H95-05

TUCANNON RIVER SPRING CHINOOK SALMON HATCHERY EVALUATION PROGRAM

1994 ANNUAL REPORT

LOWER SNAKE RIVER COMPENSATION PLAN
Hatchery Program

Washington Department of
Fish and Wildlife
Hatcheries Program

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ABSTRACT

This report summarizes activities of the Washington Department of Fish and Wildlife Lower Snake River Hatchery Evaluation Program from 1 April 1994 to 15 April 1995. We describe the Spring Chinook Salmon Program at Lyons Ferry and Tucannon Fish Hatcheries (FH).

Seventy-three spring chinook salmon escaped to the Tucannon FH trap in 1994. The total escapement to the Tucannon River in 1994 was 140 salmon. We collected 36 natural and 34 hatchery salmon for broodstock. Forty-three females were spawned for a total eggtake of 161,707 (mean fecundity - 3,761 eggs/female). Mortality prior to hatching was 9,644 eggs (6.0%) leaving 152,043 eyed eggs.

We completed a one month volitional release of the 90,295 smolts in the acclimation pond at Tucannon FH on 15 April 1995. In addition, we released 48,553 juveniles directly into the river or from small portable acclimation ponds from 20 March to 4 April 1995.

We estimated subyearling and yearling chinook salmon parr production in the Tucannon River for 1994 at 86,755 and 4,614, respectively. Electrofishing surveys were not conducted in 1994.

We operated the downstream migrant trap intermittently from 1 November 1993 to 24 June 1994. We captured 8,879 natural salmon and 4,532 hatchery salmon (outplanted and acclimated) during the 1993/1994 season. We estimate 50,800 natural salmon and 4,343 outplanted hatchery salmon migrated past the trap. We estimated 7.6% of the outplanted hatchery fish survived over the winter.

We surveyed spawning grounds from August to October and found 44 spring chinook salmon redds (42 below the Tucannon FH weir). Fifty natural and no hatchery salmon carcasses were recovered during the surveys. North Fork Asotin Creek was also surveyed for spring chinook salmon, but no redds or carcasses were found in 1994.

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SECTION 1: INTRODUCTION

Congress authorized implementation of the Lower Snake River Fish and Wildlife Compensation Program (LSRCP) in 1976. As a result of that plan, Lyons Ferry and Tucannon Fish Hatcheries (FH) were built. One objective of these hatcheries is to compensate for loss of 1,152 Tucannon River Spring Chinook salmon[1] created from hydroelectric projects on the Snake River. An evaluation program was initiated in 1984 to monitor the success of these hatcheries in meeting this goal and identifying any production adjustments required to improve performance of hatchery fish. WDFW has identified two goals in its evaluation program: 1) monitor hatchery practices at Lyons Ferry and Tucannon FH to ensure quality smolt releases, high downstream migrant survival, and sufficient contribution to fisheries with escapement to meet the LSRCP compensation goals, and 2) gather genetic information which will help maintain the integrity of Snake River Basin salmon stocks (WDF 1993). This report summarizes all work performed by the WDFW LSRCP Spring Chinook Salmon Evaluation Program from 1 April 1994 through 15 April 1995.

Lyons Ferry FH is located at the confluence of the Palouse River with the Snake River at river kilometer (Rk) 90. At Lyons Ferry FH, well water system passes once through the incubators, four adult holding ponds, and 28 raceways. A satellite facility, Tucannon FH, is maintained on the Tucannon River (Rk 61) for collection of adult salmon and release of yearling progeny (Figure 1). Tucannon FH has an adult collection trap and one holding pond, which had been used for holding broodstock and releasing yearlings. Returning natural[2] and hatchery adult salmon are trapped at the Tucannon FH and hauled to Lyons Ferry FH for holding and spawning. Eggs are fertilized, incubated, and the fry are reared to parr size at Lyons Ferry FH, then returned to Tucannon FH for release. The 1994 Tucannon salmon production goal was 88,000 fish for release as yearlings at 15 fish per pound (fpp; 5,867 lbs.).

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[1] Throughout this report, the term "salmon" refers to Tucannon River spring chinook salmon, unless otherwise noted in the text.

[2] Throughout this report, the term "natural" salmon refers to fish that are progeny of either wild or hatchery fish that spawned in the river.

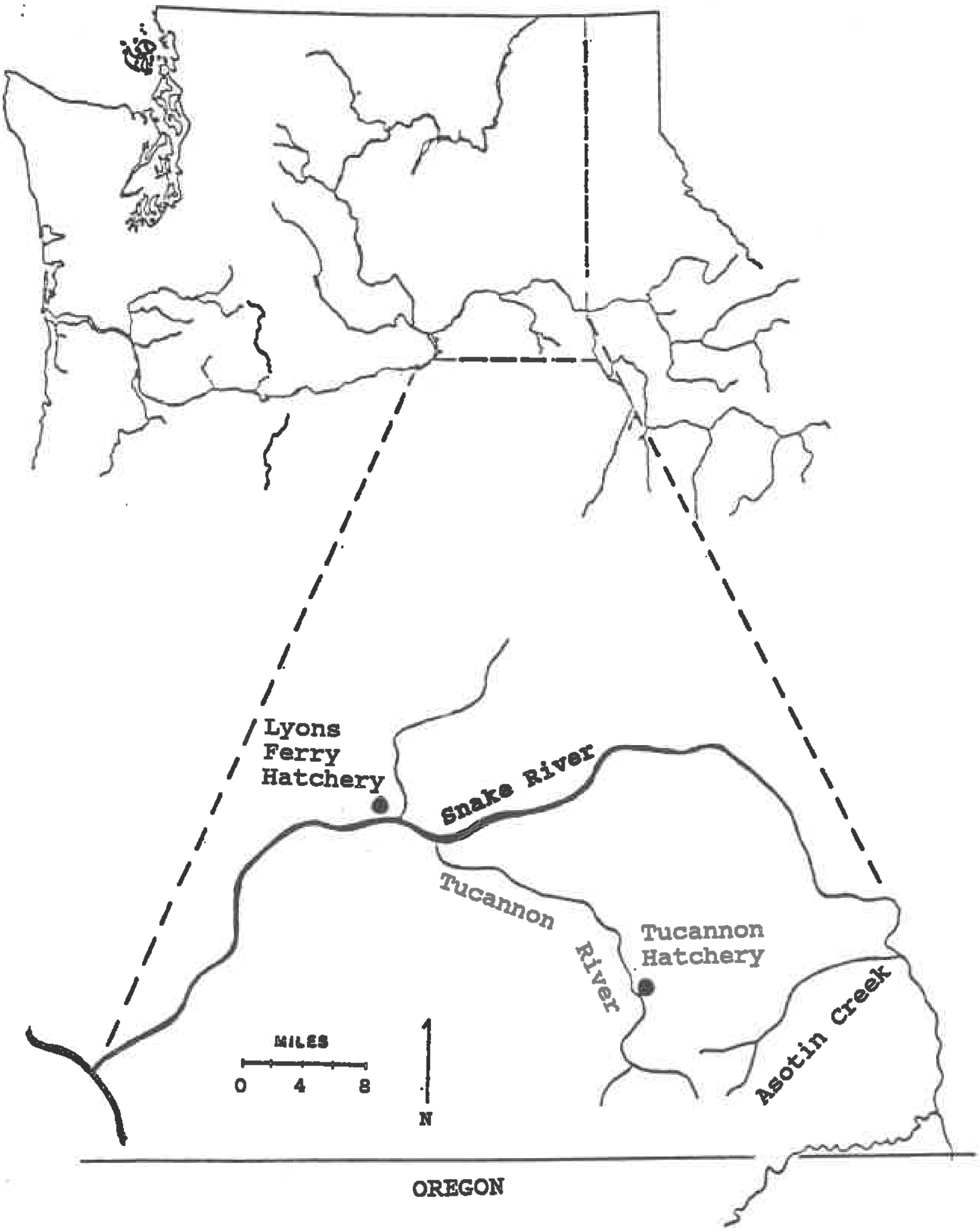

Figure 1. Location of Lyons Ferry and Tucannon Fish Hatcheries with the Lower Snake River Basin.

SECTION 2: HATCHERY EVALUATION

2.1: Broodstock Management and Collection

Hatchery and evaluation personnel operated an adult collection trap daily from 10 May through 20 September 1994. Our standard objective is to collect equal numbers of natural and hatchery salmon for broodstock throughout the run, but not to exceed 50 natural and 50 hatchery salmon. Returning hatchery salmon can be identified because they are lacking adipose fins and are coded-wire tagged (CWT).

Record low returns of spring chinook to both Columbia and Snake River basins were predicted in 1994. Accurate prediction models for the Tucannon River run size were necessary for proper broodstock and management decisions. We developed a simple model to forecast the Tucannon River run size using Ice Harbor Dam (IHR) ladder counts, returns to the Tucannon FH trap, and estimated total escapements to the Tucannon River.

Data from 1990 to 1993 were used to calculate the mean percentage of spring chinook salmon that crossed IHR and eventually arrived at the Tucannon trap or the Tucannon River (Table 1). In-season passage indices at IHR predicted of 2,500 spring chinook salmon would cross IHR in 1994. Based on that estimate, we predicted 55 salmon would return to the Tucannon weir, and 75 to the entire river. Final IHR ladder counts were 3,472 spring chinook salmon. Therefore, a revised Tucannon River spring chinook salmon prediction based on the final IHR counts were 76 adults to the trap, and 118 to the entire Tucannon River.

