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LOWER SNAKE RIVER COMPENSATION PLAN

LYONS FERRY EVALUATION PROJECT

1985 ANNUAL REPORT

by

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SECTION 1: INTRODUCTION

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, Snake River stock, and 1,152 adult spring chinook, 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 goal and to identify any production adjustments required to accomplish that objective. 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 August 1985 through 31 March 1986. Section 2 of this report outlines the fall chinook operation and evaluation progress; Section 3 outlines spring chinook operation and evaluation progress.

1.1: Description of Facilities

The Lyons Ferry facility is located at the confluence of the Palouse River with the lower Snake River (Lower Monumental Pool; River Kilometer 90; Figure 1). At capacity, it is designed to raise 101,800 pounds (9,162,000 subyearling smolts at 90 fish per pound) of fall chinook and 8,800 pounds (132,000 yearling smolts at 15 fish per pound) of spring chinook (Table 1).

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

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

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

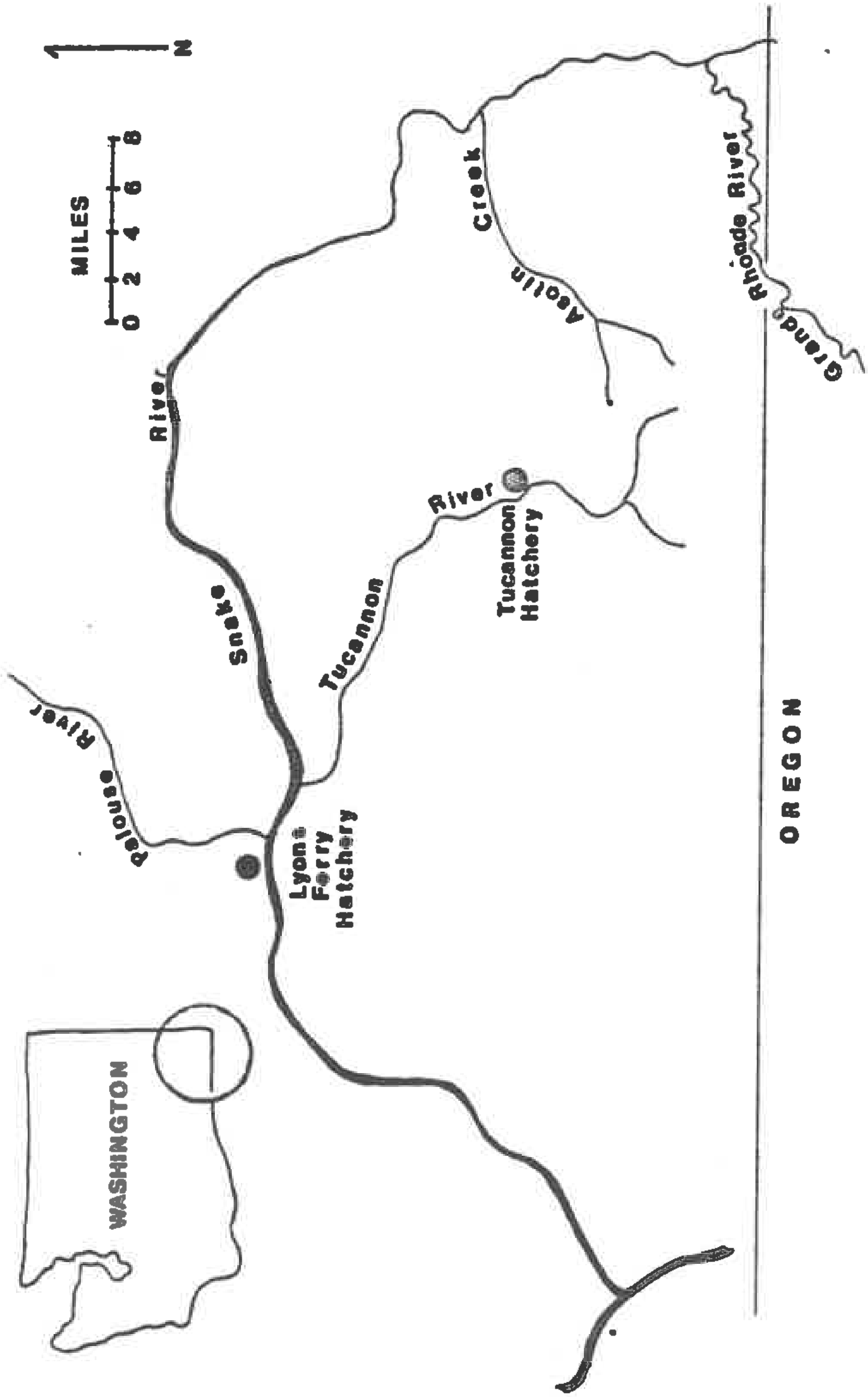

Figure 1. Lower Snake River Basin in southeast Washington, showing location of Lyons Ferry and Tucannon Fish Hatcheries.

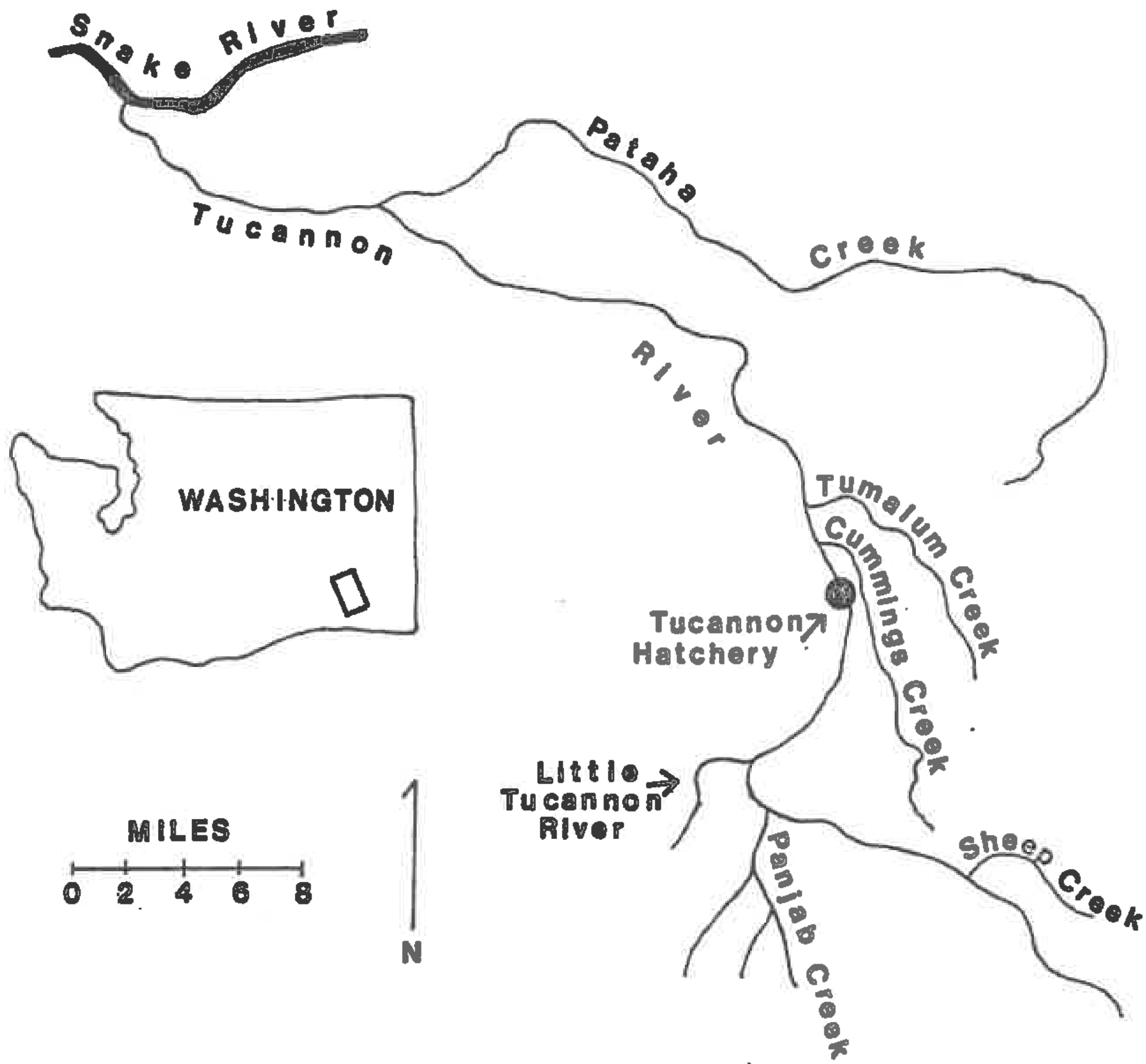

Figure 2. Tucannon River Basin, showing location of Tucannon Fish Hatchery.

SECTION 2: FALL CHINOOK 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 broodstock are currently obtained from three sources, and listed below in order of decreasing contribution: 1) returning adults trapped at Ice Harbor Dam, 2) Snake River stock eyed eggs transported from the WDF Kalama Falls FH to Lyons Ferry FH, and 3) returns to the Lyons Ferry fish ladder.

2.1.1: Ice Harbor Dam trapping

Since 1977, returning adult fall chinook have been trapped at Ice Harbor Dam and transported to Dworshak and Tucannon hatcheries in conjunction with the Snake River Fall Chinook Egg Bank Program (Bjornn and Ringe 1985). Numbers of fish transported have averaged 470 adults (range: 368 - 663) and 61 jacks (range: 0 - 150). Since its completion in 1984, Lyons Ferry FH has been receiving the transported fall chinook. Numbers of adults trapped (and percent of total run past Ice Harbor Dam) in 1984 and 1985 were 663 (47 percent) and 589 (28 percent), respectively (Tables 2, 3, 4). Duration of trapping (and peak day of trapping) was 1 September to 5 October (11 September) in 1984 and 31 August to 30 September (9 September) in 1985.

Table 2. Contribution of 1984 and 1985 fall chinook adult returns to Lyons Ferry Fish Hatchery from Ice Harbor Dam, Kalama Falls Fish Hatchery, to the Lyons Ferry fish ladder, and the total count past Ice Harbor Dam.

