1995 ANNUAL REPORT

July 1996

Tucannon River Spring Chinook Hatchery Evaluation

By Joseph Bumgarner, Glen Mendel, Deborah Milks, Lance Ross and Jerry Dedloff

Washington Department of
FISH AND WILDLIFE
Hatcheries Program
Assessment and Development Division

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TUCANNON RIVER SPRING CHINOOK SALMON HATCHERY EVALUATION PROGRAM

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ABSTRACT

This report summarizes activities of the Washington Department of Fish and Wildlife Lower Snake River Hatchery Evaluation Program (Tucannon River spring chinook) from 15 April 1995 to 22 April 1996.

Total escapement to the Tucannon River in 1995 was estimated at 54 salmon. Forty-three spring chinook salmon were captured at the Tucannon Hatchery weir/trap in 1995. We collected 10 natural and 33 hatchery salmon for broodstock. A total of twenty-one females (six natural, 15 hatchery) were spawned for a total eggtake of 85,772. Mortality prior to ponding was 21,837 eggs/fry (25.5%) because of high incidence of "soft shell"; leaving 63,935 fry ponded.

We surveyed spawning grounds from 30 August to 27 September and found 5 spring chinook salmon redds (all below the Tucannon Hatchery weir). Eight 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 1995.

We completed a 39 day volitional release of 89,437 smolts in the acclimation pond at Tucannon Hatchery on 22 April 1996. In addition, we released 5,263 juveniles directly into the river, upstream of the hatchery, and 35,369 from small portable acclimation ponds from 27 March to 19 April 1996. Each release group (by location) had unique coded-wire tags and Visual Implant elastomer tags. A sample of each release group also was PIT tagged.

We estimated subyearling and yearling chinook salmon parr production in the Tucannon River for 1995 at 12,720 and 4,375, respectively. The estimated subyearling chinook population was well below any previous years estimate (range of 1985-1994: 54,800 - 103,300), and reflects the low spawner return in 1994.

We operated the downstream migrant trap intermittently from 1 October 1994 to 23 June 1995. We captured 9,622 natural salmon and 24,706 hatchery salmon (outplanted and acclimated) during the 1994/1995 season. We estimate 49,650 natural salmon migrated past the trap during the 1994/1995 season.

Estimated smolt-to-adult survivals for the 1990 brood of natural and hatchery salmon were 0.19% and 0.03%, respectively, well below the established mitigation goal of 0.87%. Based on mean adult-to-adult survival of six complete brood years, 4.3 times more hatchery reared salmon from the Tucannon River survive than naturally reared salmon. Hatchery fish have generally been able to replace themselves in the population, whereas the naturally produced fish have not. To date, both natural and hatchery returns have been below program goals (1,152 annual run size) and have not allowed a fishery in the Tucannon River.

TABLE OF CONTENTS

LIST OF TABLES

Page

LIST OF FIGURES

LIST OF APPENDICES

Page

SECTION 1: INTRODUCTION

1.1: Hatchery Description

Congress authorized implementation of the Lower Snake River Fish and Wildlife Compensation Plan (LSRCP) in 1976. As a result of that plan, Lyons Ferry[1] and Tucannon hatcheries were built. One objective of these hatcheries is to compensate for the loss of 1,152 Tucannon River spring chinook salmon[2] caused by the construction of hydroelectric projects on the Snake River. In 1984, Washington Department of Fish and Wildlife (WDFW) began evaluating the success of these hatcheries in meeting this objective and identifying any production adjustments that would improve performance of the hatchery fish. WDFW has identified two goals in its evaluation program: 1) monitor hatchery practices at Lyons Ferry and Tucannon hatcheries to ensure quality smolt releases, high downstream migrant survival, sufficient contribution to fisheries, and 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 work performed by the WDFW LSRCP Spring Chinook Salmon Evaluation Program from 15 April 1995 through 22 April 1996, except for 1995/1996 smolt trapping.