Table 1. Four-year averages of percent arrivals to the Tucannon FH weir and estimated total escapement to the Tucannon River based on Ice Harbor Dam counts.

Year	Ice Harbor Dam counts (ladder)	Tucannon Weir Escapement	Percent of IHR Counts	Estimated Tucannon River Escapement	Percent of IHR Counts
1990	20,730	462	2.2	738	3.6
1991	11,284	311	2.8	521	4.6
1992	26,114	547	2.1	753	2.9
1993	24,935	448	1.8	586	2.3
Four-year average			2.2		3.4

The low run size predictions, survival advantage of hatchery fish over natural fish (Bumgarner et al. 1994), and concerns about pre-spawning mortality in the river, influenced WDFW and NMFS to agree to collect all salmon that returned to the trap; up to 105 adult salmon. If more than 105 salmon returned to the trap, at least 30 salmon would be returned to the river for natural spawning. This strategy would maximize survival, yet protect the integrity of the natural stock.

Peak of arrival dates for natural and hatchery salmon were 25 and 27 May, respectively (Figure 2). In 1994, seventy-three fish (three less than predicted) arrived at the trap. Between 13 May and 16 September, we collected 70 of the these salmon for broodstock (36 natural and 34 hatchery), and passed no adults upstream of the trap (Appendix A). In addition, one salmon escaped from the trap before it could be transferred to Lyons Ferry FH, and two males (natural) arrived after spawning at the hatchery was complete.

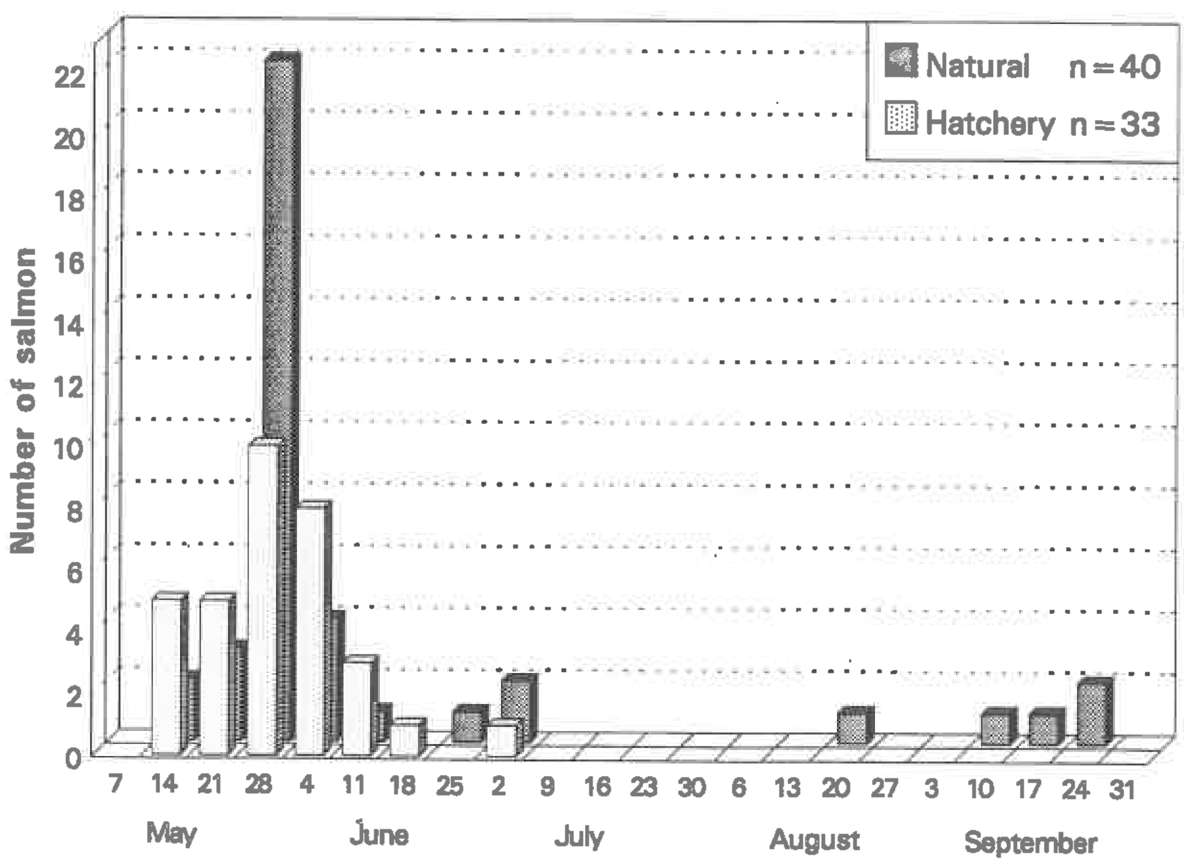

Figure 2. Weekly arrivals of natural and hatchery spring chinook salmon to the Tucannon FH trap, 1994. Includes fish that were not collected for broodstock.

2.2: Lyons Ferry/Tucannon Hatchery Practices

2.2.1: Adult holding and spawning

Salmon captured for broodstock were hauled from the trap to Lyons Ferry FH each day fish were collected. Holding salmon in the cooler water at Lyons Ferry FH has substantially reduced pre-spawning mortalities (Bumgarner et al. 1994). In 1994 only one of 70 salmon collected for broodstock died before spawning.

Spawning at Lyons Ferry FH occurred from 16 August to 20 September, with peak eggtake on 13 September (Table 2). Appendix B lists the 1994 spawning protocol guidelines. Coded-wire tags are normally extracted and read before fertilizing the eggs at the hatchery to maintain the genetic integrity of the stock. However, for the second consecutive year, we had fewer males for broodstock than required, therefore, all males were live spawned. The origin of the males were determined on the final day of spawning when all males were killed and CWTs were read. All hatchery salmon collected for broodstock were of Tucannon FH origin. Total eggtake was 161,707 eggs with 9,644 (6.0%) lost before eye up, leaving 152,043 eggs.

Table 2. Spawning and holding mortalities of Tucannon natural and hatchery spring chinook salmon at Lyons Ferry FH in 1994.

Week Ending	Natural salmon spawned		Natural salmon mortality		Hatchery salmon spawned		Hatchery salmon mortality	
	male	female	male	female	male	female	male	female
04 Jun			1					
03 Sep						1		
10 Sep		7				4		
17 Sep		10				13		
24 Sep	13	5			13	3		
Totals[a]	13	22	1	0	13	21	0	0

a Males were live-spawned and tallied as spawned when they were killed.

2.2.2: Sperm cryopreservation and evaluation

We did not freeze any semen, or conduct any experiments with Tucannon spring chinook salmon in 1994. However, we did experiment with holding eggs and semen from Ringold spring chinook salmon in a refrigerator for one week. Data and results from these experiments will be included in subsequent reports.

2.2.3: Hatchery matings (controlled matings study)

We continue to monitor an experiment begun in 1990 to examine genotypic and phenotypic differences between separate matings of natural and hatchery salmon. Eggs from natural females were fertilized with sperm from natural males and eggs from hatchery females were fertilized with sperm from hatchery males. The objective of this study is to determine if measurable differences can be detected in early survival, growth, or rate of return as a result of one generation of hatchery rearing. The 1993 brood was the last cohort in the experiment.

<u>1992 brood</u> Most of this brood was progeny from hatchery fish (Table 3). Fish were CWT and given an elastomer visual implant tag (VI) in the clear tissue behind the eye in October, 1993. Coded-wire tag codes and elastomer color and location were dependant on parentage, and eventual release site (Appendix C).

Table 3. Summary of matings and progeny releases of natural x natural, hatchery x hatchery and mixed natural x hatchery crosses of 1992 brood Tucannon spring chinook salmon.

	Natural	Hatchery	Mixed	Totals	Weight (lbs)
1992 adult escapement [a]					
To river	417	336	- -	753	
To trap	242	305	- -	547	
Collected	47	50	- -	97	
Matings	18	27 [b]	- -	45	
Progeny of 1992 brood					
Eggtake	69,376	86,983	- -	156,359	
Picking	68,527	85,067	- -	153,594	
Ponded	67,820	83,907	- -	151,727	106
Outplanted (Tucannon R.)	25,134	32,182	- -	57,316	1,592
To Tucannon FH (acclimation)	36,782	48,958	- -	85,740	
Released (Tucannon FH)	36,276	47,133	- -	83,409	5,958

a Estimated adult escapement (revised January 1995)
b Does not include one female that was spawned out in the pond, but does include a partly spawned out female that contributed eggs.

<u>1993 brood</u> Mating and rearing procedures were similar to those used for the 1992 brood (Table 4). Progeny were tagged with a CWT and a VI tag in September, 1994. Coded-wire tag codes and VI color and location were dependant on parentage, and eventual release site. No VI tag was given to the mixed progeny group (Appendix C). Fish to be released from the Tucannon FH acclimation pond were given a green VI tag, while fish to be outplanted as pre-smolts or released from small portable acclimation ponds received a red VI tag.

Table 4. Summary of matings and progeny releases of natural x natural, hatchery x hatchery and mixed natural x hatchery crosses of 1993 brood Tucannon spring chinook salmon.