Year	Collection point	Number collected		Ice Harbor Dam count	
		adults	jacks	adults	jacks
1984	Ice Harbor	663	97	1410	642
	Kalama Falls	220	10		
1985	Ice Harbor	589	90	2046	7119
	Kalama Falls	952	2	--	--
	Lyons Ferry	6	4070		

Table 3. Collection and spawning summary for 1984 fall chinook broodstock at Lyons Ferry Fish Hatchery.

Week ending	Arrivals		Mortality			Spawned			Estimated egg take
	adult	jacks	M	F	J	M	F	J	
09/08/85	123	11		1					
09/15	245	23		1					
09/22	145	36							
09/29	99	16	1	1					
10/06	51	11	8	4					
10/13			4	23					
10/20			4	26					
10/27				8					
11/03			2	1					
11/10				5			115	5	470,400
11/17			14	4		40	111	21	466,200
11/24			23	6	1	33	79	16	323,400
12/01			24	3	3	27	48		201,600
12/08			7	1		39	35	2	113,400
Total	663	97	87	84	4	139	388[a]	44	1,575,000

[a] Thirteen females were green, adjusting total spawned to 375.

2.1.2: Kalama Falls egg transport

Prior to completion of the Lyons Ferry FH, a portion of the Snake River stock fall chinook adults were collected and reared at the WDF Kalama Falls FH on the lower Columbia River as part of the Snake River Fall Chinook Egg Bank Program. Since the completion of the Lyons Ferry facility, eyed eggs are transported from the Kalama facility to Lyons Ferry for rearing and subsequent release. Hatchery staff transported 219,800 1984 brood eggs and 1,182,000 1985 brood eggs from Kalama Falls FH (Tables 2, 5). Snake River stock fall chinook have not been released from the Kalama FH since spring 1984; all releases since that time will originate at Lyons Ferry.

2.1.3: Returns to Lyons Ferry Fish Hatchery

Adults returning to the Lyons Ferry fish ladder are currently making a negligible contribution to the eggtake, but will increase in importance as on-station releases return as adults. Six adults and 4070 jacks (1983 brood) returned to the hatchery (Tables 2, 4). These jacks were a result of the yearling release (10 fpp) on 17 April 1985.

2.1.4: Fall chinook spawning ground surveys

Evaluation project staff surveyed the lower Tucannon River on 17 December 1985 to determine if fall chinook spawn in this area. No redds or evidence of spawning activities were found, but fall chinook have been observed spawning in the lower Tucannon River in recent years (Slatick, personnel communication).

Table 4. Collection and spawning summary for 1985 fall chinook broodstock at Lyons Ferry Fish Hatchery.

Week ending	Arrivals adult	Arrivals jacks	Mortality M	Mortality F	Mortality J	Spawned M	Spawned F	Spawned J	Estimated egg take
08/31/85	24	2							
09/07	174	21			1				
09/14	253	14			1				
09/21	97	24							
09/28	39	174	1	1	3				
10/05	9	475	1	3					
10/12	1	620	1	10	1				
10/19	1	449	1	16	4				
10/26		567		19	5				
11/02	1	1364	1	4	12		18	624	73,800
11/09	1	469	5	2	17	1	41	1115	172,200
11/16		47	6	3	284	6	160	924	415,800
11/23			20	1	826	28	74		306,600
11/30			14	5	37	32	57	157	226,800
12/07			22		30	44	21	109	79,800
12/14			5		9	26	6	1	8,400
Total	600	4226	77	64	1230	136	318[a]	2930	1,283,400

[a] Five females were green and 2 were spawned out, adjusting total spawned to 311.

Table 5. Contribution of Snake River fall chinook eggs from Kalama Falls Fish Hatchery to Lyons Ferry Fish Hatchery, 1984 and 1985.

Year	Number of eggs received	Date transported
1984	219,800	12-29 Dec.
1985	1,182,208	6 Dec.-23 Jan.

2.2: Fall Chinook Stock Profile Investigations

2.2.1: 1984 Broodstock

From 1 September to 5 October 1984, 698 fall chinook adults and 48 jacks (fish less than 61 cm fork length) were collected at Lyons Ferry FH. Fish were spawned, and scales were sampled from 8 November to 5 December, with a total of 587 scale samples (or 79 percent) taken. Age composition was 27.1 percent 3 year olds, 62.5 percent age 4, and 10.4 percent age 5. Males were predominantly 3 year olds; females were mostly age 4 (Table 6).

Table 6. Age composition by sex of fall chinook sampled at Lyons Ferry Fish Hatchery, 1984.

Sex	Age 2	3	4	5	Total
Male	0	161	90	23	274
Female	0	117	311	44	472
Total	0	278	401	67	746

Average fecundity for 1984 returning fall chinook adults was 4,181 eggs/female. The ratio of females to males was 2.09:1.00 (474 females and 226 males). The length frequency distribution of the 1984 fall chinook returns is presented in Figure 3.

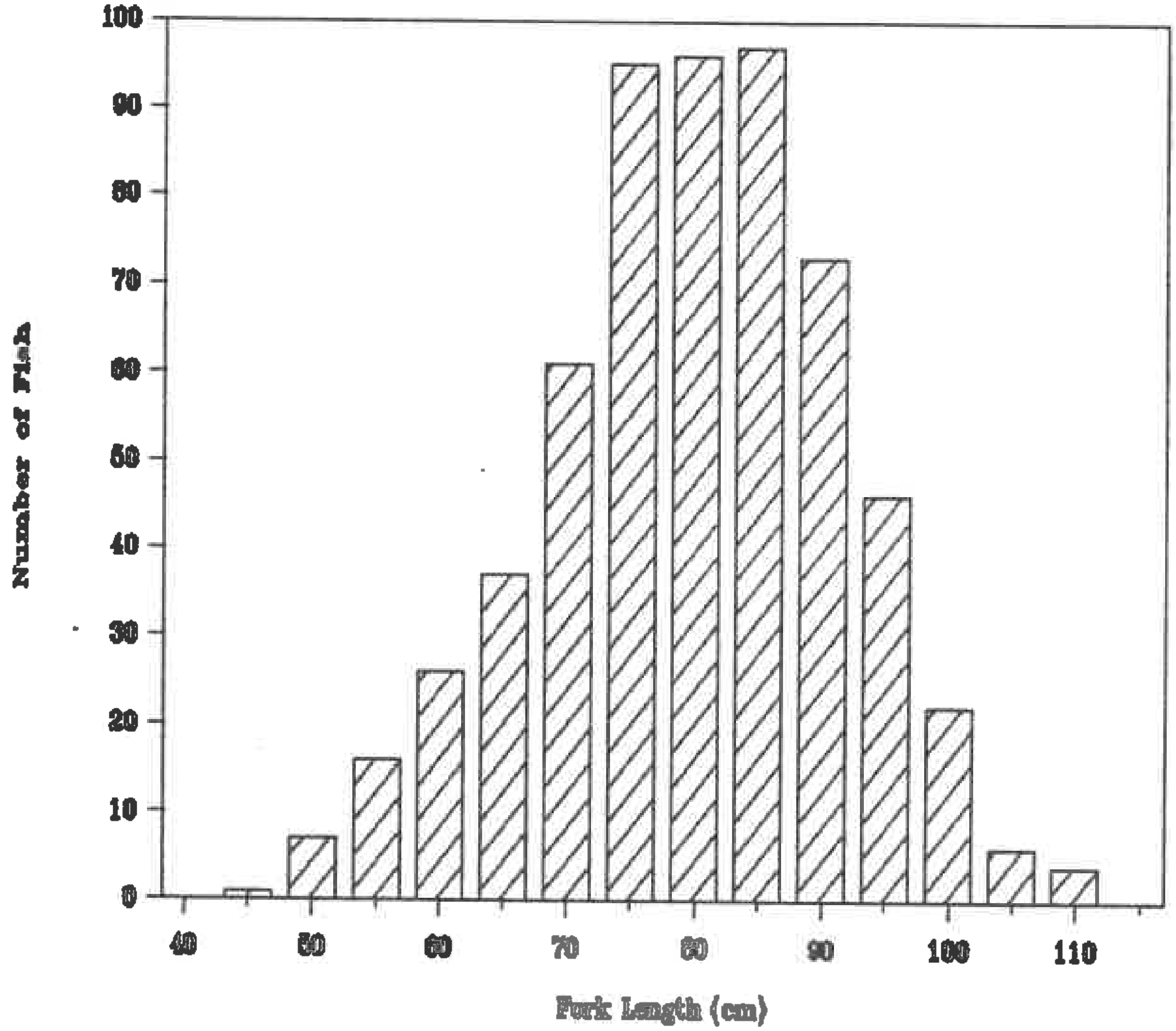

Figure 3. Length frequency distribution of fall chinook spawned at Lyons Ferry Fish Hatchery in 1984.

2.2.2: 1985 Broodstock

From 31 August through 16 November 1985, 595 fall chinook adults and 4160 jacks (fish less than 61 cm fork length) were collected at Lyons Ferry FH. Fish were spawned, and scales were sampled from 2 November to 14 December, with a total of 978 scale samples (or 20 percent) taken. Excluding the 2 year olds, age composition was 11.7 percent 3 year olds, 72.7 percent age 4, and 15.6 percent age 5 (Table 7).

Table 7. Age composition by sex of fall chinook sampled at Lyons Ferry Fish Hatchery, 1985.

	Age				
Sex	2	3	4	5	Total
Male	4160	47	154	25	4373
Female	0	24	288	70	382
Total	4160	71	442	95	4755

Average fecundity for 1985 returning fall chinook adults was 4,622 eggs/female. The ratio of females to males was 1.79:1.00 (382 females and 213 males). The length frequency distribution of the 1985 fall chinook returns excluding the age 2 jacks is presented in Figure 4. The age 2 jacks ranged in length from 29-50 cm with a mean of 35.

