerial surveys of 9 and 23 November 1987.

River kilometer	Landmark	9 November redds	9 November adults	23 November redds	23 November adults
246.3	No proximal landmark	--	--	13	7
263.4	Below Captain John Rapids	--	--	3	2
265.8	Below Billy Creek	2	0	--	--
268.3	Below Fisher Gulch	--	--	4	1
268.7	Above Fisher Gulch	--	--	2	0
278.6	Deer Head Rapids	--	--	1	0
281.0	Below Shovel Creek	--	--	1	1
308.7	Eureka Creek	--	--	1	0
309.6	Imnaha River	--	--	2	0
312.7	Above Divide Creek	4	--	--	--
313.2	Below Zigzag Creek	--	--	2	0
317.2	Dug Bar, Oregon	1	0	--	--
321.1	Above Robinson Gulch	--	--	1	0
321.6	Deep Creek	4	0	--	--
329.8	Blankenship Ranch	--	--	1	0
332.2	Getta Creek	--	--	1	0
333.5	High Range Creek	1	0	--	--
338.9	Below Camp Creek	--	--	1	0
346.8	Lower Pittsburg Landing	2	0	--	--
352.9	Cat Gulch	1	0	--	--
359.9	Suicide Rock	3	0	--	--
381.2	Hat Creek	4	0	--	--
381.5	Saddle Creek	--	--	1	2
382.5	Lower Dry Gulch	1	0	--	--
385.4	Above Three Creek Rapids	2	0	--	--
388.6	Rock Bar	6	0	--	--
393.2	Warm Springs	--	--	1	0
	Totals	31	0	35	13

APPENDIX E

Rearing habitat quality rating used for Tucannon River spring chinook salmon population assessment. The sum of point ratings from each of the four categories is used. Modified from Platts et al. (1983).

Factor	Description	Points
Depth (D)	Thalweg depth at the transect is greater than 90 cm in the main channel, and 60 cm in the side channel.	3
	Thalweg depth at the transect is greater than 60 cm in the main channel, and 30 cm in the side channel.	2
	Thalweg depth at the transect is less than 60 cm in the main channel, and 30 cm in the side channel.	1
Riparian Cover (R)	Abundant cover, 65 to 100% of the rearing area is protected.	3
	Partial cover, 35 to 65% of the rearing area is protected.	2
	Exposed, less than 35% of the rearing area is protected.	1
Woody Debris (W)	Abundant, complex debris in the main rearing area.	3
	Partial debris build-up in the main rearing area.	2
	No debris.	1
Boulder Cover (B)	High diversity, with at least one boulder larger than 60 cm at maximum diameter.	3
	Moderate diversity, some interstices available for cover.	2
	Flat uniform cobble, no interstices.	1

APPENDIX F

Data collection form used for intensive stream habitat quality surveys.

Part 1: Site Description and Water Quality

Site:________________ Crew:_______________________ Date:_____________

Time:________ Site length (m):_____________ Gradient (%):__________

% Riffle:________ % Run:_________ % Pool:________ % Boulder: ________

% Eroding banks:_____________ % Large organic debris: _______________

% Overhanging vegetation (<1m above water surface): _________________

% Split channel: _______________ Number of springs: _________________

NO3:______ppm dO2:______ppm CaCO3:______ppm Conductivity:______umhos

Discharge:________m3/sec Dye rate- -first:_________ last:_________sec

Aspect: ____________degrees HOH temp (F):______ Air Temp (F):_______

Topographic shading total months:_______ percent of site: _________

Vegetational shading total months:_______ percent of site: _________

Mean height of overstory vegetation left bank:______ right bank:____

Habitat Evaluation Criteria

Criterion	Specifications
Organic debris	LOD--material over 60cm in length, or a conglomerate of materials over 60 cm CPOM-materials 15cm-60cm FPOM-materials 5cm-15 cm DOM--materials less than 5 cm in size
Light intensity	Direct sunlight (D) <15% of point is shaded 1000-1600 hours Filtered sunlight (F) 15-85% is shaded Shaded (S) >85% is shaded

HSI Pool Score

Appendix F, continued.

Part 2: Transect Measurements

Transect:										
Habitat type:										
Width:										
Rearing score:										
Limiting factors:										
Spawning score:										
Depth 1:										
Velocity:										
Depth 2:										
Velocity:										
Depth 3:										
Velocity:										
Depth 4:										
Velocity:										
Max depth:										
Left bank slope:										
undercut:										
Vegetative overhang:										
Right bank slope:										
undercut:										
Vegetative overhang:										
Organic material :										
Light intensity:										
SAM:										
Aspect:										
HSI score:										

Appendix F, continued.

Part 3: Substrate Evaluation

Transect: ____ ____ ____ ____ ____ ____ ____ ____ ____ ____

Score*: ____ ____ ____ ____ ____ ____ ____ ____ ____ ____

*First digit denotes predominant substrate type, second denotes embeddedness. Values are as follows:

<u>Substrate type</u>

1 Smooth surface
2 Gravel < 0.6 inches
3 Pebble 0.6 - 2.5 inches
4 Cobble 2.5 - 10 inches
5 Boulder > 10 inches
6 Irregular bedrock
7 Submerged aquatic macrophytes

<u>Embeddedness</u>

1 Completely embedded
2 Partially embedded
3 Unembedded

APPENDIX G

Table 1. Matrix table of Suitability Index (SI) scores for Wilderness Stratum, Tucannon River spring chinook salmon habitat variables by life stage. Data sets are based upon those suggested by Raleigh and Miller, 1985.

Variables	Adult Data	Adult SI	Embryo Data	Embryo SI	Juvenile Data	Juvenile SI
V1 pH	7	1.0	--	--	7	1.0
V2 Maximum temp. (C)	14.4	1.0	--	--	14.4	1.0
V3 Minimum dissolved oxygen (mg/l)	--	1.0 a	--	1.0	--	1.0
V4 Percent pools	11	0.2	--	--	11	0.2
V5 Pool class b	B	0.6	--	--	B	0.6
V6 Maximum temp. (C) (embryo)	--	--	14.0	0.4	--	--
V8 Average velocity (embryo; cm/s)	--	--	0.5	1.0	--	--
V9 Average substrate size (embryo; cm)	--	--	5	1.0	--	--
V10 Percent fines (embryo)	--	--	4	1.0	--	--
V11 Ratio of annual average low flow to annual average daily flow	--	--	0.45	0.9	0.56	1.0
V12 Average annual peak flow as multiple of of average annual daily flow	--	--	1.8	1.0	1.8	1.0
V13 Substrate class b	--	--	--	--	B+	0.8
V14 Percent riffle-run fines	--	--	--	--	5	1.0
V15 Nitrate-nitrogen level (mg/l)	--	--	--	--	0.5	1.0
V16 Percent of stream area with hiding cover	--	--	--	--	32.2	1.0
V17 Percent of stream area with 10-40 cm average size boulders	--	--	--	--	10	0.7
V18 Percent of stream area with mean water velocities <60cm/s and at depths >15 cm	--	--	--	--	26	1.0
Lowest SI score		0.2		0.4		0.2

a Dissolved oxygen levels were interpolated with a nomogram.

b Refer to Raleigh and Miller (1985) for these criteria.

Appendix G, continued.

Table 2. Matrix table of Suitability Index (SI) scores for HMA Stratum, Tucannon River spring chinook salmon habitat variables by life stage. Data sets are based upon those suggested by Raleigh and Miller, 1985.

Variables	Adult Data	Adult SI	Embryo Data	Embryo SI	Juvenile Data	Juvenile SI
V1 pH	7	1.0	--	--	7	1.0
V2 Maximum temp. (C)	17.8	1.0	--	--	17.8	1.0
V3 Minimum dissolved oxygen (mg/l)	--	1.0 a	--	1.0	--	1.0
V4 Percent pools	3	0.2	--	--	3	0.2
V5 Pool class b	B+	0.8	--	--	B+	0.8
V6 Maximum temp. (C) (embryo)	--	--	14.4	0.2	--	--
V8 Average velocity (embryo; cm/s)	--	--	0.6	1.0	--	--
V9 Average substrate size (embryo; cm)	--	--	8	1.0	--	--
V10 Percent fines (embryo)	--	--	1.4	1.0	--	--
V11 Ratio of annual average low flow to annual average daily flow	--	--	0.45	0.9	0.56	1.0
V12 Average annual peak flow as multiple of of average annual daily flow	--	--	1.8	1.0	1.8	1.0
V13 Substrate class b	--	--	--	--	A	1.0
V14 Percent riffle-run fines	--	--	--	--	3	1.0
V15 Nitrate-nitrogen level (mg/l)	--	--	--	--	0.5	1.0
V16 Percent of stream area with hiding cover	--	--	--	--	14	0.5
V17 Percent of stream area with 10-40 cm average size boulders	--	--	--	--	11	0.7
V18 Percent of stream area with mean water velocities <60cm/s and at depths >15 cm	--	--	--	--	37	1.0
Lowest SI score		0.2		0.2		0.2

a Dissolved oxygen levels were interpolated with a nomogram.

b Refer to Raleigh and Miller (1985) for these criteria.