	Natural	Hatchery	Mixed	Totals	Weight (lbs)
1993 adult escapement [a]					
To river	314	272	- -	586	
To trap	191	258	- -	449	
Collected	50	47	- -	97	
Matings	21	20 [b]	8 [c]	49	
Progeny of 1992 brood					
Eggtake	70,448	71,279	26,639	168,366	
Picking	64,164	64,475	24,245	152,884	
Ponded	62,656	62,850	19,797	145,303	109
Tagged	59,722	61,063	18,379	139,164	
To Tucannon FH [d] (acclimation)	45,196	45,194	- -	90,390	
To Tucannon FH [d] (raceways)	14,680	15,667	18,371	48,718	
Released [d]					
(small ponds)	11,010	11,754	13,715	36,479	2,431
(direct stream)	3,622	3,863	4,589	12,074	805
(Tucannon FH)	45,148	45,147	- -	90,295	6,314

a Estimated adult escapement (revised January 1995)
b Does not include one female that was green, but includes one hatchery female and two natural females which were partially green.
c Includes three matings with a stray male from Meachum Cr, Oregon. Eggs fertilized from the stray male (primary male only) were later destroyed.
d These numbers are approximations, since the fish were mixed together before transport to Tucannon FH, and so the actual number of fish released from each group is unknown.

2.2.4: Disease incidence and treatments

The 1994 returning adult salmon were injected with 0.5 cc of both Erythromycin and Liquimycin when trapped, and twice again with Erythromycin before spawning. These drugs treat bacterial kidney disease (BKD) and Flexibacter columnaris. Flush treatments of formalin (1:7,000 dilution rate for 2 hours) were applied to adults every other day to control fungus infection. Prophylactic feed treatments for BKD were not given to the 1993 brood juvenile spring chinook salmon, and none were scheduled for the 1994 brood. Prophylactic feed treatments were given in the past, but the prevalence of BKD in Tucannon spring chinook salmon has been documented at low levels (Patty Michak, WDFW; pers comm.). Treatment of juveniles is not warranted at this time.

2.2.5: Smolt acclimation and releases

1992 brood smolt acclimation and release: We planned a one month volitional release period beginning in the first part of March 1994. Unfortunately, for the second year in a row, our planned volitional release was postponed until 11-18 April because of a delay in receiving a Biological Opinion/Section 10 Permit/Modification from NMFS. During that time, 83,409 smolts were released from the Tucannon FH acclimation pond.

1993 brood smolt acclimation and release: Fish reared at Lyons Ferry FH are transported to and acclimated at Tucannon FH before release. Lyons Ferry FH staff transported 90,390 yearling salmon to the main acclimation pond (26 October) and 48,718 yearling to two raceways (2 November) at the Tucannon FH in 1994. The percentage of well water was reduced on the morning of 1 March, and all fish were entirely on river water by the end of the day. This was done to ensure that fish imprinted to the Tucannon River instead of the hatchery water supply before release. About 36,000 of the fish from the Tucannon FH raceways were transported to small acclimation sites (ponds) located at Winchester Creek, Little Tucannon River, and Curl Lake (Figure 3). Fish at these acclimation sites were allowed to acclimate to the local water source for about two weeks. About 12,000 salmon from the raceways to be released directly into the river were acclimated on 100% river water for about three weeks at Tucannon FH prior to being transported upriver and released.

Release strategies in 1995 differed from previous years. We planned a one month volitional release for the 88,000 smolts in the acclimation pond at Tucannon FH beginning the first part of March 1995. In addition, approximately 48,000 juveniles were to be released directly into the stream as smolts in late March, or released from small portable acclimation ponds in March and April (Figure 3). Both release strategies were used to improve the survival of the outplanted fish compared with 1992 brood outplants (less over-winter mortality), yet address concerns of reduced spawning distribution of returning adults in the upper river. A more complete description of the releases and our study to evaluate relative survivals will be included in subsequent reports.

Fish in the main acclimation pond were sampled on 28 February and 2 March. Evaluation staff collected lengths, weights, electrophoretic, organosomatic, meristic, morphometric and plasma cortisol samples. Mean fork length, coefficient of variation and condition factor of smolts were 134.3 mm, 9.8, and 1.3, respectively (Figure 4). The volitional release from the main acclimation pond began on 15 March, and continued until 15 April. Hatchery personnel estimated that 95% of the fish in the pond migrated volitionally. The remaining 5% were forced out on 15 April.

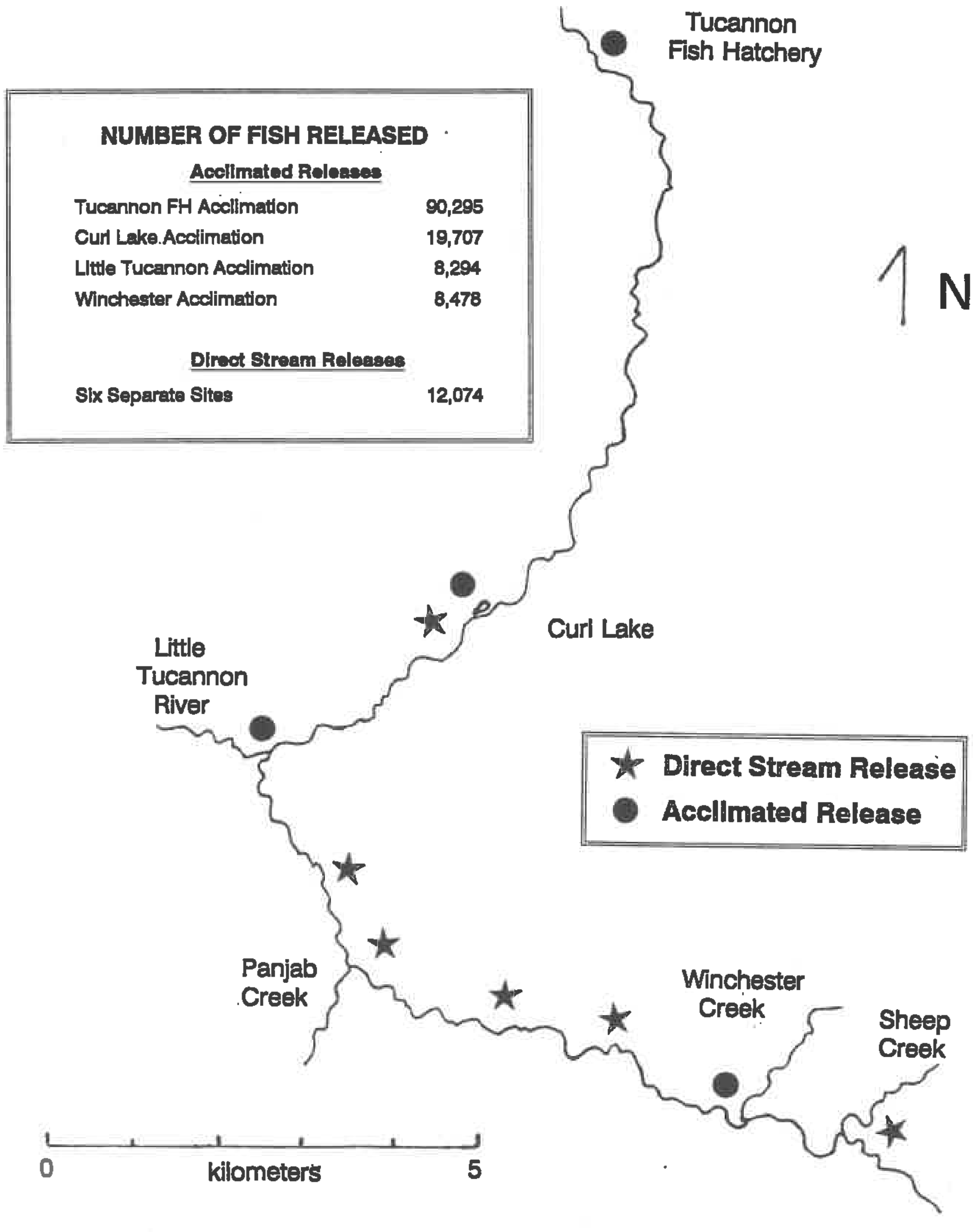

Figure 3. Locations of remote acclimation sites and direct stream release sites in the Tucannon River, and numbers of fish released per site in 1995.

The fish to be outplanted from the raceways were not sampled before release. However, 996 fish from the raceways were Passive Integrated Transponder (PIT) tagged from 6-10 March. Data collected during PIT tagging was used for pre-release size information. Mean fork length, coefficient of variation and condition factor of smolts at time of PIT tagging were 141.5 mm, 11.4, and 1.2, respectively (Figure 4). A total of 48,553 fish were released directly into the river or from small portable acclimation ponds between 20 March and 4 April (Figure 3).