Lyons Ferry is located at the confluence of the Palouse and Snake rivers at river kilometer (Rk) 90. At Lyons Ferry, well water passes once through the incubators, four adult holding ponds, and 28 raceways. A satellite facility, Tucannon Hatchery, is maintained on the Tucannon River (Rk 59) for collection of adult salmon and release of yearling progeny (Figure 1). Well water and river water are available at Tucannon Hatchery. Tucannon Hatchery has an adult collection trap and one holding pond, which had been used for holding broodstock and releasing yearlings. Returning natural[3] and hatchery adult salmon are trapped at the Tucannon Hatchery and hauled to Lyons Ferry for holding and spawning. Eggs are fertilized, incubated, and the fry are reared to parr size at Lyons Ferry, then returned to Tucannon Hatchery for rearing and release. The 1994 brood production goal was 132,000 fish for release as yearlings at 15 fish per pound (fpp; 8,800 lbs.).

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1 Throughout this report, the term "Lyons Ferry" refers to Lyons Ferry Hatchery

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

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

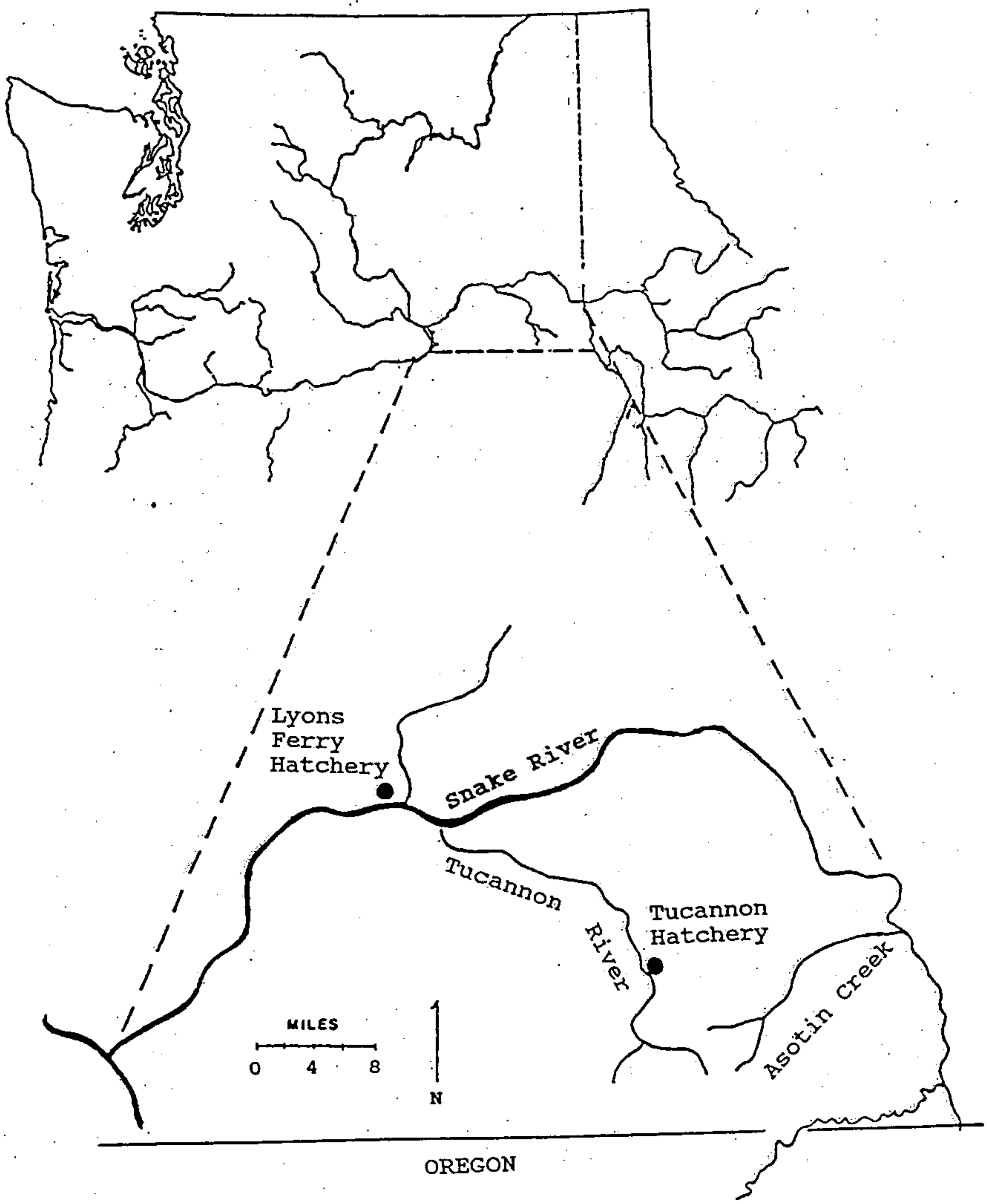

Figure 1. Location of Lyons Ferry and Tucannon Fish Hatcheries with the Lower Snake River Basin.

1.2: Tucannon River Watershed Characteristics

The Tucannon River is a third-order stream that flows through varied habitats which restrict distribution of salmonids in the watershed. To compare differences in salmon production within the Tucannon River, we designated five unique strata distinguished by the predominant land use adjacent to the river, landmarks, and river habitat conditions:

Lower	(Rk 0.0 - Rk 20.1)
Marengo	(Rk 20.1 - Rk 39.9)
Hartsock	(Rk 39.9 - Rk 55.5)
HMA (Habitat Mgt Area)	(Rk 55.5 - Rk 74.5)
Wilderness	(Rk 74.5 - Rk 86.3)

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. In addition, river discharges are periodically measured at Tucannon Hatchery (Rk 58), the Tucannon smolt trap Location (RK 20.1), and Smith Hollow Bridge (Rk 12.7). Temperatures and discharge measurements are on file at our Dayton office.

SECTION 2: ADULT EVALUATION

2.1 Hatchery Operations

2.1.1: Broodstock trapping