Appendix G, continued.

Table 3. Matrix table of Suitability Index (SI) scores for Hartsock Stratum, Tucannon River spring chinook salmon habitat variables by life stage. Data sets are based upon those suggested by Raleigh and Miller, 1985.

Variables	Adult		Embryo		Juvenile	
	Data	SI	Data	SI	Data	SI
V1 pH	7	1.0	--	--	7	1.0
V2 Maximum temp. (C)	23.0	0.3	--	--	23.0	0.3
V3 Minimum dissolved oxygen (mg/l)	--	1.0 a	--	1.0	--	1.0
V4 Percent pools	2	0.1	--	--	2	0.1
V5 Pool class b	B	0.6	--	--	B	0.6
V6 Maximum temp. (C) (embryo)	--	--	15.6	0.0	--	--
V8 Average velocity (embryo; cm/s)	--	--	0.4	1.0	--	--
V9 Average substrate size (embryo; cm)	--	--	8	1.0	--	--
V10 Percent fines (embryo)	--	--	1.4	1.0	--	--
V11 Ratio of annual average low flow to annual average daily flow	--	--	0.45	0.9	0.56	1.0
V12 Average annual peak flow as multiple of of average annual daily flow	--	--	1.8	1.0	1.8	1.0
V13 Substrate class b	--	--	--	--	A	1.0
V14 Percent riffle-run fines	--	--	--	--	3	1.0
V15 Nitrate-nitrogen level (mg/l)	--	--	--	--	0.5	1.0
V16 Percent of stream area with hiding cover	--	--	--	--	14	0.5
V17 Percent of stream area with 10-40 cm average size boulders	--	--	--	--	11	0.7
V18 Percent of stream area with mean water velocities <60cm/s and at depths >15 cm	--	--	--	--	37	1.0
Lowest SI score		0.2		0.2		**0.2**

a Dissolved oxygen levels were interpolated with a nomogram.

b Refer to Raleigh and Miller (1985) for these criteria.

APPENDIX H

Comparison of minimum and maximum stream temperatures in Tucannon River at outlets of Sheep Creek, Panjab Creek, Big 4 Lake, Deer Lake, and Cummings Creek in summer 1987. Temperatures are in degrees Fahrenheit.

	Sheep	Creek	Panjab	Creek	Big 4	Lake	Deer	Lake	Cummings	Creek
Date	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
17-Apr	39	35	41	39	43	41	45	43	45	41
18-Apr	35	34	38	36	42	39	43	39	41	37
19-Apr	36	32	39	34	45	36	46	37	43	36
20-Apr	37	32	42	36	45	36	48	37	45	36
21-Apr	39	34	45	37	48	39	50	40	46	39
22-Apr	39	35	45	37	50	41	52	42	48	41
23-Apr	39	36	45	39	47	43	48	44	47	43
24-Apr	39	36	45	37	49	41	50	43	48	41
25-Apr	39	36	45	39	48	41	50	43	48	41
26-Apr	40	34	45	39	51	39	52	41	50	41
27-Apr	41	36	46	39	52	41	54	43	52	43
28-Apr	41	36	45	39	48	43	50	45	51	45
29-Apr	41	39	45	40	48	43	50	45	51	46
30-Apr	38	37	41	39	45	43	46	45	47	43
01-May	37	36	40	38	43	41	43	43	45	39
02-May	37	34	40	38	43	37	43	39	43	39
03-May	39	36	39	37	46	40	46	41	46	41
04-May	43	36	43	37	51	41	50	43	51	41
05-May	43	31	46	39	54	42	54	45	54	43
06-May	45	37	46	41	54	42	54	46	54	45
07-May	45	37	46	41	54	43	54	46	54	45
08-May	45	39	48	42	54	45	54	47	54	45
09-May	45	39	48	43	54	45	54	48	54	48
10-May	45	39	48	43	54	45	54	48	55	46
11-May	45	39	48	42	55	45	54	46	55	46
12-May	43	41	46	43	48	46	50	48	51	48
13-May	45	41	48	43	54	45	53	47	52	46
14-May	45	40	48	43	54	45	52	48	54	46
15-May	46	43	50	45	55	46	55	49	55	49
16-May	45	41	49	43	55	45	54	48	54	46
17-May	45	39	48	41	55	43	54	46	54	45
18-May	44	39	47	42	54	45	52	46	52	46
19-May	37	36	43	39	46	43	46	45	55	43
20-May	37	34	41	37	45	39	45	42	45	41
21-May	40	36	45	37	50	39	48	41	48	40
22-May	40	36	45	39	50	41	50	43	49	42
23-May	41	37	45	39	51	43	52	45	52	43
24-May	43	39	46	41	50	45	51	46	50	45
25-May	43	41	44	43	48	46	50	48	50	46
26-May	43	41	46	43	50	46	51	47	50	46
27-May	42	41	45	44	52	45	49	47	47	46
28-May	43	41	47	43	52	45	54	46	52	46
29-May	45	39	48	41	55	45	57	45	54	45
30-May	43	42	46	45	48	46	50	47	48	46
31-May	43	41	45	43	50	45	52	46	48	45

Appendix H, continued.

Date	Sheep Creek Max.	Sheep Creek Min.	Panjab Creek Max.	Panjab Creek Min.	Big 4 Lake Max.	Big 4 Lake Min.	Deer Lake Max.	Deer Lake Min.	Cummings Creek Max.	Cummings Creek Min.
01-Jun	41	39	45	41	50	43	52	45	48	43
02-Jun	45	36	48	39	50	41	55	43	52	42
03-Jun	47	39	52	41	54	41	59	45	55	45
04-Jun	50	43	52	45	57	46	59	48	57	48
05-Jun	52	46	54	46	59	50	63	52	59	52
06-Jun	51	45	54	45	60	48	51	49	57	48
07-Jun	50	45	51	45	55	48	57	50	55	49
08-Jun	49	46	50	48	54	50	56	52	54	52
09-Jun	51	45	54	46	61	48	63	50	59	50
10-Jun	50	43	54	45	59	48	61	49	57	48
11-Jun	50	43	54	45	61	46	63	48	59	48
12-Jun	54	48	54	46	59	50	61	52	58	52
13-Jun	55	48	57	46	63	50	66	52	61	50
14-Jun	55	48	55	48	63	52	66	54	63	54
15-Jun	50	48	51	50	54	50	58	55	57	52
16-Jun	50	45	52	46	58	48	61	50	55	48
17-Jun	47	45	50	46	57	48	59	51	55	50
18-Jun	46	45	48	46	54	50	55	52	54	51
19-Jun	46	45	50	46	54	48	55	51	54	50
20-Jun	48	45	50	45	54	48	57	50	54	50
21-Jun	47	45	49	46	54	50	56	51	54	50
22-Jun	46	41	50	45	57	46	57	48	54	46
23-Jun	46	41	48	43	54	46	55	48	52	46
24-Jun	50	41	54	43	59	45	57	46	57	46
25-Jun	52	43	55	45	56	48	64	50	59	48
26-Jun	54	46	55	46	63	50	66	52	61	52
27-Jun	55	47	57	48	64	52	66	54	63	54
28-Jun	55	48	57	48	64	52	68	54	63	54
29-Jun	55	48	56	48	63	52	66	55	64	55
30-Jun	55	48	57	48	64	52	66	55	64	55
01-Jul	52	50	54	49	61	54	63	55	61	55
02-Jul	51	50	52	50	57	54	59	55	57	55
03-Jul	54	46	54	46	61	50	63	52	59	52
04-Jul	52	48	54	48	59	51	63	54	59	52
05-Jul	50	46	52	49	59	50	61	52	57	52
06-Jul	51	45	54	49	61	50	63	52	59	52
07-Jul	52	47	54	48	59	52	63	54	59	54
08-Jul	52	45	55	46	63	52	64	54	61	54
09-Jul	49	45	52	48	59	50	61	52	57	52
10-Jul	48	46	50	45	54	52	57	54	54	52
11-Jul	51	45	54	45	61	48	63	50	58	49
12-Jul	52	45	55	46	63	49	64	51	59	50
13-Jul	54	45	56	48	64	50	66	52	63	52
14-Jul	55	48	57	48	66	52	68	54	64	54
15-Jul	55	48	57	46	63	53	66	55	63	54
16-Jul	48	46	50	46	54	51	57	52	54	52
17-Jul	48	46	50	45	54	50	55	52	54	51
18-Jul	48	46	47	44	52	48	55	50	54	50
19-Jul	48	46	50	45	55	48	58	50	54	50
20-Jul	50	45	52	46	59	48	63	50	59	50

Appendix I, continued.

