AFF I/LSR - 89 - 10

LOWER SNAKE RIVER COMPENSATION PLAN

LYONS FERRY EVALUATION PROGRAM

1988 ANNUAL REPORT

by

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Cooperative Agreement 14-16-0001-88519

ABSTRACT

This report provides a synopsis of activities from 1 April 1988 to 31 March 1989 by the Washington Department Fisheries' Lower Snake River hatchery evaluation studies. This work was completed with Fiscal Year 1988 funds provided 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, back to the Snake River Basin.

Fall chinook salmon escapement to Lyons Ferry FH in 1988 was 1,403 adults (age 4+) and 1,059 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. We obtained 1,076 adults and 6 jacks from trapping operations at Ice Harbor Dam, and 327 adults and 1,053 jacks through rack returns. All release groups from the 1983, 1984, and 1985 broods have returned to Lyons Ferry FH. Preliminary coded-wire tag (CWT) recovery analysis indicates a high survival of the 1983 brood yearling on-station release. To date, 1.32 percent of this release group escaped to the LSRCP project area, and 5.64 percent contributed to high seas and Columbia River fisheries, for a total survival rate of 6.96 through age 5. Two treatment groups comprised the 1984 brood: 1) the subyearling (age 0) on-station release, which currently has a 0.09 percent escapement to the Snake River and a 1.08 percent total survival and contribution rate through age 4, and 2) the yearling on-station release, 0.09 percent escaped to the Snake River with a 0.49 percent total survival rate through age 4. The 1985 brood had 4 treatment groups: 1) the subyearling on-station release, has a 0.02 percent escapement to the Snake River and a 0.03 percent total survival rate through age 3, 2) the subyearling transport (barge) release, has 0.01 percent escapement to the Snake River and 0.03 percent total survival through age 3, 3) the yearling on-station release, has 0.16 percent escapement to the Snake River and 0.32 percent total survival through age 3, and 4) the yearling transport release, has 0.15 percent escapement to the Snake River and 0.28 percent total survival through age 3. These survival rates are preliminary and will be updated in future reports.

Fall chinook salmon were spawned at Lyons Ferry FH from 25 October to 22 November; eggtake was 2,926,700. Spawning was terminated early when 169 males, 61 females, and 9 jacks were killed by contaminated formalin administered to the fish during routine flush treatments. Lyons Ferry FH staff planted 407,840 yearling (1986 brood) fall chinook salmon in April 1988, and 4,573,447 subyearling (1987 brood) fall chinook salmon in June 1988. 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. Travel time of the yearling on-station release group from Lyons

Ferry FH to McNary Dam was 6.2 km/day. Travel time of the subyearling on-station release group over the same distance was 7.8 km/day.

We monitored fall chinook natural spawning in all streams upstream of Lower Granite Dam believed to be used by fall chinook adults. Fall chinook salmon spawning ground counts in the Clearwater, Grande Ronde, Imnaha, and mainstem Snake Rivers in 1988 totaled 21, 1, 1, and 57 redds, respectively. Six hundred twenty-seven adults were counted at Lower Granite Dam, providing an adult-to-redd ratio of 7.8. We found 26 fall chinook redds in the Lower Stratum of the Tucannon River. Coded-wire tag recoveries of 4 marked carcasses indicated the fish were from 3 separate releases from Lyons Ferry FH.

Spring chinook salmon escapement to the Tucannon River was 299; enumeration was by trapping the adults adjacent to the hatchery, and by snorkel surveys downstream of the trap. We collected 119 adults for broodstock at Tucannon FH. Peak of spawning was 10 September, which coincided well with natural spawners. Eggtake was 182,438. In February 1988, fish were diagnosed with bacterial gill disease. Subsequently, 40,000 yearlings were released from Tucannon FH in March to decrease the rearing density in the holding pond. Tucannon FH released the remaining 113,725 yearling (1986 brood) spring chinook smolts on a volitional basis on 11 to 13 April. Modal travel time to the downstream migrant trap 38 km downstream of the hatchery was about four days.

We quantitatively electrofished 42 sites in three study strata in the upper Tucannon River, and found mean spring chinook salmon rearing densities ranged from 16.06 to 25.68 fish/100m2. These data were used with extensive and intensive habitat surveys to estimate a late summer standing crop of 79,000 fry (1987 brood). We operated a downstream migrant trap from October 1987 through June 1988, and caught 11,843 natural and 5,627 hatchery spring chinook salmon smolts, at average efficiencies of 24.3 and 3.7 percent, respectively. We estimate 58,236 (with 95 percent confidence interval of 1,401) natural spring chinook salmon (1986 brood) outmigrated from the Tucannon River. The egg to fry survival rate for the natural-origin 1986 brood spring chinook salmon was 43.3 percent; fry to smolt survival for this same group was 52.3 percent. Overall egg to smolt survival for this group was 22.6 percent. Six 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 76) and Big 4 Lake (RK 66) had the largest temperature increase.

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ACKNOWLEDGMENTS

Many people assisted in all aspects of this study. Technicians Mark Harting, Kenny Melton, and Shane Snow contributed much in the field data collection and logistics. Hatchery managers Jim Bauer, Bill Hubbard, and Carl Ross offered complete cooperation in the hatchery sampling. Fish culturists Louis Case, Brent Dearing, Jeri Fulbright, Morgan Grant, Steve Henry, Tim Holder, Maryanne Olney, and Carl Sampson assisted in hatchery sampling and logistics. Todd Kleist and Dan Rawding of the Washington Department of Wildlife (WDW), Andy Appleby, Kent Dimmitt, Howard Fuss, Dave Geist and Mark Kimbel of Washington Department of Fisheries (WDF), and Doug Olson from the Confederated Umatilla Tribe assisted in spring chinook salmon spawning ground and electrofishing surveys. Terry Bruegman of WDW made life and work enjoyable in all aspects of the Tucannon River spring chinook studies. The Nez Perce Tribe, Idaho Power Company, and Oregon Department of Fish and Wildlife participated in, and helped fund, the Snake and Clearwater Rivers fall chinook salmon redd counts.

We thank Jerry Harmon and crew from National Marine Fisheries Service (NMFS) for collection of marked fall chinook jacks at Lower Granite Dam, and Ed Calame of the U.S. Forest Service for all aspects of the stream temperature studies. Dennis Rondorf of the U.S. Fish and Wildlife Service (USFWS) supplied the information on gill ATPase activity in the fall chinook salmon releases. Several individuals from the Fish Passage Center provided information on juvenile fall chinook salmon travel time.

Dan Herrig of USFWS gave invaluable logistical and technical assistance in all aspects of this study. We leaned on Kent Dimmitt and Mark Kimbel of WDF a lot in the coded-wire tag analysis. 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

1988 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 1988 through 31 March 1989. 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

Lyons Ferry FH 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

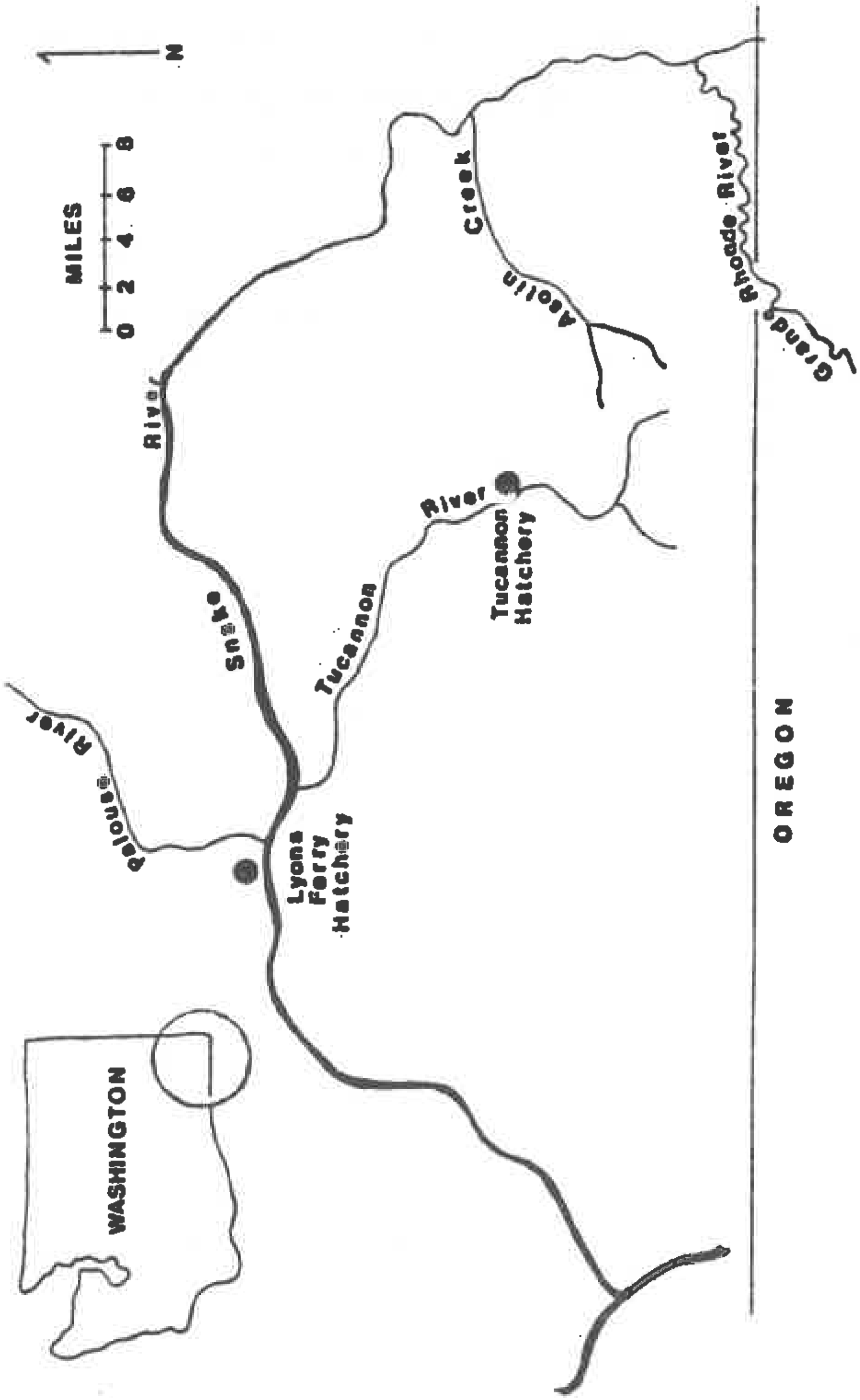

Figure 1. Lower Snake River Basin in southeast Washington, showing location of Lyons Ferry and Tucannon Fish Hatcheries.

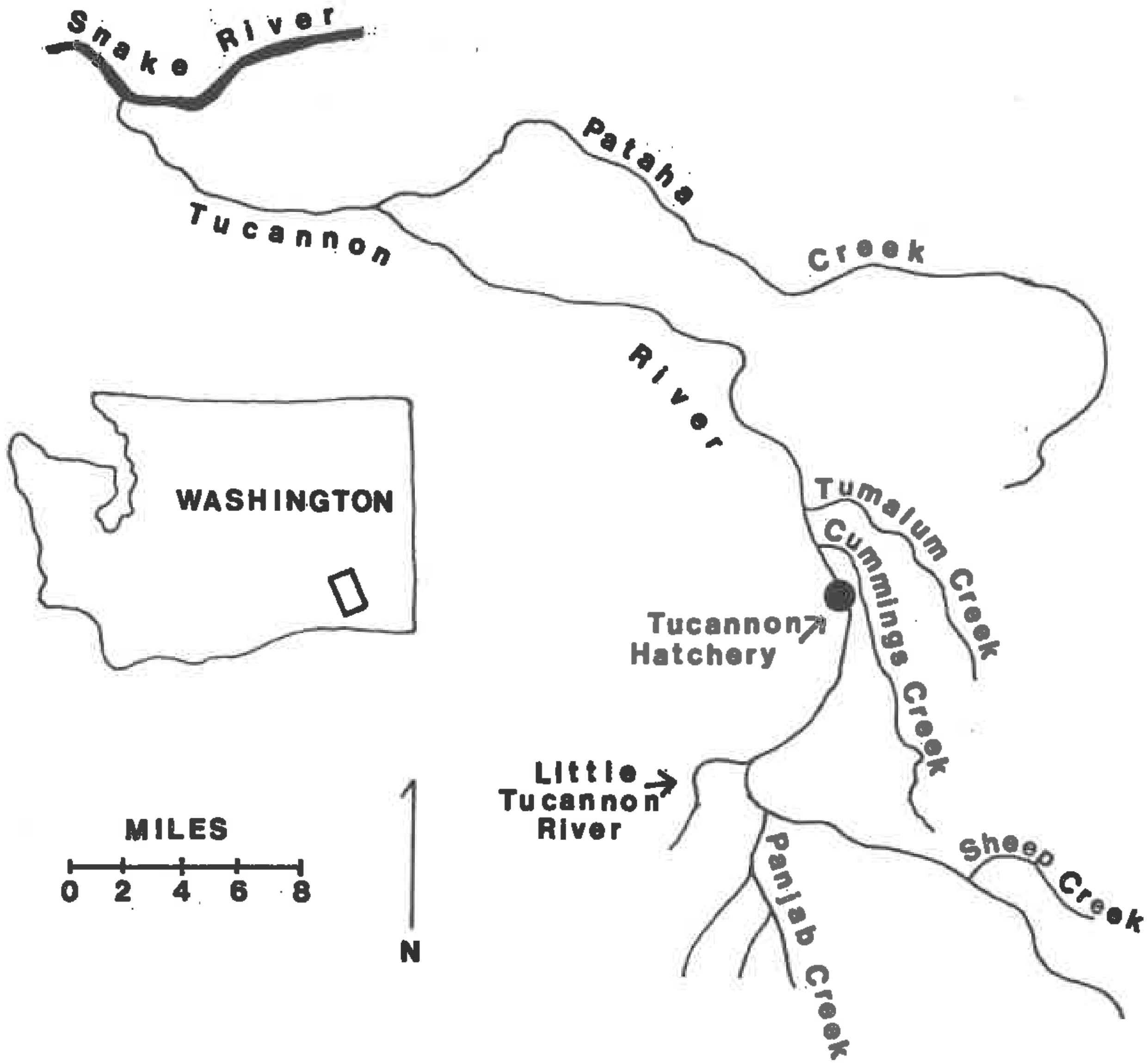

Figure 2. Tucannon River Basin, showing location of Tucannon Fish Hatchery.

chinook salmon are trapped and spawned at the Tucannon satellite facility. Progeny are fertilized, 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 olds) 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. A total of 327 adults and 1,053 jacks[a] returned to Lyons Ferry FH in 1988 (Table 2). First adult arrival to the rack was on 9 September; last arrival was on 12 December, compared to 6 October to 14 November in 1986, and 18 September to 12 December 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 1989). Since its completion in 1984, Lyons Ferry FH has been receiving the transported fall chinook salmon (Table 3). Over the twelve-year period, numbers of fish transported have averaged 603 adults (range: 212 - 1613) and 52 jacks (range: 0 - 150). In 1988, 1,067 adults and 6 marked jacks were trapped and hauled to Lyons Ferry FH, representing 28 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 47 percent.

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[a] Throughout this report jacks collected in trapping operations and returns to the hatchery rack were distinguished by size, and in some cases our estimates were 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.

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 1988.

Year	Collection point	Number collected adults	Number collected jacks	Ice Harbor Dam count adults	Ice Harbor Dam count jacks
1984	Lyons Ferry FH	0	0	1,410	642[a]
	Ice Harbor Dam	663	97		
	Kalama Falls FH	220	10		
1985	Lyons Ferry FH	6	4,070[b]	2,046	7,119
	Ice Harbor Dam	589	90		
	Kalama Falls FH	952	0		
1986	Lyons Ferry FH	245	1,125	3,152	2,665
	Ice Harbor Dam	212	23		
	Kalama Falls FH	576	0[c]		
1987	Lyons Ferry FH	1,654	543	6,812	1,619
	Ice Harbor Dam	1,613	47		
1988	Lyons Ferry FH	327	1,053	3,847	2,035
	Ice Harbor Dam	1,076	6		

[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] The last year adults returned to Kalama Falls FH was in 1986.

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 1988.

Year	Number trapped adults	Number trapped jacks	Duration of trapping	Peak trapping day date	Peak trapping day 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	1,613	47	2 Sep. - 11 Oct.	26 Sep.	97
1988	1,076	6	3 Sep. - 11 Oct.	15 Sep.	67

2.2: Coded-Wire Tag Recoveries

2.2.1: Preliminary analysis of returns

In 1988, eight 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, the 1985 brood yearling 6) on-station and 7) transport groups, and 8) the 1986 brood subyearling transport group (Table 4). With the exception of the last group, all were also represented in the 1987 returns. Each release group was differentially marked with coded-wire tags (CWT, Appendix B). A breakdown of CWT recoveries by release group is presented in Appendix C. Seidel and Bugert (1988) describe the experimental design for the fall chinook salmon release groups.

2.2.2: Lyons Ferry Hatchery returns

All release groups from the 1983, 1984 and 1985 broods have returned to the Lyons Ferry FH. One of four 1986 brood release groups has returned (Table 5). The 1983 brood yearling release comprised the majority of the escapement in 1985, 1986, 1987, and 1988. Actual age distributions of returning fall chinook salmon to Lyons Ferry FH based upon scale and coded-wire tag analyses indicate the predominance of the strong 1983 year class (Table 6). Survival of this release group upon return to the LSRCP project area is 1.32 percent; total survival and contribution to all fisheries is 6.96 percent.

2.2.3: Fishery contribution

To date, eight 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, 3) the 1984 brood subyearling on-station release, the 1985 brood subyearling 4) on-station and 5) transport groups, the 1985 brood yearling 6) on-station and 7) transport groups, and 8) the 1986 brood subyearling transport group. These groups were represented in a wide geographic distribution, ranging from California to Alaska.

Table 4. Preliminary coded-wire tag recoveries (non-expanded) from contribution to various fisheries, returns to the hatchery rack, and fish trapped at Lower Granite Dam for 1983, 1984, 1985, and 1986 broods Lyons Ferry fall chinook salmon. Results are compared by type of release and year of recovery.

Brood year / release group	Year recovered	Fishery contribution	Hatchery returns	Lower Granite Dam
1983				
yearling	1985	157	1,891	51
on-station	1986	2,839	663	40
	1987	10,403	1,444	1[a]
	1988	2,153	275	0
	Total	15,552	4,273	92
1984				
subyearling	1986	88	34	56
on-station	1987	328	112	1
	1988	454	57	0
	Total	870	203	57
yearling	1986	4	48	4
on-station	1987	142	89	3
	1988	839	98	0
	Total	985	236	7
1985				
subyearling	1987	17	18	17
on-station	1988	37	20	0
	Total	54	38	17
subyearling	1987	3	6	0
transport	1988	47	0	0
	Total	50	6	0
yearling	1987	28	129	15
on-station	1988	190	121	8
	Total	218	250	23
yearling	1987	17	112	3
transport	1988	281	120	2
	Total	298	232	5
1986				
subyearling transport	1988	44	130	7

[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.

Table 5. 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	1988	Total
1983						
yearling on-station	334,442	1,891 (0.57)	663 (0.20)	1,444 (0.43)	275 (0.08)	4,273 (1.28)
1984						
subyearling on-station	234,985	- -	34 (0.01)	112 (0.05)	57 (0.02)	203 (0.09)
yearling on-station	258,355	- -	49 (0.02)	89 (0.03)	98 (0.04)	236 (0.09)
1985						
subyearling on-station	246,625	- -	- -	18 (0.01)	20 (0.01)	38 (0.02)
subyearling transport	245,561	- -	- -	6 (0.01)	0	6 (0.01)
yearling on-station	152,479	- -	- -	129 (0.08)	121 (0.08)	250 (0.16)
yearling transport	156,036	- -	- -	112 (0.07)	120 (0.08)	232 (0.15)
1986						
subyearling transport	255,998	- -	- -	- -	130 (0.05)	130 (0.05)

Table 6. 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 (15)	453 (12)	2,823 (72)	18 (1)	3,857 (100)
1988	781 (32)	444 (18)	647 (26)	583 (24)	2,455 (100)

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 30 August through 2 December 1988. Forty-three marked jacks were observed, and 21 (49 percent) were collected for CWT analysis, compared to 79 in 1987 and 112 in 1986. Coded-wire tag analysis by the WDF tag recovery lab indicated all were were Lyons Ferry stock from five separate release groups. Straying rates varied by age and location of release (Table 7).

2.2.5: Snake River sport fishery

In 1987, WDF adopted a fall chinook salmon jack (less than 71 cm) sport fishery in the Snake River from Lower Monumental Dam upstream to the mouth of the Palouse River (adjacent to Lyons Ferry FH). In 1988, no coded-wire tags were recovered from this fishery; it appears that little exploitation occurred (Hymer, personal communication). This fishery will continue in 1989, with two changes in the regulations based upon our recommendations: 1) the length restriction will be changed to 61 cm, and 2) the open area will be extended downstream to the mouth of the Snake River.

2.3: Fall Chinook Stock Profile Characteristics

From 3 September through 12 December 1988, 1,403 fall chinook salmon adults and 1,059 jacks (fish less than 61 cm fork length) were collected at Lyons Ferry FH. Duration of returns was eight weeks longer than in 1986, and two weeks longer than in 1987. Fish were spawned, and scales were sampled from 25 October to 22 November, with a total of 677 scale samples (27 percent) taken. Age composition was 32 percent 2 year olds, 18 percent 3 year olds, 26 percent 4 year olds, and 24 percent 5 year olds (Table 8, Figure 3). In 1987, percent age composition for the 2, 3, 4, and 5 year classes was 15, 12, 72, and 1, respectively.

Table 7. Estimate of homing and straying rates for Lyons Ferry Fish Hatchery (LFFH) fall chinook salmon, based upon trapping at Lower Granite Dam (LGD) and coded-wire tag expansion rates. Results are summarized by brood year and treatment group (age and location of release).

Brood year treatment	Number trapped at LGD	Expanded number a	Expansion rate b	Estimated total passed LGD c	Marked returns to LFFH	Expanded returns to LFFH d	Homing rate e	Straying rate f
1984								
subyearling on-station	1	2	0.437	4	108	247	0.983	0.017
yearling on-station	3	6	0.540	10	89	165	0.940	0.060
1985								
subyearling on-station	17	32	0.161	198	18	112	0.360	0.640
subyearling Ice Harbor Dam	0	0	1.000	0	6	6	1.000	0.000
yearling on-station	15	28	0.666	42	131	197	0.823	0.177
yearling Ice Harbor Dam	3	6	1.000	6	110	110	0.951	0.049

[a] Expanded number is actual count divided by a 53.2 percent sampling rate at LGD.

[b] Proportion of that release with coded wire tags.

[c] Sampling expanded number divided by coded wire tag expansion rate.

[d] Marked returns divided by coded wire tag expansion rate (refer to Table 4).

[e] Returns to LFFH divided by the sum of fish passed LGD and returns to LFFH.

[f] Number passed LGD divided by the sum of fish passed LGD and returns to LFFH.

Table 8. Age composition by sex of adult fall chinook salmon sampled at Lyons Ferry Fish Hatchery, 1988.

Sex	Age				Total
	2	3	4	5	
Male	781	417	287	221	1,706
Female	0	27	360	362	749
Total	781	444	647	583	2,455 a

a These data were extrapolated from a sample of 670 fish.

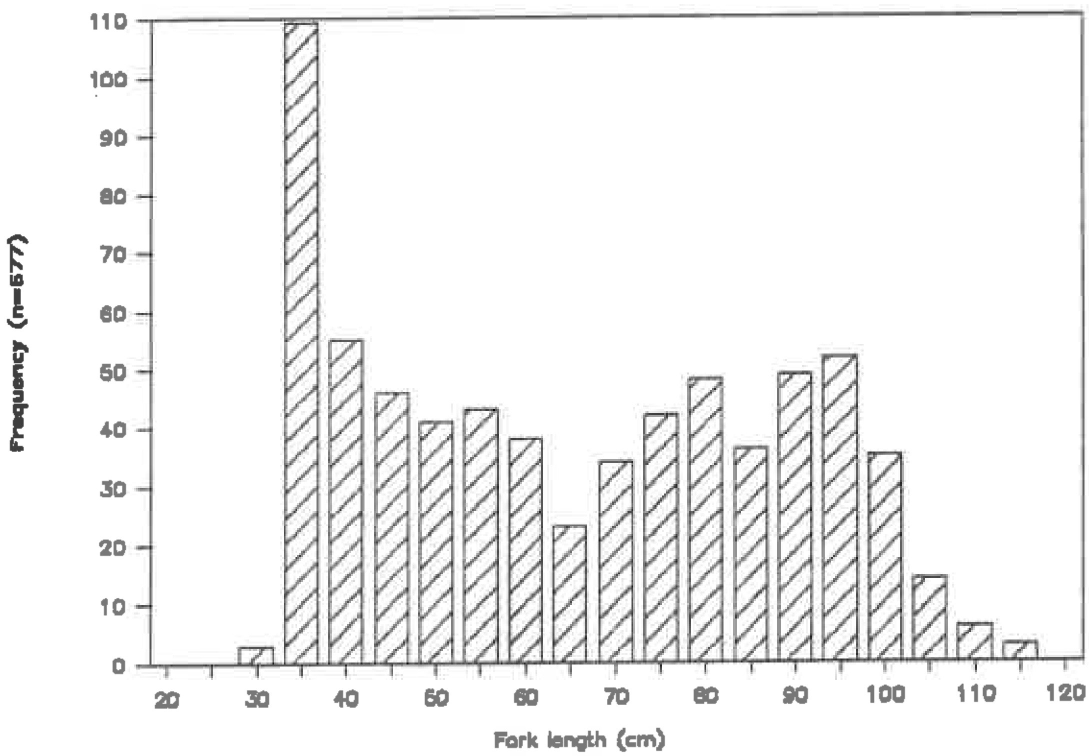

Figure 3. Length frequency distribution of fall chinook salmon sampled at Lyons Ferry Fish Hatchery in 1988.