Hatchery personnel operated two adult collection traps daily from 2 May through 30 September 1995. The existing concrete trap was used as before, with water from the hatchery providing the attraction flows. A new instream trap was positioned in front of the weir panels and used river water for attraction. We believed the instream trap would attract more natural fish than the concrete trap because of the different water source, and might reduce the effects of the weir on adult spawning distribution.

Our standard broodstock collection objective is to collect equal numbers of natural and hatchery salmon throughout the run, but not to exceed 50 of each. Returning hatchery salmon can be identified because they are lacking adipose fins and are coded-wire tagged (CWT). Salmon in excess of the 100 broodstock are passed upstream of the weir for natural spawning.

For the second year in a row, record low returns of spring chinook salmon to both the Columbia and Snake River basins were predicted. We developed a simple forecast model in 1994 to predict adult returns to the Tucannon Hatchery weir/trap and the total Tucannon River run size (see Bumgarner et al, 1995). Based on the final Ice Harbor Dam (IHR) counts of spring chinook salmon in 1995 (1,878), we predicted that 41 and 66 salmon would return to the Tucannon Hatchery weir/trap and Tucannon River, respectively (Table 1).

Due to the expected low number of returning adults, WDFW and NMFS agreed 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 maximizes survival (hatchery reared fish survive on average at a 4.3 times greater rate than naturally reared fish), and should provide enough adults in subsequent years for natural or hatchery spawning.

Table 1. Escapement to the Tucannon River and weir as a percentage of Ice Harbor Dam ladder counts.

Return Year	IHR 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	24,938	448	1.8	586	2.3
1994	3,472	73	2.1	140	4.0
Five-year average			**2.2**		**3.5**
Prediction					
1995	1,878	41		66	

In 1995, a year with good spring river flows and cooler temperatures, the first salmon arrived at the trap on 17 May; the last fish arrived on 12 September. Peak arrival date for hatchery salmon in 1995 was 8 June (Figure 2), which was considerably later than the previous three year range of 26-28 May. Peak arrival date for natural salmon could not be determined because of low run size. The peak in the previous three years ranged from 20-31 May. We monitored each trap during the run for trap selection differences between natural and hatchery returning adults. Forty-three salmon were captured in either the concrete trap, or the instream trap in 1995 (Appendix A); two more than forecasted from our escapement model.