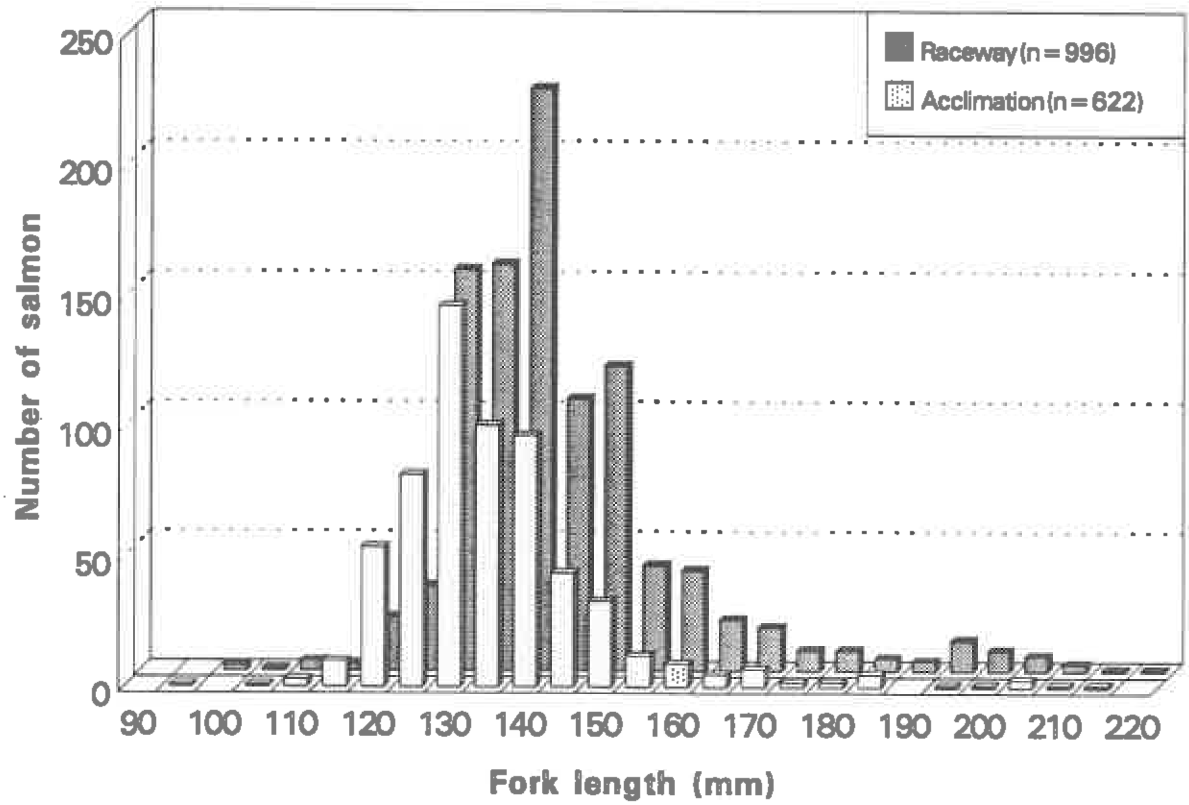

Figure 4. Length frequency distribution of 1993 brood salmon sampled 28 February and 2 March 1995 from Tucannon FH acclimation pond, and PIT tagged fish from Tucannon FH raceways sampled between 6-10 March.

All fish sampled from the raceways were left VI tagged (natural x natural cross progeny). Fish sampled from the main acclimation pond were VI tagged on both sides. Left VI fish sampled from the acclimation pond were greater in length (2.5mm) than right VI tagged fish. Fish from the raceways were greater in length (6.0mm) than left VI tagged fish from the acclimation pond. We are uncertain why fish in the raceways were substantially larger than fish in the main acclimation pond. However, fish in the raceways were transported from Lyons Ferry to Tucannon FH one week later than fish that were transported to the main acclimation pond, and may explain the size difference.

SECTION 3: RIVER EVALUATIONS

From 1985 to 1988, program staff collected biological information on wild salmon in the Tucannon River before hatchery enhancement. We are now collecting biological information from both natural and hatchery salmon. This information contributes to an assessment of the short and long term effects of hatchery supplementation. We are evaluating the effects of supplementation in two ways: 1) stock profile analysis, using a combination of electrophoresis, morphometrics, meristics, and quantifiable measures of fish demographics, and 2) observation of the population dynamics of natural and hatchery salmon spawned in the Tucannon River. The following discusses our research on the population dynamics. The Tucannon River Watershed and Strata have been described previously (e.g. Mendel et al. 1993).

3.1 Stream Temperature/Discharge Monitoring

We installed nine continuous-reading thermographs to record daily minimum and maximum water temperatures in the Tucannon River to monitor heat loading throughout the year. Miscellaneous river discharges are periodically taken at index sites on the river. Temperatures and discharge measurements are on file at our Dayton office.

3.2 Juvenile Population Dynamics

3.2.1: Snorkel surveys

In 1994, we surveyed parr production at index sites to estimate parr densities and derive a population estimate for subyearling and yearling chinook salmon in the Tucannon River, as in previous years. Population estimates were derived by multiplying the mean density (fish/100 m^2) of each habitat type by the total area of that habitat type (from the most recent habitat inventory; Appendix D) within each stratum. We estimated the subyearling and yearling chinook salmon parr production in the Tucannon River for 1994 was 86,755 and 4,614, respectively (Table 5). These were estimated by a total count snorkel method (Griffith 1981, Schill and Griffith 1984). Electrofishing surveys were not conducted in 1994 due to the high number of mortalities observed in 1993.

3.2.2: Downstream migrant trap operations

An important objective of our evaluation is to estimate the magnitude, duration, periodicity, and peak of natural salmon emigration from the Tucannon River. To trap outmigrating fish, we maintain a floating inclined plane downstream migrant trap at Rk 21.1.

Table 5. Subyearling and yearling chinook salmon density (mean number of fish per 100 m^2) and population size estimated by the total count snorkel method (by habitat type) in the Tucannon River, 1994. Number of sites and standard deviation in parenthesis.

Stratum Habitat Type	Subyearling		Yearling	
	Density	Population	Density	Population
Wilderness				
Riffle	5.4, (4, 5.8)	2,676	0.0, (4, 0.0)	0
Run	6.8, (4, 8.9)	2,119	0.0, (4, 0.0)	0
Pool	57.0, (4, 30.5)	1,512	12.3, (4, 12.7)	325
Side channel	64.4, (4, 55.2)	10,290	7.2, (4, 6.1)	1,147
Total		16,597		1,472
HMA				
Riffle	8.0, (5, 4.2)	12,314	0.1, (5, 0.2)	154
Run	31.2, (6, 20.6)	12,671	1.3, (6, 2.9)	529
Pool	67.2, (5, 10.7)	4,841	4.5, (5, 1.8)	322
Boulder	19.6, (6, 10.7)	4,121	0.5, (6, 0.8)	94
Side channel	77.5, (4, 48.3)	7,827	1.8, (4, 3.1)	181
Total		41,774		1,280
Hartsock				
Riffle	4.9, (5, 4.2)	6,512	1.3, (5, 1.7)	1,797
Run	23.3, (6, 12.6)	8,285	0.1, (6, 0.3)	45
Pool	31.3, (5, 60.4)	1,730	0.4, (5, 0.8)	20
Side channel	62.1, (4, 26.8)	6,262	0.0, (4, 0.0)	0
Total		22,789		1,862
Marengo				
Riffle	0.4, (3, 0.6)	492	0.0, (3, 0.0)	0
Run	7.1, (2, 10.1)	3,831	0.0, (2, 0.0)	0
Pool	0.0, (1, 0.0)	0	0.0, (1, 0.0)	0
Side channel	9.8, (4, 7.0)	1,272	0.0, (4, 0.0)	0
Total		5,595		0
Totals		86,755		4,614

1992 brood trapping: We operated the trap intermittently from 1 November 1993 to 24 June 1994. The trap was operated for 10 days in November, 13 days in December, 19 days in January, 10 days in February, 29 days in March, 23 days in April, 27 days in May, and 20 days in June. Trapping ceased on 24 June because low river discharge made trapping impossible.

Several times during the trapping period we calibrated trapping efficiency. To do this we clipped the distal portion of the upper or lower lobe of the caudal fin on natural migrants and transported them 1 km upstream of the trap for release. The percentage of marked fish recaptured was used as an estimate of trapping efficiency. To estimate the number of fish migrating while we did not operate the trap, we calculated the number of fish trapped per hour during each mark/recapture trial. This number was then used to estimate the number of fish that could have been captured if the trap was operating. The total estimated number of fish trapped was then divided by the trapping efficiency to estimate the number of migrants passing the trap.

We conducted one mark/recapture trial per month for December and June, two in January, three each in March and April, and four in May. Mark/recapture trials were not conducted in November or February due to low numbers of captured fish. Trapping efficiencies from other months with similar environmental conditions and discharges were used to estimate total emigration for November and February. We marked 755 natural salmon recaptured 247.

We captured 8,879 natural salmon (including 247 recaptures) and 4,532 hatchery salmon (both outplanted and hatchery acclimation releases) during the 1993/1994 season. Based on our trapping efficiencies, we estimated 50,800 natural salmon migrated past the trap (Table 6). We were also able to estimate the number of outplanted hatchery fish that migrated past the trap, giving us an over-wintering survival rate. We estimated 4,343 of 57,316 (7.6%) outplanted fish survived over the winter. Fish released from the main acclimation pond at the Tucannon Fish Hatchery were not intensively trapped. Most of the fish from the main acclimation pond pass the trap within a couple of days. We do not operate the trap during that time because we want to avoid catching large numbers of hatchery fish.

The peak migration period for natural salmon based on daily passage estimates was not clearly defined as we were unable to trap eight days in April. Catches of released hatchery salmon were going to exceed the 4,000 catch limit specified in our Section 10 permit. We pulled the trap for eight days while we waited for a response from NMFS for a permit modification. We speculate the peak migration of natural migrants occurred during the last two weeks of April when our trap was not operating. We base this assumption on two short trapping periods (< two hours) during that period. Catches of natural migrants during those short trapping periods were substantially larger than catches before or after the trap was reset, indicating large number of migrants were passing. Catches of hatchery outplanted fish during the short trapping periods was not substantially greater then what was observed earlier. Therefore, we speculate the peak migration of hatchery outplanted fish was in the first and second week of May (Figure 5).