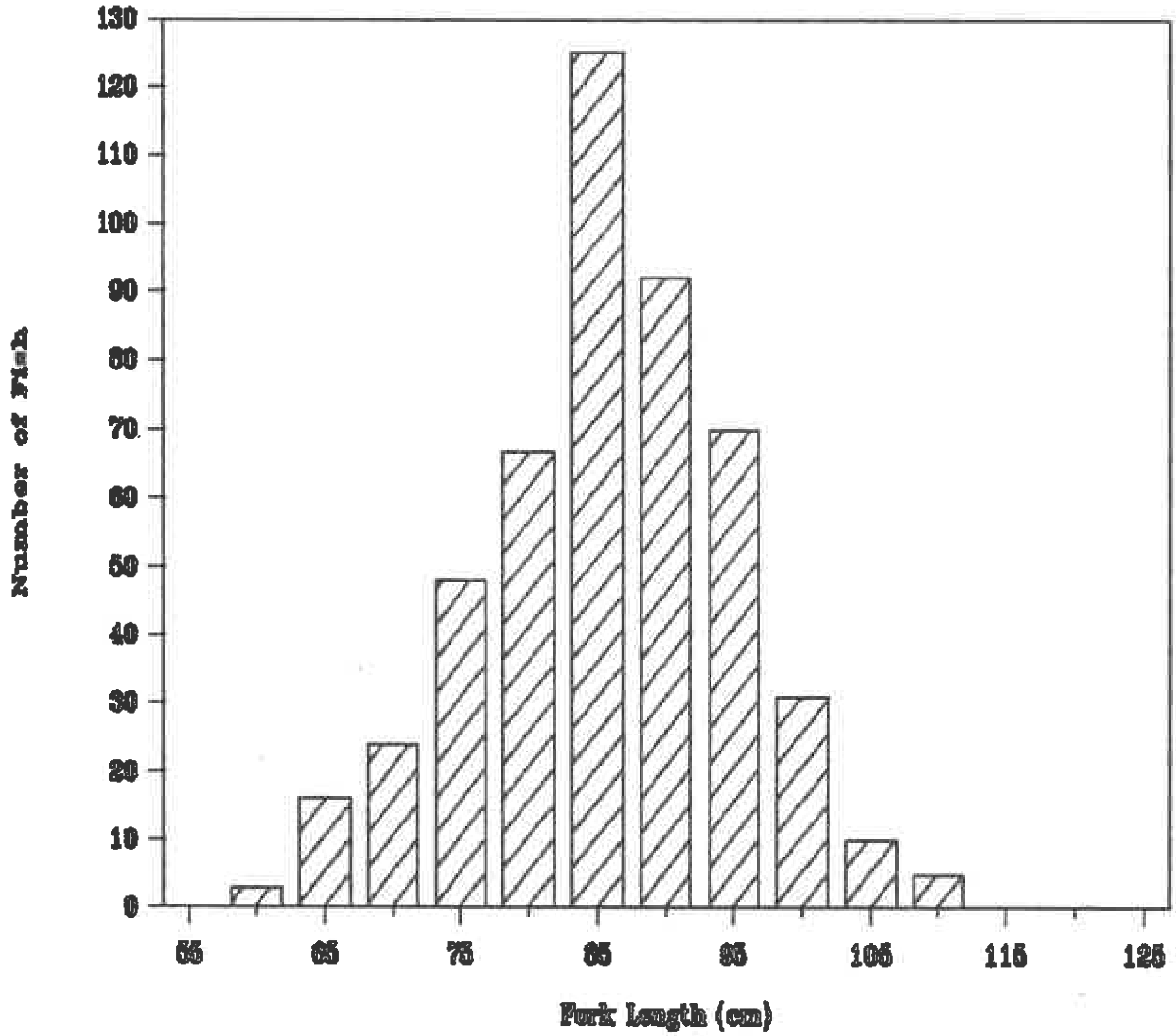

Figure 4. Length frequency distribution of fall chinook spawned at Lyons Ferry Fish Hatchery in 1985.

2.2.3: Electrophoretic analysis

Project staff collected the following fall chinook electrophoretic samples during the study period: 1) 200 samples of 1985 adult returns to Lyons Ferry FH, 2) 100 samples of 1984 brood juveniles at Lyons Ferry FH, 3) 100 samples from mid-Columbia River "bright" adults at the Priest Rapids FH, and 4) 100 samples from returning Snake River adults at Kalama Falls FH. Samples from adults include eye (vitreous humor), liver tissue, and heart and skeletal muscle tissue. Samples were maintained at $-80\,^{o}C$ prior to processing at the Genetic Stock Identification (GSI) Laboratory in Olympia, Washington. Juveniles were collected and frozen whole for processing.

Data from the electrophoretic analysis provide the following information:

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

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

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

2.3: Lyons Ferry Hatchery Practices

2.3.1: Enhanced vitamin C diets

Evaluation project staff completed a pilot study to assess the effects of an enhanced diet of vitamin C on fall chinook smolt quality. The fat-encapsulated water-soluble vitamin was given to 90,000 1984 brood fall chinook in a ration that was nearly five times the normal vitamin C content diet. A control group of 145,000 fish were fed the normal diet and handled in the same manner as the treatment group. Both groups were fed the same diet at a rate of 1.26 percent body weight per day up until the vitamin C test began. Project staff, with the help of WDF nutritionists and pathologists, monitored all qualitative physical improvements in fry health from the initiation of the diet (1 January 1986) through the time of release (3-5 April 1986). We sampled the fish on 9 January, 26 February, and 3 April, and found no external differences in fish health between the treatment and control groups (Table 8). These results may have been confounded, however, with the effects of the increased bacterial kidney disease (BKD) incidence in February and March. We collected samples from treatment and control groups at the end of the experiment for laboratory proximal analysis. We will use this analysis to determine if the treatment group fish had larger amounts of vitamin C in their muscle and organ tissues than the control group fish. We may continue these tests on the 1985 brood, and will increase the number of fish fed the enhanced vitamin C diet.

Table 8. Comparison of condition factor, mean length, and length coefficient of variation between treatment and control groups of fall chinook before and after enhanced vitamin C diets.

Period test group	Condition factor (K)	Mean length (mm)	Coefficient of variation
Before vitamin C			
treament	1.19	140.4	8.71
control	1.12	141.2	8.97
After vitamin C			
treatment	1.18	164.6	13.45
control	1.11	158.8	10.25

2.3.2: Disease incidence

The 1984 brood had minor outbreaks of BKD, viral erythrocytic necrosis (VEN), low temperature disease, and chinook lateral line syndrome (CHILLS). Monthly mortality rates averaged 0.40 percent (range: 0.07 - 1.24). Overall mortality rate for the 1984 brood fall chinook 5.88%. To prevent spread of infectious haematopoietic necrosis (IHN) disease, females were spawned in groups of five. Egg groups were reared separately until they were certified IHN negative. Four groups of the 1985 brood were found to have incidence of the IHN virus and consequently were destroyed. Table 9 outlines diseases of 1984 and 1985 brood fall chinook at Lyons Ferry FH and the treatments given for the diseases.

Table 9. Incidence, date, location, and treatment of diseases for 1984 and 1985 brood fall chinook contracted at Lyons Ferry Fish Hatchery.

Date	Brood year	Disease	Pond numbers	Treatment
08/85	1984	BKD	15-16-17-18-19	Gallimycin
08/85	1985	Fungus	29	Malachite
09/85	1984	BKD	15-16-17-18 19-25-27-30	Gallimycin
09/85	1985	Fungus	29	Malachite
10/85	1984	BKD	25-26-27	Gallimycin
10/85	1985	Fungus	29	Malachite
11/85	1985	Fungus	Incubation room	Malachite
12/85	1985	Fungus	Incubation room	Malachite
12/85	1984	Low-temperature disease	21-22-30	TM-50
01/86	1984	Low-temperature	21-22-30	TM-50
01/86	1985	Fungus	Incubation room	Malachite
02/86	1984	BKD	19-20-24-26	Gallimycin
02/86	1984	VEN	26	No treatment
02/86	1984	CHILLS	26	No treatment
03/86	1984	BKD	19-20-24-26	Gallimycin

2.3.3: Particulate manganese investigations

Wellwater supplied to the Lyons Ferry FH contains suspended manganese particles, which become lodged within the gill lamellae of the chinook rearing in the raceways. WDF pathologists have noted an increased mortality rate associated with manganese accumulation within the gill structure. Stress and hypoxia from this accumulation are likely factors in the increased mortality rates. Accumulation of abrasive materials in the gills induces mucus secretion, which may exacerbate the hypoxia problem. The U.S. Army Corps of Engineers contracted Battelle Laboratories of Richland, Washington, to develop recommendations to rectify the problem.

2.4: Smolt Releases

Hatchery staff planted 650,300 yearling (1983 brood) fall chinook on 17 April 1985 and 539,392 subyearling (1984 brood) fall chinook on 6 June 1985 (Table 10). Mean length and coefficient of variation for the yearling release were 167.4 mm and 8.06, respectively. Mean length and coefficient of variation for the subyearling release were 81.6 mm and 11.37, respectively. Both releases were on station. Table 11 describes the Snake River conditions at time of release. Length frequency distributions for the subyearling and yearling releases are presented in Figures 5 and 6, respectively.

Table 10. Summary of 1983 and 1984 brood fall chinook releases from Lyons Ferry Fish Hatchery in 1985.

Age brood year	Number planted	Pounds planted	Tag code and marks	Size at Release
Subyearlings 1984 brood				
	78,417	1,170	Ad + CWT 63 32/26	67 fish/lb
	78,064	1,165	Ad + CWT 63 32/27	67 fish/lb
	78,504	1,172	Ad + CWT 63 32/28	67 fish/lb
	707	16	Ad only	67 fish/lb
	303,700	3,573	Unmarked	85 fish/lb
Total	539,392	7,092		
Yearlings 1983 brood				
	250,831	25,083	Ad + CWT 63 21/52	10 fish/lb
	83,611	8,361	Ad + CWT 63 21/18	10 fish/lb
	2,358	236	Ad only	10 fish/lb
	313,500	31,351	Unmarked	10 fish/lb
Total	650,300	65,031		

Table 11. Lower Monumental Pool river conditions at time of Lyons Ferry Hatchery fall chinook releases in 1985.