We found no statistical difference in the number of natural and hatchery fish caught in each trap ($\chi^2 = 3.84$, $p>0.05$), even though our observations suggest otherwise. Hatchery fish seemed to prefer the concrete trap, while natural fish seemed to prefer the instream trap (70%). However, the sample size from each trap may have been inadequate to make a valid evaluation.

We planed to operate both traps again in 1996. However, bedload movement from the flood in February 1996 made the old weir location and trapping site nearly inoperable. The instream trap with a temporary weir was placed in the river about 100m upstream of the old site. In addition, a small channel was dug to allow salmon to enter the concrete trap. The outlet flow of water from the hatchery was modified to provide attraction water through the concrete trap.

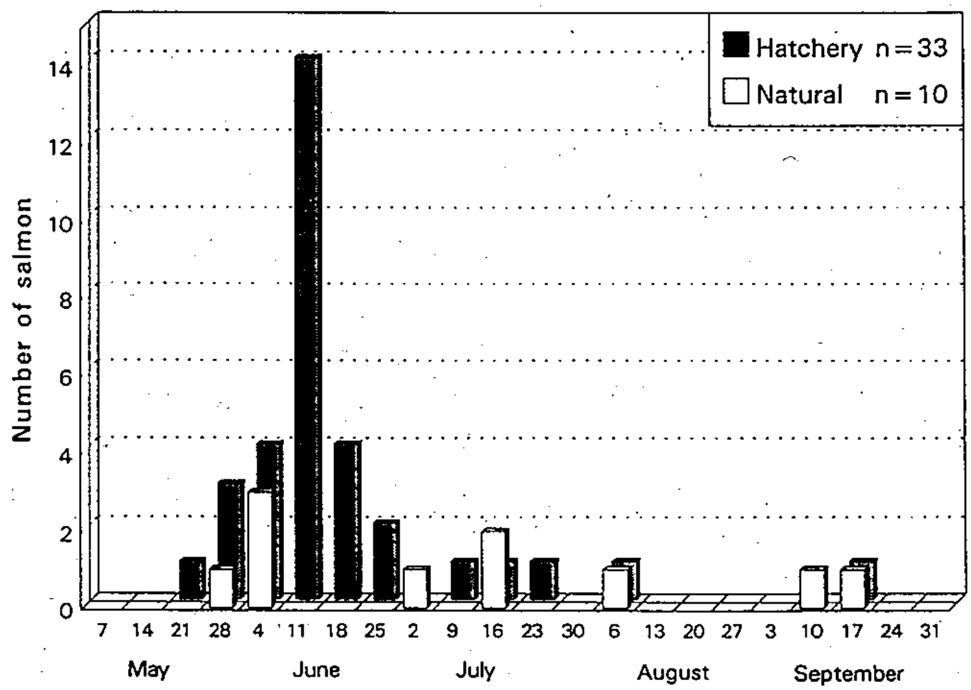

Figure 2. Weekly arrivals of natural and hatchery spring chinook salmon to the Tucannon Hatchery trap, 1995.

2.1.2: Holding, disease incidence and treatments

Salmon captured for broodstock were hauled from the traps to Lyons Ferry each day fish were collected. Salmon returning in 1995 were injected with 0.5 cc/4.5 kg of both erythromycin and oxytetracycline when trapped, and twice again with erythromycin before spawning, for treatment of bacterial kidney disease (BKD). Drip treatments of formalin (1:7,000 dilution rate for 2 hours) were applied to adults every other day to control fungus infection.

In 1995, four of the 43 salmon (9.3) collected for broodstock died before spawning. Three of those were three year old males (jacks) and apparently had toxic reactions to the erythromycin and oxytetracycline. Injection of drugs in the future will be 1/2 the regular dosage for three year-old males because they are susceptible to jaundice. The one remaining salmon (male) died of unknown causes.

Eggs were disinfected and water hardened for one hour in iodophor (100 ppm) before being placed in the incubation stacks. Formalin treatments (1667 ppm) were given every other day to control fungus on the incubating eggs. Formalin treatments were switched to every day after the "soft shell" was observed.

2.1.3: Spawning

Fish were spawned at Lyons Ferry from 22 August to 20 September, with peak eggtake on 13 September (Table 2). 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 third consecutive year, all males were live spawned. The origin of each male was determined on the final day of spawning when all of them were killed and their CWTs were read.