Date	Sheep Creek Max.	Sheep Creek Min.	Panjab Creek Max.	Panjab Creek Min.	Big 4 Lake Max.	Big 4 Lake Min.	Deer Lake Max.	Deer Lake Min.	Cummings Creek Max.	Cummings Creek Min.
21-Jul	52	46	54	48	59	50	63	52	59	50
22-Jul	48	46	50	47	54	52	57	52	54	42
23-Jul	49	46	51	46	57	50	59	52	55	50
24-Jul	54	46	55	46	60	50	64	52	59	51
25-Jul	52	48	54	48	61	52	63	54	59	50
26-Jul	55	48	57	48	64	52	68	54	63	53
27-Jul	55	48	57	48	64	52	66	55	63	52
28-Jul	54	48	54	48	61	52	63	55	61	53
29-Jul	55	49	57	48	64	52	66	55	63	54
30-Jul	55	50	55	48	63	53	66	55	62	54
31-Jul	52	48	54	48	61	52	63	54	59	52
01-Aug	51	45	54	45	59	48	61	50	57	48
02-Aug	51	45	52	45	61	48	63	50	59	48
03-Aug	51	45	54	45	63	49	64	51	61	50
04-Aug	54	46	55	46	63	51	66	54	63	52
05-Aug	54	46	55	48	63	52	64	54	61	52
06-Aug	52	46	54	46	63	50	64	52	61	51
07-Aug	54	46	55	46	63	51	66	54	63	52
08-Aug	54	46	55	46	63	52	66	54	63	52
09-Aug	55	48	56	48	64	52	66	54	64	54
10-Aug	54	49	55	49	63	54	64	55	62	55
11-Aug	52	46	54	46	61	52	64	52	60	52
12-Aug	50	45	52	46	57	50	61	52	57	51
13-Aug	48	45	49	46	54	50	55	52	54	52
14-Aug	48	46	50	46	55	50	57	52	55	51
15-Aug	48	46	50	46	55	51	57	50	55	52
16-Aug	48	45	51	45	57	48	61	48	55	49
17-Aug	48	43	51	45	57	46	59	48	55	48
18-Aug	48	43	52	45	59	47	61	50	55	48
19-Aug	50	43	52	45	59	48	63	50	59	48
20-Aug	50	45	52	45	59	49	61	49	58	50
21-Aug	48	45	51	43	58	48	61	50	57	48
22-Aug	50	45	52	45	57	48	59	52	57	48
23-Aug	50	46	51	46	55	50	59	52	55	50
24-Aug	51	46	52	46	- -	- -	63	52	59	52
25-Aug	50	45	52	46	- -	- -	63	52	59	50
26-Aug	49	45	52	45	- -	- -	61	52	59	50
27-Aug	51	46	54	46	- -	- -	63	52	59	52
28-Aug	51	46	54	46	- -	- -	63	52	59	52
29-Aug	50	45	52	46	- -	- -	63	52	59	50
30-Aug	50	46	52	46	- -	- -	63	52	59	52
31-Aug	52	46	54	46	- -	- -	63	52	61	52
01-Sep	52	48	54	48	- -	- -	63	54	61	54
02-Sep	52	48	52	48	- -	- -	63	54	57	54
03-Sep	48	45	50	45	- -	- -	59	50	55	50
04-Sep	47	45	50	45	- -	- -	59	49	55	48
05-Sep	48	46	50	45	- -	- -	59	50	57	49
06-Sep	48	45	51	45	- -	- -	61	50	57	50
07-Sep	48	45	51	45	- -	- -	61	50	58	50
08-Sep	48	45	51	45	- -	- -	60	50	59	50

Appendix H, continued.

Date	Sheep Max.	Creek Min.	Panjab Max.	Creek Min.	Big 4 Max.	Lake Min.	Deer Max.	Lake Min.	Cummings Max.	Creek Min.
09-Sep	48	45	51	45	- -	- -	61	50	59	50
10-Sep	48	45	51	45	- -	- -	- -	- -	57	50
11-Sep	48	45	52	44	- -	- -	- -	- -	58	50
12-Sep	48	45	50	44	- -	- -	- -	- -	57	51
13-Sep	48	45	- -	- -	- -	- -	- -	- -	56	51
14-Sep	47	44	- -	- -	- -	- -	- -	- -	55	49
15-Sep	45	43	- -	- -	- -	- -	- -	- -	54	50
16-Sep	43	39	- -	- -	- -	- -	- -	- -	52	44
17-Sep	42	39	- -	- -	- -	- -	- -	- -	52	45
18-Sep	43	39	- -	- -	- -	- -	- -	- -	- -	- -
19-Sep	44	39	- -	- -	- -	- -	- -	- -	- -	- -
20-Sep	45	41	- -	- -	- -	- -	- -	- -	- -	- -
21-Sep	45	41	- -	- -	- -	- -	- -	- -	- -	- -
22-Sep	45	41	- -	- -	- -	- -	- -	- -	- -	- -

APPENDIX I

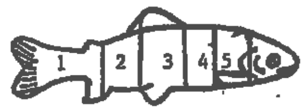
Data collection form used for downstream migrant trapping project.

TUCANNON RIVER SMOLT OUTMIGRATION FORM

RECORDER:____________________DATE:_______________TIME:_______________DEBRIS LOAD (H M L)

SECCHI DISK:_________VELOCITY (M/S):______TEMP:______MARKED FISH (LPV RPV) NUMBER:_______

RECORD DESCALING FOR 40% SCALE LOSS IN ANY ONE AREA



DESIGNATE RIGHT OR LEFT
6-SCATTERED
7-EYE/HEAD INJURIES
8-CUTS OR BRUISES
9-SUM OF TWO OR MORE REGIONS≥40%
M-DEAD

NUMBER	SPECIES	FORK LENGTH	MARK	SMOLT INDEX	DESCALING	WEIGHT (0.1g)	FIN COND.	COMMENTS
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								
21								
[illegible]								
23								
24								
25								

KEEP ALL DEAD FISH FOR ELECTROPHORETIC SAMPLES. RECORD ALL DATA FOR MORTS IF RECENTLY KILLED. RECORD LENGTHS, MARKS, SMOLT INDEX, AND DESCALING ON ALL FISH. RECORD WEIGHTS AND FIN CONDITION ON EVERY OTHER FISH.

FISH ARE CONSIDERED DESCALED IF THERE ARE TWO OR MORE SECTIONS ON THE SAME SIDE THAT SHOW 40% SCALE LOSS, OR THEY EXHIBIT THE CONDITION CODED AS (9).

APPENDIX J

Tucannon River 1986/1987 spring chinook salmon downstream migrant trapping data. Columns 3 through 15 are as follows: 3) fish marked (left ventral partial clip) and transported 250 m with 4) subsequent recaptures, 5) fish marked (right ventral partial clip) and transported 10 km with 6) subsequent recaptures, 7) fish marked (top caudal clip) and transported 40 km with 8) recaptures, 9) fish trapped, marked (bottom caudal clip), and released at 2x3 trap stationed 60 km upstream and recaptured at main trap, 10) fish that were not marked and released downstream of trap, 11) mortalities incurred at the trap (Some recaptured fish died and therefore are counted both as recaptures and mortalities, causing a disparity in the total count.), 12) samples taken for electrophoretic analysis, 13) fish held to assess delayed mortality, 14) samples taken for proximal analysis, and 15) the sum of columns 3 through 14 for that row.