Date	Mean discharge (kcfs)	Mean spill (kcfs)	Mean water temperature (degrees C)
17-23 April	96.7	29.0	9.8
6-12 June	107.2	26.4	14.3

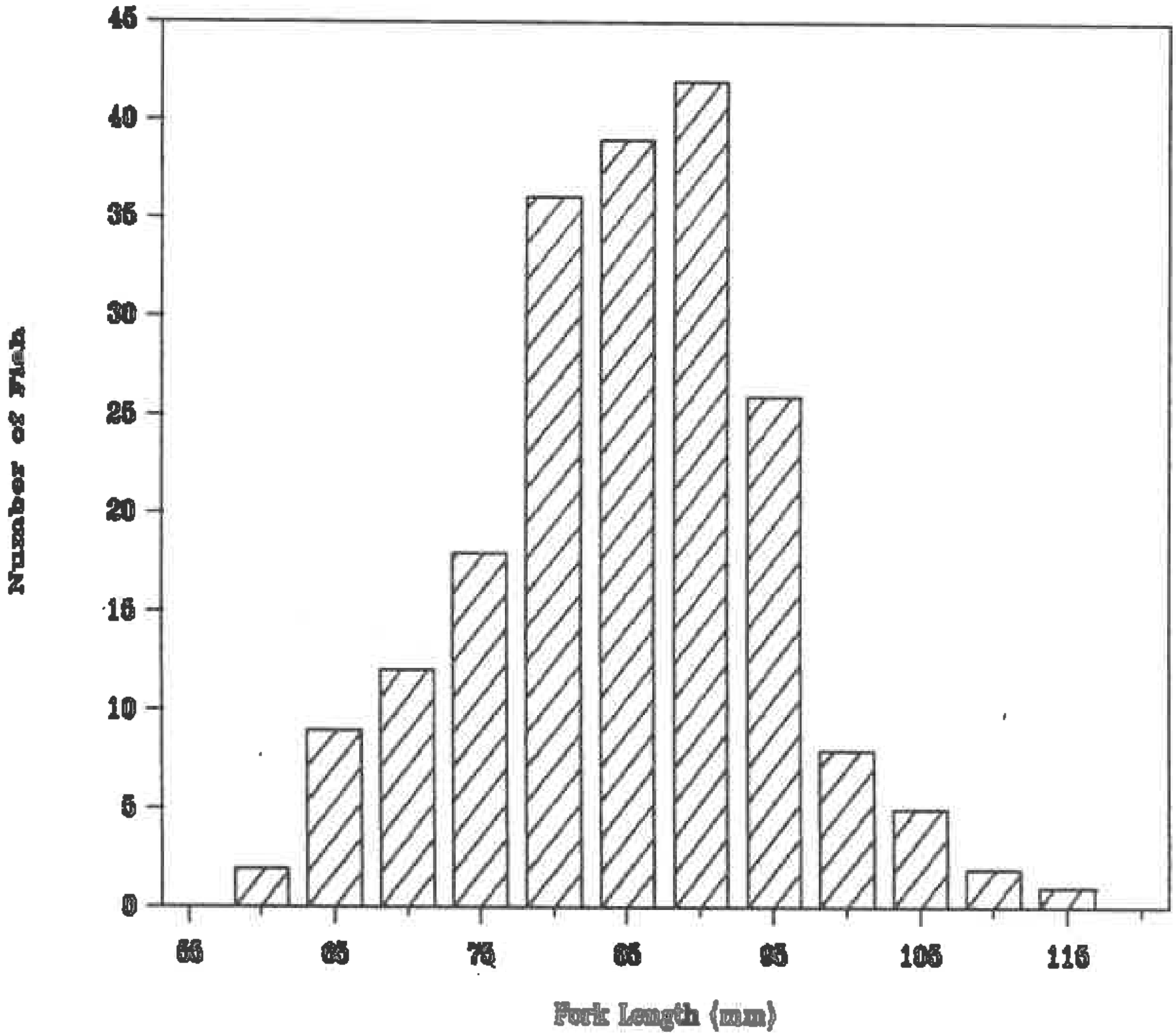

Figure 5. Length frequency distribution of subyearling fall chinook released from Lyons Ferry Fish Hatchery in June 1985.

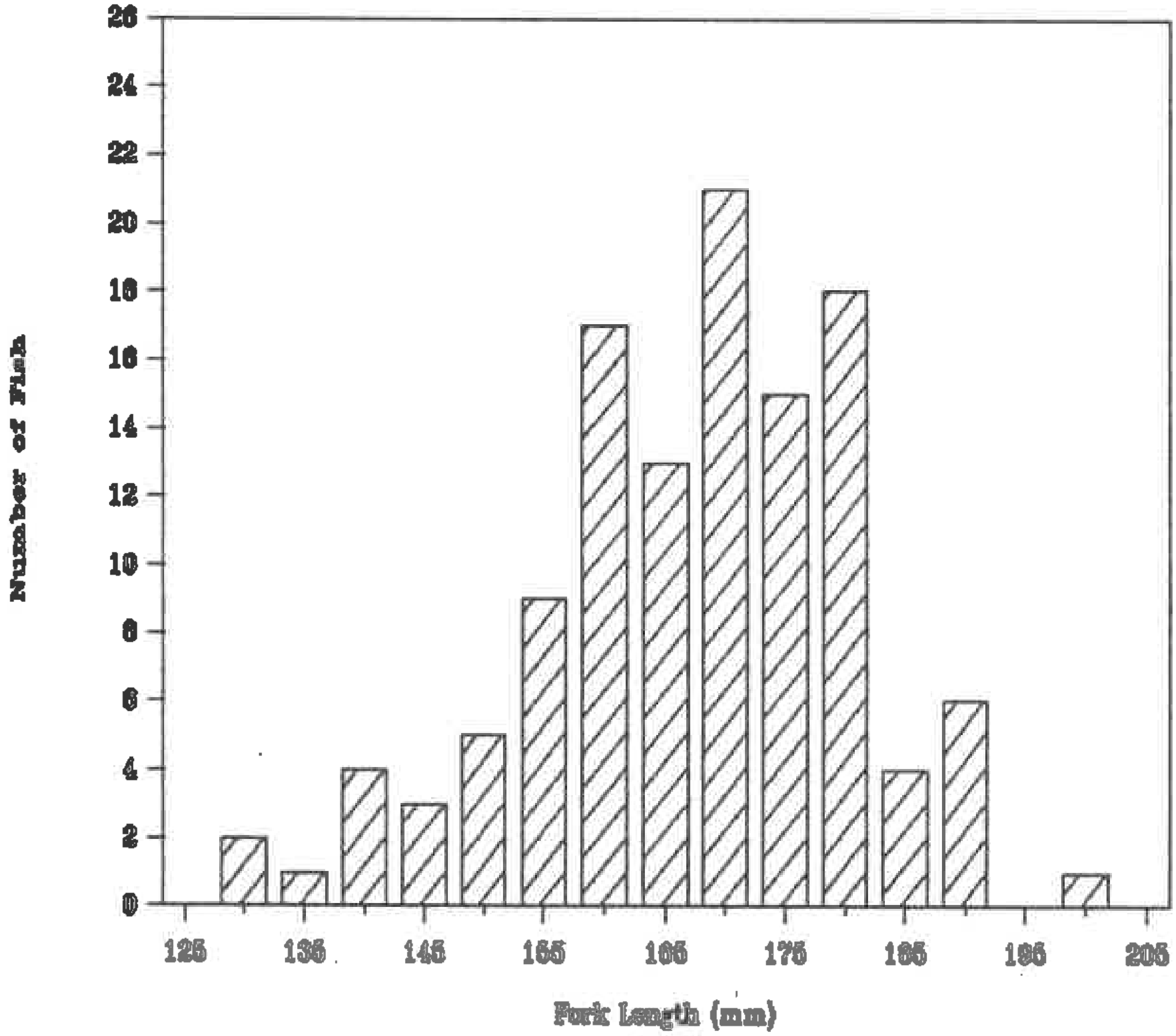

Figure 6. Length frequency distribution of yearling fall chinook released from Lyons Ferry Fish Hatchery in April 1985.

SECTION 3: SPRING CHINOOK PROGRAM EVALUATION

3.1: Broodstock Establishment

Hatchery personnel operated an adult trap adjacent to the Tucannon satellite facility to establish the spring chinook brood stock at Lyons Ferry FH. Operations design called for collection of fish on a one-to-one basis with those fish allowed to pass through the rack for natural spawning. The rack was installed on 2 April and operated until high flow damaged the structure on 14 April and allowed the majority of adults to pass. Hatchery personnel installed a replacement rack by 22 May. We were unable to collect the required number of adults to fulfill broodstock requirements, and to determine total escapement and modal time of return to the Tucannon River.

Fifteen salmon were collected during the period when the rack was intact. Of this number, six fish escaped from the holding pen and two were culled because of columnaris infection. Project staff improved the security of the holding pen to prevent further escapement. To supplement the egg take, hatchery and evaluation project staff collected (seined) six adults from the Tucannon River upstream from the hatchery. Total numbers of spring chinook spawned were 4 females and 4 males (Table 12).

Table 12. Collection and spawning summary for 1985 spring chinook broodstock at Tucannon Fish Hatchery.

Week ending	Estimated arrivals	Mortality M	Mortality F	Spawned M	Spawned F	Egg take	Eggs lost	Cumulative egg take
06/15	13		4					
06/23	2		2					
07/06	0		2					
07/27	0	1						
08/17	1							
08/24	6				4[a]	10,231		10,231
08/31	0	1	2					
09/07	0							
09/21	0	1		4	1	4,612		14,843
09/28	0						558	14,285
10/26	0						652	13,633
Total	22	3	10	4	5[a]	14,843	1,210	13,633

[a] 1 female was spawned out, adjusting total to 4.

3.2: Spring Chinook Stock Profile Investigations

3.2.1: 1985 brood year

Project staff were not hired until June, hence limited information was collected on the spring chinook returns to the Tucannon River. Average fecundity for the Tucannon River spring chinook was 3,711 eggs per female. This estimate may not be representative of the population, however, because of the small sample size of females analyzed (4) and the collection of these females from the end of the run. Length frequencies were taken from all fish collected at the rack and from spent carcasses found on the spawning ground surveys (38 total); the distribution is presented in Figure 7.