Table 2. Dates of spawning, egg collection, and mortalities of Tucannon natural and hatchery spring chinook salmon at Lyons Ferry in 1995.

	Natural salmon					Hatchery salmon				
	spawned		mortality		Eggs taken	spawned		mortality		Eggs taken
Date	male	female	male	female		male	female	male	female	
02 Jul								1		
15 Jul								1		
24 Jul								1		
22 Aug		1			5,804					
26 Aug			1							
29 Aug		1			5,227		1			3,889
06 Sep		2			12,460		5			18,903
13 Sep							9			31,278
20 Sep	3	2			8,211					
Totals[a]	3	6	1		31,702	15	15	3		54,070

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

On the first day of spawning, one natural female was ripe. Of the 18 males available, only one natural male expressed milt. Spawning protocol (Appendix B) requires a backup male to be used <30 seconds after the primary male. Because no other males were available, we used frozen semen from a five year old Tucannon spring chinook collected in 1992. Eggs from the female were divided into four lots (≈1,000 egg each), and one straw of semen was used for the backup male in each egg lot. Egg lots were combined into a single incubation tray after fertilization. Fertilization rate for this female was poor (21.4%), and many fish that survived to hatching had spinal deformities or incomplete development of the head (missing maxilla, eyes, and snout). While these deformities are common, they occurred at a much higher rate than normal (Ted Parks, Hatchery Specialist 3, pers comm.). We are unsure if the high egg loss and deformities are linked to the cryopreserved semen, but we plan to address this question in future cryogenics research.

All hatchery salmon collected for broodstock were of Tucannon/Lyons Ferry origin. Total eggtake was 85,772, with 20,197 eggs (23.5%) lost before hatching. Before ponding, 1,640 fry (2.5%) were lost, leaving 63,935 fish that were ponded. We had a large increase in egg loss in 1995, compared with previous years. Percent egg loss in 1992, 1993 and 1994 was 1.8%, 9.2% and 6.0%, respectively. We attribute this increase to an extreme case of "soft-shell" in the eggs. We suspect that treating the eggs with formalin every other day in 1995, instead of every day, as was done in the past, contributed to the problem.

Progeny from 15 unique families (200 each) were separated at ponding and have been reared in individual tanks. Fish in the tanks represent the potential captive broodstock program we initiated for the low run sizes. A decision will be made later this summer as to whether the captive broodstock program will continue.

2.1.4: Fecundity, age and sex structure

Six natural and 15 hatchery females were spawned in 1995 (Table 3). Due to "soft-shell" in the eggs, fecundity could not be estimated at initial egg picking. Egg and fry loss were recorded separately for each female until ponding. Evaluation and hatchery personnel hand counted all hatched fish and mortalities from each female during ponding.

All natural females spawned in 1995 were age 5 (mean fecundity = 5,284 eggs). Mean post-eye to hypural-plate (PE) length of spawned natural females was 70 mm. Hatchery females consisted of 14 age 4 (mean fecundity = 3,584 eggs; mean PE length = 61 mm) and one age 5 (3,889 eggs; 71 mm).

Age composition comparisons of all natural and hatchery salmon (male and female) sampled in 1995 from Lyons Ferry and the Tucannon River were not similar to each other. Natural returning fish were composed mainly of age 5 (67%) From 1985-1994 age 5 natural salmon made up only 31% of the age composition, with age 4 at 67%. However, hatchery returning fish were similar in age composition to previous years returns (1988-1994; Age 3=19%, Age 4=73%, Age 5=8%).

Table 3. Sex, mean post-eye to hypural-plate length, and age[a] (from coded-wire tags, scale impressions, or fitted by fork length) for all spring chinook salmon (natural and hatchery) sampled from the Tucannon River and Lyons Ferry, 1995 (s=standard deviation, n=sample size). Note: no hatchery salmon carcasses were recovered from the Tucannon River in 1995.