1 Date	2 Time	3 Marked 250m	4 Recapture 250m	5 Marked 10km	6 Recapture 10km	7 Marked 40km	8 Recapture 40km	9 Recapture 60km	10 Not marked	11 Dead	12 Electro- phoresis	13 Delayed mort.	14 Proximal analysis	15 Total
02-Dec-86	800	6	0	0	0	0	0	0	0	0	0	0	0	6
03-Dec-86	800	14	0	0	0	0	0	0	0	1	0	0	0	15
04-Dec-86	800	9	0	0	0	0	0	0	0	0	0	0	0	9
05-Dec-86	800	8	3	0	0	0	0	0	0	0	0	0	0	11
06-Dec-86	800	4	0	0	0	0	0	0	0	0	0	0	0	4
09-Dec-86	800	12	0	0	0	0	0	0	0	0	0	0	0	12
10-Dec-86	800	15	2	0	0	0	0	0	0	2	0	0	0	19
11-Dec-86	800	21	1	0	0	0	0	0	0	0	0	0	0	22
12-Dec-86	800	15	0	0	0	0	0	0	0	0	0	0	0	15
13-Dec-86	800	19	0	0	0	0	0	0	0	0	0	0	0	19
23-Dec-86	800	10	0	0	0	0	0	0	0	0	0	0	0	10
24-Dec-86	800	9	1	0	0	0	0	0	0	0	0	0	0	10
30-Dec-86	800	5	0	0	0	0	0	0	0	0	0	0	0	5
06-Jan-87	800	1	0	0	0	0	0	0	0	0	0	0	0	1
13-Jan-87	800	3	0	0	0	0	0	0	0	0	0	0	0	3
15-Jan-87	900	3	1	0	0	0	0	0	0	0	0	0	0	4
28-Jan-87	800	12	0	0	0	0	0	0	0	0	0	0	0	12
28-Jan-87	1400	0	3	0	0	0	0	0	0	0	0	0	0	3
29-Jan-87	800	30	2	0	0	0	0	0	0	0	0	0	0	32
30-Jan-87	800	28	7	0	0	0	0	0	0	0	0	0	0	35
31-Jan-87	800	26	10	0	0	0	0	0	0	0	0	0	0	36
01-Feb-87	900	20	5	0	0	0	0	0	0	0	0	0	0	25
02-Feb-87	800	6	6	0	0	0	0	0	0	0	0	0	0	12
03-Feb-87	800	2	3	0	0	0	0	0	0	0	0	0	0	5
04-Feb-87	800	8	1	0	0	0	0	0	0	0	0	0	0	9
05-Feb-87	800	4	2	0	0	0	0	0	0	0	0	0	0	6
06-Feb-87	800	0	0	0	0	0	0	0	5	0	0	0	0	5
10-Feb-87	800	0	1	0	0	0	0	0	1	0	0	0	0	2
11-Feb-87	800	2	0	0	0	0	0	0	0	0	0	0	0	2
12-Feb-87	800	2	0	0	0	0	0	0	0	0	0	0	0	2
13-Feb-87	800	7	0	0	0	0	0	0	0	0	0	0	0	7
20-Feb-87	800	3	0	0	0	0	0	0	0	0	0	0	0	3
21-Feb-87	800	1	1	0	0	0	0	0	0	0	0	0	0	2
22-Feb-87	800	4	0	0	0	0	0	0	0	0	0	0	0	4
23-Feb-87	800	4	0	0	0	0	0	0	0	0	0	0	0	4
23-Feb-87	1500	0	0	0	0	0	0	0	1	0	0	0	0	1
25-Feb-87	800	4	0	0	0	0	0	0	0	0	0	0	0	4
26-Feb-87	800	6	0	0	0	0	0	0	0	0	0	0	0	6

Appendix J, continued.

1 Date	2 Time	3 Marked 250m	4 Recapture 250m	5 Marked 10km	6 Recapture 10km	7 Marked 40km	8 Recapture 40km	9 Recapture 60km	10 Not marked	11 Dead	12 Electro-phoresis	13 Delayed mort.	14 Proximal analysis	15 Total
27-Feb-87	800	7	1	0	0	0	0	0	0	0	0	0	0	8
04-Mar-87	800	6	0	0	0	0	0	0	0	0	0	0	0	6
05-Mar-87	800	2	1	0	0	0	0	0	0	0	0	0	0	3
06-Mar-87	800	6	0	0	0	0	0	0	1	0	0	0	0	7
06-Mar-87	1200	2	0	0	0	0	0	0	0	0	0	0	0	2
07-Mar-87	700	16	1	0	0	0	0	0	0	0	0	0	0	17
07-Mar-87	1400	1	2	0	0	0	0	0	0	0	0	0	0	3
08-Mar-87	700	8	4	0	0	0	0	0	0	0	0	0	0	12
08-Mar-87	1400	1	1	0	0	0	0	0	0	0	0	0	0	2
09-Mar-87	700	5	2	0	0	0	0	0	0	0	0	0	0	7
09-Mar-87	1000	0	1	0	0	0	0	0	0	0	0	0	0	1
10-Mar-87	700	3	0	0	0	0	0	0	1	1	0	0	0	5
11-Mar-87	700	8	1	0	0	0	0	0	0	0	0	0	0	9
11-Mar-87	1400	1	2	0	0	0	0	0	0	0	0	0	0	3
12-Mar-87	800	9	3	0	0	0	0	0	1	0	0	0	0	13
13-Mar-87	800	3	2	0	0	0	0	0	0	0	0	0	0	5
13-Mar-87	1500	2	1	0	0	0	0	0	0	0	0	0	0	3
14-Mar-87	800	6	0	0	0	0	0	0	0	0	0	0	0	6
14-Mar-87	1300	1	3	0	0	0	0	0	0	0	0	0	0	4
15-Mar-87	800	4	1	0	0	0	0	0	0	0	0	0	0	5
15-Mar-87	1200	0	1	0	0	0	0	0	0	0	0	0	0	1
16-Mar-87	800	4	0	0	0	0	0	0	0	0	0	0	0	4
17-Mar-87	800	12	2	0	0	0	0	0	1	0	0	0	0	15
18-Mar-87	800	38	0	0	1	0	0	0	0	1	0	0	0	40
18-Mar-87	1500	3	6	0	0	0	0	0	0	0	0	0	0	9
19-Mar-87	700	47	7	0	0	0	0	0	1	0	0	0	0	55
19-Mar-87	900	0	1	0	0	0	0	0	0	0	0	0	0	1
19-Mar-87	1400	1	6	0	0	0	0	0	1	0	0	0	0	8
20-Mar-87	600	98	12	0	0	0	0	0	5	1	0	0	0	116
20-Mar-87	1400	0	27	0	0	0	0	0	1	0	0	0	0	28
21-Mar-87	700	76	10	0	0	0	0	0	0	2	0	0	0	88
21-Mar-87	1300	0	4	0	0	0	0	0	0	0	0	0	0	4
22-Mar-87	700	72	10	0	0	0	0	0	2	0	0	0	0	84
22-Mar-87	1300	0	18	0	0	0	0	0	0	0	0	0	0	18
23-Mar-87	800	28	12	0	0	0	0	0	3	0	0	0	0	43
23-Mar-87	1600	0	5	0	0	0	0	0	0	0	0	0	0	5
24-Mar-87	800	0	5	16	0	0	0	0	1	0	0	0	0	22
25-Mar-87	800	7	0	0	0	0	0	0	0	0	0	0	0	7
25-Mar-87	1400	1	1	0	0	0	0	0	0	0	0	0	0	2
26-Mar-87	800	5	0	0	0	0	0	0	0	0	0	0	0	5
26-Mar-87	1400	0	1	0	0	0	0	0	0	0	0	0	0	1
27-Mar-87	800	5	0	0	0	0	0	0	0	0	0	0	0	5
28-Mar-87	800	3	0	0	0	0	0	0	2	0	0	0	0	5
29-Mar-87	800	0	0	0	0	0	0	0	4	0	0	0	0	4
30-Mar-87	800	1	0	0	0	0	0	0	0	0	0	0	0	1
31-Mar-87	1500	0	0	0	0	0	0	0	1	0	0	0	0	1
01-Apr-87	800	18	0	0	0	0	0	0	1	0	0	0	0	19
02-Apr-87	800	20	2	0	0	0	0	0	2	0	0	0	0	24
03-Apr-87	800	9	1	0	0	0	0	0	2	0	0	0	0	12

Appendix J, continued.