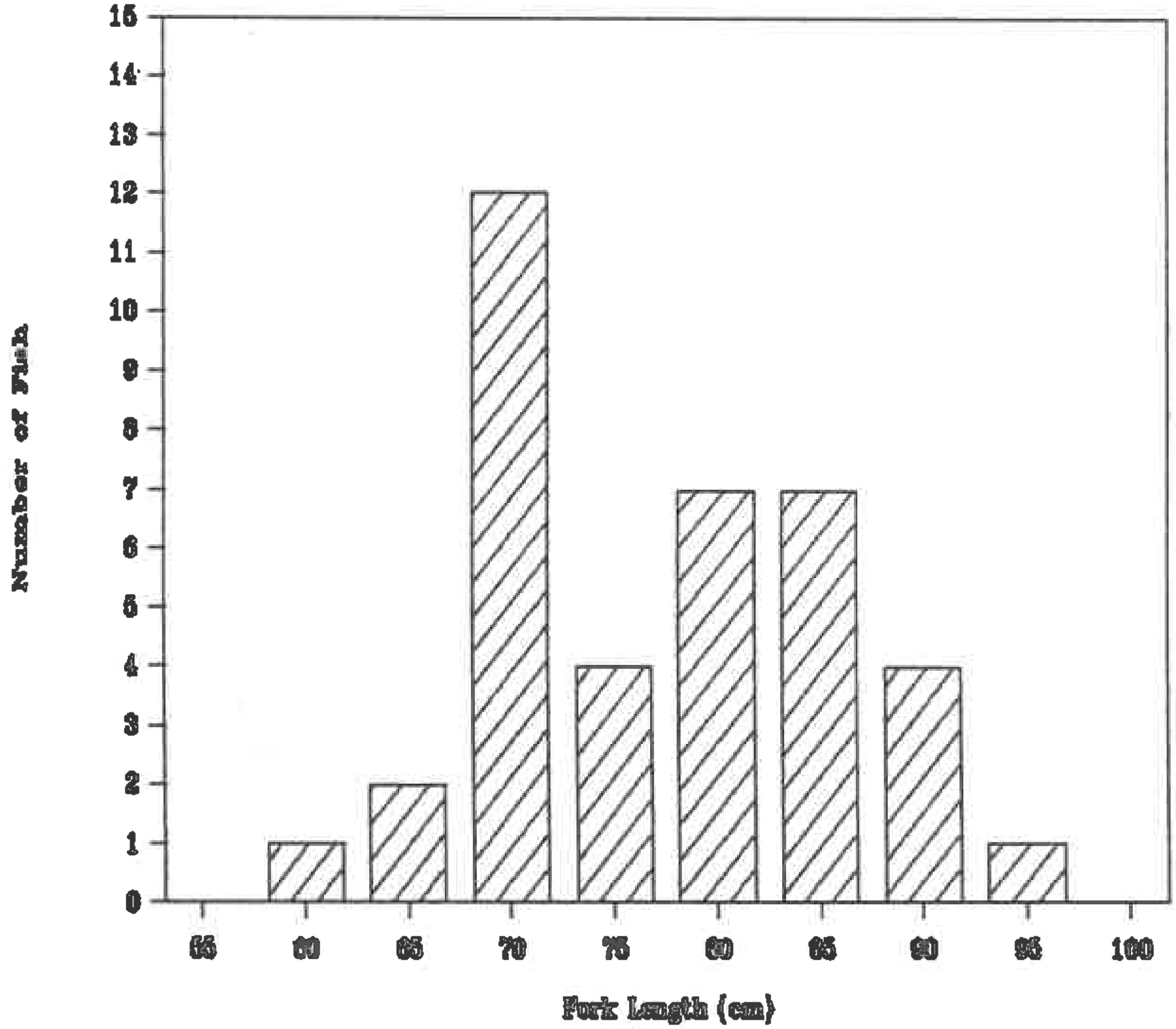

Figure 7. Length frequency distribution of spring chinook adults collected on the Tucannon River in 1985.

3.2.2Electrophoretic analyses

Project staff collected scale, otolith, and electrophoretic samples from adult spring chinook collected at the rack and spent carcasses recovered from spawning ground surveys. We also collected 100 juveniles (1984 brood) from the Tucannon River for electrophoretic analysis (Appendix B).

3.3: Lyons Ferry/Tucannon Hatchery Practices

Tucannon River spring chinook were spawned at the Tucannon FH; eggs were immediately transported to Lyons Ferry FH for incubation and rearing. Fry were ponded on 27 November and 16 December 1985. To date, the spring chinook stock has been disease free. Average weekly mortality rates since ponding is 0.14 percent (range: 0 - 0.84).

3.4: Wild Fish Production

The Tucannon River flows through varied environmental conditions that restrict habitat selection of salmonids in the watershed. To compare differences in rearing habitat quality within the Tucannon River, we designated 5 strata, based upon the predominant land use adjacent to the stream:

Lower (RK 0.0 - RK 17.9)

Marengo (RK 17.9 - RK 42.8)

Hartsock (RK 42.8 - RK 54.4)

HMA (RK 54.4 - RK 75.6)

Wilderness (RK 75.6 - Headwaters)

The Lower and Marengo strata are both within agricultural bottom-land that have exposed areas associated with braiding of the river. Water temperatures exceed the upper threshold of spring chinook tolerance. We recorded temperatures of 26.7 ^{o}C at Powers Road (RK 3.7, Lower stratum) and 25.0 ^{o}C at Marengo (RK 39.9, Marengo stratum) in July. The HMA and Wilderness strata are within public land that is forested and maintains water temperatures tolerable for spring chinook. A high temperature of 20.0 C was recorded at the Tucannon river hatchery (RK 59.2, HMA stratum) on July 11 and a high of 15.6 C was recorded at the Panjab Bridge (RK 75.5, Wilderness stratum) on July 17.

3.4.1: Lower river electrofishing surveys

Project staff selected two randomly located sampling areas within each of the Lower, Marengo, and Hartsock strata (Table 13). We evaluated rearing spring chinook habitat quality and production in these areas. Average density and biomass for the Hartsock stratum were 6.30 fish/100m^2 amd 35.34 grams/100m^2, respectively. As expected, spring chinook were not found in either the Lower or Marengo strata during the sampling period (19-30 August). Summer water temperatures within these strata were consistently above the upper lethal tolerance limits for spring chinook (25.0 ^{o}C; Piper et al., 1982). Peterson (personal communication), however, found rearing spring chinook in the Marengo stratum during October of recent years.

Table 13. Sampling areas for rearing spring chinook salmon in the Lower, Marengo, and Hartsock strata of the Lower Tucannon River, 1985.

Stratum	Sampling location (RK)	Area sampled (m2)	Density (fish/100m2)	Biomass (grams/100m2)
Lower	2	519	0	0
	11	536	0	0
Marengo	21	525	0	0
	31	560	0	0
Hartsock	48	609	3.48	27.07
	53	405	10.30	47.79

3.4.2: Upper river electrofishing surveys

We developed a random systematic sampling design to identify and electrofish riffle/run/pool segments of the HMA and Wilderness strata. Sampling originated at a stratum boundary, a number was selected randomly, multiplied by one hundred and measured out in feet. The ensuing electrofishing sites were then surveyed every one thousand feet. We placed temporary block nets at both ends of the survey unit to prevent escapement. Lengths of all collected fish were measured, and weights of an appropriate sample size were taken. Population estimation was made using the Seber-LeCren and Moran-Zippen (Ricker, 1973) methods of population estimation.

Electrofishing surveys were conducted from August 7 - October 31 with the emphasis being in the Wilderness stratum. Data from the WDG Instream Habitat Improvement Project (Hallock & Mendel, 1985) was used to supplement the population estimates in the HMA stratum.

Sample size for the number of riffle/run/pool segments to be shocked were determined through a pilot test at the beginning of the sampling period. We will continue collection of spring chinook production information in summer 1986. Thereafter, we will designate several sample units as index sites, which will be monitored yearly to determine trends in juvenile salmonid production. Selection of index sites will be based upon logistical considerations, sample size required to obtain adequate accuracy and precision, and whether a site represents the stream in general.

3.4.3: Upper river stream habitat surveys

We developed a random systematic sampling design to assess the quality of rearing and spawning habitat within the Tucannon River and tributaries. Surveys on the mainstem Tucannon originated at a stratum boundary and habitat was assessed every one hundred feet. Each transect was determined to be a riffle, run, or pool. Depths were read along each transect and then the site was scored. Scoring was done for both rearing and spawning habitat; Appendices C and D list the criteria used. Scores for each criterion were then added together and recorded, each criterion that received a score of one was noted as a possible limiting factor. Gradient measurements were taken every seventh transect. Habitat quality ratings and gradients were also done at each electrofishing site.

Habitat quality data collected in 1985 will be comparable with variables required for juvenile chinook salmon habitat suitability index (HSI; Raleigh and Miller, 1985) model development. Tentatively, we will employ the HSI model in 1986.

Population estimates were calculated for each electrofishing site. Rearing habitat quality ratings were condensed to the area of a certain type and score. This allowed us to estimate the population for a given habitat type and score similar to an electrofished site, assuming all things are equal. Spring chinook densities in the Wilderness stratum averaged 23.72 fish/100m^2 in the pools, 17.51 fish/100m^2 in the runs, and 5.63 fish/100m^2 in the riffles (Table 14). The average density and biomass throughout the 10.1 km long stream sampling area were 8.69 fish/100m^2 and 44.72 grams/100m^2, respectively. We sampled 277 meters (or 2.7 percent) of the total stream length. We did linear regression analyses on the wilderness sites for gradient vs. density and gradient vs. biomass. We found no significant correlation, P = 0.05, for either. Riffle, run, pool ratios were also calculated (Appendix E) which showed that the HMA and Wilderness strata each had 5% and 11% pool, and 19.7 Km and 10.1 Km of usable habitat respectively. Table 15 compares Tucannon River spring chinook rearing densities with other Columbia River Basin estimates.

Table 14. Tucannon River wilderness stratum spring chinook density and biomass estimates by site, related to habitat type, score and gradient (%).

Habitat type	Site	Score	Density (fish/100m2)	Biomass (fish/100m2)	Gradient (%)
Riffle	Wild 4.1	4	4.88	25.46	1.83
	Wild 3.2	6	10.55	53.55	0.83
	Wild 3.1	8	1.47	7.44	1.75
	Wild 4.2	9	0.72	3.67	2.00
Run	Wild 4.3	4	8.46	44.41	1.08
	Wild 8	5	0.00	5.83	1.58
	Wild 4	6	2.04	10.30	2.08
	Wild 2.3	6	0.96	4.74	1.88
	Wild 2	7	11.90	58.15	2.58
	Wild 1.5	7	37.27	167.72	1.50
	Wild 1	8	34.47	168.90	1.58
	Wild 6	8	4.50	24.83	0.83
	Wild 2.4	8	45.01	222.80	2.00
	Wild 3	9	20.72	104.52	0.88
	Wild 2.5	9	10.33	53.92	2.08
	Wild 2.2	11	34.51	169.73	0.67
Pool	Wild 7	6	5.20	29.48	1.42
	Wild 9	6	80.31	481.86	2.25
	Wild 3.3	7	12.92	65.78	1.67
	Wild 3.4	8	47.39	236.01	0.58
	Wild 10	8	0.00	0.00	1.83
	Wild 4.4	9	9.68	51.01	1.08
	Wild 5	10	18.15	97.28	--
	Wild 2.1	11	16.09	78.88	2.67

Table 15. Tucannon river spring chinook standing crop with density comparisons to other studies.