Smolt migration estimates for the time when the trap was pulled in April were calculated by estimating a catch rate using catches prior to, during, and after the untrapped period. Trapping efficiencies before pulling the trap and after the trap was reset were averaged and used to calculate total smolt migration for the time the trap was pulled.

Table 6. Estimated natural and outplanted hatchery juvenile migrants passing the downstream migrant trap in the Tucannon River from 1 November 1993 to 24 June 1994.

	Natural		Hatchery	
Month	Number of migrants	Percent of total	Number of migrants	Percent of total
November	1,865	3.7	26	0.6
December	5,494	10.8	182	4.2
January	1,658	3.3	14	0.3
February	1,065	2.1	20	0.4
March	9,766	19.2	221	5.1
April [a]	18,646	36.7	1,091	25.1
May	9,213	18.1	2,339	53.9
June	3,093	6.1	450	10.4
Total	50,800	100.0	4,343	100.0

[a] Estimates for April are not as reliable as other months because the trap was not operating during eight days when peak outmigration occurred.

In the eight month trapping period, we assessed the amount of descaling on 2,942 natural salmon and 623 hatchery salmon (375 red elastomer). Descaling on natural salmon was considerably less than that for hatchery salmon (Table 7). We are unsure why red elastomer hatchery fish were descaled more than the natural migrants and the acclimated release group, but believe transport of these fish to release sites may have contributed to their scale loss. We also speculate that fish reared in the hatchery environment are unaccustomed to maintaining position in the swifter currents to which they are subjected in the river, and are therefore injured and descaled more easily than natural fish.

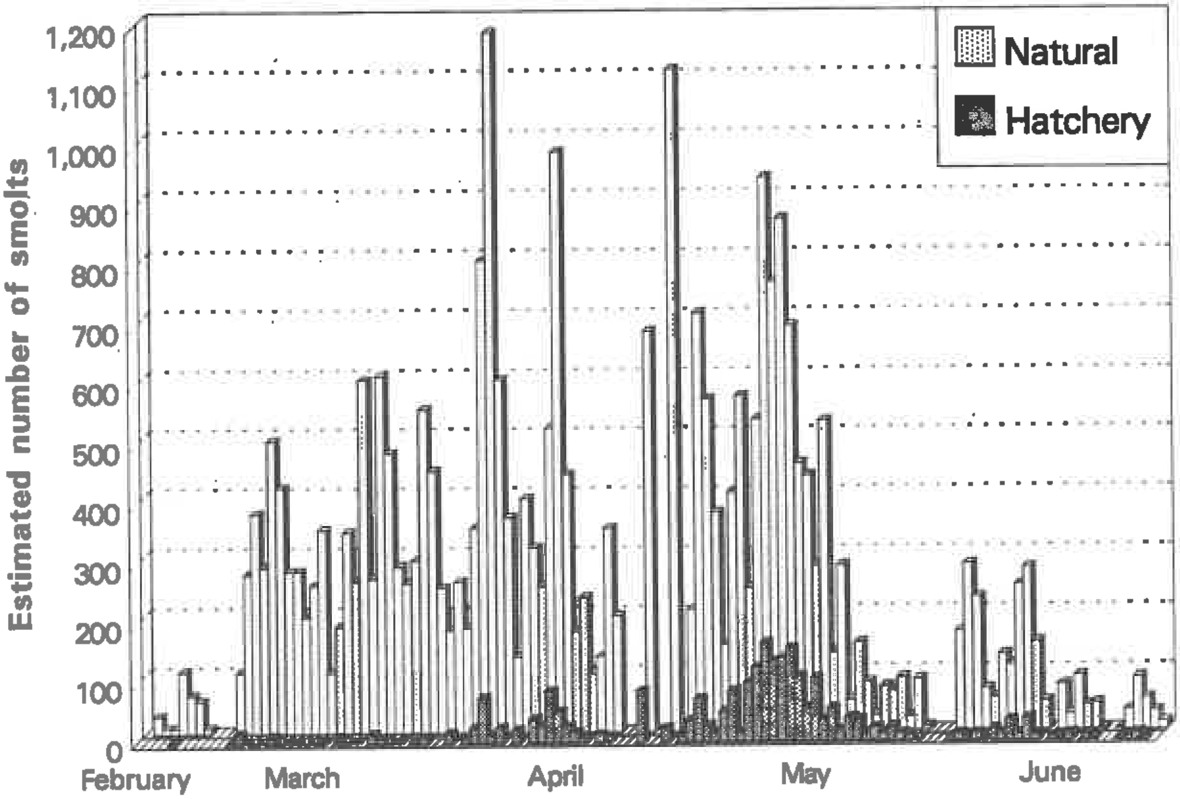

Figure 5. Daily estimated number of natural and outplanted hatchery migrants passing the downstream migrant trap in 1994. Dates of zero estimated migrants indicate days where trapping did not occur or no migrants were captured.

Table 7. Summary of observed descaling (percent) for natural and hatchery salmon captured in the downstream migrant trap 1993/1994. Sample sizes are in parentheses.

	Percent Descaled		
Regions	Natural	Hatchery (acclimated)	Hatchery (outplanted)
One only	1.1 (33)	6.5 (16)	8.5 (32)
Two or more	0.9 (26)	3.2 (8)	20.0 (75)
Total	2.0 (59)	9.7 (24)	28.5 (107)

We determined the amount of descaling caused by the trap with the use of our mark/recapture fish. We marked 755 migrants for trap efficiency tests; of these, 415 were examined for descaling. Six of 415 (1.4%) were classified as descaled in one or more regions. Four (3.3%) of the 247 fish recaptured were descaled in one or more regions. Based on the difference in descaling in marked vs recaptured, we determined the trap to have caused descaling in 1.9% of the fish captured. Therefore, the trap appears to cause nearly all the descaling in natural salmon captured, although the incidence of descaling is quite low.

During the trapping season, fish occasionally die in the trap. Eleven (0.12%) natural and seven (0.15%) hatchery fish were found dead in the trap during the season. One of eleven natural fish was killed in the process of sampling. We are uncertain what proportion of the remaining dead fish arrived dead, or were killed by the trap.

We classified approximately 95% of the natural salmon caught as parr-smolt transitionals, most of the remaining 5% were smolts. Twenty-one fish were classified as parr. Six of the parr captured from 18 March through June had recently emerged as fry. The three parr captured in March were 35, 38, and 40mm long. The remaining fish captured as parr were captured in November and ranged from 70-80 mm in length.

<u>1993 brood trapping:</u> We began intermittent juvenile migrant trapping on 1 October 1994. We continued to intermittently trap through the winter, and increased our trapping efforts as peak juvenile migration approached. Sampling summaries and population estimates for smolts emigrating from the Tucannon River during the 1994/1995 migration period will be presented in the 1995 Spring Chinook Annual Report.

3.2.3: PIT tagging studies

We began a Passive Integrated Transponder (PIT) tag study in February 1995 to determine if small remote acclimation ponds located in the upper Tucannon River watershed produced higher relative survivals than direct stream releases of smolts in the same areas. A total of 1,000 fish (five subgroups of 200 each) were PIT tagged at Tucannon FH between 6-10 March, 1995. Three of the five groups were transported to the small portable acclimation ponds (Curl Lake, Winchester Cr.), and two groups were released directly into the stream close to the small acclimation sites. In addition, 200 juveniles from the main acclimation pond at Tucannon FH were PIT tagged prior to the volitional release. Results from this study will be available in late summer, 1995.

3.3: Adult Population Dynamics

3.3.1: Pre-spawning mortality

Evaluation staff conducted three pre-spawning mortality surveys below the weir during June, 1994. Surveys ranged from two to 10 km. We found no salmon carcasses prior to spawning season from any of the pre-spawning mortality surveys, habitat surveys, or snorkel surveys conducted in 1994.

3.3.2: Radio telemetry

Due to the predicted record low returns of spring chinook salmon to the Tucannon River, our radio telemetry adult outplant study was not conducted in 1994. Telemetry studies may continue in the future if spring chinook run size increases.

3.3.3: Weir and trap evaluation

We continue to monitor and evaluate the operation of the Tucannon FH weir/trap. We believe the weir is partially responsible for causing a shift in adult spawning distribution in recent years. A modification to the weir was completed in January 1994. A frame with a 1' x 1' opening was constructed and placed in a section of weir below the water line. The opening allows fish to pass the weir without going into the trap. This new section is equipped with a removable gate to allow unrestricted passage, or closed to trap steelhead or chinook salmon broodstock. The opening is designed to improve passage of fish, and eliminate handling of fish not collected for broodstock. However, as no adult spring chinook salmon were passed upstream in 1994, we could not evaluate the effectiveness of the modification to the weir.

In March 1995, a trap with aluminum pickets was installed in front of the slot (2' x 3') in the weir panels. This trap uses Tucannon River water as an attraction, where the original concrete trap has Tucannon FH effluent. We believe using river water will attract more natural fish into the trap, and reduce the effects the weir may have on spawning distribution of adults. Both traps will be operated during the 1995 broodstock collection for comparison.