1 Date	2 Time	3 Marked 250m	4 Recapture 250m	5 Marked 10km	6 Recapture 10km	7 Marked 40km	8 Recapture 40km	9 Recapture 60km	10 Not marked	11 Dead	12 Electro- phoresis	13 Delayed mort.	14 Proximal analysis	15 Total
04-Apr-87	700	14	1	0	0	0	0	0	1	0	0	0	0	16
05-Apr-87	800	1	0	0	0	0	0	0	0	0	0	0	0	1
06-Apr-87	800	5	0	0	0	0	0	0	0	0	0	0	0	5
06-Apr-87	2300	1	0	0	0	0	0	0	0	0	0	0	0	1
07-Apr-87	600	0	0	1	0	0	0	0	0	0	0	0	0	1
08-Apr-87	100	2	0	0	0	0	0	0	0	0	0	0	0	2
08-Apr-87	400	1	0	0	0	0	0	0	0	0	0	0	0	1
08-Apr-87	800	3	0	0	0	0	0	0	0	0	0	0	0	3
08-Apr-87	2000	2	1	0	0	0	0	0	0	0	0	0	0	3
08-Apr-87	2200	19	0	0	0	0	0	0	0	0	0	0	0	19
09-Apr-87	200	19	0	0	0	0	0	0	0	0	0	0	0	19
09-Apr-87	500	2	2	0	0	0	0	0	0	0	0	0	0	4
09-Apr-87	800	2	0	0	0	0	0	0	0	0	0	0	0	2
09-Apr-87	2000	3	0	0	0	0	0	0	0	0	0	0	0	3
09-Apr-87	2200	6	0	0	0	0	0	0	1	0	0	0	0	7
10-Apr-87	200	18	2	0	0	0	0	0	0	0	0	0	0	20
10-Apr-87	500	3	2	0	0	0	0	0	0	0	0	0	0	5
10-Apr-87	1100	0	1	0	0	0	0	0	0	1	0	0	0	2
10-Apr-87	2000	0	1	0	0	0	0	0	0	0	0	0	0	1
10-Apr-87	2200	2	0	0	0	0	0	0	0	0	0	0	0	2
11-Apr-87	200	21	1	0	0	0	0	0	0	0	0	0	0	22
11-Apr-87	500	14	3	0	0	0	0	0	0	0	0	0	0	17
11-Apr-87	800	2	5	0	0	0	0	0	0	0	0	0	0	7
11-Apr-87	1400	0	0	0	0	0	0	0	1	0	0	0	0	1
11-Apr-87	2100	0	0	0	0	0	0	0	2	0	0	0	0	2
12-Apr-87	100	17	0	0	0	0	0	0	0	0	0	0	0	17
12-Apr-87	500	7	1	0	0	0	0	0	0	0	0	0	0	8
12-Apr-87	2000	1	1	0	0	0	0	0	0	0	0	0	0	2
13-Apr-87	100	10	0	0	0	0	0	0	0	0	0	0	0	10
13-Apr-87	300	9	1	0	0	0	0	0	0	0	0	0	0	10
13-Apr-87	600	3	1	0	0	0	0	0	0	0	0	0	0	4
13-Apr-87	900	0	1	0	0	0	0	0	0	0	0	0	0	1
13-Apr-87	1700	1	0	0	0	0	0	0	0	0	0	0	0	1
14-Apr-87	2300	6	0	0	0	0	0	0	0	0	0	0	0	6
14-Apr-87	500	0	0	4	0	0	0	0	0	0	0	0	0	4
15-Apr-87	100	9	0	0	0	0	0	0	0	0	0	0	0	9
15-Apr-87	600	5	1	0	0	0	0	0	0	0	0	0	0	6
15-Apr-87	1600	1	0	0	0	0	0	0	1	0	0	0	0	2
16-Apr-87	100	14	1	0	0	0	0	0	0	0	0	0	0	15
16-Apr-87	500	3	0	0	0	0	0	0	0	0	0	0	0	3
16-Apr-87	800	4	2	0	0	0	0	0	0	0	0	0	0	6
16-Apr-87	2300	15	1	0	0	0	0	0	1	0	0	0	0	17
17-Apr-87	700	44	1	0	0	0	0	0	0	1	0	0	0	46
18-Apr-87	600	31	1	0	0	0	0	0	13	2	0	5	0	52
18-Apr-87	1200	7	2	0	0	0	0	0	1	0	0	0	0	10
19-Apr-87	600	66	3	0	0	0	0	0	6	0	0	17	0	92
19-Apr-87	1700	0	3	0	0	0	0	0	1	0	0	0	0	4
19-Apr-87	2300	23	4	0	0	0	0	0	1	0	0	0	0	28
20-Apr-87	600	50	2	0	0	0	0	0	41	1	0	0	0	94

Appendix J, continued.

1 Date	2 Time	3 Marked 250m	4 Recapture 250m	5 Marked 10km	6 Recapture 10km	7 Marked 40km	8 Recapture 40km	9 Recapture 60km	10 Not marked	11 Dead	12 Electro-phoresis	13 Delayed mort.	14 Proximal analysis	15 Total
20-Apr-87	1600	7	3	0	0	0	0	0	0	0	0	0	0	10
20-Apr-87	2300	6	4	0	0	0	0	0	0	0	0	0	0	10
21-Apr-87	600	0	4	47	0	0	0	0	0	2	0	0	0	53
21-Apr-87	1800	0	1	2	0	0	0	0	0	0	0	0	0	3
21-Apr-87	2300	0	1	5	0	0	0	0	0	0	0	0	0	6
22-Apr-87	600	0	0	0	0	0	0	0	1	0	29	0	0	30
22-Apr-87	1200	0	0	0	0	0	0	0	0	0	3	0	0	3
22-Apr-87	1500	0	0	0	0	0	0	0	0	0	1	0	0	1
22-Apr-87	2300	0	0	0	0	0	0	0	0	0	11	0	0	11
23-Apr-87	600	38	0	0	2	0	0	1	2	0	10	0	0	53
23-Apr-87	1400	5	2	0	0	0	0	1	0	0	0	0	0	8
23-Apr-87	1800	3	0	0	0	0	0	0	0	0	0	0	0	3
23-Apr-87	2000	2	0	0	0	0	0	0	0	0	0	0	0	2
23-Apr-87	2300	12	1	0	1	0	0	0	0	0	0	0	0	14
24-Apr-87	600	59	1	0	0	0	0	0	3	2	0	0	0	65
24-Apr-87	1600	7	10	0	0	0	0	0	0	0	0	0	0	17
24-Apr-87	2000	5	2	0	0	0	0	0	0	0	0	0	0	7
24-Apr-87	2300	12	2	0	0	0	0	0	0	0	0	0	0	14
25-Apr-87	600	73	2	0	0	0	0	2	1	0	0	0	0	78
25-Apr-87	1300	6	0	0	0	0	0	0	0	0	0	0	0	6
26-Apr-87	800	86	13	0	0	0	0	1	1	0	0	0	0	101
26-Apr-87	1200	0	3	0	0	0	0	0	0	0	0	0	0	3
26-Apr-87	1700	0	2	0	0	0	0	0	0	0	0	0	0	2
26-Apr-87	2300	7	1	0	0	0	0	0	0	0	0	0	0	8
27-Apr-87	600	46	3	0	0	0	0	0	23	2	0	0	0	74
27-Apr-87	1700	4	2	0	0	0	0	0	0	1	0	0	0	7
27-Apr-87	2300	14	2	0	0	0	0	0	0	0	0	0	0	16
28-Apr-87	600	50	3	0	2	0	0	0	105	1	0	0	0	161
28-Apr-87	1600	0	0	22	0	0	0	0	5	1	0	0	0	28
28-Apr-87	2000	0	0	0	0	0	0	0	19	0	0	0	0	19
29-Apr-87	600	50	1	0	4	0	0	0	76	1	0	0	0	132
29-Apr-87	1500	20	0	0	2	0	0	0	32	0	0	0	0	54
29-Apr-87	2000	5	0	0	0	0	0	0	0	0	0	0	0	5
29-Apr-87	2300	29	18	0	0	0	0	0	5	0	0	0	0	52
30-Apr-87	600	26	1	0	0	0	0	0	12	2	0	0	0	41
30-Apr-87	800	0	0	0	0	0	0	0	27	0	0	0	0	27
30-Apr-87	1300	20	1	0	0	0	0	0	48	2	0	0	0	71
30-Apr-87	1600	7	0	0	0	0	0	0	11	0	0	0	0	18
30-Apr-87	2000	0	0	0	0	0	0	0	4	0	0	0	0	4
30-Apr-87	2200	0	7	0	0	0	0	0	14	0	0	0	0	21
01-May-87	1000	0	0	0	0	0	0	0	22	0	0	0	0	22
01-May-87	1400	0	0	0	0	0	0	0	13	0	0	0	0	13
01-May-87	1800	14	0	0	0	0	0	0	6	0	0	0	0	20
01-May-87	2200	0	1	0	0	0	0	0	7	0	0	0	0	8
02-May-87	200	0	1	0	0	0	0	0	28	0	0	0	0	29
02-May-87	500	18	1	0	0	0	0	0	0	1	0	0	0	20
02-May-87	1100	11	2	0	0	0	0	0	0	0	0	0	0	13
02-May-87	2000	20	0	0	0	0	0	0	5	0	0	0	0	25
03-May-87	200	48	12	0	0	0	0	0	55	1	0	0	0	116