Stream Stratum	Citation	Density (fish/100m2)
Tucannon	This study	
Wilderness		8.69
HMA		4.17
Salmon River	Platts and Partridge 1978	1.10
Lemhi River	Bjornn 1974	38.30
Icicle Creek	Mullan and McIntyre 1986	18
Wenatchee River	Griffith 1978	1.20-38.30

The length frequency distribution of the 445 fish captured and measured during the survey indicated a single age class (Figure 8).

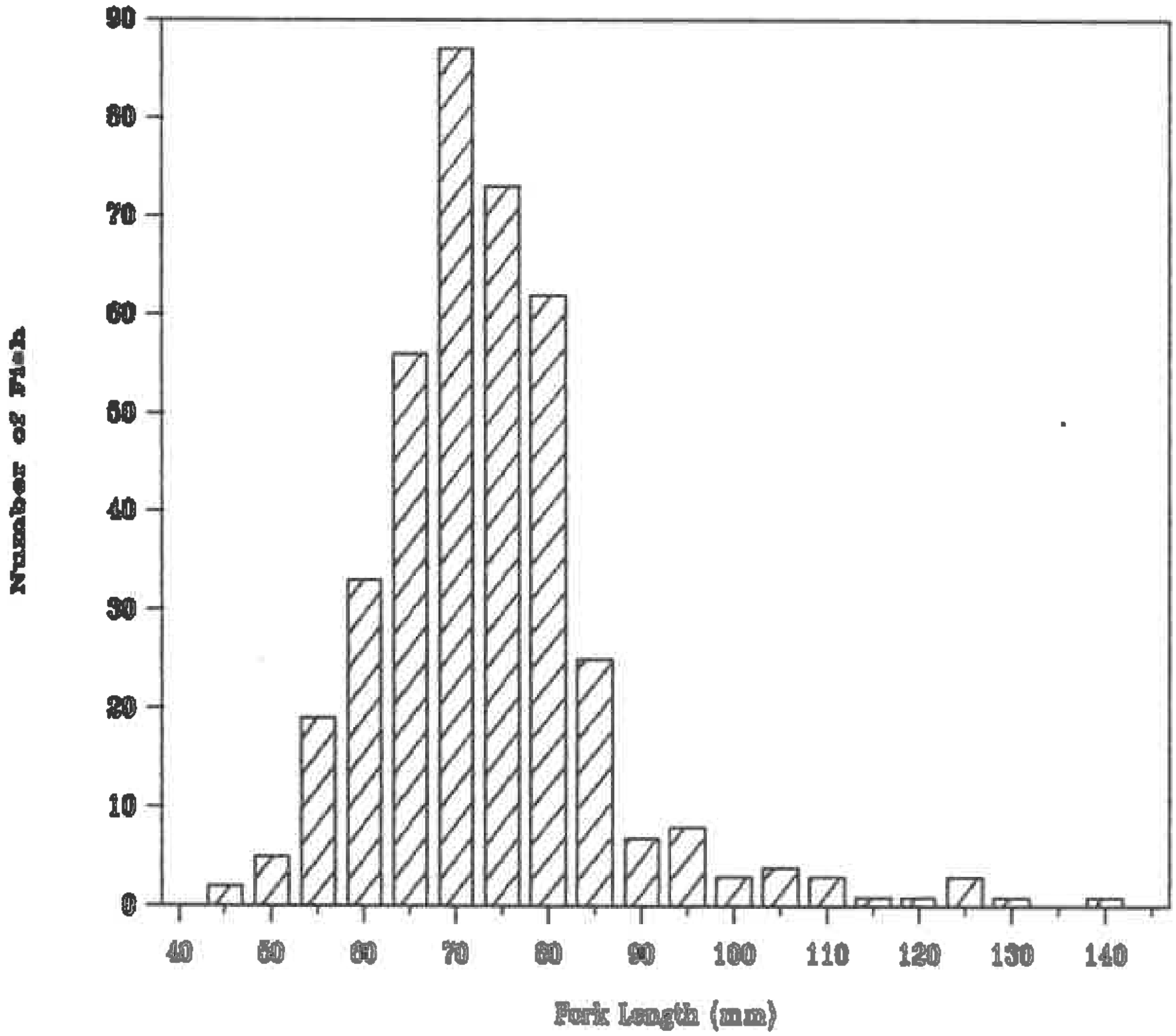

Figure 8. Length frequency distribution of juvenile spring chinook collected in Tucannon River electrofishing surveys, 1985.

3.4.4: Tucannon tributaries surveys

We surveyed four tributaries of the Tucannon River suspected to have populations of rearing spring chinook: Sheep Creek (confluence with Tucannon at RK 83), Panjab Creek (RK 76), Little Tucannon Creek (RK 73), and Cummings Creek (RK 58). Techniques for electrofishing and habitat quality surveys were comparable to that used on the mainstem Tucannon River. Although these streams are within Wilderness and HMA strata and had suitable rearing conditons, we found few juvenile spring chinook in these streams. Chinook were generally found only within the lower 1 km of each stream; densities were below that found in the mainstem Tucannon (Table 16). We completed habitat quality surveys in the lower 3 km and found the possible limiting factors for rearing in the Little Tucannon and Cummings Creeks to be flow, and high gradient (up to 8 percent) in Sheep Creek.

3.4.5: Asotin Creek electrofishing surveys

In conjunction with this study, WDG biologists electrofished two tributaries of Asotin Creek suspected to have rearing spring chinook. No chinook were found in three sampling locations on Charlie Creek (confluence with Asotin Creek at RK 21), but chinook were found in two sampling sites on the North Fork Asotin Creek (Table 17).

Table 16. Spring chinook density and biomass estimates for electrofishing sites on Tucannon River tributaries, 1985.

Stream	Site	Habitat type	Score	Density (fish/100m2)	Biomass (grams/100m2)
Sheep Creek	1	Riffle	7	2.55	13.06
	2	Pool	9	2.20	11.26
	3	Riffle	9	0	0
	4	Pool	7	0	0
Panjab Creek	1	Pool	--	13.40	68.61
	2	Pool	8	6.88	35.23
	3	Run	--	3.87	19.81
	4	Pool	8	36.23	185.50
	5	Run	9	0	0
	6	Run	8	0	0
	7	Run	10	0	0
	8	Pool	9	3.54	18.12
	9	Run	5	0	0
	10	Pool	9	0	0
Little Tucannon	1	Pool	--	0	0
	2	Pool	--	0	0
Cummings Creek	1	Pool	8	9.00	46.08
	2	Run	8	0	0
	3	Pool	9	1.72	2.92
	4	Riffle	6	0	0
	5	Riffle	6	0	0

Table 17. Density and biomass estimates of spring chinook rearing in two sampling sites on the North Fork Asotin Creek 1985.

Site	Riffle:Run:Pool Ratio	Density (fish/100m2)	Biomass (grams/100m2)	Gradient (%)
NA1	--	1.80	9.73	1.7
NA2	20:20:60	20.80	116.48	1.6

3.4.6: Spawning ground surveys

We surveyed spawning grounds on the upper Tucannon River to determine the temporal and spatial distribution of spawning, to assess the abundance and density of spawners, and to collect biological data from spent fish. Spawning grounds were surveyed on 22 August, 29 August, and 9 September.
The first two surveys took 4 man-days each to complete; the final count required 6 man-days. We completed a supplemental survey of the North Fork of Asotin Creek on 10 September, which required 3 man-days effort.

Total numbers of redds for the Tucannon River and Asotin Creek counts were 189 and 8, respectively (Table 18). The number of redds sighted in the Tucannon River increased from the previous 5 year average of 135 redds and 20 year average of 116 redds (Figure 9), but is most likely a result of additional stream coverage by a larger survey crew this year. We found no redds in the Tucannon tributaries Sheep, Panjab, Little Tucannon, or Cummings Creeks. The 8 redds located in the North Fork Asotin Creek in 1985 were considerably fewer than in 1984, when 24 redds were sighted. These are the only two years Asotin Creek has been surveyed by WDF personnel. Thirteen redds were found in the North Fork of Asotin Creek in 1973 by U.S. Forest Service biologists (Andrews, personnel communication)." From the 3 counts on the Tucannon River we concluded that the peak spawning date for spring chinook was approximately 5 September. Few adults had spawned by the 22 August survey, and several adults had not spawned by the 9 September count, indicating the duration of spawning to be at least 25 days.

Table 18. Results of 1985 upper Tucannon River spring chinook spawning ground surveys.

Stratum	River kilometer	Number of redds	Number of females	Number of males	No. unsexed adults
Wilderness	87 - 79	57	28	16	7
	79 - 76	27	29	16	1
HMA	76 - 69	82	25	15	44
	69 - 64	19	7	2	22
	64 - 57	4	3	3	0
Total		189	77	52	74

Eighty-four redds were sighted in the Wilderness stratum of the Tucannon River, which has 10.1 km of stream, resulting in a density of 8.32 redds/km. We sighted 105 redds in the 19.7 km HMA stratum, indicating a 5.33 redds/km density. Table 19 compares these data to densities from other Columbia River Basin spring chinook studies.