3.3.4: Spawning ground surveys

Evaluation staff surveyed salmon spawning grounds in the Tucannon River to determine the temporal and spatial distribution of spawning and to assess the abundance and density of spawners. We found 44 redds and recovered 50 natural and no hatchery carcasses in the Tucannon River in 1994 (Appendix E). Forty-two of the redds were below the weir. While no salmon were passed upstream of the Tucannon FH weir/trap, we believe at least two salmon passed the weir. This was evident from the two redds found above the weir, and their distance from each other. We recovered one female carcass above the weir from the redd located at Rk 68. The other redd was located at RK 73.

Evaluation staff surveyed salmon spawning grounds in North Fork Asotin Creek on 31 August and 27 September. No redds, carcasses or live adult salmon were seen on either survey. No redds were found in 1992, or in 1991. Two redds were observed in 1990, none in 1989, one in 1988, three in 1987, one in 1986, and one redd in 1985.

3.3.5: Adult escapement

In general, redd counts are directly related to escapement to the Tucannon FH weir/trap (Bugert et al. 1991). We have therefore estimated the total escapement to the Tucannon River for 1985-1994 based on redd counts (Table 8, Figure 6). These numbers are revisions or additions to escapements estimated in earlier reports.

Previously, we calculated the percentage of natural and hatchery adult returns by the number of natural and hatchery fish arriving at the weir. We assumed the composition at the weir was representative of the entire run. During our intensive spawning ground surveys in 1994, we observed mainly natural-origin adults and recovered only natural-origin carcasses. No hatchery-origin carcasses were recovered below the weir. Based on that information, we examined previous carcass recoveries below the weir. From 1988-1994, we observed that on average, 89% (range 73-96%) of the carcasses recovered below the weir were of natural-origin. Estimates of fish origin below the weir for previous years were recalculated using carcass recovery information. Using 1994 as an example, we would have estimated the run to be 47% hatchery based on weir counts. However, with carcass recovery information below the weir, the estimate dropped to 30% hatchery. The estimated total escapement for 1994 was 24 fish over the 116 predicted from our IHR escapement model (Section 2.1). During the period 1989-1993, natural salmon comprised 62% (range: 49 to 77%) of the estimated annual escapement.

Table 8. Estimated adult spring chinook salmon escapement[a] to the Tucannon River, 1985-1994.

YEAR	FISH PASSED UPSTREAM[b]	FISH/REDD RATIO[c]	TOTAL REDDS ABOVE WEIR	PERCENT WILD ABOVE WEIR	TOTAL REDDS BELOW WEIR	PERCENT WILD BELOW WEIR	TOTAL FISH IN RIVER	BROODSTOCK COLLECTED[d] wild	BROODSTOCK COLLECTED[d] hatchery	NUMBER OF PRESPAWNING MORTALITIES[e] wild	NUMBER OF PRESPAWNING MORTALITIES[e] hatchery	TOTAL ESCAPEMENT	PERCENT WILD
1985	- -	2.85	189	100	- -	- -	539	15		- -	- -	554	100.0
1986	131	2.85	163	100	37	100	570	116		- -	- -	686	100.0
1987	108	2.85	149	100	36	100	527	101		- -	- -	628	100.0
1988	142	2.85	90	97	27	95	333	126	7	- -	- -	466	96.1
1989	88	2.85	74	98	32	96	302	78	102	- -	- -	482	77.2
1990	323	3.36	96	56	84	88	605	66	68	- -	6	745	66.4
1991	170	4.25	40	35	50	73	383	41	89	- -	8	521	49.1
1992	388	2.92	130	44	70	88	584	47	50	22	50	753	55.4
1993	297	2.27	131	43	61	92	436	50	47	11	43	586	53.6
1994[f]	0	1.59	2	- -	42	90	70	36	34	- -	- -	140	70.0

a *Escapement was estimated as follows: the estimated fish/redd ratio was multiplied by the number of redds (above and below the weir) for total number of spawners in river. The number of broodstock collected and prespawning mortalities for total escapement to the river was added. By applying the percentage of wild fish above and below the wier, run composition (wild and hatchery) was calculated*

b *The number of fish passed upstream for 1990-1993 are lower than previously reported because pre-spawning mortalities recovered above the weir are omitted.*

c *Fish/redd ratios calculated from the number of fish passed upstream minus known prespawning mortalities above the weir, divided by the number of redds counted above the weir. The 1985-1989 fish/redd ratios are calculated from the 1990, 1992, and 1993 average. The 1991 fish/redd ratio was higher than normal due to a larger number of jacks returning which would bias the average. An average was calculated for 1985-1989 because the weir and trap were not operated for the entire summer, therefore, the number of fish passed upstream are underestimated.*

d *The number of broodstock collected are higher than previously reported for 1988-1990 because jacks collected, but not spawned, had not been considered part of the broodstock.*

e *The number of prespawning mortalites reported are lower than in previous reports because only prespawning mortalities above the the weir are included. Prespawning mortalities below the weir are excluded so a more accurate number can be calculated for the number of spawners above the weir.*

f *In 1994, we changed the way we calculated the escapement estimate because no fish were passed upstream. The fish/redd ratio is based on the assumption of one female/redd and a 1.59 female/male sex ratio from the broodstock collection.*

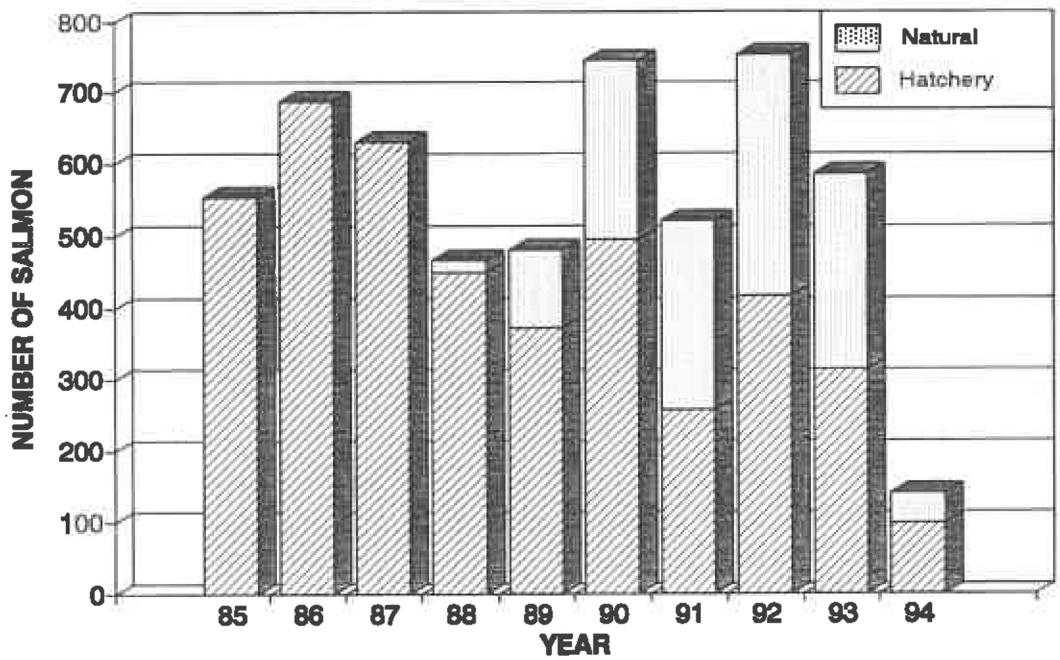

Figure 6. Estimated escapement of natural and hatchery spring chinook salmon to the Tucannon River, 1985-1994.

3.4 Survival Rates

Using egg deposition, juvenile population, smolt migration and adult escapement estimates (Appendix F), as well as proportions of natural and hatchery returns each year by age, we estimated various survival rates for natural and hatchery reared salmon. We then compared natural and hatchery production. Expanded smolt-to-adult survival for the 1989 brood of natural and hatchery salmon were 0.57 and 0.24% respectively. The 1988 brood smolt-to-adult survival rate for naturally produced salmon is 238% higher than for salmon produced in the hatchery. In contrast, our current estimate of the adult-to-adult survival rate for hatchery produced salmon is 325% higher than for salmon produced naturally.

SECTION 4: STOCK PROFILE ANALYSIS

4.1 Population Structure

4.1.1: Fecundity, sex, and age structure

Twenty-two natural and 21 hatchery females were spawned in 1994 (Table 2). Mean fecundity of all females was 3,761. Mean fecundity based on incubation room counts for natural females was 4,187 and 3,314 for hatchery females. Mean fecundity of age 4 and age 5 natural females was 3,688 and 4,906, respectively. Mean fecundity of age 4 and age 5 hatchery females was 3,280 and 3,352, respectively (Figure 7). We split out the fecundity and length data to compare natural and hatchery fecundity/length relationships. While the regression slopes were visibly distinct between natural and hatchery, no statistical difference was detected between them (p=0.19).

Natural females spawned in 1994 consisted of 13 age 4 and nine age 5 fish. Hatchery females spawned consisted of 11 age 4 fish and 10 age 5 fish (Appendix G).

We estimated the sex ratio for all salmon that returned to the Tucannon River in 1994 to be 1.59 females/male. We based this estimate on the broodstock sample of both natural and hatchery salmon. Inclusion of carcasses recovered from the river biases the sample because of the extra effort to recover spawned-out carcasses in 1994. More females were recovered from the river because of their tendency to stay close to their redds. Males were more difficult to track.