Appendix J, continued.

1 Date	2 Time	3 Marked 250m	4 Recapture 250m	5 Marked 10km	6 Recapture 10km	7 Marked 40km	8 Recapture 40km	9 Recapture 60km	10 Not marked	11 Dead	12 Electro-phoresis	13 Delayed mort.	14 Proximal analysis	15 Total
03-May-87	600	0	4	0	0	0	0	0	40	1	0	0	0	45
03-May-87	1300	0	4	0	0	0	0	0	20	0	0	0	0	24
03-May-87	1800	0	0	0	0	0	0	0	7	0	0	0	0	7
04-May-87	100	51	16	0	0	0	0	0	8	0	0	0	0	75
04-May-87	600	20	2	0	0	0	0	0	114	0	0	0	0	136
04-May-87	1100	0	0	0	0	0	0	0	12	0	0	0	0	12
04-May-87	1800	0	0	0	0	0	0	0	15	0	0	0	0	15
04-May-87	2200	0	6	0	0	0	0	0	2	0	0	0	0	8
05-May-87	400	0	24	52	0	51	1	0	35	0	0	0	0	163
05-May-87	1200	0	0	0	0	0	0	1	25	1	0	0	0	27
05-May-87	1500	0	0	0	0	0	0	0	17	0	0	10	0	27
05-May-87	2200	0	0	0	2	0	0	0	21	0	0	0	0	23
06-May-87	600	53	0	0	4	0	0	1	108	1	0	0	0	166
06-May-87	1500	0	0	0	0	0	0	0	49	0	0	0	0	49
06-May-87	2200	0	0	0	0	0	0	0	11	0	0	0	0	11
06-May-87	2300	0	0	0	0	0	0	0	11	0	0	0	0	11
07-May-87	600	39	15	0	0	0	3	1	35	0	0	0	0	93
07-May-87	1500	0	0	0	0	0	1	0	26	0	0	0	0	27
08-May-87	600	11	0	0	0	0	3	0	82	0	0	0	0	96
08-May-87	1500	0	0	0	0	0	4	0	35	5	0	0	0	44
09-May-87	600	45	16	0	0	0	0	0	6	0	0	0	0	67
09-May-87	2000	5	0	0	0	0	0	0	8	0	0	0	0	13
10-May-87	600	29	14	0	0	0	0	0	14	0	0	0	0	57
10-May-87	1100	6	0	0	0	0	0	0	0	0	0	0	0	6
10-May-87	2100	0	3	0	2	0	1	1	13	0	0	0	0	20
10-May-87	2300	0	1	0	1	0	0	0	2	0	0	0	0	4
11-May-87	600	23	1	0	0	0	0	1	4	0	0	0	0	29
11-May-87	2100	0	4	0	0	0	0	0	8	0	0	0	0	12
11-May-87	2300	0	1	0	0	0	0	0	4	0	0	0	0	5
12-May-87	700	0	1	9	1	0	0	0	4	0	0	0	0	15
12-May-87	1600	0	0	0	0	0	0	0	5	0	0	0	0	5
12-May-87	2100	0	0	0	0	0	0	0	3	0	0	0	0	3
12-May-87	2300	0	0	0	0	0	0	0	2	0	0	0	0	2
13-May-87	600	11	0	0	0	0	0	0	9	0	0	0	0	20
13-May-87	2000	0	0	0	0	0	0	0	15	0	0	0	0	15
13-May-87	2200	0	5	0	0	0	0	0	3	0	0	0	0	8
14-May-87	600	21	0	0	0	0	1	0	0	0	0	0	0	22
14-May-87	1800	10	0	0	0	0	0	0	0	0	0	0	0	10
14-May-87	2200	0	3	0	0	0	0	0	1	0	0	0	0	4
15-May-87	800	49	6	0	0	0	1	0	7	0	0	0	0	63
15-May-87	2100	0	1	0	0	0	0	0	10	0	0	0	0	11
16-May-87	800	50	23	0	1	0	0	0	76	0	0	0	0	150
16-May-87	2200	0	0	0	0	0	0	0	7	0	0	0	0	7
17-May-87	600	50	23	0	0	0	0	0	11	0	0	0	0	84
17-May-87	2200	0	8	0	0	0	0	0	2	0	0	0	0	10
18-May-87	700	30	14	0	0	0	0	0	17	0	0	0	0	61
18-May-87	1800	0	0	0	0	0	0	0	6	0	0	0	0	6
18-May-87	2200	0	9	0	0	0	0	0	2	0	0	0	0	11
19-May-87	700	0	7	25	0	0	0	0	40	0	0	0	0	72

Appendix J, continued.

1 Date	2 Time	3 Marked 250m	4 Recapture 250m	5 Marked 10km	6 Recapture 10km	7 Marked 40km	8 Recapture 40km	9 Recapture 60km	10 Not marked	11 Dead	12 Electro-phoresis	13 Delayed mort.	14 Proximal analysis	15 Total
19-May-87	1800	0	0	0	0	0	0	0	10	0	0	0	0	10
19-May-87	2200	0	0	0	0	0	0	0	4	0	0	0	0	4
20-May-87	700	25	0	0	5	0	0	0	84	0	0	0	0	114
21-May-87	600	0	0	25	0	0	0	0	58	0	0	0	0	83
22-May-87	800	0	0	25	8	0	0	0	35	1	0	0	0	69
22-May-87	1600	0	0	0	0	0	0	0	3	0	0	0	0	3
23-May-87	800	0	0	0	4	0	1	0	123	0	0	0	0	128
26-May-87	600	0	0	25	0	0	0	0	58	0	0	0	0	83
26-May-87	1600	0	0	0	0	0	0	0	13	0	0	0	0	13
27-May-87	600	0	0	25	4	0	0	0	22	0	0	8	0	59
27-May-87	1400	0	0	0	0	0	0	0	5	0	0	0	0	5
28-May-87	700	0	0	22	6	24	0	0	20	0	0	0	0	72
28-May-87	1600	0	0	0	0	0	0	0	3	0	0	0	0	3
29-May-87	600	0	0	25	7	0	1	0	34	0	0	0	0	67
29-May-87	1800	0	0	0	1	0	0	0	4	0	0	0	0	5
30-May-87	700	25	0	0	2	0	0	0	39	0	0	0	0	66
31-May-87	600	0	3	24	2	0	0	1	33	0	0	0	0	63
01-Jun-87	600	0	1	25	2	0	1	0	4	1	0	0	0	34
01-Jun-87	1400	0	0	0	1	0	0	0	3	0	0	0	0	4
02-Jun-87	600	0	0	25	4	0	0	0	4	0	0	0	0	33
02-Jun-87	1500	0	0	0	1	0	0	0	0	0	0	0	0	1
03-Jun-87	600	0	0	25	10	0	0	0	24	0	0	0	0	59
03-Jun-87	1400	0	0	0	1	0	0	0	5	0	0	0	0	6
04-Jun-87	700	0	0	25	3	0	0	0	25	0	0	0	0	53
04-Jun-87	1500	0	0	0	1	0	0	0	12	0	0	0	0	13
05-Jun-87	700	0	0	3	0	0	0	0	3	0	0	0	0	6
06-Jun-87	800	0	0	25	1	0	0	0	17	1	0	0	0	44
06-Jun-87	1500	0	0	0	0	0	0	0	1	0	0	0	0	1
07-Jun-87	600	0	0	8	3	0	0	0	3	0	0	0	0	14
07-Jun-87	1400	0	0	4	0	0	0	0	0	0	0	0	0	4
08-Jun-87	600	0	0	3	0	0	0	0	0	0	0	0	0	3
09-Jun-87	600	0	0	2	1	0	0	0	0	0	0	0	0	3
10-Jun-87	600	0	0	1	0	0	0	0	0	0	0	0	0	1
11-Jun-87	600	0	0	0	0	0	0	0	0	0	0	0	1	1
12-Jun-87	600	0	0	0	0	0	0	0	0	0	0	0	1	1
13-Jun-87	700	0	0	0	0	0	0	0	0	0	0	0	3	3
17-Jun-87	600	0	0	0	0	0	0	0	1	0	0	0	0	1
23-Jun-87	600	0	0	2	0	0	0	0	0	0	0	0	0	2
24-Jun-87	600	0	0	4	0	0	0	0	0	0	0	0	0	4
25-Jun-87	600	0	0	3	0	0	0	0	0	0	0	0	0	3
26-Jun-87	600	0	0	0	0	0	0	0	0	0	0	0	0	0
27-Jun-87	600	0	0	0	0	0	0	0	0	0	0	0	0	0
28-Jun-87	600	0	0	0	0	0	0	0	0	0	0	0	0	0
29-Jun-87	600	0	0	0	0	0	0	0	0	0	0	0	0	0
30-Jun-87	600	0	0	0	0	0	0	0	0	0	0	0	0	0
Totals		2,591	573	509	90	75	18	11	2,239	39	54	40	5	6,239