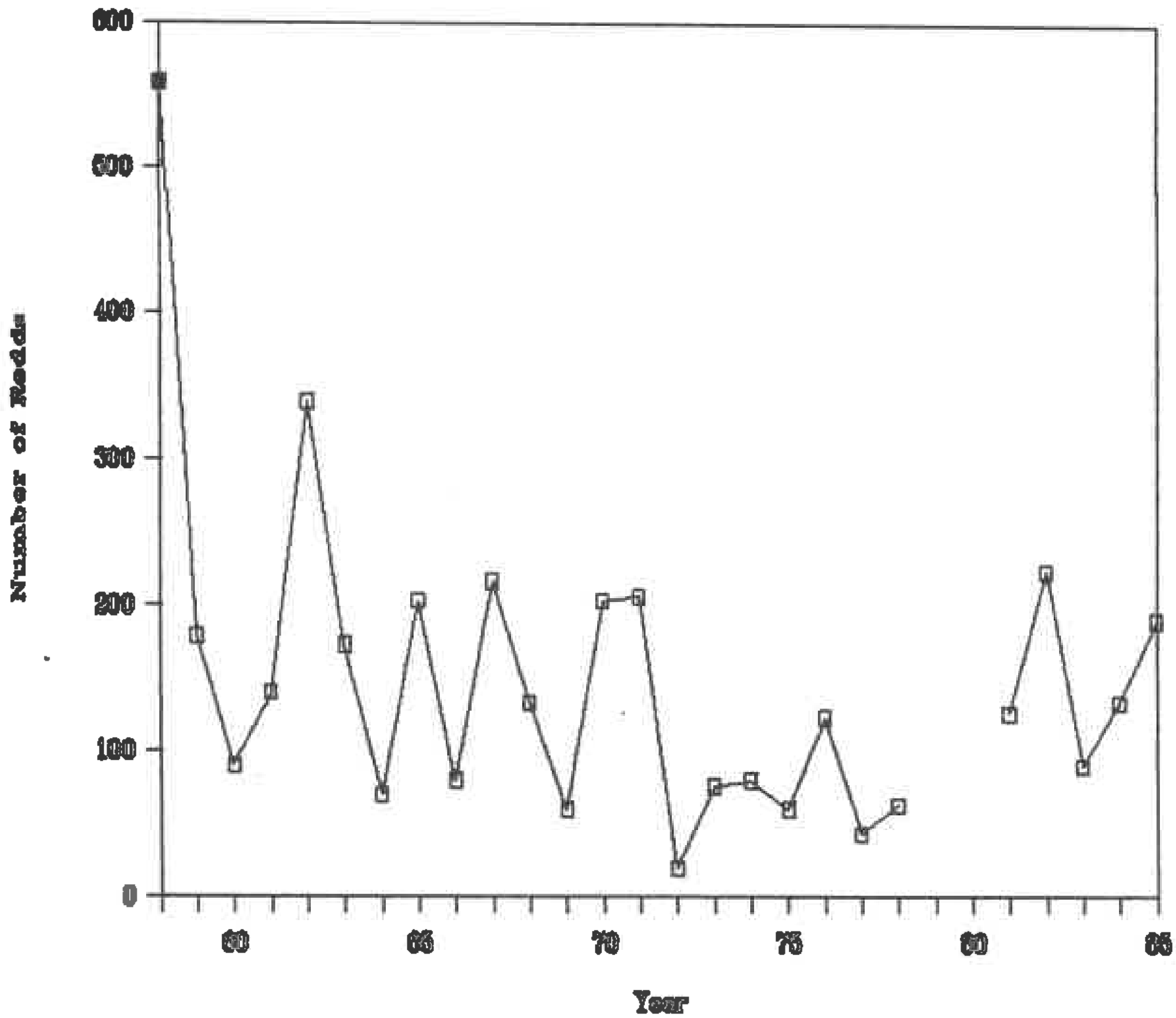

Figure 9. Numbers of spring chinook redds counted in Tucannon River during the period 1958-1985.

Table 19. Comparison of upper Tucannon River spring chinook spawning ground densities and midpoint of spawning to that of other Columbia River Basin streams.

River / Survey area	Source	Density (redds/km)	Spawning midpoint
Tucannon	This study		
Wilderness		8.32	1-5 Sept.
HMA		5.33	
Total		6.34	
John Day[a]	Burck et al. 1979	5.80	7-17 Sept.
Wenatchee[b]	Easterbrooks, pers. comm.		
Wenatchee R.		2.31	20-25 Aug.
Icicle Cr.		9.83	
Chiwawa R.		16.24	
White R.		7.29	
L.Wenatchee R.		6.36	
Nason Cr.		13.67	
Entiat[c]		13.72	25-31 Aug.
Methow[d]			
Methow R.		8.87	20-31 Aug.
Lost R.		9.31	20-31 Aug.
Chewack R.		8.31	20-31 Aug.
Twisp R.		10.28	15-25 Aug.
Early Winters Cr.		1.41	20-31 Aug.
Imnaha[e]	Witty, pers. comm.	13.28	
Wallowa[e]		1.36	
Upper Minan		16.66	
Lower Minan		5.59	

a Five-year average 1974 - 1978.
b Twenty-five year average 1961 - 1985.
Wenatchee R., N.S. (No Survey) 1968 - 1971.
N.S. 1975 and 1983.
c Twenty-six year average 1960 - 1985.
d Twenty-six year average 1960 - 1985.
Chewack R., N.S. 1967.
Early Winters Cr., N.S. 1962 - 1967.
N.S. 1972 and 1976.
e Five-year average 1980 - 1984.

Data collected on spent carcasses included sex, fork length, scale, and electrophoretic samples. Chinook salmon that spawned in the upper Tucannon River were mostly 4 years old, with two years of their life in the ocean (4_2) the remainder were 5 year olds having spent 3 years in the ocean (5_2; Table 20). Of the carcasses we recovered, none were 3 year olds. We found the mean length of age 4 returning adults (74.5 cm) to be significantly less than age 5 adults (86.6 cm; $p<0.05$).

Table 20. Sex, mean fork length (cm), and age (from scale impressions) of recovered spring chinook carcasses found on upper Tucannon River spawning ground counts, 1985.

Sex	Fork length (SD, n) at given age		Total number
	4_2	5_2	
Female	74[a] (6.7, 17)	87 (3.0, 8)	25
Male	74 (5.7, 11)	86 (--, 2)	13
Total			38

[a] Fork length between two ages different at $p<0.05$.

3.4.7: Smolt trap operations

Project staff installed a floating inclined plane downstream migrant trap on the Tucannon River 2.5 kilometers upstream from the Snake River confluence. The smolt trap (Figure 10) consists of two 29 ft long by 3 ft wide by 3 ft deep pontoons placed 5 ft apart with decks fore and aft. The trap is located between the pontoons and strains a 4 x 4 ft section of stream flow with the

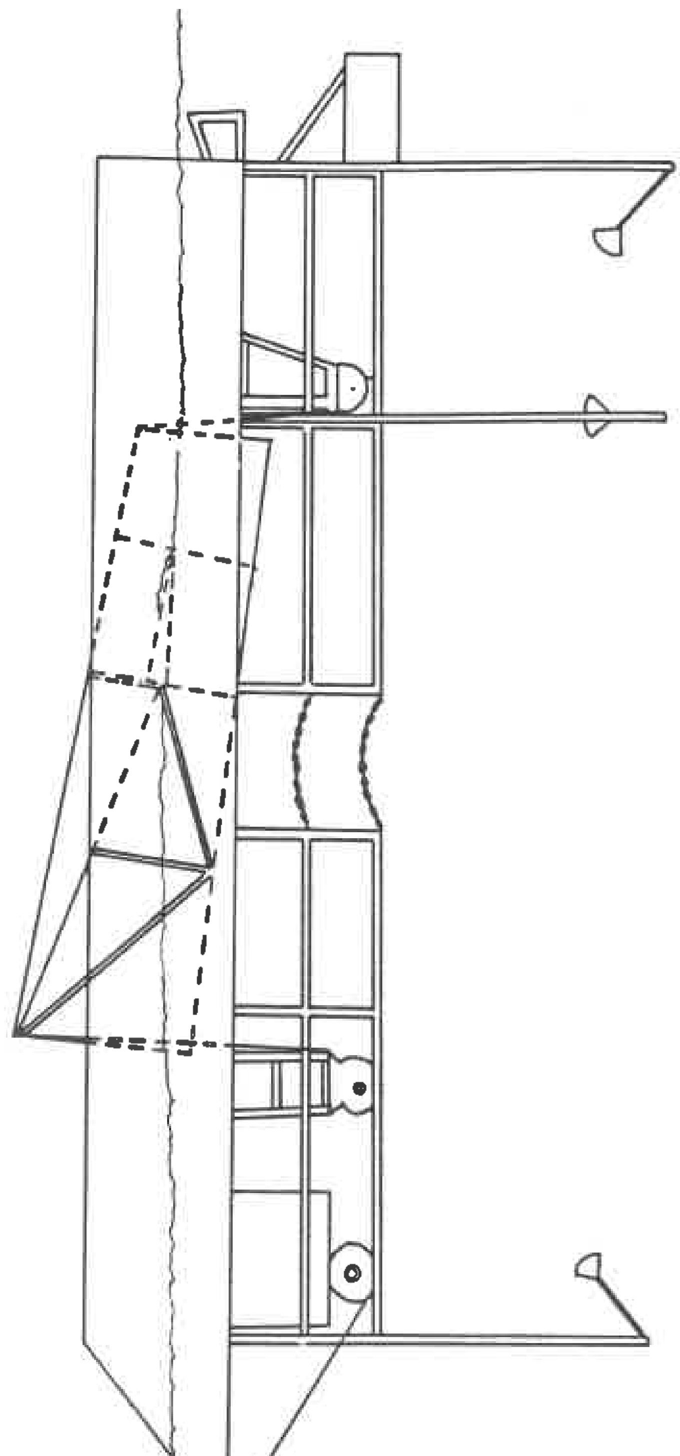

Figure 10. Side view of floating inclined-plane smolt trap.

inclined plane fully lowered. Approximately 100 cfs of flow are strained throught the trap during optimum trapping conditions. Seiler et al. (1981) give a detailed description of floating trap operations. The trap was placed on 3 March, and has been trapping continuously (24 hours a day, 7 days a week) since that date.

Primary information to be gained from the trap include magnitude, duration, periodicity, and peak of spring chinook migration. Ancillary information includes an assessment of smolt quality at migration (degree of smoltification, descaling, condition factor, and a subjective index of fish health). We placed the trap as far downstream as possible to collect information on lower-river spawners and to determine if any fall chinook rear in the lower Tucannon River. We will compare redd counts in 1984 with numbers of smolts outmigrating to estimate egg-to-smolt mortality rates.

To calibrate trapping efficiency, we will mark captured smolts and transport them in an aerated live box 4 km upstream of the trap and released. The percent of marked fish captured indicate percent total downstream migrants trapped. With these data, we will use the standard Peterson mark-recapture method (Chapman, 1948) to estimate spring chinook smolt production in the Tucannon River Basin. Each group of fish is marked in a unique location; date, time, and location of release are recorded for these groups, allowing us to determine both travel time and trap efficiency. Temperature, water flow and velocity, and water clarity are recorded daily to be used as covariates in explaining the variability in smolt migrations. Moonphase and photoperiod may be used as covariates also. Mains and Smith (1955) found the numbers of Snake River spring chinook outmigration to be a function of discharge and water temperature.