The ratio of females to males in 1988 was 0.44:1.00 (749:1706). This value includes all age classes. The average female:male ratio since 1977 is 1.07:1.00 (Table 9). Average fecundity and egg size for 1988 adult fall chinook salmon was 4,526 eggs/female and 1,462 eggs/pound (0.31 grams/egg), respectively (Table 9). Average fecundity of Snake River stock fall chinook salmon since inception of the egg bank program in 1977 is 4,316 (n=12). Fecundity values were determined by dividing the total number of eggs taken by the number of females spawned. To obtain a more precise estimate of fecundity, we collected about 100 eggs from 48 randomly selected females during the eggtake, weighed and counted them, and compared this value to the total weight of eggs in that female. We then compared the age and length of females with their number and size of eggs. Using this method, average fecundity was 4,693 eggs per female (s=1,166) and average egg weight was 0.27 grams (s=0.04, 1,677 eggs/pound, Appendix D). We found a direct linear relationship between fecundity and fork length (least squares r=0.80, p<0.10).

Table 9. Comparison of fecundity, egg size, and sex ratios of Snake River fall chinook salmon from 1977 through 1988.

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	- -	1.72:1.00
1985[a]	4,622	1,312	0.09:1.00
1986	4,386	1,720	0.10:1.00
1987	3,874	1,539	0.91:1.00
1988	4,526	1,462	0.44:1.00

[a] The first year of spawning at Lyons Ferry FH was 1985.

Program staff collected 100 electrophoretic samples of adult fall chinook salmon at Lyons Ferry FH. The 1988 brood fall chinook salmon represented the fifth year of electrophoretic screening. Program staff collected 100 1987 brood fall chinook salmon parr for morphometric analysis. We used the same techniques for electrophoretic and morphometric research as in 1987 (Seidel et al. 1988). Results and a discussion of these studies will be published separately. We also collected otoliths from 100 Lyons Ferry adults to be retained for supplementary stock identification in the future (Neilson et al. 1985).

2.4: Lyons Ferry Hatchery Practices

2.4.1: Spawning and rearing

Duration of 1988 fall chinook salmon spawning was from 18 October through 6 December (Table 10), compared to 20 October through 14 December in 1987. Peak of spawning was 12 November, compared to 17 November in 1987, and 19 November in 1986. Eggtake was 2,926,700, with a mortality rate of 3.41 percent, compared with egg mortality rates of 3.82 percent in 1987, 3.98 percent in 1986, and 3.99 percent in 1985.

Table 10. Collection and spawning summary for 1988 fall chinook salmon broodstock at Lyons Ferry Fish Hatchery.

Week ending	Arrivals adult	/ jacks	Mortality M	/ F	/ J	Spawned M	/ F	Estimated eggtake
09/10/88	226			1				
09/17	356			1				
09/24	304		11	2	18			
10/01	197							
10/08	135		1	1				
10/15	104		1					
10/22	56		1	2	4		5	20,000
10/29	34		4	10	1		22	84,000
11/05	12		3	2	4	12	77	296,000
11/12	21		8	1	12	35	200	784,000
11/19	38		37	3	6	76	194	740,000
11/26	28		63	6	6	221	148	584,000
12/03	17		172[b]	61	10	4	13	48,000
12/10	3		1			1	3	12,000
Total	1531[a]	1059	302	90	61	349	662	2,568,000[c]

[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 1,403 adults

[b] High loss caused by contaminated formalin in adult pond.

[c] Corrected eggtake after shocking was 2,926,700.

2.4.2: Disease incidence

The 1988 adult fall chinook salmon were given flush treatments of formalin (1:10,000) for fungus infection. One of the formalin drums was contaminated and caused the mortality of 169 males, 61 females and 9 jacks on 26 and 27 November.

The 1987 brood fall chinook salmon had minor outbreaks of bacterial kidney and gill diseases (Table 11). Monthly mortality rates for the 1987 and 1988 broods during this study period averaged 0.55 percent (range: 0.17 - 1.22, n = 12) and 1.10 percent (range: 0.41 - 2.03, n = 3), respectively. Monthly mortality rates for the 1986 brood subyearling and yearling groups averaged 1.90 and 1.02 respectively. Monthly mortality rates for the 1985 brood subyearling and yearling groups averaged 2.28 percent and 1.24 percent respectively. Monthly mortality rates for the 1984 brood subyearling and yearling groups averaged 2.40 percent and 1.02 percent respectively. Table 12 lists the overall (egg to smolt) mortality rates for the 1984 through 1987 brood subyearling and yearling release groups.

Table 11. Incidence, date, location, and treatment of diseases for 1987 and 1988 broods fall chinook salmon contracted at Lyons Ferry Fish Hatchery. Data are summarized by calendar year.

Brood year	Date	Disease	Pond numbers	Treatment
1987	01/88	Fungus	Incubation room	Formalin
	03/88	Enteric redmouth	3 to 13	Terramycin
	03/88	Bacterial kidney	3 to 20	Gallimycin
	03/88	Bacterial gill	4	Diquat
	04/88	Bacterial kidney	3 to 20	Gallimycin
	04/88	Bacterial gill	3 to 20	Diquat
	04/88	Enteric redmouth	3	Romet
	05/88	Bacterial gill	12, 13, 19	Diquat
	06/88	Enteric redmouth	13, 14	Romet
	07/88	Bacterial kidney	11, 14	Gallimycin
1988	10/88	Fungus	Incubation room	Formalin
	11/88	Fungus	Incubation room	Formalin
	12/88	Fungus	Incubation room	Formalin

Table 12. Lyons Ferry fall chinook salmon overall (egg to smolt) mortality rates, with monthly ranges, for the 1984 through 1987 brood years.

Brood year	Percent mortality: Subyearling (Monthly range, n)	Percent mortality: Yearling (Monthly range, n)
1984	13.78 (0.24 - 7.99, 6)	16.49 (0.03 - 7.99, 17)
1985	12.65 (0.55 - 4.81, 6)	13.77 (0.11 - 4.81, 17)
1986	10.95 (0.25 - 4.95, 6)	15.31 (0.23 - 4.95, 17)
1987	9.11 (0.73 - 3.75, 6)	11.41 (0.17 - 3.75, 17)

2.5: Smolt Releases

Hatchery staff planted 407,840 yearling (1986 brood) fall chinook salmon in April 1988 and 4,573,447 subyearling (1987 brood) fall chinook salmon in June 1988 (Table 13). Of the yearling group, 286,611 fall chinook salmon were released from Lyons Ferry FH, and 121,229 were transported for release. We released 2,009,148 subyearling fall chinook salmon on-station and transported 2,564,299 subyearlings below Ice Harbor Dam. Our experimental design for fall chinook salmon releases is a 2x2 factorial treatment of yearlings and subyearlings released both

Table 13. Summary of 1986 and 1987 broods fall salmon chinook releases from Lyons Ferry Fish Hatchery in 1988. 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	124,394	2,347	Ad + CWT	6352/14 R6 a	53.0	89	10.08	1.12
1987 brood	On-station	124,345	2,346	Ad + CWT	6352/16 R6	53.0	89	10.08	1.12
	On-station	748	14	Ad only		53.0	89	10.08	1.12
	On-station	79,961	1,509	Brand	RD/R/1 b	53.0	89	10.08	1.12
	On-station	1,679,700	31,692	Unmarked		53.0	89	10.08	1.12
subtotal		2,009,148	37,908						
	Ice Harbor	122,850	2,318	Ad + CWT	6352/11 R6	53.0	90	9.15	1.16
	Ice Harbor	122,899	2,319	Ad + CWT	6352/13 R6	53.0	90	9.15	1.16
	Ice Harbor	4,250	80	Ad only		53.0	90	9.15	1.16
	Ice Harbor	42,500	802	Unmarked		53.0	90	9.15	1.16
	Ice Harbor	886,300	8,953	Unmarked		99.0	76	8.56	1.05
	Ice Harbor	1,114,000	8,984	Unmarked		124.0	76	8.56	1.05
	Ice Harbor	271,500	3,879	Unmarked		70.0	76	8.56	1.05
subtotal		2,564,299	27,335						
Total 1987 brood		4,310,795	65,243						
Yearlings	On-station	58,735	7,342	Ad + CWT	6344/11 R6	8.0	173	8.41	1.05
1986 brood	On-station	58,970	7,371	Ad + CWT	6344/13 R6	8.0	173	8.41	1.05
	On-station	473	60	Ad only		8.0	173	8.41	1.05
	On-station	39,952	4,994	Brand	RA/7S/1	8.0			
	On-station	128,481	16,059	Unmarked		8.0	173	8.41	1.05
subtotal		286,611	35,826						
	Ice Harbor	60,523	7,565	Ad + CWT	6344/7 R6	8.0	177	7.92	1.02
	Ice Harbor	60,281	7,535	Ad + CWT	6344/8 R6	8.0	177	7.92	1.02
	Ice Harbor	425	54	Ad only		8.0	177	7.92	1.02
subtotal		121,229	15,154						
Total 1986 brood		407,840	50,980						

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.

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 (Appendix B). In 1987 and 1988, we had enough smolts to perform all four treatments.

To assess smoltification in the yearling and subyearling fall chinook salmon on-station releases, USFWS personnel sampled groups at Lyons Ferry FH one month prior, two weeks prior, and at the time of release (Rondorf, personal communication). Samples were also taken at McNary Dam during outmigration. Gill ATPase activities of both the yearling and subyearling on-station release groups were high at time of release (Figure 4), but the yearling's enzyme levels were less than at two weeks prior to release. Gill ATPase levels of the subyearlings increased sharply before release. At McNary Dam, the yearling's enzyme activity rose only slightly higher than release levels, and the subyearling's enzyme activity increased until the late part of the outmigration.

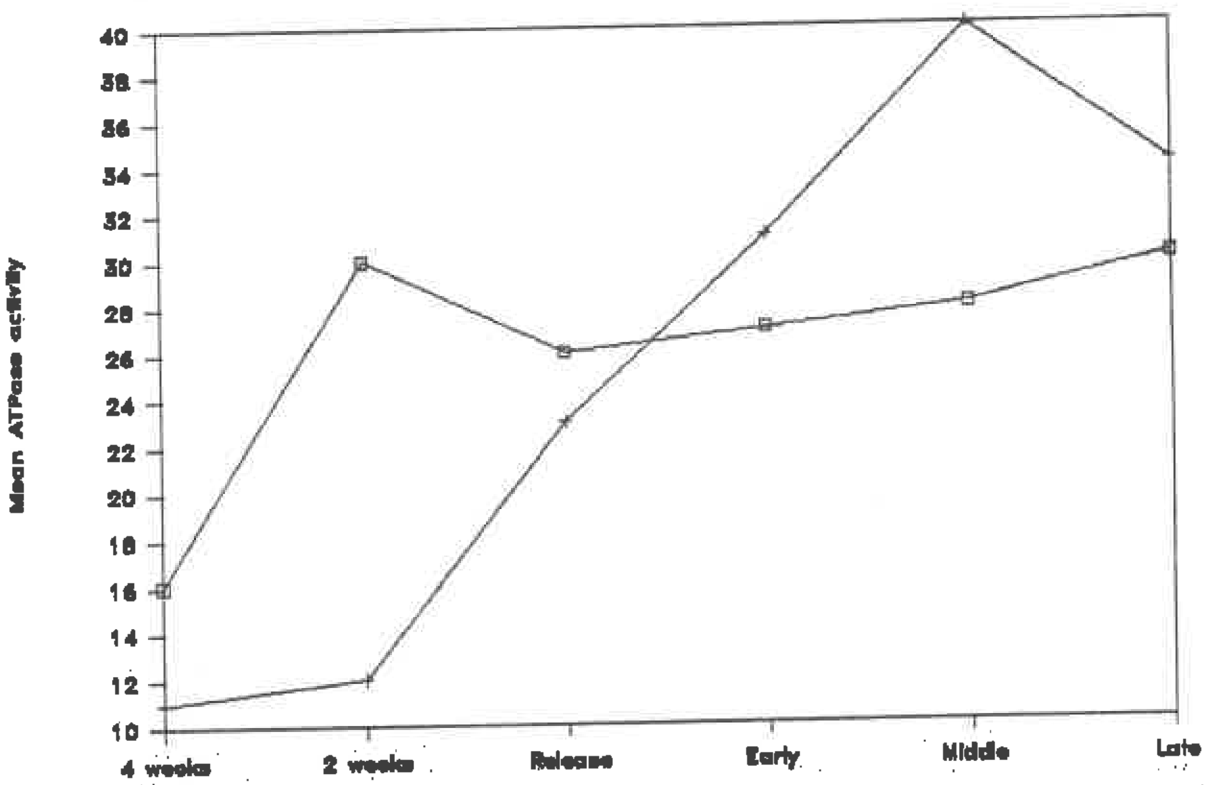

Figure 4. Gill ATPase levels in fall chinook salmon yearling and subyearling on-station releases from Lyons Ferry FH. Samples were taken four and two weeks prior to release, at release, and during the early, middle, and late stages of outmigration through McNary Dam.

2.5.1: Yearling releases

On-station group Mean length and coefficient of variation for the yearling (1986 brood) fall chinook salmon released at Lyons

Ferry FH were 173.3 mm and 8.9, respectively (Figure 5). The date 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 8.9 degrees C.

Transport group Fish were loaded into the barge on 19 April and were released adjacent to the lower navigation wing wall at Ice Harbor Dam the following day. Water temperature was 10.0 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 176.6 mm and 7.9, respectively (Figure 6).

2.5.2: Subyearling releases

On-station group Mean length and coefficient of variation for the subyearling (1987 brood fall chinook salmon) released from Lyons Ferry FH were 88.5 mm and 10.1, respectively (Figure 7). The date of release (1 June) was coordinated with the Corps of Engineers for a controlled spill (100 percent of instantaneous discharge) at Lower Monumental Dam. Snake River water temperature during release was 13.3 degrees C.

Transport group Fish were loaded into the barge on 8 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 13.9 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 89.7 mm and 9.2, respectively (Figure 8).

2.5.3: Fish passage

Branded yearling fall chinook released from Lyons Ferry FH on 14 April began arriving at Lower Monumental Dam on 16 April. Spill occurred at the dam on 15, 16, and 17 April for 3 hours/day, and from 30 April to 11 May for 10 hours/day. Branded subyearling fall chinook released from Lyons Ferry FH on 1 June began arriving at Lower Monumental Dam on 2 June. Spill occurred from 1 through 5 June, and 13 through 16 June. Based upon recoveries of branded fish, passage indices of the subyearlings released from Lyons Ferry FH remained high through 15 July, and continued through 26 July, when gatewell sampling at Lower Monumental Dam was terminated.

Travel time of the branded yearling fall chinook from Lyons Ferry FH to McNary Dam was 6.2 km/day. Flows on the Snake River during this period averaged 44.3 kcfs. Travel time of branded subyearling fall chinook from Lyons Ferry FH to McNary Dam was 7.8 km/day. Snake River flow during this period averaged 53.6 kcfs (Fish Passage Center 1989).

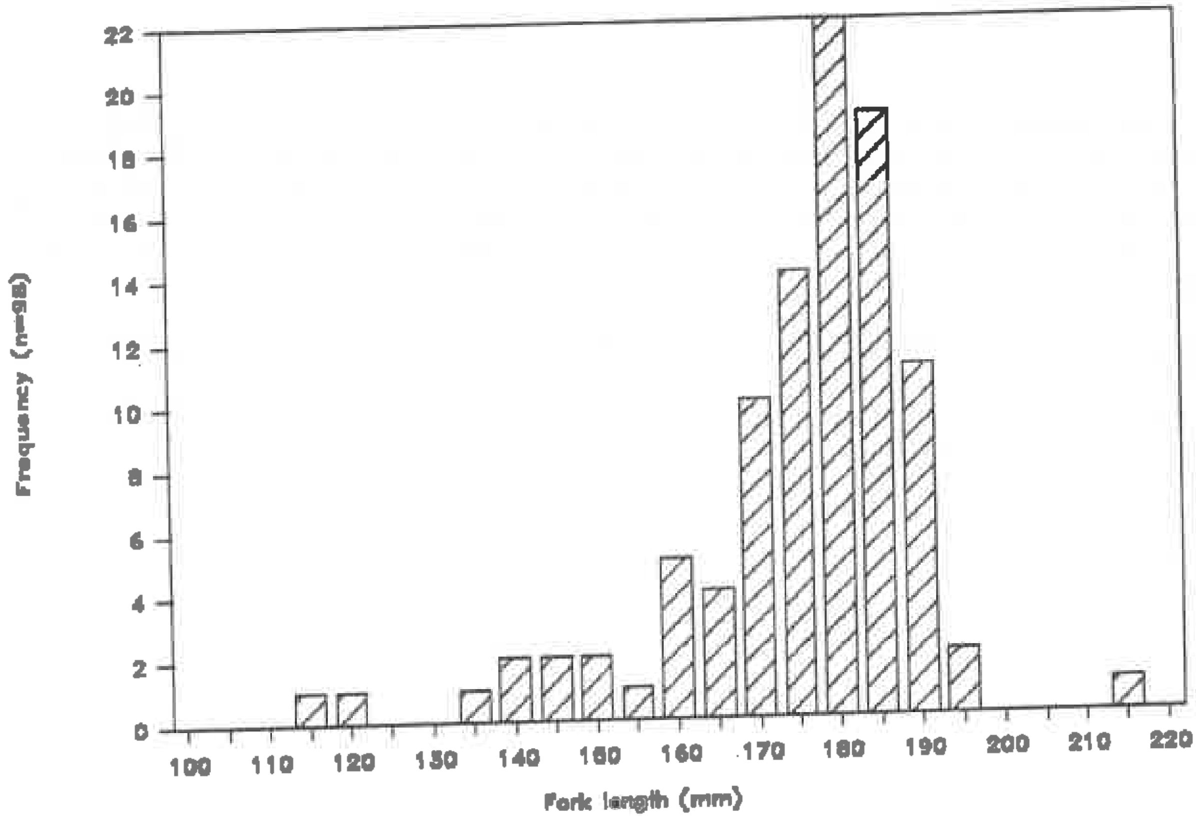

Figure 5. Length frequency distribution of yearling fall chinook salmon released at Lyons Ferry Fish Hatchery in April 1988.

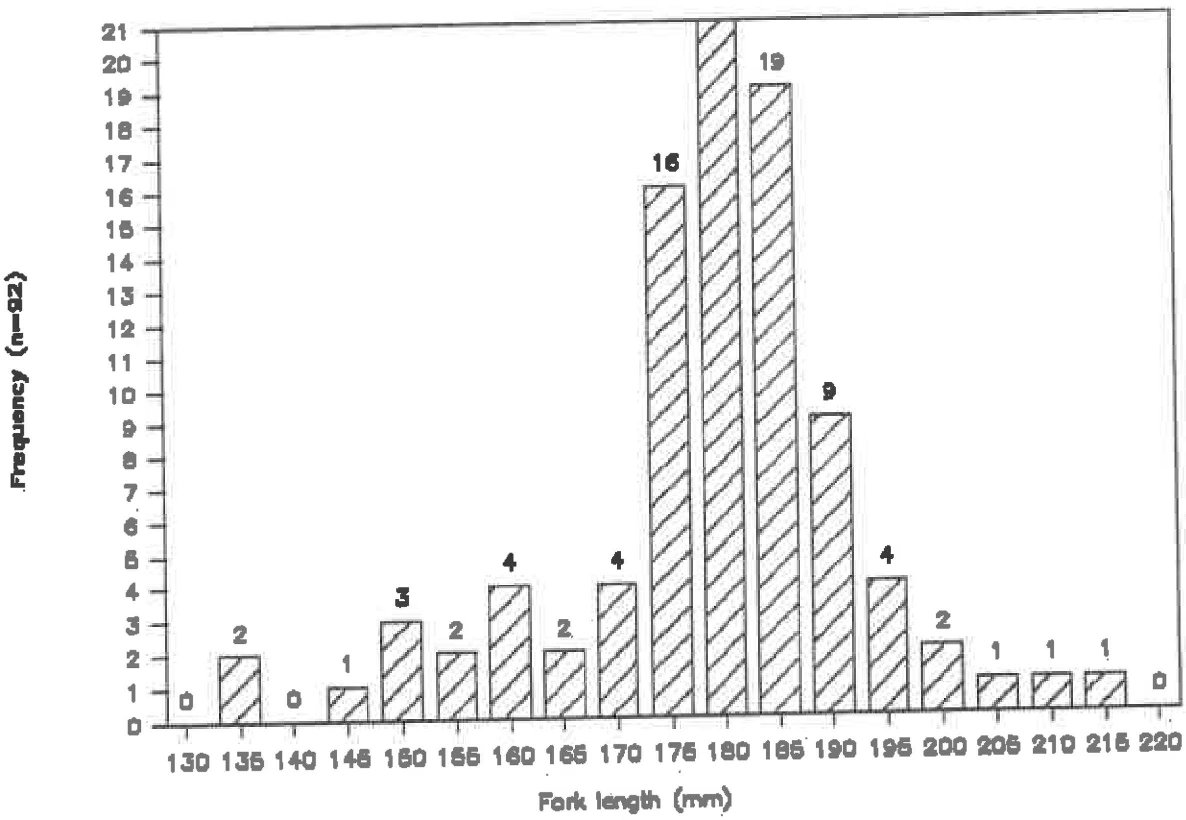

Figure 6. Length frequency distribution of yearling fall chinook salmon transported below Ice Harbor Dam in April 1988.

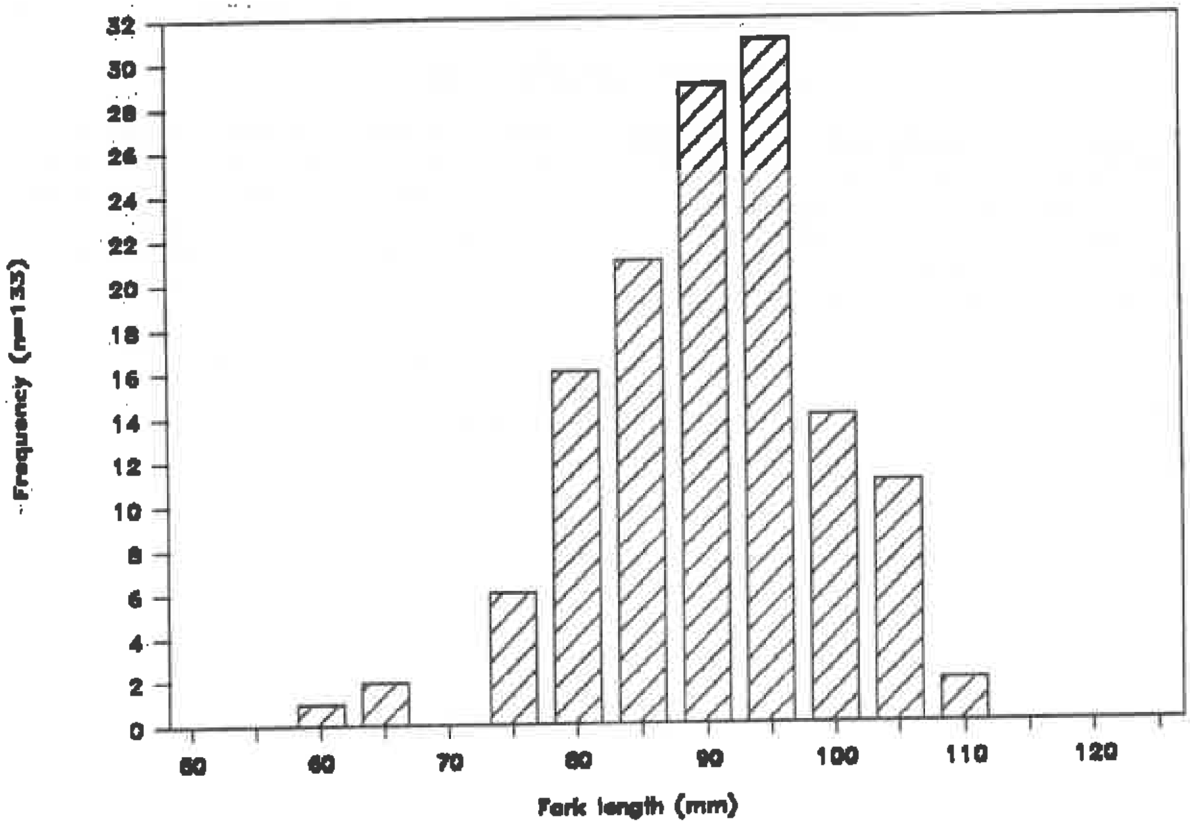

Figure 7. Length frequency distribution of subyearling fall chinook salmon released from Lyons Ferry Fish Hatchery in June 1988.