APPENDIX K

Incidental species caught in the Tucannon River downstream migrant trap in spring 1987, with an indication of relative abundance.

Species	Relative abundance
River lamprey (Lampetra richardsoni)	common
Dolly Varden (Salvelinus malma)	rare
Brown trout (Salmo trutta)	rare
Longnose dace (Rhinichthys cataractae)	common
Speckled dace (Rhinichthys osculs)	abundant
Redside shiner (Richardsonius balteatus)	common
Northern squawfish (Ptychocheilus oregonensis)	rare
Bridgelip sucker (Catostomus columbianus)	rare
Pumpkinseed (Lepomis gibbosus)	rare
Margined sculpin (Cottus marginatus)	rare

APPENDIX L

Table 1. Loci and alleles screened in 1987-88.

	Allele codes and standard relative mobilities										
Locus	1	2	3	4	5	6	7	8	9	Tissue	Buffer(s)
Aat1,2	100	85	105							M,H	CAM 6.8 TC-4
Aat3	100	90	113	95						E	TECB & TC-1
Aat4	100	130	63							L	CAM 6.8 TRIS-GLY
mAat1	-100	-77	-104	-85						M,H	CAM 6.8, TC-4
mAat2	[-100]	[-125]	[-90]							M,H	CAM 6.8, TC-4
Ada1	100	83								M,H	EBT CAME 6.8
Ada2	100	105								M,H	EBT
Ah1	100	86	116	108						L	CAM(E)6.8 TRIS-GLY
mAh1	100	65								H	CAME 6.8
mAh2	100									H	CAME 6.8
mAh3	100									M,H	CAME 6.8
mAh4	100	117	113	109						M,H	CAME 6.8
Ak	100									M	TC-4
Ck1	-100									M	TC-4
Ck2	100									M	TC-4
Ck3	100									E	CAM 6.8
Ck4	[100]	[103]	[93]							E	TC-1
Ck5	100	96								E	TC-1
Dpep1	100	90	XXX	81	86					M,H,E,L	T-G EBT TECB
EstD	100									M,H	EBT
Gpi1	100	60								M	TRIS-GLY
Gpi2	100	60	135	24						M	TRIS-GLY
Gpi3	100	105	93	85						M	TRIS-GLY
GpiH	100	{%}								M	TRIS-GLY
Gr	100	85	110	89						H,E	LIOH-RW TC-4 TECB
Hagh	100	143	131	65						M,H,L	TRIS-GLY (EBT)
Idh1	100									M	CAME 6.8
Idh2	100	154	50							M	CAME 6.8
Idh3,4	100	127	74	142	50	94	83	129	136	66 E,L,M	CAM(E) 6.8
Idh3	100		74	142		94	83	129	136	M	CAM 6.8 TC-4
Idh42	100	127		142	50		83			66 =	(IDH3,4)-(IDH3)2
Ldh3	100									E	TRIS-GLY
Ldh4	100	112	134	71						E,L	TECB TC-1 TRIS-GLY
Ldh5	100	90	70	84						E	TC-1 & TECB
Mdh1,2	100	120	27	-45	160					E,M	CAME & CAM 6.8
Mdh3,4	100	121	70	83	126					M,E,H	CAM & CAME 6.8
mMdh1	-100	-900								M,H	CAME 6.8
mMdh2	100	200	180							M,H	CAM 6.8
MdhP1	100	92	105							H,M	TC-4
Mpi	100	109	95	113						H,E	TRIS-GLY TECB CAM6.8
Pdpep2	100	112	83							H,M	CAM 6.8 & TC-4
PepC	100									E	TRIS-GLY TECB
PepLT	100	110	120	88						M,L,H	EBT CAME**6.8 TC-4
Pgdh	100	90	85	95						E,H	CAME 6.8
Pgk2	100	90	74							E,M,L	CAM(E) 6.8
Pgm1	100	210	165							M,H,L	TRIS-GLY
Pgm2	100	166	136							M,H,L	TRIS-GLY

Appendix L, Table 1, continued.

Locus	Allele codes and standard relative mobilities 1	2	3	4	5	6	7	8	9	Tissue	Buffer(s)
Sod1	-100	-260	580	1260	-175					H,M	EBT TC-4
Sod2	[100]	[120]								H	TC-4
mSod1	100	142	141							H,M	EBT & LIOH-RW
Tapep1	100	130	-350							H,M,L	LIOH-RW or EBT (TC-4 for -350)
Tapep2	[100]	[108]								H,M	LIOH-RW TRIS-GLY
Tpi1	-100									H,L	EBT TRIS-GLY
Tpi2	-100									H,L	EBT TRIS-GLY
Tpi3	100	104	106							H,L	EBT, TRIS-GLY
Tpi4	[100]	[104]	XXX	XXX	[12]	[101]				M,H,E	EBT, TRIS-GLY

2 = Idh4 is scored as the difference of the Idh3,4 score minus the Idh3 score.

APPENDIX L

Table 2. Allele frequencies at variable loci for: upper Columbia River fall chinook collected at Priest Rapids Hatchery (N=100); Snake River fall chinook from Lyons Ferry Hatchery (N=99); and spring chinook from the Tucannon River (hatchery adults, N=85; wild smolts (1986 brood), N=100).