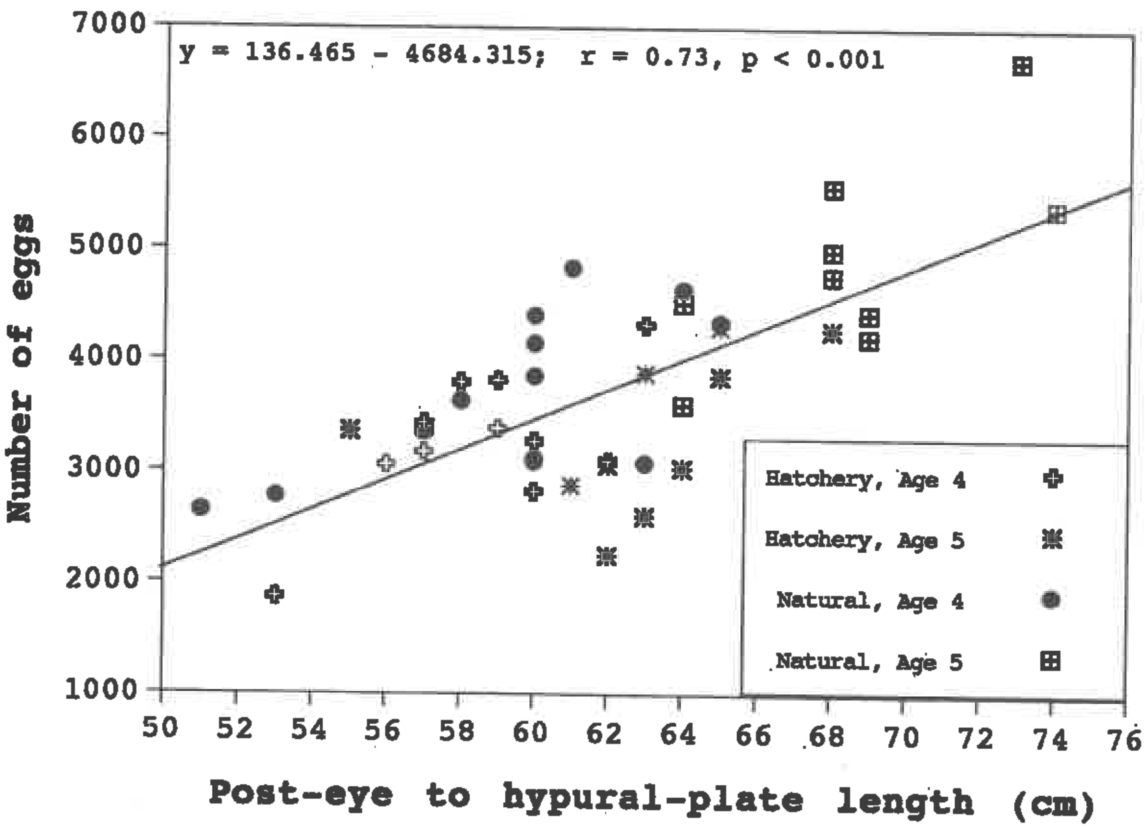

Figure 7. Relationship of post-eye to hypural-plate length and age to fecundity of Tucannon River spring chinook natural and hatchery salmon collected for broodstock, 1994.

4.1.2: Morphometrics, meristics, and electrophoretics

Due to the length and complexity of analysis and results from morphometric, meristic and electrophoretic studies, samples collected over the study period will be presented in separate, future reports. Collection over the study period included 401 fish (Table 9). Multiple samples were collected from some of the fish.

Table 9. Summary of the type and number of electrophoretic, morphometric, or meristic samples collected over the study period.

Sample type	Origin	N
Electrophoretics		
Juvenile (92 BY)	natural	100
(93 BY)	hatchery x hatchery cross	100
	natural x natural cross	100
Adult (94 BY)	hatchery	34
	natural	67
Morphometrics		
Juvenile (93 BY)	hatchery x hatchery cross	50
	natural x natural cross	50
Meristics		
Juvenile (92 BY)	natural	50
(93 BY)	hatchery x hatchery cross	50
	natural x natural cross	50

SECTION 5: RECOMMENDATIONS

We have provided four recommendations to improve performance of the Tucannon salmon program.

1) Initiate discussions between hatchery and evaluation personnel about the benefits and feasibility of exercising hatchery reared fish in the raceways by increasing flow, or drawing down ponds. We could potentially increase swimming performance and survival of hatchery reared fish once they have been released into the Tucannon River. Snorkeler observations during smolt releases recorded hatchery fish were not in control once released into the river. Prior exposure to swifter currents may enable hatchery fish to sustain less injuries once released. In addition, release dates should be flexible to avoid releases in high river flow, lessening the chance of injury and mortality.

2) Increase the collection and preservation of sperm, particularly from natural salmon. Refine cryopreservation techniques with the goal of increasing fertilization rates. Investigate and develop new technology for short term egg and sperm storage to increase genetic contribution and management options.

3) Continue to evaluate and refine outplanting (both acclimated and direct stream) release strategies to increase juvenile or smolt survival and adult returns.

4) Design a proposal and begin discussions with tribal co-managers and others regarding development a captive broodstock program for Tucannon spring chinook salmon. Less than 25 spawning pairs are expected for the entire Tucannon river in 1995.

Bibliography

Bugert, R., C. Busack, G. Mendel, L. Ross, K. Petersen, D. Marbach, J. Dedloff. 1991. Lower Snake River Compensation Plan Tucannon River Spring Chinook Salmon Hatchery Evaluation Program 1990 Annual Report to U.S. Fish and Wildlife Service, Aff1/LSR-91-14, Cooperative Agreement 14-16-0001-90524. Washington Department of Fisheries, Olympia, Washington.

Bumgarner, J.D., G. Mendel, L. Ross, D. Milks, J. Dedloff. 1994. Lower Snake River Compensation Plan Tucannon River Spring Chinook Salmon Hatchery Evaluation Program 1993 Annual Report to U.S. Fish and Wildlife Service, Aff1/LSR-94-09, Cooperative Agreement 14-16-0001-93539. Washington Department of Fish and Wildlife, Olympia, Washington.

Griffith, J.S. 1981. Estimation of the age-frequency distribution of stream-dwelling trout by underwater observation. Progressive Fish-Culturist 43:51-53.

Schill, D.J., and J.S. Griffith. 1984. Use of underwater observations to estimate cutthroat trout abundance in the Yellowstone River. North American Journal of Fisheries Management 4:479-487.

USACE (U.S. Army Corps of Engineers), 1975. Special Reports: Lower Snake River Fish and Wildlife Compensation Plan. Walla Walla, Washington.

WDF (Washington Department of Fisheries) 1993. Lower Snake River Compensation Plan, Snake River Hatchery Evaluation Program Five-Year Plan 1991-1995. Washington Department of Fisheries, Olympia, Washington.

APPENDIX A

Spring chinook salmon captured and collected at the Tucannon FH trap in 1994. No salmon were passed upstream of the trap.

Date	Arrived Natural	Arrived Hatchery	Collected Natural	Collected Hatchery	Died in Pond Natural	Died in Pond Hatchery
5/13	1	2	1	2		
5/14	1		1			
5/15	1	3	1	3		
5/16						
5/17	1	1	1	1		
5/18	1		1			
5/19		1		1		
5/20		2		2		
5/21		1		1		
5/22	2	1	2	1		
5/23	1		1			
5/24	3		3			
5/25	6	3	6	3		
5/26	7	2	7	2		
5/27	3	3	3	3		
5/28		1		1	1	
5/29	2	1	2	1		
5/30		2		2		
5/31	1		1			
6/02	1	1	1	1		
6/03		2		2		
6/04		2		2		
6/06	1	1	1	1		
6/07		1		1		
6/09		1		1		
6/14		1		1		
6/23	1		1			
6/27	1	1	1	1		
7/01	1		1			
9/10	1		1			
9/16	1		1			
Totals[a]	37	33	37	33	1	0

a Actual number of natural and hatchery salmon trapped were adjusted after completion of broodstock spawning. One hatchery salmon was mistaken to be a natural salmon during collection because of a poorly clipped adipose fin. Actual number of adult salmon collected was 36 natural and 34 hatchery origin fish.

APPENDIX B

Tucannon River Spring Chinook Salmon
Broodstock Spawning Protocol

This plan was developed to meet three criteria: 1) obtain genetic contribution from all broodstock, 2) obtain high fertilization and survival rates, and 3) remove non-indigenous (stray) spawners (verified through scale or CWT analysis).

We will use the following guidelines for fertilization:

- Eggs from each female will be split into two lots. Each lot will be fertilized by a different primary male, with semen from a backup male added ≤ 15 seconds later. The two lots of eggs from each female will be incubated separately. Live and dead eggs will be enumerated for each egg lot.

- Hatchery x hatchery matings will be avoided if possible.

- Males will be live spawned and marked to minimize repeated use. The priority in mate selection will be a fish that hasn't contributed yet, or has contributed the least. Eggs fertilized by males that are later identified as strays, will be destroyed or shipped out of the Snake River Basin, if the stray male was the first male used in fertilization.

- Backup males will be used whenever possible to maximize fertilization rates.

- Fresh semen will have priority for matings over cryopreserved semen unless use of fresh semen would force a hatchery x hatchery cross, or use of available semen will cause a particular male to be the primary male in matings with more than three females.