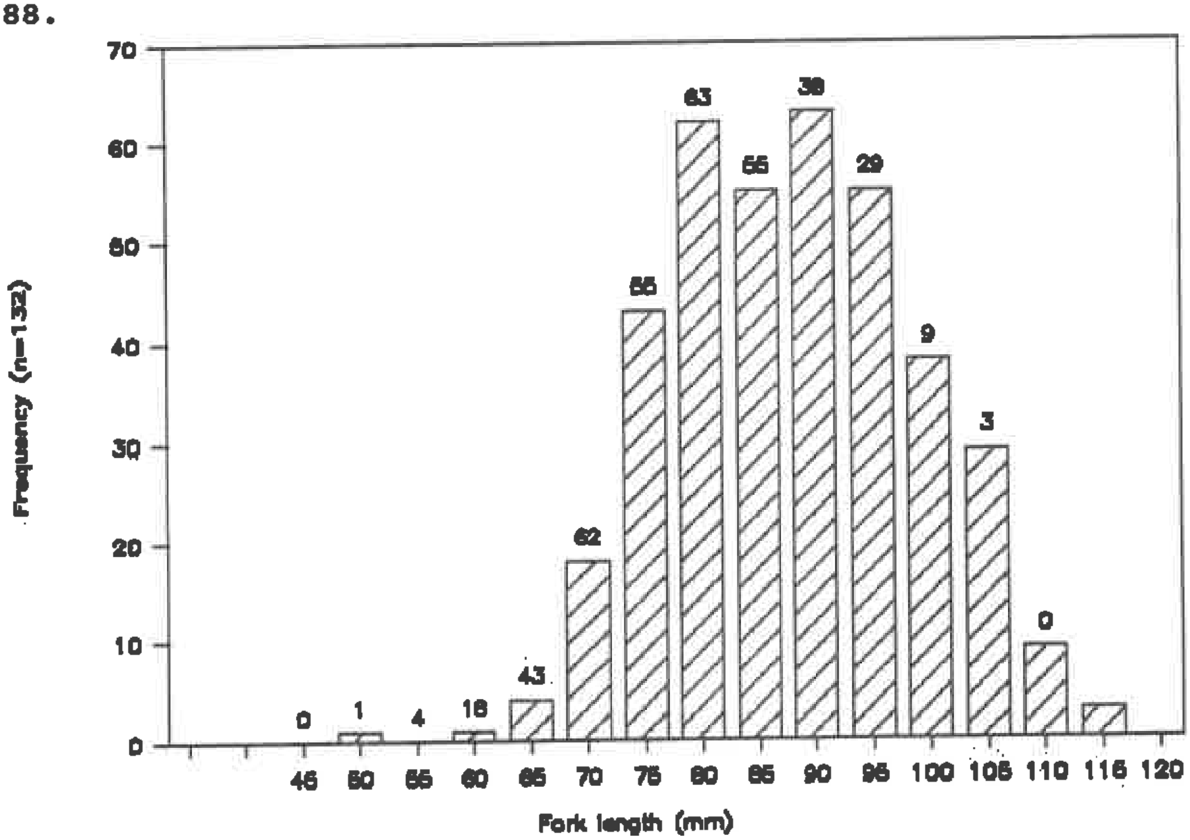

Figure 8. Length frequency distribution of subyearling fall chinook salmon transported below Ice Harbor Dam in June 1988.

2.6: Natural Production

Above Lower Granite Dam In November and December 1988, the Nez Perce Tribe, Idaho Power Company, Oregon Department of Fish and Wildlife, and WDF program staff cooperatively surveyed the Snake River from Asotin to Hells Canyon Dam and all its tributaries believed to be used by fall chinook salmon adults. Surveys were made with a Hiller 12E helicopter.

The mainstem Snake River was surveyed on 14 November and 1 December 1988. The final tally for both counts was 57 redds and 19 adults (Table 14), compared to 66 redds and 13 adults for the same area in 1987.

Table 14. Number and location of fall chinook salmon redds and adults seen on the mainstem Snake River in 1988.

River km	Landmark	14 November count Redds	14 November count Adults	1 December count Redds	1 December count Adults
245.5	Tenmile Canyon	--	--	1	--
246.3	No proximal landmark	4	11	4	--
262.4	Captain John Creek	--	--	2	--
266.8	Billy Creek	5	4	--	--
268.4	Above Fisher Gulch	10	--	4	--
284.4	Washington/Oregon border				
308.3	Below Eureka Creek	1	--	4	--
309.6	Imnaha River	--	--	4	--
313.5	Zigzag Creek	--	--	2	--
316.7	Doug Creek, Idaho	--	--	3	--
333.5	High Range Creek	3	3	1	--
335.5	Lookout Rapids #117	--	--	1	--
336.0	Lookout Rapids #118	2	--	--	--
354.6	Upper Kirby Rapids	2	--	--	--
361.5	Temperance Creek	--	--	1	--
381.4	Saddle Creek	--	--	2	--
398.5	Rocky Point	--	--	1	1
Totals		27	18	30	1

Conditions were excellent on the first flight, and good on the second flight. Virtually all redds seen on the first flight were not visible by the second flight, necessitating the need for two independent surveys. Mean flow and Secchi disk readings for the day of the first survey were 11,607 cfs (range: 10,920 - 13,350) and 2.7 m, respectively. Mean flow for the day of the second flight was 15,635 cfs (range: 13,480 - 18,610). A Secchi disk reading was not made for the second flight.

The Grande Ronde River was surveyed from the mouth to the Wenaha River confluence on 14 November 1988: no redds or fish were seen. The second Grande Ronde count was on 2 December 1988.

One redd was seen below the Highway 129 bridge. Conditions were excellent in the first count, and fair in the second.

The Imnaha River was surveyed up to the Cow Creek bridge on 11 November 1988: three live adults were seen. The second count was made from the mouth to the town of Imnaha on 2 December: one redd was seen in the vicinity of Cow Creek.

The Clearwater River was surveyed from the mouth to the North Fork Clearwater confluence, and up the North Fork to Dworshak Dam on 21 November 1988. Twenty one redds and four carcasses were seen; all were downstream of Bedrock Creek. Conditions were good.

Program staff surveyed the lower Asotin Creek and lower Alpowa Creek, by foot on 9 November 1988. No redds, live fish or carcasses were seen.

Fall chinook salmon counts at Lower Granite Dam were 613 adults and 325 jacks by 14 November (the first Snake River flight), 625 adults and 327 jacks by 1 December (the second flight), and 627 adults and 329 jacks by 15 December (the final day of counts at the dam). The total redd count above Lower Granite Dam in 1988 was 80, resulting in a ratio of about 8 adults per redd.

Below Lower Granite Dam Program staff surveyed fall chinook salmon spawning grounds in the lower 22.6 km of the Tucannon River on 2 November and 16 November 1988. We surveyed the lower 9.2 km on 9 November, 21 November, and 30 November 1988. A total of 26 redds were observed (Table 15). For the second successive year all were within the lower 9.2 kilometers of the river. No fall chinook salmon carcasses or redds were found above the 1.3 m high irrigation diversion dam at RK 9.4. Spawning ground density was 2.77 redds/km, compared to 1.70 redds/km in 1987.

We observed one redd on our initial survey of 2 November, and observed no new redds deposited by our last survey on 30 November. We inferred the duration of spawning to be at least 29 days. We estimate the peak of spawning to be 16 November compared to 12 November at Lyons Ferry FH. For comparison, the peak spawning dates in 1987 were 25 November on the Tucannon River and 17 November at Lyons Ferry FH. We retrieved 21 carcasses (nine females, ten males, and two jacks), of which 5 were recovered for CWT processing. Two of the marked fish were from the 1984 brood yearling on-station release, one was from the 1984 brood subyearling on-station release, one was from the 1985 brood subyearling on-station release, and the fifth marked fish had no CWT.

We surveyed the Palouse River from the falls downstream to its confluence with the Snake River on 21 November 1988. No redds, live fish or carcasses were seen.

Table 15. Number of fall chinook salmon redds observed and carcasses recovered by survey date and location on the Tucannon River in 1988.

Survey date	River kilometer	Number of redds	Carcasses recovered females	males
2 Nov.	22.6 - 9.4	0	-	-
	9.4 - 6.1	0	-	-
	6.1 - 0.0	1	-	1
9 Nov.	9.4 - 6.1	7	-	-
	6.1 - 0.0	2	-	2
16 Nov.	22.6 - 9.4	0	-	-
	9.4 - 6.1	0	-	-
	6.1 - 0.0	14	5	3
21 Nov.	9.4 - 6.1	1	2	1
	6.1 - 0.0	1	1	1
30 Nov.	9.4 - 6.1	0	1	1
	6.1 - 0.0	0	0	3
Totals		26	9	12

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 6 May; the last adult arrived on 27 June. Peak day of arrival was 24 May (compared to 27 May in 1986 and 15 May in 1987). We collected 119 adults and 15 jacks to fulfill broodstock requirements, and passed 142 adults upstream (Table 16), giving a total escapement to the rack of 261 adults and 15 jacks (compared to 247 adults in 1986 and 209 adults in 1987). Prior to removal of the rack, we counted 38 adults by snorkel surveys in the 6.4 km of stream immediately downstream of the rack (compared to 42 in 1987). This adjusts the total Tucannon River adult spring chinook salmon escapement to 299.

Table 16. Escapement, collection, and spawning summary for 1988 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
05/07	1	1	0				
05/14	37	23	14				
05/21	60	30	30				
05/28	64	34	30	1	1		
06/04	13	0	13				
06/11	8	3	5				
06/18	64	47	17		1		
06/25	9	4	5				
07/02	1	0	1				
07/09							
07/16							
07/23							
07/30					1		
08/06					1		
08/13					2		
08/20				2	1		
08/27				1	6		
09/03					5		8
09/10				1	2	6	23
09/17						4	12
09/24				3	1	31	6
Totals	257[a]	142	115[a]	8	21	41	49

[a] Weekly escapements were estimated; numbers were corrected at end of spawning. Actual numbers were 261 adults escaped to the rack, of which 119 were collected for broodstock.

Seven of the 15 jacks sampled at the Tucannon FH were coded-wire tagged. All tagged fish were from the first release of spring chinook smolts from Tucannon FH (12,992 in 1987). Survival of this release group through age 3 is 0.05 percent.

3.2: Stock Profile Characteristics

Average fecundity for the 1988 Tucannon River spring chinook salmon was 3,882, compared to 4,095 in 1987 and 3,916 in 1986. Average egg size for the 1988 adults was 1,793 eggs/pound, compared to 1,748 eggs/pound in 1987. Fecundity values were determined by dividing the total number of eggs taken by the number of females spawned. To obtain a more precise estimate of fecundity, we collected about 100 eggs from 35 randomly selected females during the eggtake, weighed and counted them, and compared these values to the total weight of eggs in that female. Using this method, average fecundity was 4,329 eggs per female (s=697) and average egg weight was 0.22 grams (s=0.04) or 2,095 eggs/pound (Appendix D).

Spring chinook salmon spawned at the Tucannon FH were mostly 4 years old (69 of 137 fish measured), with two years of their life in the ocean (4/2), 20 three-year old jacks (3/2) were recovered, and the remainder (55 fish) were 5 year olds having spent 3 years in the ocean (5/2; Table 17). Mean fork length was 74.5 cm (n=137; Figure 9). We found the mean length of age 4 returning adults (71.8 cm) to be significantly less than age 5 adults (85.1 cm; unpaired t-test $p<0.05$). Mean length by age class differed little from spring chinook adults returning in 1985 and 1986 (Table 18). For the three year classes, 80 cm is a consistent breakoff between four and five year olds using one standard deviation.

Table 17. Sex, mean fork length (cm), and age (from scale impressions) of spring chinook salmon sampled at the Tucannon Fish Hatchery, 1988.

Sex	Fork length (s, n) at given age: 3/2	4/2	5/2	Totals
Female	- -	71.3 (7.1, 32)	83.4 (3.4, 32)	64
Male	49.1 (2.0, 7)	72.2 (8.2, 25)	88.7 (4.9, 15)	47
Totals	7	57	47	111
Percent	6	52	42	100

Table 18. Comparison of fork length (cm), by age of adult spring chinook salmon sampled at the Tucannon Fish Hatchery from 1985 through 1988.

Return year	Age 3 (x, s, n)	Age 4 (x, s, n)	Age 5 (x, s, n)
1985	- -	74.5, 5.7, 19	86.6, 2.9, 8
1986	63.0, - -, 2	72.3, 4.1, 89	86.9, 3.7, 13
1987	47.0, - -, 1	70.9, 4.7, 61	86.7, 5.6, 36
1988	49.1, 2.0, 7	71.7, 7.5, 57	85.1, 4.6, 47

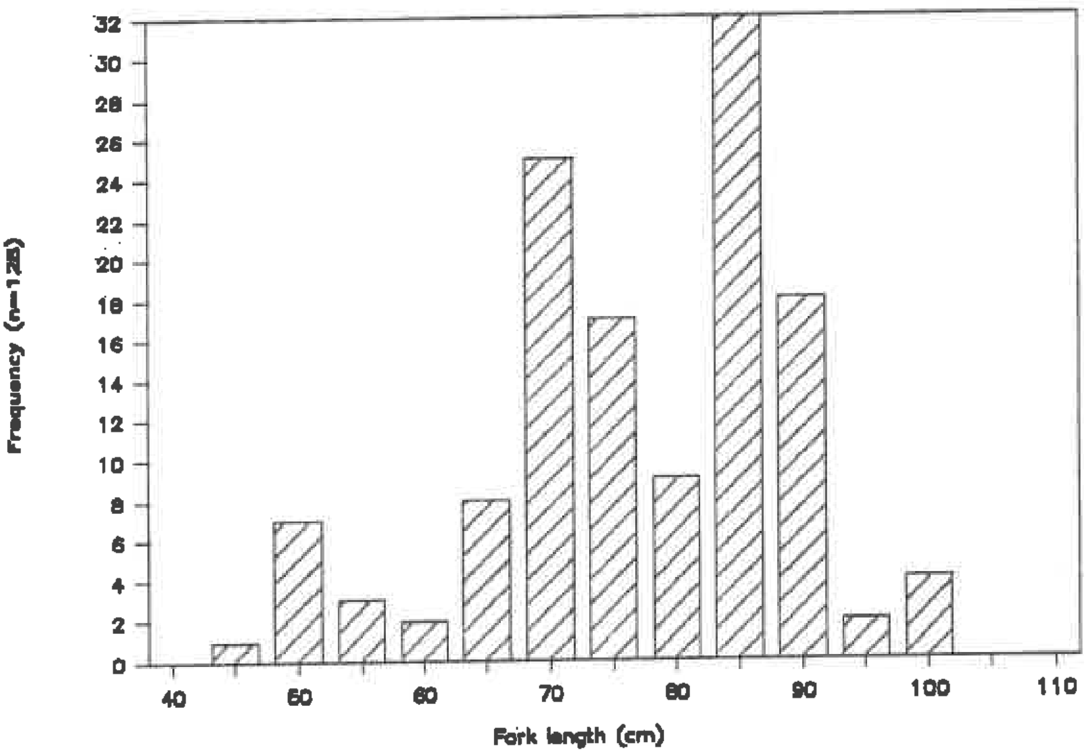

Figure 9. Length frequency distribution of spring chinook salmon adults sampled at the Tucannon Hatchery in 1988.

Program staff collected 100 electrophoretic samples from 1988 adult spring chinook salmon trapped at the Tucannon FH, and 100 natural-origin juveniles (1986 brood) at the downstream migrant trap. Program staff collected 100 hatchery-reared 1987 brood spring chinook salmon for morphometric analysis. We also retained all mortalities of natural-origin juveniles (both 1986 and 1987 broods) incurred during the electrofishing surveys and downstream migrant trap operations on the Tucannon River for morphometric analysis (Taylor 1986). We used the same techniques for electrophoretic and morphometric research as in 1987 (Seidel et al. 1988). Otoliths were retained on all adults as a possible supplement in stock identification (Neilson et al. 1985). Results and a discussion of these studies will be published separately.

3.3: Lyons Ferry/Tucannon Hatchery Practices

3.3.1: 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 30 August to 20 September, with peak of spawning on 7 September, compared with 17 September in 1986 and 19 September in 1987 (Table 16). Eggtake was 182,438 with 29,695 lost (16.28 percent). Soft-egg disease apparently was a primary factor of the high egg loss.

3.3.2: Disease incidence

The 1988 adult spring chinook salmon were injected with Erythromycin prior to spawning for treatment of bacterial kidney disease (BKD) and injected with Terramycin for treatment of the bacterial disease _Flexibacter columnaris_. Flush treatments of formalin (1:5000) were applied to the adults for control of fungus infection. The 1986 brood had a mild outbreak of bacterial gill disease prior to release. The 1987 brood had mild outbreaks of BKD (Table 19). Monthly mortality rates averaged 0.29 percent (range: 0.04 - 0.98, n = 12) for the 1986 brood and 0.39 percent (range: 0.03 - 0.59, n=12) for the 1987 brood. Average monthly mortality rate for the 1988 brood was 0.50 percent (range: 0.00 - 1.38, n=4). Overall mortality rate (egg to smolt) for the 1986 brood spring chinook salmon was 11.94 percent, compared to 12.94 percent for the 1985 brood.

Table 19. Incidence, date, location, and treatment of diseases for 1986, 1987, and 1988 broods spring chinook salmon contracted at Lyons Ferry Fish Hatchery. Data are listed by calendar year.

Brood year	Date	Disease	Pond numbers	Treatment
1986	02/88	Bacterial gill	Tucannon pond	Diquat
1987	02/88	Bacterial kidney	1, 2	Gallimycin
	03/88	Bacterial kidney	1, 2	Gallimycin
	07/88	Bacterial kidney	1 to 10	Gallimycin
1988	08/88	Fungus	Incubation room	Formalin
	09/88	Fungus	Incubation room	Formalin
	10/88	Fungus	Incubation room	Formalin
	11/88	Fungus	Incubation room	Formalin

3.3.3: Smolt releases

Lyons Ferry FH staff transported 156,138 yearling (1986 brood at 16 fpp) spring chinook salmon to the adult holding pond at Tucannon FH on 12 November 1987. The fish were acclimated to river water at least four months prior to release. We released roughly one-fourth of the fish on 7 March 1988 to reduce the loading density of the holding pond. We held the remaining 113,725 fish until 5 days prior to spill at Lower Monumental Dam (the first dam on the Snake River downstream of the Tucannon FH). We based this release time on the previous year's travel time estimates derived from the downstream migrant trap. Smolts volitionally emigrated from 11 to 13 April. Mean size and coefficient of variation of the smolts at the April release were 158.3 mm and 13.6, respectively (Figure 10). Condition factors of these fish at release averaged 1.17. All were coded-wire tagged and adipose-fin clipped. The ratio of females to males at time of release was 0.58:1.00 (n=144). Three percent of the males (3 of 91 sampled) were precocious.

Program staff monitored travel time of the smolts from the hatchery to the main downstream migrant trap located 38 km downstream (refer to section 3.4.10 for methods). Roughly four percent (5,627 of 153,725 released) of the hatchery-reared fish were collected at the trap; modal travel time for the hatchery-reared spring chinook salmon was about four days for the 38 km distance. Travel times of the hatchery-reared fish were the same as that of the natural-origin spring chinook salmon. We analyzed 911 hatchery-origin fish and found 41 percent were descaled in two or more zones. In general, larger fish had higher levels of descaling, both prior to release, and during outmigration.

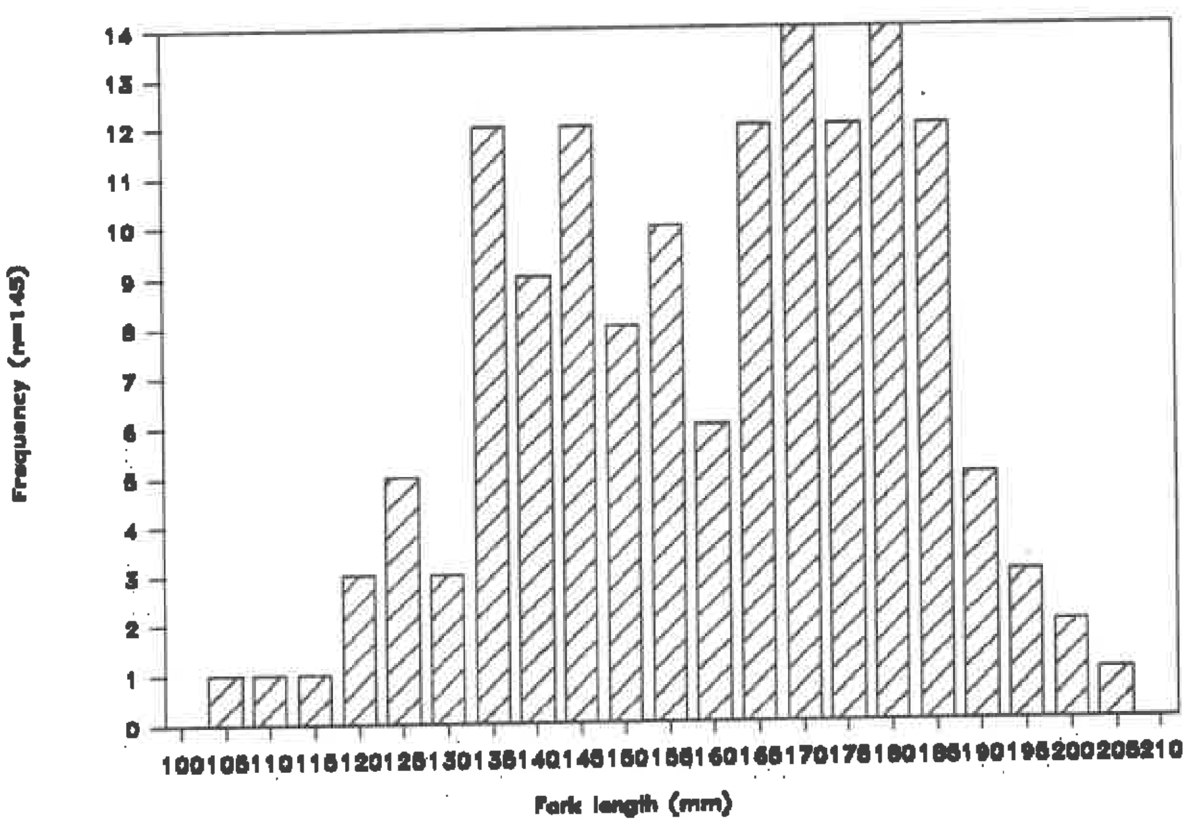

Figure 10. Length frequency distribution of 1986 brood spring chinook salmon released from Tucannon Fish Hatchery in April 1988.

3.4: Natural Production

We conducted electrofishing surveys in the Hartsock, HMA, and Wilderness Strata from 13 July through 11 October. We sampled several index sites within each stratum; these are monitored yearly to determine trends in juvenile salmonid production (refer to Appendix E for a description of site locations). Sampling design and methods for these surveys are presented in previous annual reports. 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 in the HMA Stratum with snorkel surveys in the 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).

3.4.1: Wilderness Stratum parr production

Methods We used a stratified random sampling design to identify and survey three distinct habitat types within the Wilderness Stratum: riffles, runs, and pools. These sites are sampled yearly to serve as indicators of relative parr abundance. In 1988, we sampled 6 of the 24 sites established.

Results Mean density and biomass of spring chinook salmon parr for the 10.1 km long Wilderness Stratum were 23.42 fish/100m2 and 119.33 grams/100m2, respectively (Tables 20, 21). Spring chinook salmon densities averaged 38.96 fish/100m2 in the pools (n=3), 10.38 fish/100m2 in the runs (n=2), and 2.84 fish/100m2 in the riffles (n=1). Spring chinook salmon parr mean densities were lower in each respective habitat type in 1988 compared to 1987. We sampled a cumulative 480 m2 (or 0.62 percent) of the stream within the Wilderness Stratum. Rearing density estimates for 1985, 1986, 1987, 1988 are shown in Table 22.