LOCUS alleles #scored	Priest Rapids	Snake River/ Lyons Ferry	Tucannon adults	Tucannon smolts
Aat3				
100	1.000	0.995	1.000	1.000
90	0.000	0.005	0.000	0.000
113	0.000	0.000	0.000	0.000
(N)	100	99	85	100
Aat4				
100	0.995	0.995	0.869	0.900
130	0.000	0.000	0.000	0.000
63	0.005	0.005	0.131	0.100
163	0.000	0.000	0.000	0.000
(N)	100	99	84	95
mAat1				
-100	0.985	0.970	0.959	@
- 77	0.000	0.015	0.000	@
-104	0.015	0.015	0.041	@
- 85	0.000	0.000	0.000	@
(N)	100	99	85	86
mAat2				
[-100]	0.855	0.732	1.000	@
[-125]	0.005	0.000	0.000	@
[- 90]	0.140	0.268	0.000	@
(N)	100	99	85	81
Ada1				
100	0.995	1.000	0.965	0.965
83	0.005	0.000	0.035	0.035
69	0.000	0.000	0.000	0.000
(N)	100	99	85	99
Ah1				
100	0.805	0.854	0.918	0.884
86	0.190	0.131	0.082	0.116
116	0.005	0.015	0.000	0.000
108	0.000	0.000	0.000	0.000
69	0.000	0.000	0.000	0.000
(N)	100	99	85	99

LOCUS alleles #scored	COLLECTION Priest Rapids	Snake River/ Lyons Ferry	Tucannon adults	Tucannon smolts
mAh4				
100	0.875	0.838	0.971	0.965
117	0.125	0.141	0.029	0.035
113	0.000	0.020	0.000	0.000
109	0.000	0.000	0.000	0.000
(N)	100	99	85	100
Ck4				
[100]	@	@	@	0.985
[103]	@	@	@	0.015
[93]	@	@	@	0.000
(N)	76	89	76	100
Dpep1				
100	0.985	0.975	0.865	0.920
90	0.015	0.025	0.118	0.075
81	0.000	0.000	0.000	0.000
86	0.000	0.000	0.018	0.005
(N)	100	99	85	100
Gpi2				
100	0.955	0.960	0.976	0.968
{60}	0.045	0.040	0.024	0.032
135	0.000	0.000	0.000	0.000
24	0.000	0.000	0.000	0.000
(N)	100	99	85	93
Gpi3				
100	1.000	0.995	1.000	1.000
105	0.000	0.005	0.000	0.000
93	0.000	0.000	0.000	0.000
85	0.000	0.000	0.000	0.000
(N)	100	99	85	100
GpiH*				
100	0.800	0.900	1.000	1.000
{%}	0.200*	0.100*	0.000	0.000
(N)	100	99	85	100
Gr				
100	0.970	0.990	1.000	1.000
85	0.025	0.010	0.000	0.000
110	0.000	0.000	0.000	0.000
89	0.005	0.000	0.000	0.000
(N)	100	99	85	100

LOCUS alleles #scored	COLLECTION Priest Rapids	Snake River/ Lyons Ferry	Tucannon adults	Tucannon smolts
Hagh				
100	0.995	0.980	0.912	0.935
143	0.000	0.020	0.088	0.065
131	0.000	0.000	0.000	0.000
65	0.005	0.000	0.000	0.000
(N)	100	99	85	100
Idh3				
100	0.990	0.995	0.824	0.775
127	0.000	0.000	0.000	0.000
74	0.005	0.000	0.165	0.225
142	0.000	0.000	0.000	0.000
50	0.000	0.000	0.000	0.000
94	0.005	0.005	0.012	0.000
83	0.000	0.000	0.000	0.000
129	0.000	0.000	0.000	0.000
136	0.000	0.000	0.000	0.000
(N)	100	99	85	100
Idh4				
100	0.815	0.914	1.000	1.000
127	0.185	0.076	0.000	0.000
142	0.000	0.000	0.000	0.000
50	0.000	0.000	0.000	0.000
83	0.000	0.005	0.000	0.000
66	0.000	0.005	0.000	0.000
(N)	100	99	85	100
Ldh5				
100	0.975	0.995	0.988	0.995
90	0.025	0.005	0.000	0.000
70	0.000	0.000	0.000	0.000
84	0.000	0.000	0.012	0.005
(N)	100	99	85	100
Mdh3,4				
100	0.980	0.982	1.000	1.000
121	0.012	0.008	0.000	0.000
70	0.007	0.010	0.000	0.000
83	0.000	0.000	0.000	0.000
126	0.000	0.000	0.000	0.000
(N)	100	99	85	100
mMdh2				
100	0.975	0.985	0.747	0.730
200	0.020	0.015	0.253	0.270
180	0.005	0.000	0.000	0.000
(N)	100	99	85	100

LOCUS alleles #scored	COLLECTION Priest Rapids	Snake River/ Lyons Ferry	Tucannon adults	Tucannon smolts
MdhP1				
100	0.850	0.722	0.094	0.126
92	0.150	0.278	0.906	0.874
105	0.000	0.000	0.000	0.000
(N)	100	99	85	99
Mpi				
100	0.695	0.737	0.894	0.690
109	0.295	0.258	0.106	0.310
95	0.010	0.005	0.000	0.000
113	0.000	0.000	0.000	0.000
(N)	100	99	85	100
Pdpep2				
100	0.980	0.995	1.000	1.000
112	0.020	0.005	0.000	0.000
83	0.000	0.000	0.000	0.000
(N)	100	99	84	100
PepLT				
100	0.758	0.904	0.976	0.990
110	0.242	0.096	0.024	0.010
(N)	99	99	85	100
Pgk2				
100	0.610	0.500	0.124	0.105
90	0.385	0.500	0.876	0.895
74	0.005	0.000	0.000	0.000
(N)	100	99	85	100
Sod1				
-100	0.500	0.566	0.829	0.845
-260	0.500	0.429	0.171	0.155
580	0.000	0.000	0.000	0.000
1260	0.000	0.000	0.000	0.000
-175	0.000	0.005	0.000	0.000
(N)	100	99	85	100
Sod2				
[100]	0.775	0.914	0.841	-
[120]	0.225	0.086	0.159	-
(N)	100	99	85	0
mSod1				
100	1.000	1.000	0.918	0.918
142	0.000	0.000	0.082	0.082
141	0.000	0.000	0.000	0.000
(N)	100	99	85	97

LOCUS alleles #scored	Priest Rapids	COLLECTION Snake River/ Lyons Ferry	Tucannon adults	Tucannon smolts
Tapep1				
100	0.730	0.904	0.924	0.910
130	0.265	0.096	0.006	0.050
-350	0.005	0.000	0.071	0.040
(N)	100	99	85	100
Tapep2				
[100]	0.990	1.000	1.000	1.000
[108]	0.010	0.000	0.000	0.000
(N)	100	99	85	100
Tpi4				
[100]	0.985	1.000	0.918	0.910
[104]	0.015	0.000	0.082	0.090
[102]	0.000	0.000	0.000	0.000
[101]	0.000	0.000	0.000	0.000
(N)	100	99	85	100

[ ] = relative mobilities determined from the mobility of the interlocus heteropolymer

{%} = this allele represents the absence of the GPI-1/3 heterodimer; it can only be detected in the homozygous state

* = reported allele frequency is the square root of the observed frequency of the homozygous variant

@ = fewer than 90% of the fish in the sample successfully scored; no data reported

APPENDIX L

Table 3. Loci screened from 1985 to 1988 and number of alleles recognized.

	NUMBER OF ALLELES1			
LOCUS	1985	1986	1987	1988
Aat1,2	3	3	3	3
Aat3	3	3	3	4
Aat4	3	3	3	3
mAat1			4	4
mAat2			2	3
Ada1	2	2	2	2
Ada2	2	2	2	2
Ah1	5	5	5	5
mAh1			1	2
mAh2			1	1
mAh3			1	1
mAh4			2	4
Ak	1	1	1	1
Ck1	1	1	1	1
Ck2	1	2	1	1
Ck3	1	1	1	1
Ck4	1	1	3	3
Ck5	1	1	1	1
Dpep1	3	3	3	4
EstD		1	1	1
Gpi1	1	1	1	1
Gpi2	3	3	3	4
Gpi3	4	4	4	4
GpiH	2	2	2	2
Gr	3	3	4	4
Hagh	2	2	2	4
Idh1	1	1	1	1
Idh2	3	3	3	3
Idh3,4	5	5	9	10
Idh3			7	7
Idh42			4	5
Ldh3	1	1	1	1
Ldh4	4	4	4	4
Ldh5	3	3	4	4
Mdh1,2	5	5	5	5
Mdh3,4	4	4	5	5
mMdh1				1
mMdh2		2	2	3
MdhP1			3	3
Mpi	4	3	3	4
Pdpep2	1	1	2	2
PepC	2?	1	1	1
PepLT	2	2	2	2
Pgdh	3	3	4	4
Pgk2	2	2	2	3
Pgm1	?	?	1	3
Pgm2	?	?	1	3
Sod1	4	5	5	5

Appendix L, Table 3, continued.

	NUMBER OF ALLELES1			
LOCUS	1985	1986	1987	1988
Sod2			2	2
mSod1			1	1
Tapep1	2	2	3	3
Tapep2	1	1	1	2
Tpi1	1	1	1	1
Tpi2	1	1	1	1
Tpi3	1	1	1	3
Tpi4	1	2	4	4

1 = blank indicates locus was not screened in that year.
2 = Idh4 is scored as the difference of the Idh3,4 score minus the Idh3 score.