A 2x3 foot smolt trap has been placed and operated by WDG biologists at RK 25 of Asotin Creek. Data to be taken on collected spring chinook outmigrants is the same as on the Tucannon River smolt trap.

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APPENDIX A: Long-Term Objectives of Lyons Ferry Hatchery Evaluation Program

The following list outlines nine WDF objectives of the LSRCP Lyons Ferry Hatchery Evaluation Project. 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 project 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, project staff will retrieve and summarize data for the Lyons Ferry/Tucannon facilities and for basin-wide fall chinook. 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 populations. Similiar 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.** 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. Project 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 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

Allele frequencies at polymorphic loci for Snake River fall chinook collected at Lyons Ferry FH, Snake River fall chinook collected at Kalama Falls FH, Upper Columbia River fall chinook collected at Priest Rapids FH, and Tucannon River spring chinook.

Populations:
1. Lyons Ferry Hatchery adults: N=187
2. Priest Rapids Hatchery adults: N=91
3. Tucannon River adults: N=25
4. Kalama Falls adults: N=101
5. Tucannon River 1984 brood juveniles: N=119
6. Lyons Ferry Hatchery Kalama Falls 1984 brood juveniles: N=95
7. Lyons Ferry Hatchery Snake River 1984 brood juveniles: N=153

		Alleles				
LOCUS	POP.	A	B	C	D	E
Ada-1	1	.997	.003	0	0	0
	2	.995	.005	0	0	0
	3	.960	.040	0	0	0
	4	.990	.010	0	0	0
	5	.979	.021	0	0	0
	6	1.000	0	0	0	0
	7	.993	.007	0	0	0
Ada-2	1	1.000	0	0	0	0
	2	1.000	0	0	0	0
	3	.980	.020	0	0	0
	4	.995	.005	0	0	0
	5	1.000	0	0	0	0
	6	1.000	0	0	0	0
	7	1.000	0	0	0	0
Dpep-1	1	.967	.033	0	0	0
	2	.989	.011	0	0	0
	3	.935	.065	0	0	0
	4	.974	.026	0	0	0
	5	.860	.140	0	0	0
	6	.968	.032	0	0	0
	7	.979	.021	0	0	0
Tpi-3	1	.994	.006	0	0	0
	2	1.000	0	0	0	0
	3	.860	.140	0	0	0
	4	1.000	0	0	0	0

5	.891	.109	0	0	0
6	1.000	0	0	0	0
7	.992	.008	0	0	0

Gpi-2	1	.997	.003	0	0	0
	2	.995	.005	0	0	0
	3	1.000	0	0	0	0
	4	.985	.015	0	0	0
	5	.996	.004	0	0	0
	6	.963	.037	0	0	0
	7	.971	.029	0	0	0
Gpi-3	1	.995	.005	0	0	0
	2	.995	.005	0	0	0
	3	.979	.021	0	0	0
	4	1.000	0	0	0	0
	5	1.000	0	0	0	0
	6	1.000	0	0	0	0
	7	.993	.007	0	0	0
Gpi-H	1	.989	.011	0	0	0
	2	.967	.033	0	0	0
	3	1.000	0	0	0	0
	4	.990	.010	0	0	0
	5	1.000	0	0	0	0
	6	1.000	0	0	0	0
	7	.980	.020	0	0	0
Gr	1	.995	.005	0	0	0
	2	.984	.016	0	0	0
	3	1.000	0	0	0	0
	4	.960	.040	0	0	0
	5	1.000	0	0	0	0
	6	1.000	0	0	0	0
	7	.995	.005	0	0	0
Idh-2	1	.987	.013	0	0	0
	2	1.000	0	0	0	0
	3	1.000	0	0	0	0
	4	1.000	0	0	0	0
	5	1.000	0	0	0	0
	6	1.000	0	0	0	0
	7	.997	.003	0	0	0
Idh3,4	1	.968	.030	.002	0	0
	2	.887	.105	.008	0	0
	3	.802	.032	.166	0	0
	4	.963	.030	.007	0	0
	5	.930	.002	.068	0	0
	6	.947	.053	0	0	0
	7	.950	.045	.005	0	0

Ldh-5	1	.989	.011	0	0	0
	2	.995	.005	0	0	0
	3	.980	.020	0	0	0
	4	.985	.015	0	0	0
	5	1.000	0	0	0	0
	6	.995	.005	0	0	0
	7	.990	.010	0	0	0
Tapep	1	.874	.126	0	0	0
	2	.764	.236	0	0	0
	3	.980	.020	0	0	0
	4	.872	.128	0	0	0
	5	.936	.064	0	0	0
	6	.750	.250	0	0	0
	7	.849	.151	0	0	0
Capep	1	-	-	-	-	-
	2	.981	.019	0	0	0
	3	-	-	-	-	-
	4	.925	.075	0	0	0
	5	.992	.008	0	0	0
	6	1.000	0	0	0	0
	7	-	-	-	-	-
Mdh-1,2	1	.999	0	.003	0	0
	2	1.000	0	0	0	0
	3	1.000	0	0	0	0
	4	1.000	0	0	0	0
	5	1.000	0	0	0	0
	6	1.000	0	0	0	0
	7	1.000	0	0	0	0
Mdh-3,4	1	.986	.007	.007	0	0
	2	.984	.013	.003	0	0
	3	1.000	0	0	0	0
	4	.977	.010	.013	0	0
	5	1.000	0	0	0	0
	6	.987	.008	.005	0	0
	7	.975	.010	.015	0	0
Mpi	1	.749	.251	0	0	0
	2	.720	.280	0	0	0
	3	.600	.400	0	0	0
	4	.752	.248	0	0	0
	5	.870	.130	0	0	0
	6	.711	.289	0	0	0
	7	.692	.308	0	0	0

Pgk-2	1	.534	.466	0	0	0
	2	.593	.407	0	0	0
	3	.060	.940	0	0	0
	4	.640	.360	0	0	0
	5	.088	.912	0	0	0
	6	.695	.305	0	0	0
	7	.578	.422	0	0	0
Pgm-1	1	1.000	0	0	0	0
	2	1.000	0	0	0	0
	3	1.000	0	0	0	0
	4	1.000	0	0	0	0
	5	1.000	0	0	0	0
	6	1.000	0	0	0	0
	7	.993	0	0	.007	0
Sod-1	1	.658	.332	.008	0	.003
	2	.517	.478	.006	0	0
	3	.896	.083	.021	0	0
	4	.663	.337	0	0	0
	5	.826	.174	0	0	0
	6	.656	.344	0	0	0
	7	.563	.433	0	0	.003
Ah-4	1	.872	.126	.003	0	0
	2	.876	.124	0	0	0
	3	.940	.060	0	0	0
	4	.931	.059	.010	0	0
	5	.932	.068	0	0	0
	6	.921	.079	0	0	0
	7	.902	.098	0	0	0
Hagh	1	.995	.005	0	0	0
	2	1.000	0	0	0	0
	3	.840	.060	.100	0	0
	4	.939	.061	0	0	0
	5	.943	.057	0	0	0
	6	.945	.055	0	0	0
	7	.992	.008	0	0	0
Adh	1	-	-	-	-	-
	2	-	-	-	-	-
	3	-	-	-	-	-
	4	-	-	-	-	-
	5	1.000	0	0	0	0
	6	.879	.121	0	0	0
	7	.967	.033	0	0	0

Ck-5	1	-	-	-	-	-
	2	-	-	-	-	-
	3	1.000	0	0	0	0
	4	.925	.070	.005	0	0
	5	.910	.090	0	0	0
	6	.975	.043	0	0	0
	7	.936	.064	0	0	0
mMdh-1	1	.975	.025	0	0	0
	2	.984	.016	0	0	0
	3	.796	.204	0	0	0
	4	1.000	0	0	0	0
	5	.714	.286	0	0	0
	6	1.000	0	0	0	0
	7	.987	.013	0	0	0
bGa-1	1	.991	.009	0	0	0
	2	1.000	0	0	0	0
	3	1.000	0	0	0	0
	4	1.000	0	0	0	0
	5	.987	.013	0	0	0
	6	1.000	0	0	0	0
	7	.988	.012	0	0	0
Fbald-4	1	1.000	0	0	0	0
	2	-	-	-	-	-
	3	-	-	-	-	-
	4	1.000	0	0	0	0
	5	1.000	0	0	0	0
	6	1.000	0	0	0	0
	7	.980	.020	0	0	0
Ck-2	1	1.000	0	0	0	0
	2	.992	.008	0	0	0
	3	1.000	0	0	0	0
	4	1.000	0	0	0	0
	5	1.000	0	0	0	0
	6	1.000	0	0	0	0
	7	1.000	0	0	0	0
Gapdh-3	1	.988	.012	0	0	0
	2	-	-	-	-	-
	3	-	-	-	-	-
	4	-	-	-	-	-
	5	-	-	-	-	-
	6	-	-	-	-	-
	7	-	-	-	-	-

Pep-LT	1	1.000	0	0	0	0
	2	.996	.004	0	0	0
	3	1.000	0	0	0	0
	4	1.000	0	0	0	0
	5	-	-	-	-	-
	6	-	-	-	-	-
	7	-	-	-	-	-

APPENDIX C: Rearing habitat quality rating used for Tucannon River spring chinook population assessment.

Factor	Description	Points
Depth (D)	The mean depth of the transect is greater than three feet.	3
	The mean depth of the transect is greater than two feet.	2
	The mean depth of the transect is less than two feet.	1
Riparian Cover (R)	Abundant cover (65-100%)	3
	Partial cover (35-65%)	2
	Exposed (Less than 35%)	1
Woody Debris (W)	Abundant	3
	Partial	2
	None	1
Boulder Cover (B)	High	3
	Medium	2
	Low	1

APPENDIX E: Tucannon river and tributary count of riffles, runs, and pools, and their ratio within the HMA and Wilderness strata.

River kilometer	Riffle	Run	Pool	Ratio
HMA Stratum				
57.1-61.2	312	11	11	94:3:3
61.2-65.7	119	33	14	72:20:8
65.7-69.4	86	55	11	57:36:7
69.4-75.3	138	47	5	72:25:3
Total count	655	146	41	78:17:5
Wilderness stratum				
75.3-78.9	129	8	13	86:5:9
78.9-86.3	120	41	24	65:22:13
Total count	249	49	37	74:15:11
Total count both strata	904	195	78	77:16:7