Table 20. Comparison of spring chinook salmon rearing densities and biomass (with sample size, mean, and standard deviation) by stratum, Tucannon River, Washington, 1988

Stratum	Sample size	Density (fish/100m2)		Biomass (grams/100m2)	
		mean	S.D.	mean	S.D.
Wilderness	6	23.42	20.10	119.33	115.33
HMA	30	25.68	23.76	105.75	110.66
Hartsock	6	16.06	19.90	105.28	155.66

Table 21. Spring chinook salmon rearing densities and biomass within the Wilderness Stratum, Tucannon River, Washington, 1988.

Habitat type	Site	1988 density (fish/100m2)	1988 biomass (grams/100m2)
Riffle	Wild 1	2.84	6.97
Run	Wild 10	4.41	25.39
	Wild 15	16.35	49.37
Pool	Wild 3	39.42	234.42
	Wild 5	53.90	283.36
	Wild 11	23.57	116.44

Table 22. Comparison of 1985, 1986, 1987, and 1988 spring chinook salmon rearing densities in selected index sites in the Wilderness Stratum, Tucannon River, Washington.

Habitat type	Site	Density (fish/100m2) by year			
		1985	1986	1987	1988
Run	Wild 10 [a]	12.92	37.48	15.65	4.41
Pool	Wild 3	34.51	96.65	40.60	39.42
	Wild 5	45.01	41.22	79.06	53.90
	Wild 11	47.39	80.72	46.76	23.57

[a] Refer to Appendix E for site description.

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). We sampled six replicates of each habitat type. The 1988 sampling design for the HMA Stratum is identical to 1986 and 1987 sampling designs (Seidel and Bugert 1987, Seidel et al. 1988).

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 25.68 fish/100m2 and 105.75 grams/100m2, respectively (Table 20). We sampled 1.70 percent of the stream within the HMA Stratum. Stratum densities decreased from summers of 1986 and 1987 by 34 percent and 21 percent respectively (Appendix G). Densities differed significantly among habitat types within the HMA Stratum (Friedman's two-way ANOVA $p<0.05$). We used Wilcoxon sign-rank pairwise comparisons (Daniel 1978) to compare densities by habitat type. Riffles and boulder sites had lower densities than side channels ($p<0.05$). Boulder sites also had lower densities than pools and runs ($p<0.05$). Biomass was highest in side channels, and lowest in the boulder sites (Table 23).

Table 23. Spring chinook salmon parr mean density and mean biomass by habitat type within the HMA Stratum, Tucannon River, Washington, 1988.

Habitat type	Mean density (fish/100m2)	Mean biomass (grams/100m2)
Riffle	12.35	43.29
Run	28.05	118.97
Pool	27.20	122.17
Boulder	9.35	34.93
Side channel	51.44	209.37

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 index sites are used for annual electrofishing surveys to monitor relative changes in parr production.

Results Mean spring chinook salmon density and biomass for the Hartsock Stratum were 16.06 fish/100m2 and 105.28 grams/100m2, respectively, (Tables 20, 24). We sampled 0.73 percent of the stream within the Hartsock Stratum. Spring chinook salmon densities decreased from 1987 by 29 percent (Table 25).

Table 24. Spring chinook salmon rearing densities and biomass in the Hartsock Stratum, Tucannon River, Washington, 1988.

Habitat type	Site	1988 density (fish/100m2)	1988 biomass (grams/100m2)
Riffle	Hart 5	5.04	31.30
	Hart 8	17.66	83.35
	Hart 9	10.12	54.58
Run	Hart 1	1.92	13.46
	Hart 6	6.46	29.86
Pool	Hart 7	55.16	419.13

Table 25. Comparison of 1985, 1986, 1987, and 1988 spring chinook salmon rearing densities in selected index sites in the Hartsock Stratum, Tucannon River, Washington.

		Density (fish/100m2) by year			
Habitat type	Site	1985	1986	1987	1988
Riffle	Hart 3[a]	- -	- -	21.95	- -
	Hart 5	- -	13.91	10.67	5.04
	Hart 8	- -	9.13	21.16	17.66
	Hart 9	- -	- -	17.80	10.12
Run	Hart 1	- -	- -	24.63	1.92
	Hart 2	3.48	12.56	34.83	- -
	Hart 6	10.30	21.48	16.41	6.46
Pool	Hart 4	- -	- -	4.26	- -
	Hart 7	- -	- -	52.49	55.16

[a] Refer to Appendix E for site description.

3.4.4: Tucannon tributaries parr production

We electrofished index sites on three tributaries of the Tucannon River: Sheep Creek (confluence with Tucannon River at RK 83), Panjab Creek (RK 76), and Cummings Creek (RK 58). Index sites were the same selected and electrofished in 1985, 1986, and 1987. We did not find rearing spring chinook salmon in Panjab Creek or Sheep Creek. There has been either low densities or no production of spring chinook salmon in Sheep Creek since surveys have been conducted (Table 26). For the four 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.

Table 26. Comparison of spring chinook salmon rearing densities in index sites on Tucannon River tributaries in 1985, 1986, 1987, and 1988.

		Density (fish/100m2) by year			
Stream	Site	1985	1986	1987	1988
Sheep Creek	1	3.48	0.00	0.00	0.00
	2	10.30	0.00	0.00	0.00
Panjab Creek	1	13.40	1.13	31.26	-
	2	6.88	0.00	24.62	0.00
Cummings Creek	1	9.00	5.70	9.63	7.04
	2	0.00	2.79	10.88	3.36

3.4.5: Rate of growth

Program staff calculated growth rates for 1987 brood year Tucannon River spring chinook salmon parr for the Wilderness and HMA Strata. Dates for the growth study were 27 July to 26 September. The instantaneous growth rate (Ricker 1975) in the Wilderness Stratum for 61 days was 0.28. The HMA Stratum instantaneous growth rate for 55 days was 0.48. Relative growth rates were 32 percent and 61 percent for the Wilderness and HMA Strata respectively. Virtually all the 1809 rearing parr we sampled during the electrofishing surveys in 1988 were subyearlings (Figure 11).

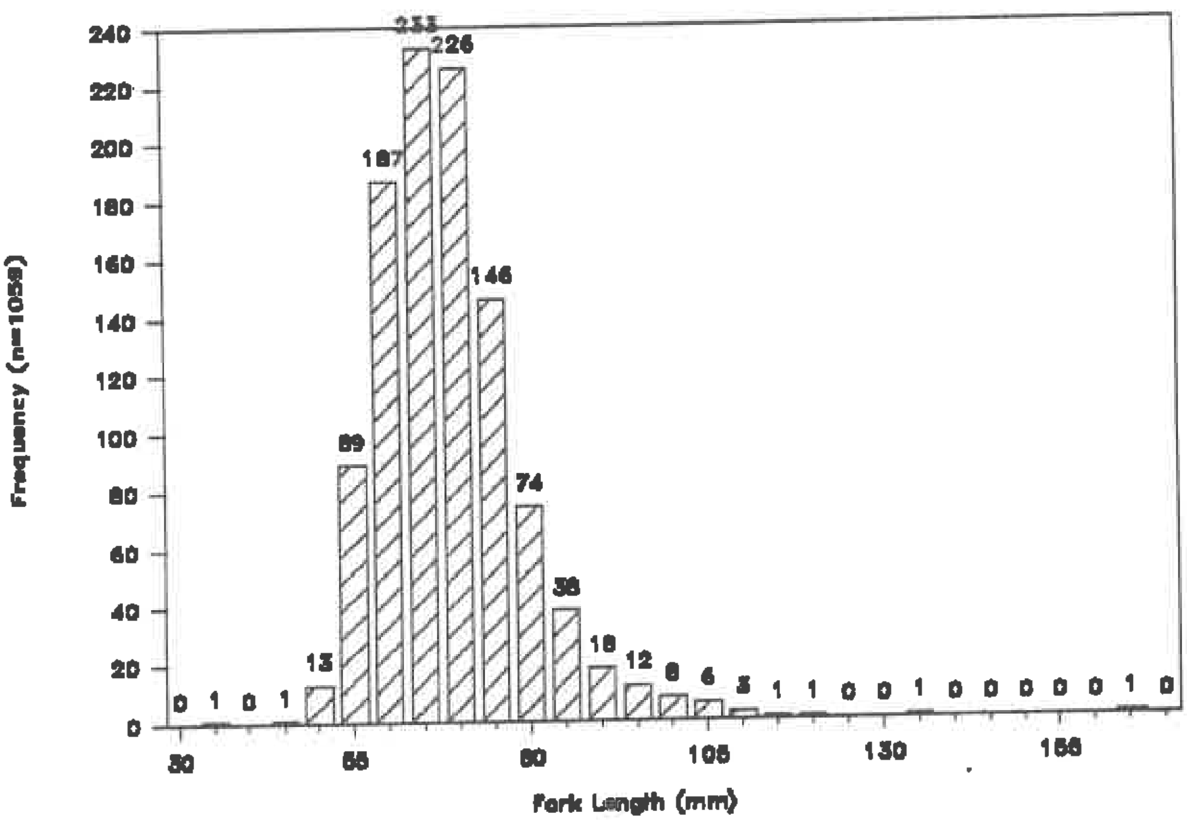

Figure 11. Length frequency distribution of spring chinook salmon sampled during electrofishing surveys in 1988.

3.4.6: HMA Stratum snorkel surveys

We used a modified line transect sampling method (Emlen 1971) to estimate rearing salmonid abundance during summer and winter in the HMA Stratum. The summer snorkeling surveys were completed in the same month (August) as the electrofishing surveys, enabling us to draw some comparisons between these two techniques for population estimation.

Estimates of density (expressed as fish/100m2) and total number of fish derived through line transect snorkel surveys were consistently higher than multiple-pass depletion electrofishing surveys in the same sites. We found snorkeling to be an effective means to assess changes in distribution of salmonids from summer to winter, both in terms of habitat used and location of the river continuum used. For late summer rearing salmonid estimates, we believe line transect sampling is most reliable when estimating the size of single age class populations (such as spring chinook salmon), but is not as effective when used on multiple aged populations (such as steelhead). We will present detailed results of this study in a separate report in March 1990.

3.4.7: North Fork Asotin Creek parr production

We sampled five index sites established in 1986 to determine spring chinook salmon parr abundance (one riffle, two runs, and two pools) and found no spring chinook salmon parr. The sites were North Fork Asotin two through six.

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 11 May through 31 October. Locations of the thermographs were as follows:

1) 300 m upstream of the Sheep Creek confluence (RK 83)
2) 300 m downstream of the Panjab Creek confluence (RK 76)
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 62)
6) 100 m downstream of the Cummings Creek confluence (RK 58)

The thermograph at the Sheep Creek 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 27). The most significant temperature increase occurred between the Panjab Creek and Big 4 Lake thermographs. We saw this same phenomenon in 1987. Stream temperatures remained essentially the same between the Beaver-Watson Lakes complex and Deer Lake. Daily maximum stream temperatures were lower at the Cummings Creek sampling location than at the Deer Lake location, 5 km upstream. This tempering process is probably a result of the spring water effluent from Tucannon FH at RK 61. The daily record for the five thermographs is presented in Appendix H.

Table 27. Mean monthly ranges (minimum to maximum) water temperatures at selected Tucannon River sampling locations in 1988. Data are listed in degrees Celsius.

Month	Panjab Creek	Big 4 Lake	Beaver Lake	Deer Lake	Cummings Creek
May	3.3-10.0	5.0-12.8	6.1-15.0	6.1-15.0	6.1-15.0
June	3.9-13.9	6.1-17.8	7.2-20.0	6.1-20.0	7.2-17.2
July	6.1-14.4	7.2-18.3	7.2-20.0	7.8-21.1	8.9-18.9
August	6.1-12.8	7.8-17.2	10.0-18.9	8.9-18.9	10.0-17.2
September	5.0-12.2	6.1-15.6	7.2-17.2	7.2-17.2	7.8-17.2
October	- - [a]	7.8-12.2	3.9-12.8	3.9-12.8	7.2-12.2

[a] The Panjab Creek thermograph operated only to 23 September.

3.4.9: Spawning ground surveys

<u>Tucannon River</u> 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 24 and 31 August, 6, 14, 21 and 28 September, and 5 October. Person-days required for the surveys were 1, 4, 9, 9, 5, 6, and 2 respectively. The 14 and 28 September surveys encompassed all known spring chinook salmon spawning areas within the Tucannon River.

Total number of redds in the Tucannon River in 1988 was 117 (Table 28). The number of redds sighted in the Tucannon River decreased from the estimated previous five year mean of 162 redds (Table 29), and 20 year mean of 127 redds. We found no redds in the Tucannon River tributaries Sheep, Panjab, or Cummings Creeks.

Table 28. Results of Tucannon River spring chinook salmon spawning ground surveys, 1988.

Stratum	River kilometer	Number of redds	Carcasses recovered: females	Carcasses recovered: males
Wilderness	87-76	18	1	1
HMA	76-69	25	10	9
	69-64	42	10	6
	64-55	12	5	3
Hartsock	55-48	16	8	8
	48-43	4	1	2
Totals		117	35	29

Eighteen redds were sighted in the Wilderness Stratum of the Tucannon River, which is 10.1 km long, resulting in a density of 1.78 redds/km. This density is similar to our 1987 results but is considerably lower than we found in 1985 and 1986 (Table 29). We saw 79 redds in the 20.2 km HMA Stratum, indicating a 3.91 redds/km density, which is lower than the previous three years. Twenty redds were found in the 12.7 km Hartsock Stratum, resulting in a density of 1.57 redds/km. This is lower than the 1987 and 1986 density.

Table 29. Comparison of spring chinook salmon redd density (redds/km) by stratum and by year, Tucannon River, Washington.

Stratum	1985	1986	1987	1988
Wilderness	8.32	5.25	1.49	1.78
HMA	5.33	5.79	6.93	3.91
Hartsock	-	2.28	2.36	1.57

From the seven counts on the Tucannon River, we concluded that the peak of spawning for spring chinook salmon varied by river kilometer. Peak of spawning was 14 September for the upstream reaches (Wilderness and HMA Strata), and 21 September for the Hartsock Stratum. We found one spring chinook salmon redd by the 24 August survey of the Wilderness Stratum, and 18 new redds were deposited the week of the 28 September count, indicating the duration of spawning to be at least 35 days.

<u>Asotin Creek</u> On 1 and 22 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 one redd, for a density of 0.10 redds/km. The redd was deposited by 1 September. We counted one redd in 1986 and three redds in 1987 in this section of Asotin Creek.

<u>Butte Creek</u> This was the second year we surveyed this stream, which is a tributary to the Wenaha River. The Oregon reach of Butte Creek is usually surveyed by ODFW (Witty, personal communication). In 1988 we were able to survey all available spawning areas within the Washington reach of the Butte Creek system, which is 11 km. Survey dates were 29 August and 19 September. We sighted ten redds, all were below the confluence of the East Fork and the West Fork Butte Creek. Four redds were deposited by 29 August and six redds deposited by 19 September. The section within Washington below the East Fork and West Fork Butte Creek confluence is 6.4 km. The density for this reach in 1988 was 1.56 redds/km. In 1987 we found 8 redds within a 3.2 km survey area, for a density of 2.50 redds/km.

<u>North Fork Wenaha River</u> Program staff surveyed 2.4 km of this river within Washington on 8 September. One redd was sighted.

Wenatchee Creek We surveyed this tributary to the Grande Ronde River on 1 September 1988 and found no redds or adult salmon. In 1987 WDW biologists observed spring chinook salmon parr rearing in Wenatchee Creek.

3.4.10: Downstream migrant trap operations

An important objective of our study is to estimate the magnitude, duration, periodicity, and peak of spring chinook salmon outmigration from the Tucannon River. To do this, we maintain a floating inclined plane downstream migrant trap on the river at RK 21. We operated the trap intermittently from 6 October 1987 to 1 March 1988, and then trapped continuously until 30 June 1988. A detailed description of our trapping operations is given in previous annual reports.

Methods To calibrate trapping efficiency, we marked (clipped the tip of the pelvic fin) captured smolts and transported them 10 km upstream of the trap for release. Only natural-origin 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. 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

We marked a separate group of natural-origin smolts (clipped the tip of the caudal fin) and released them adjacent to the Tucannon FH, 38 km upstream of the trap. Our objectives were: 1) to determine and compare travel time of natural and hatchery smolts, and 2) use this information to estimate the appropriate release date for the hatchery smolts to arrive at Lower Monumental Dam during spill conditions.

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 (10,327) and weighed 1,842 (18 percent) of the fish on a random basis. Water temperature, flow, velocity, clarity (determined with a 25 cm Secchi disk), and photoperiod were recorded daily to be used as covariates in explaining variability in smolt migrations.

Results During the period 6 October 1987 to 30 June 1988, we caught and processed 11,843 natural and 5,627 hatchery spring chinook salmon smolts, compared to 6,239 natural and 35 hatchery smolts in the 1986/87 season. Peak of outmigration was the period 20 April to 10 May (Figure 12), coinciding well with the peak flow (least squares $p<0.05$), and roughly the same period as in the 1986/87 season. Mains and Smith (1955) found peaks of outmigration from the Tucannon River 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.

During the 1987/1988 season, average trap efficiency was 23.7 percent (812 of 3,429) for the 10 km release test fish and 28.5 percent (151 of 530) for the 38 km release test fish (Appendix I). Overall trap efficiency during the 1987/1988 season was 24.3 percent (963 of 3,959), compared to 21.6 percent in the 1986/1987 season. We estimate 58,236 (95 percent confidence interval of 1,401) natural spring chinook salmon smolts outmigrated in the 1987/1988 season, compared to 35,559 (95 percent confidence interval of 2,485) in the 1986/1987 season.

Dates of the 5, 25, 50, 75, and 95 percentiles of cumulative outmigrants caught occurred on 25 January, 3 April, 22 April, 6 May and 26 May, respectively. We compared Julian date, photoperiod, 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 $p<0.05$). Eighty percent of the outmigrants were caught between 2201 and 0700 hours, 10 percent were caught between 0701 and 1500 hours, and 10 percent were caught between 1501 and 2200 hours.

Travel time for the natural-origin spring chinook salmon from the 38 km release fish varied from 2 to more than 14 days. Modal travel time was 4 days, the same as the hatchery-reared spring chinook. Mean and median travel times were 6.2 and 8 days, respectively.

Mean length of the 10,327 natural spring chinook salmon measured was 99.79 mm (Figure 13). Fish of this year class were much larger than the outmigrants in the 1986/1987 season (the mean length of 6,221 fish measured then was 89.57 mm). We found the yearling spring chinook salmon average length increased as the outmigration season progressed (least squares r=0.19, p<0.10). Mains and Smith (1955) and Major and Mighell (1969) also saw this relationship. Condition factors of the 1987/1988 outmigrants were larger than the 1986/1987 outmigrants. Mean condition factors for parr, transitional smolts, and full smolts were 1.26 (n=13), 1.10 (n=411), and 1.13 (n=1,484), respectively, and increased as the outmigration season progressed (least squares r=0.31, p<0.10).

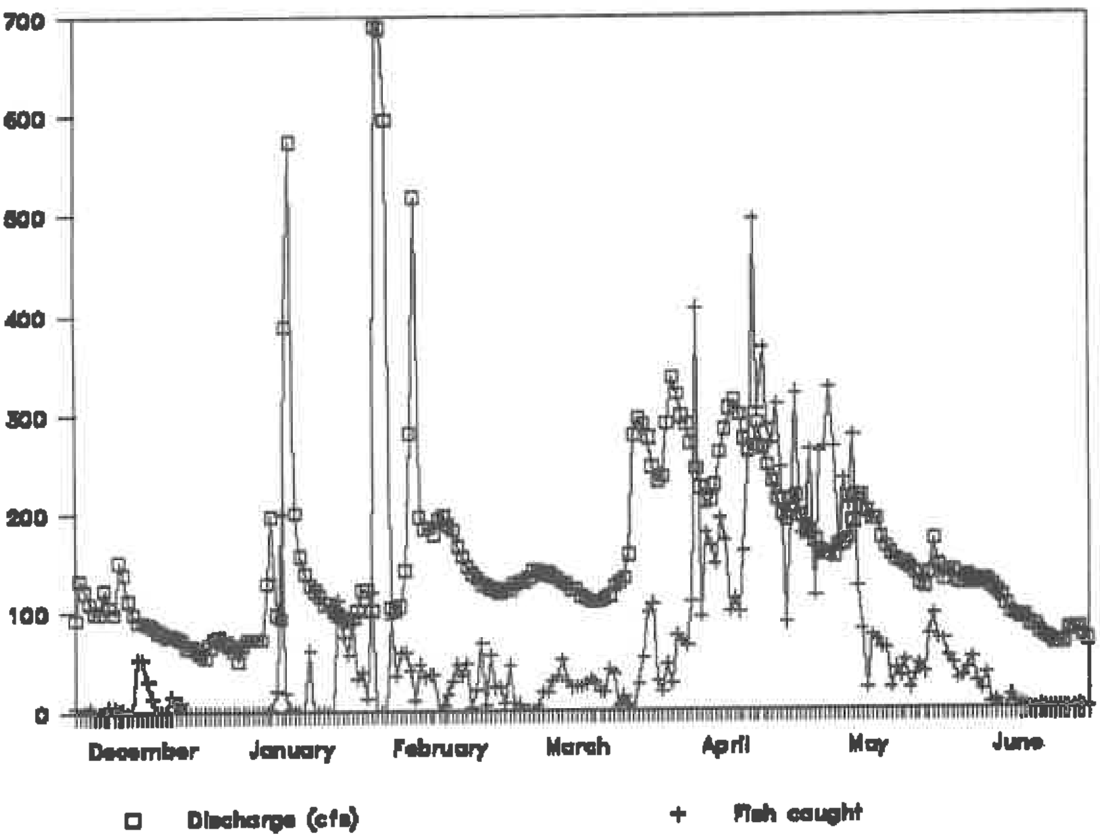

Figure 12. Comparison of daily number of spring chinook salmon caught in the Tucannon River downstream migrant trap with average daily flow.

We assessed the degree of smoltification on 10,066 natural spring chinook salmon; 81 percent (8,184) were classified as full smolts, 18 percent (1,803) were considered transitional smolts, and one percent (79) were assessed as parr. Virtually all of the outmigrants were yearlings. Most parr were collected in May. We took scale samples of 18 parr in the lower 25th percentile for length (fork lengths ranged from 51 to 66 mm); all were age zero.

We found an overall 2.2 percent descaling rate (two or more zones each with 40 percent scale loss), compared to 6.9 percent in the 1986/1987 season. We saw no difference in descaling between fish captured once and those captured and handled twice (recaptured marked fish). Overall, 34 natural and no hatchery spring chinook salmon died in the trap during the eight month season (0.3 percent).

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 J lists species caught, and their relative abundance.

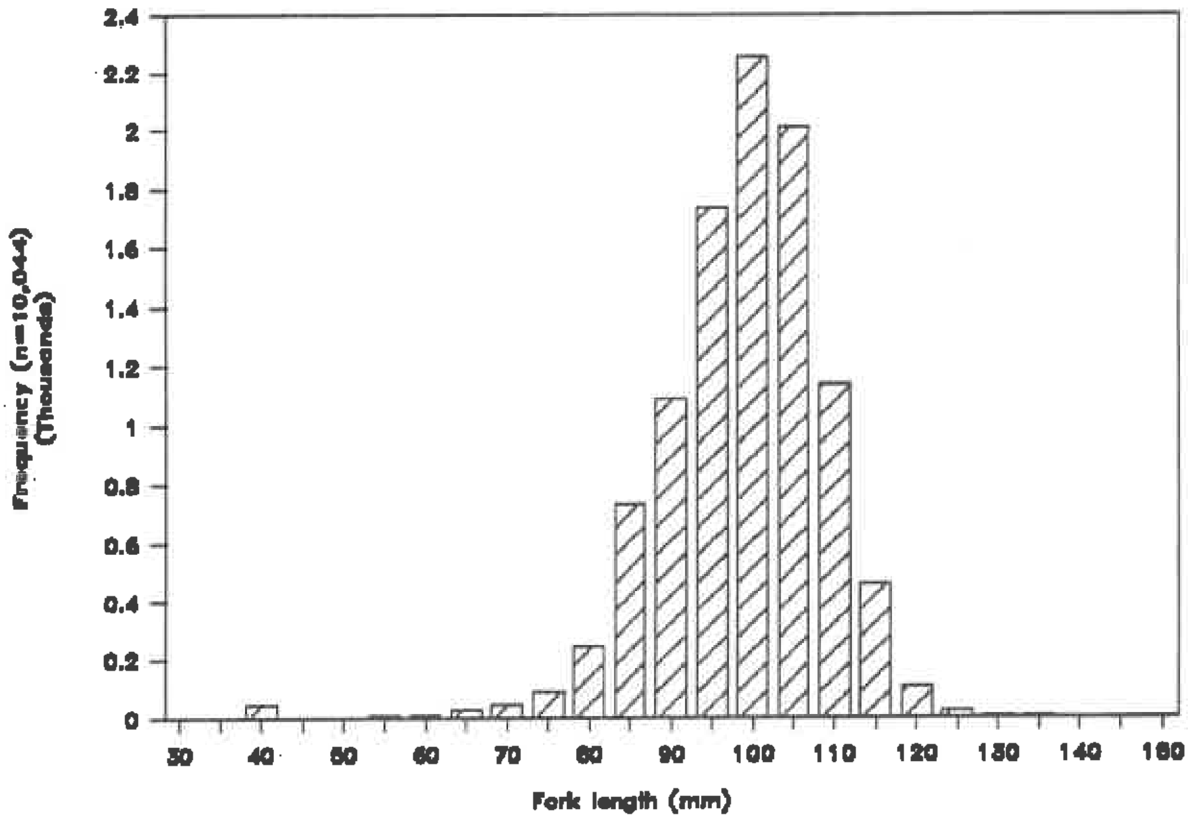

Figure 13. Length frequency distribution of natural spring chinook salmon caught at downstream migrant trap, Tucannon River, 1987/1988 season.