APPENDIX C

Table 1. Summary of salmon yearling releases for the Tucannon River, 1989-1993 brood years.

Brood year (released)	Parents male	Parents female	Release dates mon/day	Release dates Yr.	Number released [a]	No. lbs.	Fish/ pound	CWT code
1989[b]	31	37	4/1-12	91	75,661	8,407		63-14-61
(1991)					22,118	2,458		63-01-31
					99,057	11,007	9	
1990[c]	33	19	3/30-4/10	92	51,149	4,649		63-40-21[d]
(1992)		19			21,108	1,924		63-43-11[e]
		6			13,480	1,225		63-37-25
					85,797	7,798	11	
1991	11	11	4/6-12	93	16,745	1,116		63-46-47[f]
(1993)	17	17			55,716	3,714		63-46-25[g]
					74,058	4,937	15	
1992	25	18	10/22-25	93	24,883	698	36	63-48-23[g]
(1994)			4/11-18	94	35,405	2,591	14	63-48-10[h]
	20	27	10/22-25	93	24,685	694	36	63-48-24[f]
			10/22-25	93	7,111	200	36	63-48-56
			4/11-18	94	35,469	2,718	14	63-49-05[i]
			4/11-18	94	8,277	648	14	63-48-55
					140,698	7,549		
1993	14	20	3/20-4/3	95	15,617	1,038	15	63-56-16[f]
(1995)			3/15-4/15	95	45,147	3,166	14	63-53-43[j]
		5	3/20-4/3	95	18,304	1,217	15	63-56-18[g]
	26	21	3/20-4/3	95	14,632	972	15	63-56-17[k]
			3/15-4/15	95	45,148	3,166	14	63-53-44
					138,848			

a Total number of fish released for each brood year (bold) includes fish that were adipose clipped only and not CWT. Total number of fish ad-clipped and CWT is generally greater than 96%%.
b Includes hatchery and natural adults in the spawning; gametes were pooled.
c Began controlled matings study, some males were used more than once but matings were kept separate by origin of fish, except in the mixed group.
d Natural cross progeny have blank-wire tags in right cheek.
e Hatchery cross progeny have blank-wire tags in left cheek.
f Hatchery cross progeny have red elastomer tags behind right eye.
g Natural cross progeny have red elastomer tags behind left eye.
h Natural cross progeny (released from the acclimation pond) have yellow elastomer tags behind the left eye.
i Hatchery cross progeny (released from the acclimation pond) have yellow elastomer tags behind the right eye.
j Hatchery cross progeny (released from the acclimation pond) have green elastomer tags behind the right eye.
k Natural cross progeny (released from the acclimation pond) have green elastomer tags behind the left eye.

Appendix C (continued).

Table 2. Summary of the number of spring chinook salmon (natural and hatchery) sampled from the Tucannon River, 1994

Total escapement to Tucannon River:	140	
Broodstock collected	-70	
Fish dead in trap	- 0	
	===	
Total	70	[a]
In-river CWT sampled fish:		
Prespawning mortality	0	
Spawned carcasses recovered	50	(50 natural)
	===	
Spawning ground CWT sample	50	
Total number of carcasses sampled in 1994	**120**	

a One natural male was a prespawning mortality.

Table 3. Summary of all hatchery salmon sampled from the Tucannon River, 1994.

CWT code	Broodstock collected	Dead in trap	Pre-spawn mortality	Spawned in river	Total
63-01-31	5				5
63-14-61	9				9
63-37-25	1				1
63-40-21	9				9
63-43-11	6				6
63-46-25	1				1
63-45-47	3				3
Strays	0				0
Lost or no tags	0				0
Total	**34**				**34**

APPENDIX D

Washington Department of Fish and Wildlife estimates of area (m^2) for habitat types within four designated strata of the Tucannon River Watershed.

(Survey year) **Stratum** [b] Habitat	Length available (m)	Average width (m)	Area [a] available (m^2)
(1991) **Wilderness**			
Riffle	5,910	8.4	49,644
Run	4,230	7.4	31,302
Pool	390	6.8	2,652
Side Channel	3,330	4.8	15,984
TOTAL AREA			99,582
(1994) **HMA**			
Riffle	13,455	11.4	153,387
Run	4,080	10.0	40,800
Pool	660	10.9	7,194
Boulder	1,740	12.1	21,054
Side Channel	2,041	5.0	10,205
TOTAL AREA			232,640
(1994) **Hartsock**			
Riffle	11,760	11.4	134,064
Run	3,690	9.6	35,424
Pool	690	8.0	5,520
Side Channel	2,230	4.5	10,081
TOTAL AREA			185,089
(1994) **Marengo**			
Riffle	14,815	9.5	140,743
Run	6,270	8.6	53,922
Pool	840	7.5	6,300
Side Channel	3190	4.1	13,079
TOTAL AREA			214,044

a Total area available depends to a minor degree on the amount of flow at the time of survey. Tucannon River flows at time of surveys in 1991 were approximately 70-75 cfs. Flows recorded during the 1994 surveys ranged from 27-42 cfs.

b Tucannon River Stratum are defined by the following river kilometers: Lower (0.0-20.1), Marengo (20.1-39.9), Hartsock (39.9-55.5), HMA (55.5-74.5), and Wilderness (74.5-86.3),

APPENDIX E

Numbers of spring chinook salmon redds observed and general location of natural and hatchery salmon carcasses recovered during spawning ground surveys on the Tucannon River 1994.

			Carcasses recovered			
	River	Number	Natural		Hatchery	
Stratum	kilometer	of redds	male	female	male	female
Wilderness	86-78					
	78-75	1				
HMA	75-73					
	73-68	1		1		
	68-66					
	66-62					
	62-59					
	59-58					
Tucannon Weir						
	58-56	9	1	8		
Hartsock	56-52	6		5		
	52-47	7	2	6		
	47-43	10	4	7		
	43-40	5	1	4		
Marengo	40-34	5	7	4		
Totals	86-34	44	15	35	0	0

APPENDIX F

Estimates of natural Tucannon spring chinook salmon abundance by life stage for 1985-1994 broods. Estimated number of females and estimated number of eggs deposited are revised and updated from previous reports due to changes in the way escapement estimates are derived.

Brood year	Females in river [a] (natural/hatchery)	Mean fecundity [b] (natural/hatchery)	Number of eggs	Number of fry [c]	Number of smolts [d]	Returning adults [e]
1985	270 / - -	3,883 / - -	1,048,410	90,200	35,600	422
1986	309 / - -	3,916 / - -	1,210,044	102,600	58,200	472
1987	282 / - -	4,095 / - -	1,154,790	79,100	44,000	222
1988	168 / - -	3,882 / - -	652,176	69,700	37,500	545
1989	133 / 4	3,883 / 2,606	526,863	58,600	25,900	147
1990	192 / 106	3,993 / 2,694	1,052,220	64,100	49,500	
1991	98 / 67	3,741 / 2,517	535,257	54,800	26,000 [f]	
1992	165 / 133	3,854 / 3,295	1,074,145	103,292	50,800	
1993	127 / 106	3,701 / 3,237	813,149	86,723		
1994	38 / 5	4,187 / 3,314	175,676			

a Number of females estimated from total adult returns, percentage of natural and hatchery returns, sex ratios of natural and hatchery fish respectively, and subtraction of known prespawning mortalities.

b Mean fecundity based on incubation room counts. 1985 (natural) and 1989 natural and hatchery fecundities are the mean average of other years. Natural mean fecundity for 1985 and 1989 were calculated from the mean of 1986-1988, and 1990-1993 fecundities. Hatchery mean fecundity for 1989 was calculated from the mean of 1990 and 1991. In 1985 very few fish were spawned (n=5), and in 1989 natural and hatchery incubation counts were not kept separate.

c Number of fry (parr) estimated from electrofishing (1985-1989), Line transect snorkel surveys (1990-1992), and Total Count snorkel surveys (1993,1994).

d Number of smolts estimated from smolt trapping.

e Number of returning adult from each brood year are calculated using expanded age composition numbers for each run year.

f Approximated number of out-migrating smolts based on mean egg-to-smolt, and mean fry-to-smolt survival using previous years data.

APPENDIX G

Sex, mean post-eye to hypural-plate length, and age (from scale impression or fitted by fork length) for all spring chinook salmon (natural and hatchery) sampled from the Tucannon River and Lyons Ferry FH, 1994 (s=standard deviation, n=sample size). Note: no hatchery salmon carcasses were recovered from the Tucannon River in 1994.

Origin Sex	Mean length (s, n) at given age $3/_2$	 $4/_2$	 $5/_2$	Totals
Natural salmon (at hatchery)				
Female	- -	59.4 (4.0, 13)	68.6 (3.4, 9)	22
Male	- -	58.3 (2.9, 10)	65.8 (3.3, 4)	14
Totals	- -	23	13	36
All natural salmon (river and hatchery) [a]				
Female	- -	57.5 (3.4, 38)	66.8 (3.2, 17)	55
Male	- -	58.5 (3.4, 24)	67.0 (4.0, 5)	29
Total	- -	62	22	84
All hatchery salmon				
Female	- -	58.5 (2.8, 11)	62.8 (3.4, 10)	21
Male	38.0 (2.1, 4)	53.6 (3.9, 5)	66.8 (2.8, 4)	13
Totals	4	16	14	34

a Two females (age 4, age 5) not included because length samples could not be taken when the fish were sampled.