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, we have estimates for the 1985 and 1986 broods at all juvenile life stages. 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 3.2.1). We have three years' data to date (1986, 1987, and 1988 broods), and are able to extrapolate these data to the 1985 brood.

The rearing fry population estimate is the product of 1) parr production density estimates (Sections 3.4.1 to 3.4.4), and 2) areal measurements of the stream derived from previous habitat surveys (Seidel et al. 1988). Both estimators are stratified by stream reach, habitat type, and habitat quality. We have three years' data to date (1985, 1986, and 1987 broods).

We have estimates of smolt yield for two brood years (1985 and 1986, Section 3.4.10), and can calculate egg-to-smolt survival by comparing population estimates by life stage (Table 30, Bugert and Seidel 1988).

Table 30. Estimates of Tucannon River spring chinook salmon abundance by life stage for 1985, 1986, 1987, and 1988 broods.

Brood year	Redds	Adults	Eggs	Fry	Smolts
1985	189 a	138 b	283,800 c	90,000	36,000
1986	200	131	256,500	111,000	58,000
1987	185	151	309,200	79,000	- -
1988	117	180	573,000	- -	- -

[a] Number of adults in 1985 was extrapolated from average adult to redd ratio (1.37:1.00) from 1986 and 1987.

[b] The female to male ratio of adults trapped for broodstock was 1:1 in 1986 and 1987, and 1.36:1 in 1988. We assume the 1985 value was 1:1.

[c] Average fecundity was 3,916 in 1986, 4,095 in 1987, and 4,329 in 1988. The 1985 value is the average of the three years (4,113).

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APPENDIX A

Washington Department of Fisheries' 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

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
yearling on-station	117,705	168,906	0.4107	286,611
yearling	120,804	425	0.9965	121,229
1987				
subyearling on-station	248,739	1,760,409	0.1238	2,009,148
subyearling transport	245,749	2,318,550	0.0958	2,564,299

APPENDIX C

Contribution of 1983, 1984, 1985, and 1986 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, 1987, and 1988.

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	C	1	9
Columbia River net	C	2	7
OSU experimental ocean purse seine	C	8	8
BC: west coast sport (21, 23-27)	C	3	
Lyons Ferry hatchery rack	C	494	504
Lower Granite Dam trap	C	16	16
1985 totals:		524	545
1986			
Oregon ocean troll	C	25	63
Oregon ocean sport	C	6	12
Columbia River net	C	69	268
Oregon estuary sport	C	4	15
Puget Sound sport	C	6	33
Puget sound net	C	1	2
Washington ocean sport (charter boat)	C	13	30
Washington ocean sport (kicker boat)	C	8	23
Washington ocean troll (Indian)	C	2	12
Groundfish observer CA/OR/WA	I	25	41
S.E. Alaska commercial (unkn gear)	I	1	
S.E. Alaska commercial seine	I	1	
Lyons Ferry hatchery rack	C	156	158
Lower Granite Dam trap	C	12	24
1986 Totals:		329	681
1987			
California ocean troll	C	30	178
California ocean sport	C	1	4
B.C. Vancouver Island troll (25-27)	C	36	143
B.C. Van. Island troll (21,23,24)	C	147	776
B.C. northern troll (1-5)	C	11	48
B.C. northern net (1-5)	C	1	5
Oregon ocean troll	C	327	951
Oregon ocean sport	C	17	35
Columbia River sport	C	1	10
Columbia River net	C	227	998

Appendix C, Table 1., continued.

Year Fishery	Status	Observed recoveries	Estimated contribution
Oregon estuary sport	C	25	67
Washington ocean troll	I	68	188
Puget Sound net	I	1	1
Washington ocean sport (charter boat)	I	85	183
Washington ocean sport (kicker boat)	I	30	109
Washington ocean troll (Indian)	I	31	81
S.E. Alaska commercial troll	I	11	19
S.E. Alaska sport	C	1	
B.C. Johnstone Strait net (12, 13)	C	1	3
B.C. West coast sport (21, 23-27)	C	6	
B.C. north central troll (6-9, 30)	C	3	10
B.C. south central troll (10-12)	C	12	39
Lyons Ferry hatchery rack	C	365	365
1987 totals:		1437	4214
1988			
California ocean troll	I	2	11
Oregon ocean troll	I	20	69
Oregon ocean sport	C	3	5
Columbia River net	I	63	244
Oregon estuary sport	C	4	13
Washington ocean troll	I	16	51
Puget Sound sport	I	1	5
Washington ocean sport (charter boat)	I	3	6
Washington ocean sport (kicker boat)	I	2	10
Washington ocean troll (Indian)	I	3	17
S.E. Alaska commercial troll	I	6	5
S.E. Alaska commercial seine	I	1	3
B.C. Vancouver Island troll (25-27)	I	6	36
B.C. Van. Island troll (21,23,24)	I	21	94
B.C. northern troll (1-5)	I	2	9
B.C. south central troll (10-12)	I	3	11
Lyons Ferry hatchery rack	C	90	90
1988 totals:		246	679
Totals for tagcode 633218:		2536	6119

[a] Complete estimates are designated "C" "I" designates incomplete estimates.

[b] Numbers in parentheses designate statistical harvest area.

Appendix C, 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	C	5	11
Columbia River sport	C	2	19
Columbia River net	C	22	78
OSU experimental ocean purse seine	C	18	18
Washington ocean sport (charter boat)	C	1	2
Groundfish observer CA/OR/WA	C	1	2
B.C. west coast sport (21, 23-27)	C	7	
Lyons Ferry hatchery rack	C	1397	1425
Lower Granite Dam trap	C	35	36
1985 totals:		1488	1589
1986			
California ocean sport	C	1	3
Oregon ocean troll	C	86	272
Oregon ocean sport	C	11	21
Columbia River net	C	202	933
Oregon estuary sport	C	10	38
Puget Sound sport	C	22	114
Puget Sound net	C	4	18
Washington ocean sport (charter boat)	C	29	65
Washington ocean sport (kicker boat)	C	30	86
Washington ocean troll (day boat)	C	3	8
Washington ocean troll (trip boat)	C	1	4
Washington ocean troll (Indian)	C	8	36
Groundfish observer CA/OR/WA	I	79	129
S.E. Alaska sport	I	1	
Lyons Ferry hatchery rack	C	507	512
Lower Granite Dam trap	C	28	57
1986 totals:		1022	2295
1987			
California ocean troll	C	82	515
California ocean sport	C	11	51
B.C. Vancouver Island troll (25-27)	C	136	586
B.C. Van. Island troll (21,23,24)	C	365	1918
B.C. northern troll (1-5)	C	14	67
B.C. northern net (1-5)	C	1	3
Oregon ocean troll	C	810	2382
Oregon ocean sport	C	58	153
Columbia River sport	C	3	30
Columbia River net	C	644	2874
Oregon Columbia River test	C	1	1
Oregon fish trap	C	1	1

Appendix C, Table 2., continued.

Year Fishery	Status	Observed recoveries	Estimated contribution
Oregon estuary sport	C	34	93
Washington ocean troll	I	220	567
Puget Sound sport	I	9	54
Puget Sound net	I	6	12
Washington ocean sport (charter boat)	I	211	449
Washington ocean sport (kicker boat)	I	86	310
Washington ocean troll (Indian)	I	77	198
S.E. Alaska commercial troll	I	18	55
S.E. Alaska commercial seine	C	1	3
B.C. Johnstone Strait net (12, 13)	C	2	4
B.C. central net (6-11)	C	1	4
B.C. Juan de Fuca net (20)	C	2	8
B.C. west coast sport (21, 23-27)	C	9	
B.C. Georgia Strait sport (13-20, 28-29)	C	2	11
B.C. north central troll (6-9, 30)	C	11	39
B.C. south central troll (10-12)	C	23	82
Lyons Ferry hatchery rack	C	1057	1057
1987 totals:		3895	11527
1988			
California ocean troll	I	8	70
California ocean sport	I	1	2
Oregon ocean troll	I	46	148
Oregon ocean sport	C	2	5
Columbia River net	I	167	640
Oregon Columbia River test	C	3	3
Oregon estuary sport	C	8	27
Washington ocean troll	I	52	164
Washington ocean sport (charter boat)	I	4	8
Washington ocean sport (kicker boat)	I	7	32
Washington ocean troll (Indian)	I	5	20
S.E. Alaska commercial troll	I	4	5
B.C. Vancouver Island troll (25-27)	I	23	115
B.C. Van. Island troll (21,23,24)	I	67	289
B.C. northern troll (1-5)	I	6	24
B.C. north central troll (6-9, 30)	I	1	2
B.C. south central troll (10-12)	I	2	10
Lyons Ferry hatchery rack	C	185	185
1988 totals:		591	1750
Totals for tagcode 632152:		6996	17161

a Complete estimates are designated "C", "I" designates incomplete estimates.
b Numbers in parentheses designate statistical harvest area.

Appendix C, continued.
Table 3. 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	C	3	11
Washington ocean sport (kicker boat)	C	1	3
Lyons Ferry hatchery rack	C	13	13
Lower Granite Dam trap	C	24	49
1986 totals:		41	76
1987			
B.C. Vancouver Island troll (25-27)	C	5	19
B.C. Van. Island troll (21,23,24)	C	6	34
B.C. northern troll (1-5)	C	1	3
Oregon ocean troll	C	10	23
Oregon ocean sport	C	2	5
Columbia River net	C	14	58
Oregon estuary sport	C	1	3
Washington ocean troll	I	1	2
Washington ocean sport (charter boat)	I	3	7
Washington ocean sport (kicker boat)	I	2	8
Washington ocean troll (Indian)	I	1	6
S.E. Alaska commercial troll	I	1	2
S.E. Alaska commercial gillnet	C	1	
B.C. west coast sport (21, 23-27)	C	2	
B.C. south central troll (10-12)	C	5	19
Lyons Ferry hatchery rack	C	35	35
1987 totals:		90	223
1988			
Oregon ocean troll	I	2	7
Columbia River net	I	17	67
Oregon Columbia River test	C	1	1
Washington ocean troll	I	2	8
Washington ocean troll (Indian)	I	1	2
B.C. Vancouver Island troll (25-27)	I	2	9
B.C. Van. Island troll (21,23,24)	I	5	21
B.C. northern troll (1-5)	I	2	7
B.C. south central troll (10-12)	I	1	2
Lyons Ferry hatchery rack	C	17	17
1988 totals:		50	140
Totals for tagcode 633226:		181	439

[a] Complete estimates are designated "C", "I" designates incomplete estimates.

[b] Numbers in parentheses designate statistical harvest area.

Appendix C, continued.

Table 4. 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	C	3	14
Groundfish observer CA/OR/WA	I	1	2
Lyons Ferry fish hatchery	C	12	12
Lower Granite Dam trap	C	13	27
1986 Totals:		29	54
1987			
California ocean troll	C	1	5
B.C. Vancouver Island troll (25-27)	C	4	15
B.C. Van. Island troll (21,23,24)	C	2	8
B.C. northern troll (1-5)	C	3	8
Oregon ocean troll	C	7	25
Oregon ocean sport	C	2	4
Columbia River net	C	11	49
Oregon estuary sport	C	1	3
Washington ocean troll	I	1	3
Washington ocean sport (charter boat)	I	1	2
Washington ocean sport (kicker boat)	I	1	3
S.E. Alaska commercial troll	I	1	2
B.C. Juan de Fuca net (20)	C	1	4
B.C. west coast sport (21, 23-27)	C	1	
B.C. south central troll (10-12)	C	2	9
Lyons Ferry hatchery rack	C	35	35
1987 totals:		74	175
1988			
California ocean troll	I	1	13
Oregon ocean troll	I	3	8
Columbia River net	I	24	90
Washington ocean troll	I	6	21
Washington ocean sport (kicker boat)	I	2	11
Washington ocean troll (Indian)	I	1	1
S.E. Alaska commercial troll	I	4	9
B.C. Vancouver Island troll (25-27)	I	4	20
B.C. Van. Island troll (21,23,24)	I	4	17
B.C. northern troll (1-5)	I	4	16
B.C. south central troll (10-12)	I	1	3
Lyons Ferry hatchery rack	C	19	19
1988 totals:		73	229
Totals for tagcode 633227:		176	458

Appendix C. continued.
Table 5. 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	C	3	10
Lyons Ferry hatchery rack	C	9	9
Lower Granite Dam trap	C	19	39
1986 totals:		31	58
1987			
B.C. Vancouver Island troll (25-27)	C	4	20
B.C. Van. Island troll (21,23,24)	C	7	33
B.C. northern troll (1-5)	C	1	3
Oregon ocean troll	C	11	25
Columbia River net	C	6	26
Washington ocean troll	I	4	16
Washington ocean sport (kicker boat)	I	1	2
S.E. Alaska commercial troll	I	3	5
S.E. Alaska sport	C	1	
B.C. north central troll (6-9, 30)	C	1	3
Lyons Ferry hatchery rack	C	42	42
1987 totals:		81	175
1988			
Oregon ocean troll	I	1	2
Columbia River net	I	16	59
Oregon estuary sport	C	2	7
Washington ocean troll	I	2	5
Washington ocean troll (Indian)	I	3	10
S.E. Alaska commercial troll	I	3	7
B.C. Vancouver Island troll (25-27)	I	2	9
B.C. Van. Island troll (21,23,24)	I	4	18
B.C. northern troll (1-5)	I	1	4
Lyons Ferry hatchery rack	C	21	21
1988 totals:		55	141
Totals for tagcode 633228:		167	374

[a] Complete estimates are designated "C", "I" designates incomplete estimates.

[b] Numbers in parentheses designate statistical harvest area.

Appendix C, continued.

Table 6. 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	C	1	4
NMFS Alaska research	I	2	2
Lyons Ferry hatchery rack	C	49	49
Lower Granite Dam trap	C	4	8
1986 totals:		56	63
1987			
B.C. Vancouver Island troll (25-27)	C	4	8
B.C. Van. Island troll (21,23,24)	C	1	21
Oregon ocean troll	C	1	3
Oregon ocean sport	C	3	8
Columbia River net	C	9	43
Puget Sound sport	I	3	19
Puget Sound net	I	1	4
Washington ocean sport (charter boat)	I	1	2
Washington ocean sport (kicker boat)	I	4	12
B.C. Johnstone Strait net (12, 13)	C	1	2
B.C. central net (6-11)	C	8	22
B.C. Juan de Fuca net (20)	C	3	10
B.C. cental sport (6-12, 30)	C	2	
B.C. west coast sport (21, 23-27)	C	1	
B.C. Georgia Strait sport (13-20, 28-29)	C	1	23
B.C. south central troll (10-12)	C	2	9
Lyons Ferry hatchery rack	C	89	89
1987 totals:		134	274
1988			
California ocean troll	I	2	15
Oregon ocean troll	I	58	195
Oregon ocean sport	C	3	6
Columbia River net	I	41	155
Washington ocean troll	I	28	83
Puget Sound sport	I	1	5
Washington coastal net	I	1	2
Washington ocean sport (charter boat)	I	9	18
Washington ocean sport (kicker boat)	I	7	27
Washington ocean troll (Indian)	I	18	51
S.E. Alaska commercial troll	I	2	2
B.C. Vancouver Island troll (25-27)	I	17	80
B.C. Van. Island troll (21,23,24)	I	32	137

Appendix C, Table 6., continued.

Year Fishery	Status	Observed recoveries	Estimated contribution
B.C. northern troll (1-5)	I	10	45
B.C. west coast sport (21, 23-27)	I	1	4
B.C. north central troll (6-9, 30)	I	1	3
B.C. south central troll (10-12)	I	4	11
Lyons Ferry hatchery rack	C	98	98
1988 totals:		333	936
Totals for tagcode 632841:		523	1273

[a] Complete estimates are designated "C", "I" designates incomplete estimates.

[b] Numbers in parentheses designate statistical harvest area.

Table 7. Recoveries of 1985 brood subyearlings transported below Ice Harbor Dam in June 1987. Tagcode was 633634. Mark rate was 99.26 percent (49,112 out of 49,478). Size of fish at release was 55.0 fpp.

Year Fishery	Status	Observed recoveries	Estimated contribution
1987			
Lyons Ferry hatchery rack	C	1	1
1987 total:		1	1
1988			
Oregon ocean troll	I	1	4
Columbia River net	I	2	8
Puget Sound net	I	1	3
B.C. northern troll (1-5)	I	1	4
Lyons Ferry hatchery rack	C	3	3
1988 totals:		8	22
Totals for tagcode 633634:		9	23

[a] Complete estimates are designated "C", "I" designates incomplete estimates.

[b] Numbers in parentheses designate statistical harvest area.

Appendix C, continued.

Table 8. Recoveries of 1985 brood subyearlings transported below Ice Harbor Dam in June 1987. Tagcode was 633635. Mark rate was 99.26 percent (49,112 out of 49,478). Size of fish at release was 55.0 fpp.

Year Fishery	Status	Observed recoveries	Estimated contribution
1988			
Columbia River net	I	1	4
Washington ocean troll (Indian)	I	1	2
Lyons Ferry hatchery rack	C	2	2
Totals for tagcode 633635:		4	8

a Complete estimates are designated "C", "I" designates incomplete estimates.

b Numbers in parentheses designate statistical harvest area.

Table 9. Recoveries of 1985 brood subyearlings transported below Ice Harbor Dam in June 1987. Tagcode was 633636. Mark rate was 99.26 percent (49,113 out of 49,480). Size of fish at release was 55.0 fpp.

Year Fishery	Status	Observed recoveries	Estimated contribution
1988			
Columbia River net	I	1	5
Washington ocean sport (charter boat)	I	1	2
Washington ocean troll (Indian)	I	1	1
B.C. Van. Island troll (21,23,24)	I	1	4
Lyons Ferry hatchery rack	C	1	1
Totals for tagcode 633636:		5	13

a Complete estimates are designated "C", "I" designates incomplete estimates.

b Numbers in parentheses designate statistical harvest area.

Appendix C, continued.

Table 10. Recoveries of 1985 brood subyearlings transported below Ice Harbor Dam in June 1987. Tagcode was 633637. Mark rate was 99.26 percent (49,112 out of 49,478). Size of fish at release was 55.0 fpp.

Year Fishery	Status	Observed recoveries	Estimated contribution
1987			
B.C. Johnstone Strait Net (12, 13)	C	1	3
Lyons Ferry hatchery rack	C	3	3
1987 Totals:		4	6
1988			
Columbia River net	I	1	3
Washington ocean troll (Indian)	I	1	2
B.C. northern troll (1-5)	I	1	5
Lyons Ferry hatchery rack	C	5	5
1988 Totals:		8	15
Totals for tagcode 633637:		12	21

Table 11. Recoveries of 1985 brood subyearlings released on-station in June 1987. Tagcode was 633638. Mark rate was 99.06 percent (49,325 out of 49,793). Size of fish at release was 58.0 fpp.

Year Fishery	Status	Observed recoveries	Estimated contribution
1987			
B.C. Johnstone Strait net (12, 13)	C	1	3
B.C. Central net (6-11)	C	1	5
Lyons Ferry hatchery rack	C	4	4
1987 totals:		6	12
1988			
Oregon ocean troll	I	1	7
Wachington ocean sport (charter boat)	I	1	2
Lyons Ferry hatchery rack	C	2	2
1988 totals:		4	11
Totals for tagcode 633638:		10	23

[a] Complete estimates are designated "C", "I" designates incomplete estimates.

[b] Numbers in parentheses designate statistical harvest area.

Appendix C, continued.

Table 12. Recoveries of 1985 brood subyearlings released on-station in June 1987. Tagcode was 633639. Mark rate was 99.06 percent (49,325 out of 49,793). Size of fish at release was 58.0 fpp.

Year Fishery	Status	Observed recoveries	Estimated contribution
1987			
B.C. northern net (1-5)	C	1	5
Lyons Ferry hatchery rack	C	1	1
1987 totals:		2	6
1988			
Columbia River net	I	1	4
B.C. central net (6-11)	I	1	3
Lyons Ferry hatchery rack	C	7	7
1988 Totals:		9	14
Totals for tagcode 633639:		11	20

Table 13. Recoveries of 1985 brood subyearlings released on-station in June 1987. Tagcode was 633640. Mark rate was 99.06 percent (49,325 out of 49,793). Size of fish at release was 58.0 fpp.

Year Fishery	Status	Observed recoveries	Estimated contribution
1987			
Lyons Ferry hatchery rack	C	3	3
1987 Totals:		3	3
1988			
Columbia River net	I	2	7
Washington ocean sport (charter boat)	I	1	1
Lyons Ferry hatchery rack	C	2	2
1988 Totals:		5	10
Totals for tagcode 633640:		8	13

[a] Complete estimates are designated "C", "I" designates incomplete estimates.

[b] Numbers in parentheses designate statistical harvest area.

Appendix C, continued.

Table 14. Recoveries of 1985 brood subyearlings released on-station in June 1987. Tagcode was 633641. Mark rate was 99.06 percent (49,325 out of 49,793). Size of fish at release was 58.0 fpp.

Year Fishery	Status	Observed recoveries	Estimated contribution
1987			
Lyons Ferry hatchery rack	C	7	7
1987 Totals:		7	7
1988			
Washington ocean troll (Indian)	I	1	2
B.C. northern troll (1-5)	I	1	4
Lyons Ferry hatchery rack	C	3	3
1988 Totals:		5	9
Totals for tagcode 633641:		12	16

Table 15. Recoveries of 1985 brood subyearlings released on-station in June 1987. Tagcode was 633642. Mark rate was 99.06 percent (49,325 out of 49,793). Size of fish at release was 58.0 fpp.

Year Fishery	Status	Observed recoveries	Estimated contribution
1987			
Columbia River net	C	1	4
Lyons Ferry hatchery rack	C	3	3
1987 Totals:		4	7
1988			
Oregon ocean troll	I	2	6
Columbia River net	I	1	4
Washington ocean sport (charter boat)	I	1	2
B.C. central net (6-11)	I	1	2
Lyons Ferry hatchery rack	C	6	6
1988 Totals:		11	20
Totals for tagcode 633642:		15	27

[a] Complete estimates are designated "C", "I" designates incomplete estimates.

[b] Numbers in parentheses designate statistical harvest area.

Appendix C, continued.

Table 16. Recoveries of 1985 brood yearlings released on-station in April 1987. Tagcode was 634156. Mark rate was 99.30 percent (152,479 out of 153,554). Size of fish at release was 6.0 fpp.

Year Fishery	Status	Observed recoveries	Estimated contribution
1987			
B.C. northen net (1-5)	C	3	16
Oregon ocean sport	C	1	2
Columbia River net	C	2	10
Lyons Ferry hatchery rack	C	129	129
1987 totals:		135	156
1988			
Oregon ocean troll	I	4	16
Oregon ocean sport	C	2	4
Columbia River net	I	15	60
Oregon estuary sport	C	7	23
Puget Sound net	I	3	6
Washington ocean sport (charter boat)	I	3	6
Washington ocean sport (kicker boat)	I	6	23
Washington ocean troll (Indian)	I	1	7
S.E. Alaska commercial seine	I	2	
S.E. Alaska sport	I	1	
B.C. Vancouver Island troll (25-27)	I	1	4
B.C. central net (6-11)	I	15	36
BC: Juan de Fuca net (20)	I	1	1
BC: west coast sport (21, 23-27)	I	1	4
Lyons Ferry hatchery rack	C	121	121
Lower Granite Dam	C	8	16
1988 totals:		191	327
Totals for tagcode 634156:		326	483

a Complete estimates are designated "C", "I" designates incomplete estimates.

b Numbers in parentheses designate statistical harvest area.

Appendix C, continued.
Table 17. Recoveries of 1985 brood yearlings transported below Ice Harbor Dam in April 1987. Tagcode was 634159. Mark rate was 99.70 percent (156,036 out of 156,506). Size of fish at release was 6.9 fpp.

Year Fishery	Status	Observed recoveries	Estimated contribution
1987			
B.C. northern net (1-5)	C	1	3
Oregon ocean sport	C	1	2
Columbia River net	C	1	4
Puget Sound sport	I	1	4
S.E. Alaska sport	C	1	
B.C. Juan de Fuca net (20)	C	1	4
Lyons Ferry hatchery rack	C	112	112
1987 totals:		118	129
1988			
Oregon ocean troll	I	2	6
Oregon ocean sport	C	5	13
Columbia River net	I	22	86
Oregon estuary sport	C	8	25
Puget Sound sport	I	9	40
Puget Sound net	I	4	17
Washington ocean sport (charter boat)	I	6	13
Washington ocean sport (kicker boat)	I	3	8
Washington ocean troll (Indian)	I	2	10
Washington jetty sport	I	1	4
B.C. Vancouver Island troll (25, 27)	I	1	4
B.C. northern net (1-5)	I	3	15
B.C. central net (6-11)	I	11	27
B.C. S.W. Van. Island net (18-24)	I	1	4
B.C. Central sport (6-12, 30)	I	1	4
B.C. Georgia Strait sport (13-20, 28-29)	I	1	5
Lyons Ferry hatchery rack	C	120	120
Lower Granite Dam trap	C	2	4
1988 totals:		202	304
Totals for tagcode 634159:		320	433

[a] Complete estimates are designated "C", "I" designates incomplete estimates.

[b] Numbers in parentheses designate statistical harvest area.

Appendix C, continued.

Table 18. Recoveries of 1986 brood subyearlings transported below Ice Harbor Dam in June 1987. Tagcode was 634262. Mark rate was 99.20 percent (127,715 out of 128,745). Size of fish at release was 71.0 fpp.

Year Fishery	Status	Observed recoveries	Estimated contribution
1988			
Columbia River net	I	3	10
S.E. Alaska commercial seine	I	1	5
Lyons Ferry hatchery rack	C	63	63
Lower Granite Dam trap	C	4	8
Totals for tagcode 634262:		71	86

Table 19. Recoveries of 1986 brood subyearlings transported below Ice Harbor Dam in June 1987. Tagcode was 634401. Mark rate was 98.42 percent (128,283 out of 130,347). Size of fish at release was 71.0 fpp.

Year Fishery	Status	Observed recoveries	Estimated contribution
1988			
Columbia River net	I	6	24
S.E. Alaska commercial seine	I	1	
B.C. northern net (1-5)	I	1	3
B.C. Central net (6-11)	I	1	2
Lyons Ferry hatchery rack	C	67	67
Lower Granite Dam trap	C	3	6
Totals for tagcode 634401:		79	103

a Complete estimates are designated "C", "I" designates incomplete estimates.

b Numbers in parentheses designate statistical harvest area.

APPENDIX D

Table 1. Fork length/fecundity/egg size relationships of Lyons Ferry fall chinook salmon during 1988 season.

Fork length (mm)	Total egg weight (grams)	Sample weight (grams)	Sample count	Estimated fecundity	Egg size (grams)
765	976	34.1	165	4723	0.2067
837	1611	24.0	84	5639	0.2857
799	949	22.4	91	3855	0.2462
900	1577	25.9	98	5967	0.2643
918	1388	33.6	99	4090	0.3394
932	1468	25.1	89	5205	0.2820
896	1333	36.7	126	4577	0.2913
724	820	23.8	98	3376	0.2429
915	1801	28.8	97	6066	0.2969
706	841	27.0	105	3271	0.2571
891	1582	21.4	70	5175	0.3057
885	1438	23.8	96	5800	0.2479
974	1366	27.3	121	6054	0.2256
925	1799	31.6	109	6205	0.2899
958	1849	27.7	91	6074	0.3044
893	1358	31.4	85	3676	0.3694
674	573	32.9	146	2543	0.2253
858	1053	23.1	94	4285	0.2457
809	999	30.0	167	5561	0.1796
669	766	39.2	150	2931	0.2613
780	949	32.1	123	3636	0.2610
969	1757	27.2	80	5168	0.3400
851	1325	22.5	84	4947	0.2679
784	1279	24.3	101	5316	0.2406
883	1617	30.5	101	5355	0.3020
827	1140	26.5	131	5635	0.2023
882	1760	35.4	132	6563	0.2682
911	1711	34.7	127	6262	0.2732
934	1956	28.6	95	6497	0.3011
805	1169	30.5	98	3756	0.3112
711	798	29.0	129	3550	0.2248
670	561	30.2	153	2842	0.1974
738	1096	25.2	101	4393	0.2495
830	1286	34.1	113	4262	0.3018
589	461	19.5	92	2175	0.2120
868	1305	30.5	103	4407	0.2961
685	942	30.4	138	4276	0.2203
778	1010	26.8	96	3618	0.2792
866	1387	34.0	123	5018	0.2764
704	599	33.7	128	2275	0.2633
882	1533	33.5	101	4622	0.3317
892	1748	30.0	97	5652	0.3093
907	1713	29.6	89	5151	0.3326
790	1091	33.0	142	4695	0.2324

Appendix D, Table 1., continued.

Length (mm)	Total egg weight (gm)	Sample weight	Sample count	Estimated fecundity	Egg size (grams)
750	1013	29.2	111	3851	0.2631
949	1788	30.7	118	6872	0.2602
879	1358	28.5	97	4622	0.2938
900	1460	35.5	116	4771	0.3060

Table 2. Length/fecundity/egg size relationships of Tucannon River spring chinook salmon during 1988 season.

Fork length (mm)	Total egg weight (grams)	Sample weight	Sample count	Estimated fecundity	Egg size (grams)
839	1091	23.0	118	5597	0.1949
866	1296	27.0	111	5328	0.2432
795	943	27.2	117	4056	0.2325
722	684	24.8	143	3944	0.1734
829	1142	26.2	100	4359	0.2620
807	1023	26.8	123	4695	0.2179
781	1131	28.8	120	4712	0.2400
845	1391	28.6	125	6080	0.2288
767	1035	26.5	118	4609	0.2246
751	875	24.9	108	3795	0.2306
818	1141	25.4	99	4447	0.2566
724	828	30.0	148	4085	0.2027
665	648	24.5	125	3306	0.1960
825	1306	27.7	90	4243	0.3078
683	617	21.5	148	4247	0.1453
830	1178	24.0	96	4712	0.2500
678	708	26.2	135	3648	0.1941
821	1204	23.1	104	5421	0.2221
703	804	27.7	137	3976	0.2022
685	828	21.0	116	4574	0.1810
675	726	20.0	105	3812	0.1905
712	768	31.0	154	3815	0.2013
873	1710	36.1	118	5589	0.3059
864	1085	29.6	116	4252	0.2552
736	848	27.8	135	4118	0.2059
648	614	24.1	127	3236	0.1898
839	1229	26.7	105	4833	0.2543
656	637	24.0	121	3212	0.1983
668	609	29.0	170	3570	0.1706
701	702	27.1	135	3497	0.2007
703	884	35.4	182	4545	0.1945
714	646	28.4	174	3958	0.1632
669	769	25.9	138	4097	0.1877
716	814	40.2	205	4151	0.1961
848	1301	30.9	119	5010	0.2597

APPENDIX E

Washington Department of Fisheries' Tucannon River electrofishing and snorkeling index site location and identification.

Site	Site length (m)	Marker location a	Habitat type	Road mile b	Description and reference point c
Wilderness Stratum					
WILD-1	15.0	RB, LE	riffle	0.3	47 m upstream from Panjab bridge to lower net; CG 1
WILD-2	9.9	RB, LE	pool	0.5	244 m upstream from UE of Wild-1, just below natural log weir
WILD-3	12.6	RB, LE	pool	0.6	305 m upstream from UE of WILD-2 to LE; against far LB wall with large rock; (2.2) d
WILD-4	12.9	RB, LE	riffle	0.8	346 m upstream from UE of WILD-3 to LE; river split, LB channel
WILD-5	8.6	RB, LE	pool	1.0	323 m upstream from UE of WILD-4 to lower net, river split, RB channel, log in middle of site; (2.4) d
WILD-6	12.0	RB, LE	run	1.2	335 m upstream from UE of WILD-5 to LE; LE of CG 2
WILD-7	14.2	-	pool	1.3	171 m upstream from UE of WILD-6 to LE; middle CG 2
WILD-8	10.4	RB, LE	run	1.6	358 m upstream from UE of WILD-7 to LE
WILD-9	8.5	RB, LE	riffle	2.0	353 m upstream from UE of WILD-8 to LE: LE of CG 2.5
WILD-10	16.0	RB, LE	run	2.3	331 m upstream from UE of WILD-9 to LE; UE of CG 2.5; (3.3) d
WILD-11	19.9	RB, LE	pool	2.4	366 m upstream from UE of WILD-10 to LE; middle of CG 3; (3.4) d
WILD-12	16.2	RB, LE	riffle	2.5	104 m upstream from UE of WILD-11 to LE; UE of CG 3
WILD-13	- -	RB, LE	riffle	2.6	380 m upstream from UE of WILD-12 to LE; visible from road
WILD-14	- -	RB, LE	riffle	2.8	flag on the road, near wide turnout with year round spring on RB side of road, down steep bank to river; (4.2) d
WILD-15	- -	RB, LE	run	3.5	345 m upstream from WILD-14 sign, down steep bank from road
WILD-16	- -	RB, LE	run	3.7	499 m upstream from LE of

Appendix E, continued.

Site	Site length (m)	Marker location a	Habitat type	Road mile b	Description and reference point c
					WILD-15; red flag in center of river
WILD-17	- -	RB, LE	pool	3.8	big beaver dam and beaver feed caches
WILD-18	- -	RB, LE	riffle	4.4	about 610 m downstream of Cold Creek.
WILD-19	- -	RB, LE	pool	5.0	above Sheep Creek; (7) d
WILD-20	15.0	RB, LE	run	- -	343 m upstream from the UE of WILD-19
WILD-21	15.7	LB, LE	run	- -	760 m upstream from the UE of WILD-20
WILD-22	9.7	RB, LE	riffle	- -	77 m upstream from the UE of WILD-21
WILD-23	11.0	RB, LE	pool	- -	114 m upstream from the UE of WILD-22
HMA Stratum					
HMA-1	18.2	LB, LE	riffle	0.0	147 m below Cummings Cr. bridge.
HMA-2	26.0	LB, LE	boulder	0.1	First cutback road on left after Cummings Cr. bridge, CG 2 road.
HMA-3	17.8	LB, LE	run	0.5	LE of CG 4
HMA-4	18.5	RB, middle	pool	0.9	Day use area across from Blue Lake, at LE follow trail to river, site is 37 m down from trail end.
HMA-5	27.0	RB, LE	riffle	1.2	UE is under Tucannon Fish Hatchery bridge.
HMA-6	15.5	LB, LE	run	1.8	279 m below Rainbow Lake intake
HMA-7	19.1	LB, LE	boulder	2.4	CG 6, immediately above rock weir
HMA-8	15.1	RB, log	pool	3.2	CG 7, at LE, 152 m below barb wire fence; stream split LB channel
HMA-9	16.8	RB, LE	riffle	3.7	Below Beaver-Watson; pull out with dirt pile on left, site below cottonwood tree, UE at cottonwood tree
HMA-10	19.5	LB, LE	run	4.8	192 m downstream of lower campsite of CG 8
HMA-11	19.8	RB, LE	boulder	5.2	LE of CG 9 behind outhouse, lower net is 43 m upstream.
HMA-12	17.1	RB, LE	pool	6.1	LE of CG 10, site on main river above Big Four Lake intake, UE is under upper part of large log.

Appendix E, continued.

Site	Site length (m)	Marker location a	Habitat type	Road mile b	Description and reference point c
HMA-13	19.7	LB, LE	riffle	6.7	adjacent to U.S.F.S. Guard Station at LE of pullout
HMA-14	14.8	LB, LE	run	7.4	UE is 274 m downstream from the Tucannon CG bridge. UE is under crossing tree.
HMA-15	17.8	RB, LE	boulder	7.9	810 m above Tucannon CG bridge
HMA-16	21.3	middle, crossing	log river pool	8.8	first cutback road on left before second cattle guard; staying right go to the end of road, go straight to to river. Bottom end is 28 m upstream from trail.
HMA-17	16.0	LB, LE	boulder	9.3	LE of CG 11, downstream 38 m from trail.
HMA-18	14.4	RB, LE	riffle	9.3	LE is 90 m from the UE of HMA-17.
HMA-19	17.5	RB, LE	run	10.0	UE is Cow Camp bridge.
HMA-20	16.4	RB, LE	riffle	10.4	First cutback road on right before private cabins on left; go to LE of CG and walk trail on left to river, go downstream 136 m to UE.
HMA-21	16.6	LB, LE	pool	11.3	LE of CG 12, 97 m upstream from outhouse.
HMA-22	14.5	RB, LE	pool	11.4	Middle access road to CG 12, third gate; LE is at the top of TN-30-84 boulder site.
HMA-23	18.5	RB, LE	boulder	11.6	UE is 26 m downstream from Panjab bridge.
HMA-24	14.3	LB, LE	run	11.7	LE is 46 m upstream of Panjab bridge.
HMAS-1	14.8	LB middle	side channel	6.1	Upper net is 19 m down from Big Four intake.
HMAS-2	22.2	LB, LE		10.0	Below Cow Camp bridge, first RB channel along rock wall.
HMAS-3	13.2	LB, LE		10.1	169 m upstream from Cow Camp bridge along LB past two RB channels.
HMAS-4	14.0	RB, LE		10.1	LE is 103 m upstream UE of HMAS-3; extreme LB channel.
HMAS-5	12.5	RB, LE		10.2	LE is 40 m upstream UE of HMAS-4; extreme LB channel.
HMAS-6	17.0	RB, LE		11.3	first side channel downstream of outhouse in LE of CG 12, LE is at mouth

Appendix E, continued.

Site	Site length (m)	Marker location a	Habitat type	Road mile b	Description and reference point c
					where site enters mainstem Tucannon River.
Hartsock Stratum					
HART-1	11.1	LB, LE	run		47 m upstream from bridge 11 to the LE
HART-2	37.7	LB, LE	run		116 m upstream from bridge 12 to the LE
HART-3	18.2	RB, LE	riffle		181 m downstream from bridge 13 to UE, just below small island
HART-4	13.5	LB, middle	pool		15 m upstream from bridge 13 to LE
HART-5	17.1	LB middle	run		620 m downstream from bridge 14 to the UE; just below barb wire fence
HART-6	30.4	LB	run		305 m upstream from bridge 14 to the LE; (3) d
HART-7	10.4	RB, UE	pool		80 m downstream to UE from upper most gabion at Herb Dahm's
HART-8	24.5	LB, L	riffle		36 m upstream to LE from Herb Dahm's uppermost gabion; (4) d
HART-9	18.0	RB, LE	riffle		30 m downstream from the HMA boundry fence behind T. Bruegman's to UE; (10) d

a
RB - right bank, LB - left bank, LE - lower end, UE - upper end

b
Bridge above HMA campground 1 is mile 0.0 for HMA sites; Panjab Bridge is 0.0 for Wilderness sites. Mileage is to the site access.

c
CG - campground

d
1985, 1986 number designation; Hart-9 was Hart-10 in 1987.

APPENDIX F

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 G

Comparison of 1986, 1987, and 1988 spring chinook salmon rearing density estimates for riffles, runs, pools, boulder sites, and side channels within the HMA Stratum, Tucannon River, Washington.

Habitat type	Site	Density (fish/100m2) by year		
		1986	1987	1988
Riffle	HMA 1 [a]	23.37	19.77	20.86
	HMA 5	24.10	12.79	26.66
	HMA 9	11.77	10.33	7.10
	HMA 13	17.35	9.74	8.87
	HMA 18	13.87	7.91	8.66
	HMA 20	18.37	18.19	1.93
Run	HMA 3	24.75	45.09	44.16
	HMA 6	19.91	6.78	2.31
	HMA 10	20.72	65.54	24.04
	HMA 14	96.68	56.43	29.03
	HMA 19	48.94	37.43	33.44
	HMA 24	92.45	45.48	35.33
Pool	HMA 4	12.14	4.43	9.00
	HMA 8	10.53	47.53	31.73
	HMA 12	38.73	33.04	14.51
	HMA 16	67.43	46.80	34.63
	HMA 21	60.89	31.40	34.57
	HMA 22	126.26	71.64	38.77
Boulder sites	HMA 2	8.95	7.48	14.82
	HMA 7	13.68	37.48	13.57
	HMA 11	12.99	9.00	7.72
	HMA 15	12.79	34.87	11.68
	HMA 17	22.96	20.53	6.87
	HMA 23	17.73	15.39	1.46
Side channel	HMAS-1	75.44	36.89	38.19
	HMAS-2	23.79	123.60	113.33
	HMAS-3	41.22	49.07	13.34
	HMAS-4	35.23	23.33	27.09
	HMAS-5	122.11	19.41	82.81
	HMAS-6	53.20	30.21	33.86

[a] Refer to Appendix E for site description.

APPENDIX H

Comparison of minimum and maximum stream temperatures in Tucannon River near confluences of Sheep, Panjab, and Cummings Creeks, and outlets of Big 4, Beaver, and Deer Lakes in summer 1988. Temperatures are in degrees Fahrenheit.

	Sheep Cr.		Panjab Cr.		Big 4 Lk.		Beaver Lk.		Deer Lk.		Cummings C[illegible]	
Date	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Ma[illegible]
11-May	39	45	43	49	46	55	50	57	50	57	48	[illegible]
12-May	37	45	41	48	43	54	45	57	45	57	47	[illegible]
13-May	37	41	41	43	43	48	45	50	45	50	47	[illegible]
14-May	37	39	39	43	41	48	43	50	43	50	45	[illegible]
15-May	36	43	38	48	41	52	43	55	43	55	43	[illegible]
16-May	37	41	41	45	43	48	45	50	45	50	46	[illegible]
17-May	35	39	39	43	41	49	43	52	43	52	45	[illegible]
18-May	36	39	38	43	41	47	43	50	43	50	45	[illegible]
19-May	37	41	39	45	41	52	43	54	43	55	45	[illegible]
20-May	36	43	39	46	41	53	43	55	43	55	46	[illegible]
21-May	37	46	39	49	43	55	45	57	45	58	48	[illegible]
22-May	39	46	43	50	45	55	46	59	46	59	48	[illegible]
23-May	39	45	42	48	45	54	46	57	46	57	48	[illegible]
24-May	39	43	42	46	45	54	46	55	46	55	48	[illegible]
25-May	39	45	42	48	45	55	46	57	46	57	48	[illegible]
26-May	39	45	41	48	45	54	46	57	46	57	48	[illegible]
27-May	41	43	43	45	46	50	48	54	48	54	50	[illegible]
28-May	39	41	41	43	45	46	46	48	45	48	48	[illegible]
29-May	39	39	40	41	43	45	45	47	43	46	45	[illegible]
30-May	37	41	39	46	43	52	45	54	43	54	45	[illegible]
31-May	37	40	39	43	43	46	45	48	43	48	45	[illegible]
01-Jun	39	41	41	43	44	48	45	50	45	50	46	[illegible]
02-Jun	37	43	40	46	43	51	45	54	45	52	46	[illegible]
03-Jun	41	43	43	45	46	49	48	52	47	51	48	[illegible]
04-Jun	41	42	43	45	45	46	46	48	46	48	46	[illegible]
05-Jun	39	49	41	43	44	45	45	46	45	46	46	[illegible]
06-Jun	39	41	41	43	44	45	45	48	45	47	46	[illegible]
07-Jun	40	41	41	43	45	46	45	49	45	49	46	[illegible]
08-Jun	39	40	39	43	43	46	45	49	43	48	45	[illegible]
09-Jun	37	43	39	45	43	48	45	51	43	50	45	[illegible]
10-Jun	41	45	43	46	45	54	46	57	46	57	46	[illegible]
11-Jun	39	45	41	48	45	55	45	59	45	57	46	[illegible]
12-Jun	39	45	41	48	44	55	45	57	45	57	46	[illegible]
13-Jun	39	45	41	49	45	57	46	51	46	61	47	[illegible]
14-Jun	40	48	43	52	46	59	48	63	46	63	48	[illegible]
15-Jun	43	50	45	52	48	59	50	63	50	63	51	[illegible]
16-Jun	45	51	46	55	50	61	52	64	52	64	54	[illegible]
17-Jun	46	50	48	54	52	59	54	61	54	61	55	[illegible]
18-Jun	46	52	48	55	51	62	52	64	54	64	54	[illegible]
19-Jun	46	52	46	55	50	63	52	66	51	66	52	[illegible]
20-Jun	46	54	48	55	52	63	54	66	54	66	54	[illegible]
21-Jun	--	--	48	57	52	64	54	66	54	66	54	[illegible]
22-Jun	--	--	48	57	52	64	54	68	54	68	55	[illegible]

Appendix H, continued.

	Sheep Cr.		Panjab Cr.		Big 4 Lk.		Beaver Lk.		Deer Lk.		Cummings Cr	
Date	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
23-Jun	- -	- -	50	54	54	61	55	63	55	63	57	61
24-Jun	- -	- -	46	55	50	63	52	64	51	64	52	61
25-Jun	- -	- -	48	50	52	54	54	55	54	55	54	57
26-Jun	- -	- -	48	52	52	58	54	63	54	63	54	59
27-Jun	- -	- -	48	52	52	59	54	63	53	63	54	59
28-Jun	- -	- -	47	49	52	54	52	55	52	55	52	55
29-Jun	- -	- -	45	50	48	55	50	59	48	59	50	61
30-Jun	- -	- -	43	52	46	55	48	61	48	61	49	57
01-Jul	- -	- -	45	54	48	61	50	63	48	63	52	59
02-Jul	- -	- -	46	54	50	61	52	63	52	63	54	61
03-Jul	- -	- -	46	51	51	57	52	59	52	59	54	57
04-Jul	- -	- -	45	50	48	54	50	57	49	57	51	55
05-Jul	- -	- -	46	48	50	52	51	54	50	54	52	54
06-Jul	- -	- -	43	51	45	58	45	61	46	61	48	55
07-Jul	- -	- -	43	54	46	61	48	63	48	63	50	59
08-Jul	- -	- -	45	54	48	63	50	64	50	64	52	61
09-Jul	- -	- -	46	55	50	63	52	66	52	66	54	61
10-Jul	- -	- -	46	57	51	64	54	66	54	67	55	63
11-Jul	- -	- -	48	52	52	58	54	61	54	61	57	59
12-Jul	- -	- -	46	48	52	54	52	55	52	55	54	57
13-Jul	- -	- -	46	50	51	55	54	59	52	59	54	57
14-Jul	- -	- -	46	52	50	59	54	63	52	63	54	59
15-Jul	- -	- -	46	54	50	61	52	64	52	64	54	61
16-Jul	- -	- -	45	54	49	62	52	64	51	64	53	61
17-Jul	- -	- -	45	54	50	63	52	64	52	64	54	61
18-Jul	- -	- -	45	54	49	63	52	64	51	65	54	61
19-Jul	- -	- -	45	55	50	63	52	66	52	66	54	63
20-Jul	- -	- -	46	57	51	64	54	68	54	68	55	64
21-Jul	- -	- -	48	57	52	64	55	68	54	69	57	65
22-Jul	- -	- -	48	57	52	64	54	68	54	68	55	64
23-Jul	- -	- -	48	55	52	63	54	68	54	66	55	64
24-Jul	- -	- -	48	57	52	64	54	68	54	68	57	63
25-Jul	- -	- -	46	57	52	64	54	68	54	68	57	65
26-Jul	- -	- -	46	57	52	65	55	68	55	70	57	66
27-Jul	- -	- -	46	54	54	63	55	67	55	68	57	64
28-Jul	- -	- -	46	58	53	61	55	64	54	64	57	63
29-Jul	- -	- -	46	55	51	64	54	67	52	68	55	64
30-Jul	- -	- -	48	57	52	64	55	68	54	68	57	64
31-Jul	- -	- -	48	55	52	63	55	66	54	67	57	64
01-Aug	- -	- -	46	54	52	61	54	64	54	64	55	61
02-Aug	- -	- -	45	52	50	58	52	61	52	61	54	59
03-Aug	- -	- -	45	54	49	61	52	64	51	64	52	61
04-Aug	- -	- -	45	54	50	63	52	66	52	66	54	63
05-Aug	- -	- -	46	51	51	57	54	59	53	59	55	59
06-Aug	- -	- -	48	54	52	61	54	64	54	64	55	61
07-Aug	- -	- -	45	52	48	60	51	63	50	63	52	60
08-Aug	- -	- -	45	54	49	61	52	64	51	63	54	61
09-Aug	- -	- -	46	54	50	63	52	66	52	66	54	63

Appendix H, continued.

Date	Sheep Cr. Min.	Sheep Cr. Max.	Panjab Cr. Min.	Panjab Cr. Max.	Big 4 Lk. Min.	Big 4 Lk. Max.	Beaver Lk. Min.	Beaver Lk. Max.	Deer Lk. Min.	Deer Lk. Max.	Cummings Cr. Min.	Cummings Cr. Max.
10-Aug	- -	- -	46	54	51	63	54	66	54	66	55	[illegible]
11-Aug	- -	- -	46	54	50	61	54	64	52	65	55	[illegible]
12-Aug	- -	- -	48	55	61	63	55	64	54	66	55	[illegible]
13-Aug	- -	- -	48	54	53	60	55	63	55	64	57	[illegible]
14-Aug	- -	- -	48	54	52	61	54	64	54	64	55	[illegible]
15-Aug	- -	- -	45	48	52	59	54	63	54	63	55	[illegible]
16-Aug	- -	- -	46	52	50	59	52	63	52	63	54	[illegible]
17-Aug	- -	- -	46	52	50	59	54	63	52	63	54	[illegible]
18-Aug	- -	- -	45	52	48	59	52	61	50	63	54	[illegible]
19-Aug	- -	- -	45	52	48	58	51	61	50	61	52	[illegible]
20-Aug	- -	- -	46	50	50	57	52	61	52	61	54	[illegible]
21-Aug	- -	- -	43	50	47	57	50	61	48	61	52	[illegible]
22-Aug	- -	- -	43	52	46	59	50	61	48	61	51	[illegible]
23-Aug	- -	- -	45	52	48	60	50	63	50	63	50	[illegible]
24-Aug	- -	- -	45	54	52	61	52	64	52	64	54	[illegible]
25-Aug	- -	- -	46	54	50	59	54	64	54	64	55	[illegible]
26-Aug	- -	- -	45	52	50	60	52	63	52	63	55	[illegible]
27-Aug	- -	- -	44	52	50	61	52	63	52	63	54	[illegible]
28-Aug	- -	- -	45	53	50	61	52	63	52	64	54	[illegible]
29-Aug	- -	- -	46	54	50	61	54	64	53	64	55	[illegible]
30-Aug	- -	- -	46	51	50	61	52	63	52	63	54	[illegible]
31-Aug	- -	- -	45	50	48	59	50	61	50	61	52	[illegible]
01-Sep	- -	- -	45	51	48	59	50	61	50	61	52	[illegible]
02-Sep	- -	- -	45	52	48	59	50	62	50	63	52	[illegible]
03-Sep	- -	- -	46	53	50	59	52	63	52	63	54	[illegible]
04-Sep	- -	- -	46	54	51	60	52	63	54	63	55	[illegible]
05-Sep	- -	- -	46	52	51	59	54	63	54	63	55	[illegible]
06-Sep	- -	- -	46	48	51	59	54	63	54	63	55	[illegible]
07-Sep	- -	- -	45	50	51	57	54	61	52	61	55	[illegible]
08-Sep	- -	- -	43	49	47	55	50	59	49	59	52	[illegible]
09-Sep	- -	- -	43	49	46	55	50	59	49	59	51	[illegible]
10-Sep	- -	- -	43	45	46	48	48	52	48	50	50	[illegible]
11-Sep	- -	- -	43	46	45	52	46	55	46	55	48	[illegible]
12-Sep	- -	- -	41	46	45	54	46	55	46	55	48	[illegible]
13-Sep	- -	- -	41	48	45	54	46	57	46	57	48	[illegible]
14-Sep	- -	- -	43	48	46	55	48	57	46	57	50	[illegible]
15-Sep	- -	- -	43	48	46	54	49	57	48	58	50	[illegible]
16-Sep	- -	- -	45	46	48	54	50	55	49	55	52	[illegible]
17-Sep	- -	- -	42	45	45	48	46	52	46	52	48	[illegible]
18-Sep	- -	- -	41	45	46	48	45	52	45	52	46	[illegible]
19-Sep	- -	- -	43	45	45	48	48	52	48	52	50	[illegible]
20-Sep	- -	- -	43	46	43	50	48	52	46	52	48	[illegible]
21-Sep	- -	- -	41	45	43	50	45	54	45	52	46	[illegible]
22-Sep	- -	- -	41	45	43	50	45	54	45	52	46	51
23-Sep	- -	- -	43	46	44	49	45	52	45	51	46	50
24-Sep	- -	- -	- -	- -	46	52	48	54	48	54	48	[illegible]
25-Sep	- -	- -	- -	- -	46	51	48	54	48	52	50	[illegible]
26-Sep	- -	- -	- -	- -	48	50	50	52	49	52	51	[illegible]

Appendix H, continued.

Date	Sheep Cr. Min.	Sheep Cr. Max.	Panjab Cr. Min.	Panjab Cr. Max.	Big 4 Lk. Min.	Big 4 Lk. Max.	Beaver Lk. Min.	Beaver Lk. Max.	Deer Lk. Min.	Deer Lk. Max.	Cummings Cr Min.	Cummings Cr Max.
27-Sep	--	--	--	--	46	48	50	51	46	50	50	52
28-Sep	--	--	--	--	43	49	45	52	45	51	46	51
29-Sep	--	--	--	--	45	52	46	54	46	54	48	52
30-Sep	--	--	--	--	46	53	46	54	46	55	48	54
01-Oct	--	--	--	--	46	54	48	55	48	55	50	54
02-Oct	--	--	--	--	46	54	48	55	48	55	50	54
03-Oct	--	--	--	--	46	54	48	55	48	55	50	54
04-Oct	--	--	--	--	46	54	48	54	46	54	49	54
05-Oct	--	--	--	--	46	54	48	54	47	54	49	54
06-Oct	--	--	--	--	46	50	48	54	48	54	49	54
07-Oct	--	--	--	--	--	--	48	54	47	54	48	54
08-Oct	--	--	--	--	--	--	48	54	46	54	48	54
09-Oct	--	--	--	--	--	--	48	54	47	54	48	53
10-Oct	--	--	--	--	--	--	46	54	46	54	48	52
11-Oct	--	--	--	--	--	--	46	53	46	54	48	52
12-Oct	--	--	--	--	--	--	46	54	46	54	48	52
13-Oct	--	--	--	--	--	--	48	53	48	54	50	53
14-Oct	--	--	--	--	--	--	50	52	50	52	52	53
15-Oct	--	--	--	--	--	--	50	54	50	54	53	54
16-Oct	--	--	--	--	--	--	52	55	52	54	52	54
17-Oct	--	--	--	--	--	--	48	50	46	50	49	52
18-Oct	--	--	--	--	--	--	45	48	45	48	46	48
19-Oct	--	--	--	--	--	--	46	52	48	52	49	51
20-Oct	--	--	--	--	--	--	46	51	46	50	47	50
21-Oct	--	--	--	--	--	--	45	50	45	50	46	50
22-Oct	--	--	--	--	--	--	46	49	46	48	48	50
23-Oct	--	--	--	--	--	--	42	48	43	48	45	48
24-Oct	--	--	--	--	--	--	45	48	43	48	45	48
25-Oct	--	--	--	--	--	--	45	48	45	48	46	48
26-Oct	--	--	--	--	--	--	45	49	45	48	--	--
27-Oct	--	--	--	--	--	--	40	43	39	43	--	--
28-Oct	--	--	--	--	--	--	39	43	39	43	--	--
29-Oct	--	--	--	--	--	--	40	45	69	43	--	--
30-Oct	--	--	--	--	--	--	43	46	41	46	--	--
31-Oct	--	--	--	--	--	--	--	--	41	46	--	--

APPENDIX I

Tucannon River 1987/1988 spring chinook salmon downstream migrant trapping data. Columns 3 through 15 are as follows: 3) fish marked (left partial ventral clip) and transported 10 km with 4) subsequent recaptures, 5) fish marked (right partial ventral clip) and transported 10 km with 6) subsequent recaptures, 7) fish marked (top caudal clip) and transported 40 km with 8) recaptures, 9) fish marked (bottom caudal clip) with 10) subsequent recaptures, 11) fish that were not marked and released downstream of trap, 12) 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), 13) the sum of columns 3 through 12 for that row, 14) spring chinook salmon released from Tucannon Fish Hatchery and caught at the trap, and 15) the sum of columns 13 and 14 for that row.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Date	Time	Mark LPV	Recapture LPV	Mark RPV	Recapture RPV	Mark TC	Recapture TC	Mark BC	Recapture BC	No marks	Morts	Total wild	Total hatchery	Total fish
06-Oct-87	700	0	0	0	0	0	0	0	0	1	0	1	0	1
20-Oct-87	700	0	0	0	0	0	0	0	0	1	0	1	0	1
21-Oct-87	930	0	0	0	0	0	0	0	0	0	0	0	0	0
22-Oct-87	900	0	0	0	0	0	0	0	0	1	0	1	0	1
23-Oct-87	800	0	0	0	0	0	0	0	0	2	0	2	0	2
27-Oct-87	730	0	0	0	0	0	0	0	0	2	0	2	0	2
28-Oct-87	730	0	0	0	0	0	0	0	0	1	0	1	0	1
29-Oct-87	730	0	0	0	0	0	0	0	0	0	0	0	0	0
30-Oct-87	1300	0	0	0	0	0	0	0	0	0	0	0	0	0
03-Nov-87	700	0	0	0	0	0	0	0	0	0	0	0	0	0
04-Nov-87	1600	0	0	0	0	0	0	0	0	0	0	0	0	0
17-Nov-87	700	0	0	0	0	0	0	0	0	1	0	1	0	1
18-Nov-87	730	0	0	0	0	0	0	0	0	1	0	1	0	1
20-Nov-87	830	0	0	0	0	0	0	0	0	1	0	1	0	1
01-Dec-87	800	0	0	0	0	0	0	0	0	4	0	4	0	4
02-Dec-87	800	0	0	0	0	0	0	0	0	0	0	0	0	0
03-Dec-87	800	0	0	0	0	0	0	0	0	1	0	1	0	1
04-Dec-87	1200	0	0	0	0	0	0	0	0	5	0	5	0	5
08-Dec-87	900	0	0	0	0	0	0	0	0	5	0	5	0	5
09-Dec-87	1000	0	0	4	0	0	0	0	0	0	0	4	0	4
10-Dec-87	1100	0	0	0	0	0	0	0	0	1	0	1	0	1
11-Dec-87	800	0	0	0	0	0	0	0	0	2	0	2	0	2
14-Dec-87	730	0	0	0	0	0	0	0	0	51	1	52	0	52
15-Dec-87	730	0	0	25	0	0	0	0	0	26	1	52	0	52
16-Dec-87	800	0	0	25	2	0	0	0	0	4	0	31	0	31
17-Dec-87	800	0	0	0	1	0	0	0	0	13	0	14	0	14
21-Dec-87	800	0	0	0	0	0	0	0	0	14	1	15	0	15
23-Dec-87	1200	0	0	0	0	0	0	0	0	8	1	9	0	9
11-Jan-88	830	0	0	0	0	0	0	0	0	2	0	2	0	2
12-Jan-88	730	0	0	15	0	0	0	0	0	5	0	20	0	20
12-Jan-88	1530	0	0	0	0	0	0	0	0	5	2	7	0	7
13-Jan-88	730	0	0	0	10	0	0	0	0	180	9	199	0	199
14-Jan-88	1100	0	0	19	0	0	0	0	0	0	0	19	0	19
15-Jan-88	800	0	0	0	0	0	0	0	0	3	0	3	0	3
19-Jan-88	730	0	0	0	0	0	0	0	0	60	1	61	0	61
25-Jan-88	730	0	0	25	0	0	0	0	0	87	0	112	0	112
26-Jan-88	800	0	0	25	4	0	0	0	0	38	9	76	0	76
27-Jan-88	800	0	0	25	4	0	0	0	0	28	0	57	0	57

Appendix I, continued.

1 Date	2 Time	3 Mark LPV	4 Recapture LPV	5 Mark RPV	6 Recapture RPV	7 Mark TC	8 Recapture TC	9 Mark BC	10 Recapture BC	11 No marks	12 Morts	13 Total wild	14 Total hatchery	15 Total fish
28-Jan-88	800	0	0	25	2	0	0	0	0	62	0	89	0	89
29-Jan-88	830	0	0	24	6	0	0	0	0	2	0	32	0	32
30-Jan-88	830	0	0	34	3	0	0	0	0	2	0	39	0	39
31-Jan-88	800	0	0	11	0	0	0	0	0	1	0	12	0	12
01-Feb-88	800	0	0	0	4	0	0	0	0	16	0	20	0	20
05-Feb-88	800	0	0	0	1	0	0	0	0	91	1	93	0	93
06-Feb-88	1000	0	0	32	1	0	0	0	0	2	0	35	0	35
07-Feb-88	830	0	0	36	18	0	0	0	0	4	0	58	0	58
08-Feb-88	800	0	0	42	14	0	0	0	0	3	0	59	0	59
09-Feb-88	800	0	0	20	15	0	0	0	0	5	0	40	0	40
10-Feb-88	800	0	0	8	3	0	0	0	0	0	0	11	0	11
11-Feb-88	800	0	0	32	3	0	0	0	0	2	0	37	0	37
11-Feb-88	1500	0	0	0	3	0	0	0	0	6	0	9	0	9
12-Feb-88	800	0	0	28	5	0	0	0	0	0	0	33	0	33
13-Feb-88	900	0	0	31	1	0	0	0	0	4	0	36	0	36
14-Feb-88	900	0	0	0	9	0	0	0	0	26	1	36	0	36
16-Feb-88	800	0	0	5	0	0	0	0	0	1	0	6	0	6
17-Feb-88	800	0	0	16	0	0	0	0	0	1	0	17	0	17
18-Feb-88	800	0	0	27	1	0	0	0	0	2	0	30	0	30
19-Feb-88	800	38	0	0	7	0	0	0	0	1	0	46	0	46
20-Feb-88	800	30	3	0	2	0	0	0	0	0	0	35	0	35
21-Feb-88	1000	0	6	34	3	0	0	0	0	4	0	47	0	47
22-Feb-88	800	3	0	0	0	0	0	0	0	0	0	3	0	3
23-Feb-88	800	0	0	17	1	0	0	0	0	3	0	21	0	21
24-Feb-88	800	50	0	0	6	0	0	0	0	11	0	67	0	67
24-Feb-88	1500	0	0	0	0	0	0	0	0	5	0	5	0	5
25-Feb-88	730	3	2	34	1	0	0	0	0	1	0	41	0	41
26-Feb-88	730	43	1	0	7	0	0	0	0	5	0	56	0	56
27-Feb-88	800	0	3	19	0	0	0	0	0	1	0	23	0	23
28-Feb-88	730	18	3	0	3	0	0	0	0	0	0	24	0	24
29-Feb-88	730	0	2	0	4	0	0	0	0	1	0	7	0	7
01-Mar-88	730	3	0	0	0	0	0	0	0	2	0	5	0	5
02-Mar-88	800	0	0	6	0	0	0	0	0	1	0	7	0	7
03-Mar-88	730	4	1	0	1	0	0	0	0	0	0	6	0	6
04-Mar-88	800	0	0	0	0	0	0	0	0	1	0	1	0	1
07-Mar-88	730	0	0	4	0	0	0	0	0	0	0	4	0	4
08-Mar-88	730	17	0	0	1	0	0	0	0	1	0	19	0	19
09-Mar-88	730	0	3	15	0	0	0	0	0	0	0	18	0	18
10-Mar-88	800	23	0	0	4	0	0	0	0	2	0	29	9	38
11-Mar-88	800	0	9	23	2	0	0	0	0	0	0	34	11	45
11-Mar-88	1400	0	0	0	0	0	0	0	0	0	0	0	1	1
12-Mar-88	900	24	4	0	7	0	0	0	0	16	0	51	3	54
13-Mar-88	700	0	6	19	0	0	0	0	0	4	0	29	8	37
14-Mar-88	700	17	1	0	3	0	0	0	0	2	0	23	5	28
15-Mar-88	730	0	5	19	0	0	0	0	0	0	0	24	5	29
16-Mar-88	730	0	0	17	4	0	0	0	0	3	0	24	4	28
17-Mar-88	800	0	0	23	3	0	0	0	0	0	0	26	4	30
18-Mar-88	800	20	0	0	10	0	0	0	0	1	0	31	6	37

Appendix I, continued.

1 Date	2 Time	3 Mark LPV	4 Recapture LPV	5 Mark RPV	6 Recapture RPV	7 Mark TC	8 Recapture TC	9 Mark BC	10 Recapture BC	11 No marks	12 Morts	13 Total wild	14 Total hatchery	15 Total fish
19-Mar-88	800	20	6	0	1	0	0	0	0	1	0	28	2	30
20-Mar-88	630	2	1	0	0	0	0	0	0	15	1	19	0	19
21-Mar-88	730	0	1	16	0	0	0	0	0	1	0	18	0	18
22-Mar-88	800	0	2	32	2	0	0	0	0	5	0	41	6	47
23-Mar-88	730	0	1	3	2	0	0	0	0	28	2	36	0	36
24-Mar-88	700	3	0	0	0	0	0	0	0	1	0	4	0	4
25-Mar-88	800	13	0	0	0	0	0	0	0	0	0	13	1	14
26-Mar-88	800	3	0	0	1	0	0	0	0	1	0	5	0	5
27-Mar-88	630	0	0	0	0	0	0	0	0	0	0	0	0	0
27-Mar-88	1800	0	0	0	0	0	0	0	0	5	0	5	3	8
28-Mar-88	730	0	0	4	0	0	0	0	0	0	0	4	0	4
28-Mar-88	1300	0	0	4	1	0	0	0	0	0	0	5	1	6
28-Mar-88	1800	0	0	0	0	0	0	0	0	9	0	9	0	9
28-Mar-88	2030	0	0	0	0	0	0	0	0	8	0	8	2	10
29-Mar-88	130	0	0	0	0	0	0	0	0	2	0	2	4	6
29-Mar-88	600	0	1	14	1	0	0	0	0	4	0	20	1	21
29-Mar-88	1200	0	2	11	0	0	0	0	0	5	0	18	0	18
29-Mar-88	2030	0	0	0	8	0	0	0	0	0	0	8	4	12
29-Mar-88	2300	0	0	5	0	0	0	0	0	0	0	5	1	6
30-Mar-88	130	0	0	13	0	0	0	0	0	0	0	13	0	13
30-Mar-88	600	0	0	13	2	0	0	0	0	17	0	32	3	35
30-Mar-88	1200	0	0	0	0	0	0	0	0	6	0	6	0	6
30-Mar-88	1800	0	0	0	1	4	0	0	0	1	0	6	0	6
30-Mar-88	2030	0	0	0	3	15	0	0	0	0	0	18	1	19
30-Mar-88	2300	0	1	0	0	22	0	0	0	0	0	23	1	24
31-Mar-88	130	0	1	0	1	11	0	0	0	2	0	15	0	15
31-Mar-88	400	0	0	0	1	0	0	0	0	16	0	17	1	18
31-Mar-88	800	0	1	0	1	0	0	0	0	7	0	9	1	10
31-Mar-88	1200	0	0	0	0	0	0	0	0	5	0	5	0	5
31-Mar-88	1500	6	1	0	0	0	0	0	0	1	0	8	0	8
31-Mar-88	1900	13	0	0	2	0	0	0	0	0	0	15	0	15
31-Mar-88	2030	15	0	0	0	0	0	0	0	0	0	15	0	15
31-Mar-88	2330	16	0	0	6	0	0	0	0	0	0	22	0	22
01-Apr-88	400	0	0	0	2	0	0	0	0	17	0	19	0	19
01-Apr-88	900	0	0	0	0	0	0	0	0	3	0	3	0	3
01-Apr-88	1700	0	0	0	0	0	0	0	0	2	0	2	0	2
01-Apr-88	2000	5	0	0	0	0	0	0	0	0	0	5	0	5
02-Apr-88	400	6	1	0	0	0	0	0	0	0	0	7	0	7
02-Apr-88	900	0	2	0	0	0	0	0	0	8	0	10	0	10
02-Apr-88	1500	0	0	0	0	0	0	0	0	2	0	2	0	2
03-Apr-88	700	10	1	0	0	0	0	0	0	0	0	11	0	11
03-Apr-88	1000	4	0	0	0	0	0	0	0	0	0	4	1	5
03-Apr-88	1200	4	0	0	1	0	0	0	0	0	0	5	1	6
03-Apr-88	1800	0	1	12	0	0	0	0	0	0	0	13	0	13
03-Apr-88	2000	0	0	7	0	0	0	0	0	0	0	7	0	7
03-Apr-88	2200	0	0	3	1	0	0	0	0	0	0	4	0	4
03-Apr-88	2330	0	0	2	0	0	0	0	0	0	0	2	1	3

Appendix I, continued.

1 Date	2 Time	3 Mark LPV	4 Recapture LPV	5 Mark RPV	6 Recapture RPV	7 Mark TC	8 Recapture TC	9 Mark BC	10 Recapture BC	11 No marks	12 Morts	13 Total wild	14 Total hatchery	15 Total fish
04-Apr-88	500	0	0	1	0	0	0	0	0	0	0	1	0	1
04-Apr-88	800	0	0	0	0	0	0	0	0	3	0	3	0	3
04-Apr-88	1500	0	0	0	2	0	0	0	0	6	0	8	0	8
04-Apr-88	1800	0	0	0	1	0	0	0	0	5	0	6	0	6
04-Apr-88	2030	0	0	0	0	0	0	0	0	2	0	2	0	2
04-Apr-88	2300	0	0	0	0	0	0	0	0	7	0	7	1	8
05-Apr-88	100	0	0	7	1	0	0	0	0	0	0	8	0	8
05-Apr-88	400	0	0	7	0	0	0	0	0	0	0	7	0	7
05-Apr-88	1100	0	0	8	0	0	0	0	0	0	0	8	1	9
05-Apr-88	1600	0	0	8	0	0	1	0	0	0	0	9	0	9
05-Apr-88	1830	0	0	5	0	0	0	0	0	0	0	5	0	5
05-Apr-88	2100	0	0	3	1	0	0	0	0	0	0	4	0	4
05-Apr-88	2300	0	2	31	1	0	0	0	0	1	0	35	2	37
06-Apr-88	200	0	0	0	1	0	0	0	0	25	0	26	2	28
06-Apr-88	600	0	1	0	0	0	0	0	0	11	0	12	0	12
06-Apr-88	1200	0	0	0	0	0	0	0	0	10	0	10	0	10
06-Apr-88	1830	0	0	0	1	3	0	0	0	0	0	4	0	4
06-Apr-88	2100	0	0	0	0	2	0	0	0	0	0	2	0	2
06-Apr-88	2330	0	0	0	4	11	0	0	0	0	0	15	1	16
07-Apr-88	130	0	0	0	3	9	0	0	0	1	0	13	2	15
07-Apr-88	700	0	2	0	4	21	0	0	0	3	0	30	1	31
07-Apr-88	1200	0	0	0	0	0	0	0	0	0	0	0	0	0
07-Apr-88	1800	6	0	0	1	0	0	0	0	0	0	7	0	7
07-Apr-88	2030	1	0	0	0	0	0	0	0	0	0	1	0	1
07-Apr-88	2300	13	0	0	0	0	0	0	0	0	0	13	1	14
08-Apr-88	200	33	0	0	1	0	0	0	0	0	0	34	2	36
08-Apr-88	600	0	0	0	0	0	0	0	0	14	0	14	1	15
08-Apr-88	1200	0	0	0	0	0	0	0	0	0	0	0	0	0
08-Apr-88	1500	0	2	0	0	0	0	0	0	11	0	13	0	13
08-Apr-88	1800	4	0	0	0	0	0	0	0	0	0	4	0	4
08-Apr-88	2300	38	3	0	1	0	0	0	0	2	0	44	0	44
09-Apr-88	200	8	0	0	0	0	0	0	0	36	0	44	0	44
09-Apr-88	500	0	1	0	2	0	0	0	0	32	0	35	4	39
09-Apr-88	800	0	0	0	0	0	0	0	0	17	0	17	0	17
09-Apr-88	1030	0	0	0	0	0	0	0	0	2	0	2	1	3
09-Apr-88	1600	0	1	0	0	0	0	0	0	4	0	5	0	5
10-Apr-88	100	24	3	0	0	0	0	0	0	0	0	27	4	31
10-Apr-88	300	25	0	0	0	0	3	0	0	2	0	30	0	30
10-Apr-88	600	0	0	0	0	0	0	0	0	21	0	21	1	22
10-Apr-88	1500	0	0	1	0	0	0	0	0	0	0	1	0	1
10-Apr-88	1900	0	0	1	0	0	0	0	0	0	0	1	0	1
10-Apr-88	2200	0	2	0	1	0	0	0	0	3	0	6	0	6
10-Apr-88	2300	0	5	21	0	0	0	0	0	2	0	28	0	28
11-Apr-88	630	0	7	27	0	0	5	0	0	107	0	146	3	149
11-Apr-88	1100	0	0	0	0	0	0	0	0	5	0	5	0	5
11-Apr-88	1400	0	1	0	0	0	0	0	0	6	1	8	0	8
11-Apr-88	2300	0	2	16	1	0	0	0	0	0	0	19	0	19
12-Apr-88	300	0	1	34	1	0	1	0	0	30	0	67	1	68

Appendix I, continued.

1 Date	2 Time	3 Mark LPV	4 Recapture LPV	5 Mark RPV	6 Recapture RPV	7 Mark TC	8 Recapture TC	9 Mark BC	10 Recapture BC	11 No marks	12 Morts	13 Total wild	14 Total hatchery	15 Total fish
12-Apr-88	600	0	0	0	2	0	0	0	0	43	0	45	1	46
12-Apr-88	900	0	0	0	0	0	1	0	0	4	0	5	0	5
12-Apr-88	1400	0	0	0	1	0	0	0	0	12	0	13	0	13
12-Apr-88	1800	0	0	7	0	0	0	0	0	1	0	8	0	8
12-Apr-88	2000	0	0	7	1	0	0	0	0	0	0	8	0	8
12-Apr-88	2300	0	0	19	1	0	0	0	0	0	0	20	1	21
13-Apr-88	300	0	0	17	3	0	0	0	0	33	0	53	6	59
13-Apr-88	600	0	0	0	4	0	1	0	0	38	0	43	3	46
13-Apr-88	900	0	0	0	0	0	0	0	0	7	0	7	0	7
13-Apr-88	1430	0	0	0	0	0	0	0	0	6	0	6	0	6
13-Apr-88	1800	0	0	0	0	0	0	5	0	0	0	5	0	5
13-Apr-88	2000	0	0	0	0	0	0	7	0	0	0	7	0	7
13-Apr-88	2230	0	1	0	4	0	0	18	0	3	0	26	5	31
14-Apr-88	130	0	0	0	4	0	0	20	0	15	0	39	12	51
14-Apr-88	300	0	0	0	6	0	1	0	0	61	0	68	132	200
14-Apr-88	1130	0	1	0	2	0	0	0	0	29	0	32	8	40
14-Apr-88	1630	0	1	0	0	0	0	16	0	1	0	18	1	19
14-Apr-88	1930	0	0	0	0	0	0	9	0	1	0	10	4	14
14-Apr-88	2030	0	1	0	0	0	0	14	0	0	0	15	53	68
15-Apr-88	200	0	2	0	1	0	2	16	1	30	0	52	221	273
15-Apr-88	530	0	0	0	0	0	0	0	4	46	0	50	681	731
15-Apr-88	900	0	0	0	0	0	0	1	0	5	0	6	11	17
15-Apr-88	1130	0	0	0	2	0	0	0	0	20	0	22	3	25
15-Apr-88	1400	0	0	0	0	0	1	0	0	19	0	20	1	21
15-Apr-88	1600	0	0	0	0	0	0	0	1	14	0	15	0	15
15-Apr-88	1800	5	0	0	0	0	0	0	0	0	0	5	2	7
15-Apr-88	2100	11	0	0	0	0	0	0	0	0	0	11	50	61
16-Apr-88	100	9	0	0	0	0	0	0	0	0	0	9	180	189
16-Apr-88	300	23	0	0	0	0	0	0	0	0	0	23	208	231
16-Apr-88	600	2	1	0	0	0	1	0	1	36	0	41	144	185
16-Apr-88	900	0	0	0	0	0	0	0	0	6	0	6	5	11
16-Apr-88	1200	0	0	0	0	0	0	0	0	8	0	8	4	12
16-Apr-88	1530	0	0	0	0	0	0	0	0	3	0	3	3	6
16-Apr-88	1830	0	0	0	0	0	0	0	0	2	0	2	1	3
16-Apr-88	2130	0	1	0	0	0	0	0	0	6	0	7	31	38
17-Apr-88	30	15	1	0	0	0	0	0	1	0	0	17	92	109
17-Apr-88	330	9	0	0	0	0	0	0	1	0	0	10	113	123
17-Apr-88	730	4	1	0	0	0	0	0	0	0	0	5	14	19
17-Apr-88	1030	13	1	0	0	0	0	0	0	0	0	14	27	41
17-Apr-88	1330	9	1	0	0	0	0	0	0	8	0	18	175	193
17-Apr-88	1530	0	1	0	0	0	0	0	0	7	0	8	97	105
17-Apr-88	1830	0	0	3	0	0	0	0	0	0	0	3	35	38
17-Apr-88	2130	0	2	29	2	0	0	0	0	4	0	37	738	775
18-Apr-88	30	0	2	17	0	0	0	0	0	4	0	23	190	213
18-Apr-88	330	0	1	1	0	0	0	0	0	14	0	16	102	118
18-Apr-88	730	0	0	0	0	0	0	0	0	6	0	6	28	34
18-Apr-88	1100	0	0	0	0	0	0	0	0	2	0	2	10	12
18-Apr-88	1330	0	1	0	0	0	0	0	0	9	0	10	2	12

Appendix I, continued.

1 Date	2 Time	3 Mark LPV	4 Recapture LPV	5 Mark RPV	6 Recapture RPV	7 Mark TC	8 Recapture TC	9 Mark BC	10 Recapture BC	11 No marks	12 Morts	13 Total wild	14 Total hatchery	15 Total fish
18-Apr-88	1500	0	0	0	0	0	0	0	0	2	0	2	0	2
18-Apr-88	1830	0	0	3	0	0	0	0	0	0	0	3	1	4
18-Apr-88	2130	0	2	31	2	0	0	0	0	1	0	36	116	152
19-Apr-88	30	0	1	14	1	0	2	0	1	46	0	65	166	231
19-Apr-88	330	0	0	2	3	0	1	0	0	37	1	44	120	164
19-Apr-88	1330	0	1	0	0	0	0	0	0	25	0	26	27	53
19-Apr-88	1530	0	0	0	0	0	0	0	0	3	0	3	2	5
19-Apr-88	1800	0	0	4	0	0	0	0	0	0	0	4	4	8
19-Apr-88	2000	0	0	3	0	0	0	0	0	0	0	3	7	10
19-Apr-88	2200	0	1	12	1	0	0	0	1	0	0	15	18	33
20-Apr-88	100	0	0	23	5	0	0	0	2	11	0	41	58	99
20-Apr-88	300	0	1	3	2	0	1	0	3	79	0	89	67	156
20-Apr-88	600	0	0	0	0	0	0	0	1	57	0	58	11	69
20-Apr-88	1230	0	0	0	0	0	0	0	0	15	0	15	3	18
20-Apr-88	1730	0	0	0	2	0	0	0	1	24	0	27	11	38
20-Apr-88	2200	0	0	0	1	35	0	0	0	0	0	36	25	61
21-Apr-88	200	0	2	0	12	15	1	0	2	265	1	298	108	406
21-Apr-88	600	0	0	0	2	0	0	0	2	138	0	142	115	257
21-Apr-88	1000	0	0	0	0	0	0	0	0	7	0	7	8	15
21-Apr-88	1500	0	0	0	0	0	1	0	0	16	0	17	0	17
21-Apr-88	1500	0	0	0	0	0	1	0	0	11	0	12	7	19
21-Apr-88	2100	0	0	0	0	0	0	0	0	18	0	18	21	39
22-Apr-88	100	49	0	0	3	0	1	0	1	59	0	113	0	113
22-Apr-88	400	0	0	0	1	0	0	0	0	50	0	51	45	96
22-Apr-88	630	0	0	0	3	0	0	0	0	42	0	45	11	56
22-Apr-88	1230	0	0	0	0	0	0	0	1	21	0	22	13	35
22-Apr-88	1530	0	0	0	0	0	0	0	0	22	0	22	5	27
22-Apr-88	2200	49	0	0	0	0	1	0	0	0	0	50	17	67
23-Apr-88	100	1	3	0	1	0	0	0	0	51	0	56	22	78
23-Apr-88	300	0	1	0	0	0	0	0	0	191	0	192	46	238
23-Apr-88	830	0	0	0	1	0	2	0	0	42	1	46	32	78
23-Apr-88	1230	0	1	0	0	0	0	0	0	19	0	20	17	37
23-Apr-88	1530	0	2	0	0	0	0	0	0	24	0	26	3	29
23-Apr-88	2000	22	3	0	0	0	0	0	0	0	0	25	14	39
24-Apr-88	100	29	1	0	0	0	1	0	1	27	0	59	21	80
24-Apr-88	300	0	6	0	1	0	0	0	0	78	0	85	42	127
24-Apr-88	800	0	1	0	1	0	0	0	1	43	0	46	12	58
24-Apr-88	1200	0	0	0	0	0	0	0	0	12	0	12	9	21
24-Apr-88	1600	0	2	36	1	0	0	0	0	2	0	41	2	43
24-Apr-88	2030	0	0	11	0	0	0	0	0	0	0	11	6	17
24-Apr-88	2230	0	5	4	0	0	0	0	0	24	0	33	8	41
25-Apr-88	30	0	2	0	0	0	2	0	0	113	0	117	18	135
25-Apr-88	300	0	1	0	0	0	1	0	0	75	0	77	24	101
25-Apr-88	700	0	3	0	0	0	0	0	3	155	0	161	44	205
25-Apr-88	1230	0	1	0	0	0	0	0	0	7	0	8	3	11
25-Apr-88	1500	0	1	0	0	0	0	0	0	4	0	5	2	7
25-Apr-88	1930	0	0	0	0	0	0	0	0	0	0	0	1	1
25-Apr-88	2200	0	1	15	2	0	0	0	0	0	0	18	2	20

Appendix I, continued.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Mark	Recapture	Mark	Recapture	Mark	Recapture	Mark	Recapture	No		Total	Total	Total
Date	Time	LPV	LPV	RPV	RPV	TC	TC	BC	BC	marks	Morts	wild	hatchery	fish
26-Apr-88	30	0	1	39	1	0	0	0	0	25	0	66	11	77
26-Apr-88	300	0	0	0	3	0	0	0	0	79	0	82	21	103
26-Apr-88	700	0	2	0	0	0	1	0	0	98	0	101	46	147
26-Apr-88	1100	0	1	0	0	0	0	0	0	5	0	6	0	6
26-Apr-88	1500	0	1	0	0	0	0	0	0	4	0	5	0	5
26-Apr-88	2100	0	0	12	2	0	0	0	0	1	0	15	1	16
26-Apr-88	2300	0	1	28	1	0	1	0	0	2	0	33	3	36
27-Apr-88	100	0	2	10	4	0	0	0	0	29	0	45	3	48
27-Apr-88	300	0	0	0	3	0	0	0	0	79	0	82	16	98
27-Apr-88	630	0	2	0	4	0	0	0	1	96	0	103	45	148
27-Apr-88	1200	0	0	0	0	0	0	0	0	8	0	8	1	9
27-Apr-88	1530	0	0	0	0	0	0	0	0	3	0	3	1	4
27-Apr-88	2100	0	0	0	1	0	0	3	0	0	0	4	5	9
28-Apr-88	100	0	0	0	1	0	0	5	0	0	0	6	1	7
28-Apr-88	300	0	0	0	3	0	0	10	0	0	0	13	8	21
28-Apr-88	700	0	0	0	7	0	1	34	0	14	0	56	22	78
28-Apr-88	1200	0	0	0	1	0	0	0	0	6	0	7	1	8
28-Apr-88	1430	0	0	0	0	0	0	0	0	6	0	6	3	9
28-Apr-88	2000	8	0	0	0	0	0	0	0	0	0	8	6	14
29-Apr-88	100	15	0	0	0	0	0	0	0	0	0	15	6	21
29-Apr-88	230	26	0	0	0	0	1	0	1	59	0	87	11	98
29-Apr-88	630	0	0	0	2	0	1	0	1	47	0	51	10	61
29-Apr-88	1600	0	0	0	0	0	0	0	1	33	0	34	10	44
29-Apr-88	2000	10	0	0	0	0	1	0	0	0	0	11	1	12
30-Apr-88	100	24	5	0	0	0	0	0	0	0	0	29	7	36
30-Apr-88	230	16	8	0	0	0	0	0	0	41	0	65	13	78
30-Apr-88	700	0	7	0	0	0	0	0	0	181	0	188	24	212
30-Apr-88	1730	4	0	0	0	0	0	0	0	1	0	5	1	6
30-Apr-88	2200	12	0	0	0	0	0	0	1	0	0	13	5	18
01-May-88	30	34	2	0	0	0	0	0	4	9	0	49	6	55
01-May-88	230	0	4	0	0	0	0	0	0	27	0	31	3	34
01-May-88	700	0	3	0	1	0	0	0	0	85	0	89	48	137
01-May-88	1300	0	0	0	0	0	0	0	0	3	0	3	1	4
01-May-88	1930	0	0	0	0	0	0	0	0	5	0	5	1	6
02-May-88	30	0	1	39	0	0	0	0	1	4	0	45	5	50
02-May-88	330	0	1	11	0	0	0	0	0	56	0	68	7	75
02-May-88	800	0	2	0	0	0	0	0	0	58	0	60	11	71
02-May-88	1200	0	0	0	2	0	0	0	0	6	0	8	3	11
02-May-88	1530	0	0	0	0	0	0	0	0	3	0	3	0	3
02-May-88	2000	0	0	6	1	0	0	0	0	0	0	7	5	12
03-May-88	30	0	2	44	6	0	1	0	0	18	0	71	5	76
03-May-88	700	0	1	0	6	0	0	0	0	101	0	108	20	128
03-May-88	1430	0	1	0	1	0	0	0	0	9	0	11	0	11
03-May-88	2330	0	1	50	12	0	0	0	1	8	0	72	10	82
04-May-88	300	0	0	0	4	0	0	0	1	54	1	60	21	81
04-May-88	830	0	1	0	3	0	0	0	1	43	0	48	4	52
04-May-88	1300	0	0	0	0	0	0	0	0	5	0	5	5	10
04-May-88	2100	0	0	0	0	0	0	0	0	2	0	2	1	3

Appendix I, continued.

1 Date	2 Time	3 Mark LPV	4 Recapture LPV	5 Mark RPV	6 Recapture RPV	7 Mark TC	8 Recapture TC	9 Mark RC	10 Recapture RC	11 No marks	12 Morts	13 Total wild	14 Total hatchery	15 Total fish
05-May-88	30	0	0	0	14	0	1	0	1	121	0	137	11	148
05-May-88	700	0	0	0	2	50	0	0	0	59	0	111	22	133
05-May-88	1200	0	0	0	0	0	0	0	0	4	0	4	1	5
05-May-88	2100	0	0	0	1	0	0	0	0	6	0	7	1	8
06-May-88	30	0	2	0	7	0	0	0	0	114	0	123	12	135
06-May-88	230	0	0	0	0	0	0	0	0	34	0	34	3	37
06-May-88	730	50	0	0	2	0	1	0	0	7	2	62	15	77
06-May-88	1430	0	0	0	0	0	0	0	0	24	0	24	5	29
06-May-88	2100	0	0	0	0	0	1	0	0	11	0	12	1	13
07-May-88	100	0	6	0	0	0	2	0	1	146	0	155	13	168
07-May-88	230	0	1	0	0	0	2	0	1	84	0	88	11	99
07-May-88	700	50	2	0	0	0	0	0	0	14	0	66	16	82
07-May-88	2100	0	0	0	0	0	0	0	1	15	0	16	7	23
08-May-88	100	0	9	0	0	0	4	0	2	83	0	98	10	108
08-May-88	230	0	2	0	0	0	1	0	0	58	0	61	8	69
08-May-88	630	50	4	0	0	0	2	0	0	3	0	59	9	68
08-May-88	1530	0	1	0	0	0	0	0	0	7	0	8	2	10
08-May-88	1930	0	0	0	0	0	0	0	0	2	0	2	0	2
08-May-88	2330	0	1	0	1	0	0	0	0	35	0	37	2	39
09-May-88	300	0	5	0	0	0	2	0	2	89	0	98	9	107
09-May-88	700	0	1	47	0	0	0	0	0	6	0	54	9	63
09-May-88	1200	0	0	0	0	0	0	0	0	8	0	8	2	10
09-May-88	1830	0	0	0	0	0	0	0	0	2	0	2	1	3
09-May-88	2130	0	0	0	0	0	0	0	1	8	0	9	0	9
10-May-88	30	0	0	0	1	0	0	0	0	69	0	70	5	75
10-May-88	300	0	0	0	1	0	1	0	0	68	0	70	14	84
10-May-88	630	0	0	50	1	0	1	0	0	12	0	64	13	77
10-May-88	1200	0	0	0	0	0	0	0	0	12	0	12	2	14
10-May-88	1900	0	0	0	0	0	0	0	0	7	0	7	4	11
10-May-88	2200	0	0	0	0	0	0	0	0	9	0	9	1	10
11-May-88	100	0	0	0	1	0	1	0	0	23	0	25	2	27
11-May-88	300	0	1	0	0	0	0	0	0	58	0	59	6	65
11-May-88	700	0	0	50	0	0	1	0	0	21	0	72	13	85
11-May-88	1400	0	0	0	0	0	0	0	0	16	0	16	7	23
11-May-88	2000	0	0	0	1	0	0	0	0	5	0	6	0	6
11-May-88	2330	0	0	1	0	0	0	0	1	28	0	30	7	37
12-May-88	330	0	0	0	0	0	1	0	1	90	0	92	9	101
12-May-88	700	0	0	0	1	0	2	48	0	45	1	97	23	120
12-May-88	1100	0	0	0	0	0	0	0	0	50	0	50	7	57
12-May-88	1430	0	0	0	0	0	0	0	0	31	0	31	3	34
12-May-88	2000	0	0	0	0	0	0	0	0	6	0	6	3	9
13-May-88	700	30	0	0	1	0	0	0	1	8	2	42	15	57
13-May-88	1200	0	0	0	0	0	2	0	0	46	0	48	11	59
13-May-88	1900	0	0	0	0	0	0	0	0	10	0	10	4	14
13-May-88	2300	0	0	0	1	0	0	0	0	23	0	24	1	25
14-May-88	300	0	0	0	0	0	0	0	0	38	0	38	0	38
14-May-88	600	0	0	0	1	0	0	0	0	42	0	43	0	43
15-May-88	1000	0	0	0	0	0	0	0	1	2	0	3	0	3

Appendix E, continued.

1 Date	2 Time	3 Mark LPV	4 Recapture LPV	5 Mark RPV	6 Recapture RPV	7 Mark TC	8 Recapture TC	9 Mark BC	10 Recapture BC	11 No marks	12 Morts	13 Total wild	14 Total hatchery	15 Total fish
15-May-88	1500	0	0	0	0	0	0	0	2	5	0	7	0	7
15-May-88	1900	0	0	0	0	0	0	0	0	1	1	2	0	2
15-May-88	2300	0	0	0	0	0	1	0	0	9	0	10	1	11
16-May-88	300	0	0	0	0	0	1	0	0	17	0	18	2	20
16-May-88	630	16	0	0	0	0	0	1	0	2	0	19	6	25
16-May-88	1500	20	1	0	0	0	0	0	0	1	0	22	2	24
16-May-88	1900	0	0	0	0	0	0	0	0	1	0	1	0	1
16-May-88	2330	0	0	0	0	0	0	0	0	14	0	14	1	15
17-May-88	330	0	3	29	0	0	0	0	1	8	0	41	1	42
17-May-88	630	0	1	7	0	0	0	0	0	0	0	8	0	8
17-May-88	1530	0	0	0	0	0	0	0	0	6	0	6	2	8
17-May-88	1900	0	0	0	0	0	0	0	0	5	0	5	1	6
17-May-88	2300	0	2	0	0	0	0	0	0	6	0	8	1	9
18-May-88	300	0	0	23	3	0	0	0	0	4	0	30	2	32
18-May-88	630	0	0	13	2	0	0	0	0	1	0	16	1	17
18-May-88	1500	0	0	0	0	0	0	0	0	4	0	4	0	4
18-May-88	1900	0	0	0	0	0	0	0	0	2	0	2	0	2
18-May-88	2330	0	0	0	0	0	0	0	0	9	0	9	0	9
19-May-88	230	0	0	0	3	0	0	0	0	17	0	20	2	22
19-May-88	700	0	0	0	2	24	0	0	0	3	0	29	2	31
19-May-88	1400	0	0	0	1	0	0	0	0	2	0	3	1	4
19-May-88	2000	0	0	0	0	0	0	0	0	9	0	9	0	9
20-May-88	700	17	1	0	0	0	1	0	0	3	0	22	2	24
21-May-88	630	22	0	0	0	0	0	0	0	3	0	25	3	28
21-May-88	1500	0	0	0	0	0	0	0	0	4	0	4	0	4
21-May-88	2330	11	0	0	0	0	0	0	0	1	0	12	0	12
22-May-88	330	26	0	0	0	0	0	0	1	5	0	32	0	32
23-May-88	300	0	2	22	0	0	0	0	0	0	0	24	0	24
23-May-88	700	0	1	23	0	0	0	0	0	0	0	24	4	28
24-May-88	700	0	1	18	1	0	0	0	0	0	0	20	1	21
25-May-88	300	0	0	7	2	0	0	0	0	0	0	9	0	9
25-May-88	630	0	0	17	3	0	0	0	1	3	0	24	1	25
26-May-88	330	0	0	0	0	0	1	26	0	1	1	29	0	29
26-May-88	630	0	0	0	1	0	0	9	0	5	0	15	0	15
27-May-88	430	29	0	0	0	0	0	0	0	1	0	30	1	31
27-May-88	700	5	0	0	0	0	1	0	0	0	0	6	0	6
28-May-88	300	0	1	16	0	0	1	0	0	1	0	19	0	19
28-May-88	430	34	5	0	1	0	0	0	0	3	0	43	1	44
28-May-88	630	8	1	0	0	0	0	0	3	2	0	14	0	14
29-May-88	600	0	17	0	0	0	0	0	2	76	1	96	1	97
01-Jun-88	630	0	0	47	0	0	0	0	1	5	0	53	0	53
02-Jun-88	630	0	0	0	1	39	0	0	0	4	0	44	2	46
03-Jun-88	630	28	0	0	0	0	0	0	0	2	0	30	0	30
04-Jun-88	700	25	6	0	0	0	0	0	0	1	0	32	1	33
06-Jun-88	630	0	0	37	0	0	2	0	0	10	0	49	0	49
06-Jun-88	1330	0	0	0	0	0	0	0	0	2	0	2	0	2
07-Jun-88	630	0	0	21	4	0	0	0	0	2	0	27	0	27
08-Jun-88	630	0	0	13	2	0	0	0	0	4	0	19	0	19

Appendix I, continued.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Date	Time	Mark LPV	Recapture LPV	Mark RPV	Recapture RPV	Mark TC	Recapture TC	Mark BC	Recapture BC	No. marks	Morts	Total wild	Total hatchery	Total fish
09-Jun-88	700	0	0	0	7	0	0	26	0	2	0	35	0	35
10-Jun-88	800	0	0	0	0	0	0	0	0	5	0	5	0	5
11-Jun-88	1000	8	0	0	0	0	0	0	0	0	0	8	0	8
14-Jun-88	700	0	0	12	0	0	0	0	0	0	0	12	0	12
15-Jun-88	700	0	0	4	0	0	0	0	0	1	0	5	0	5
16-Jun-88	700	0	0	4	0	0	0	0	0	0	0	4	0	4
17-Jun-88	630	0	0	0	0	0	0	0	0	1	0	1	0	1
20-Jun-88	630	0	0	1	0	0	0	0	0	1	0	2	0	2
21-Jun-88	630	0	0	0	0	0	0	0	0	0	0	0	0	0
22-Jun-88	700	0	0	0	0	0	0	0	0	0	0	0	0	0
23-Jun-88	700	0	0	0	0	0	0	0	0	0	0	0	0	0
24-Jun-88	630	0	0	0	0	0	0	0	0	0	0	0	0	0
27-Jun-88	700	0	0	0	0	0	0	0	0	0	0	0	0	0
28-Jun-88	630	0	0	1	0	0	0	0	0	0	0	1	0	1
29-Jun-88	700	0	0	0	0	0	0	0	0	0	0	0	0	0
30-Jun-88	730	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 J

Table 1. Incidental species caught in the Tucannon River downstream migrant trap in spring 1988, with an indication of relative abundance.

Species	Relative abundance
River lamprey (*Lampetra richardsoni*)	common
Dolly Varden (*Salvelinus malma*)	rare
Longnose dace (*Rhinichthys cataractae*)	abundant
Speckled dace (*Rhinichthys osculus*)	common
Redside shiner (*Richardsonius balteatus*)	common
Northern squawfish (*Ptychocheilus oregonensis*)	rare
Peamouth (*Mylocheilus caurinus*)	rare
Bridgelip sucker (*Catostomus columbianus*)	rare
Pumpkinseed (*Lepomis gibbosus*)	rare
Smallmouth bass (*Micropterus dolomieui*)	rare
Margined sculpin (*Cottus marginatus*)	rare

Table 2. Numbers of selected incidental fish caught by month at Tucannon River downstream migrant trap in 1988.

Species	February	March	April	May	June
River lamprey	110	34	2	6	12
Dolly Varden	0	1	0	0	0
Longnose dace	10	- -	120	1,814	235
Speckled dace	25	- -	92	288	404
Unclassified dace	184	1,190	437	0	0
Redside shiner	300	440	592	103	108
Northern squawfish	0	7	12	0	37
Peamouth	15	15	12	0	0
Bridgelip sucker	0	0	6	2	0
Pumpkinseed	0	0	0	1	0
Smallmouth bass	0	0	0	0	2
Margined sculpin	1	1	2	0	1