Origin Sex	Mean length (s, n) at given age 3_2	 4_2	 5_2	Totals
Natural salmon (at hatchery)				
Female	- -	- -	70 (3.5, 6)	6
Male	36 (- -, 1)	57 (- -, 1)	72 (0.7, 2)	4
Total (%)	1 (10.0)	1 (10.0)	8 (80.0)	10
All natural salmon (river and hatchery)				
Female	- -	- -	69 (3.8, 9)	9
Male	37 (1.4, 2)	64 (6.1, 4)	70 (2.1, 3)	9
Total (%)	2 (11.1)	4 (22.2)	12 (66.7)	18
All hatchery salmon				
Female	- -	61 (3.3, 14)	71 (- -, 1)	15
Male	40 (2.2, 11)	57 (4.2, 6)	62 (- -, 1)	18
Total (%)	11 (33.3)	20 (60.6)	2 (6.1)	33

a Age 3_2 salmon spend one year in the ocean, two in freshwater; Age 4_2 salmon spend two years in the ocean, two in freshwater; Age 5_2 salmon spend three year in the ocean, two in freshwater;

2.2 In River Evaluation

2.2.1: Spawning ground surveys

We 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 surveyed spawning grounds above and below the weir from 30 August to 27 September. We located five redds and recovered eight natural and no hatchery carcasses in the Tucannon River in 1995 (Table 4). All redds were below the Tucannon Hatchery weir because no salmon were passed upstream of the weir/trap.

We also surveyed salmon spawning grounds in North Fork Asotin Creek on 7 and 28 September. No salmon redds, carcasses or live adult salmon were seen on either survey. Counts from redd surveys since 1984 would indicate that the North Fork Asotin spring chinook salmon stock has been extirpated. Redd counts from previous years are as follows: 1995-0, 1994-0, 1993-2, 1992-0, 1991-0, 1990-2, 1989-0, 1988-1, 1987-3, 1986-1, 1985-8, and 1984-21.

Table 4. Numbers of salmon redds observed and general location of natural and hatchery salmon carcasses recovered during spawning ground surveys on the Tucannon River 1995.

Stratum	River[a] kilometer	Number of redds	Carcasses recovered: Natural male	Natural female	Hatchery male	Hatchery female
Wilderness	86-78					
	78-75					
HMA	75-73					
	73-68					
	68-66					
	66-62					
	62-59					
	59-58					
- - - Tucannon Fish Hatchery Weir - - -						
	58-56	2	1	1		
Hartsock	56-52	2	3	1		
	52-47	1		1		
	47-43					
	43-40		1			
Marengo	40-34					
Totals	86-34	5	5	3		

a River kilometers descriptions are as follows: 86:Rucherts Camp; 78:Lady Bug Flat CG; 75:Panjab Br.;73:Cow Camp Br.; 68:Tucannon CG; 66:Curl Lake; 62:Beaver/Watson Br.; 59:Hatchery Intake; 58:Tucannon Weir Fence; 56:HMA Boundary Fence; 52:Br.14; 47: Br.12; 43:Br.10.; 40:Marengo Br.; 34:King Grade BR.

2.2.2: Total escapement

In general, redd counts are directly related to escapement to the Tucannon weir/trap (Bugert et al. 1991). We therefore estimated the total escapement to the Tucannon River for 1985-1995 based on redd counts (Table 5, Figure 3). The estimated total escapement for 1995 was 54 fish; 12 less than the 66 predicted from our IHR escapement model (Section 2.1.1). Escapements for 1994 and 1995 are the lowest recorded escapements for the Tucannon River. From 1989-1995, natural salmon comprised 58.7% (range: 38.9 to 77.2%) of the estimated annual escapement.

Table 5. Estimated spring chinook salmon escapement[a] to the Tucannon River, 1985-1995.

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	22		- -	- -	561	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	575	47	50	22	50	753	55.4
1993	297	2.27	131	43	61	92	433	50	47	11	43	586	53.6
1994[f]	0	1.59	2	- -	42	90	70	36	34	- -	- -	140	70.0
1995[f]	0	2.13	0	- -	5	100	11	10	33	- -	- -	54	38.9

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 and 1995, 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 in 1994 and a 0.95 female/male sex ratio in 1995 from the broodstock collection.*

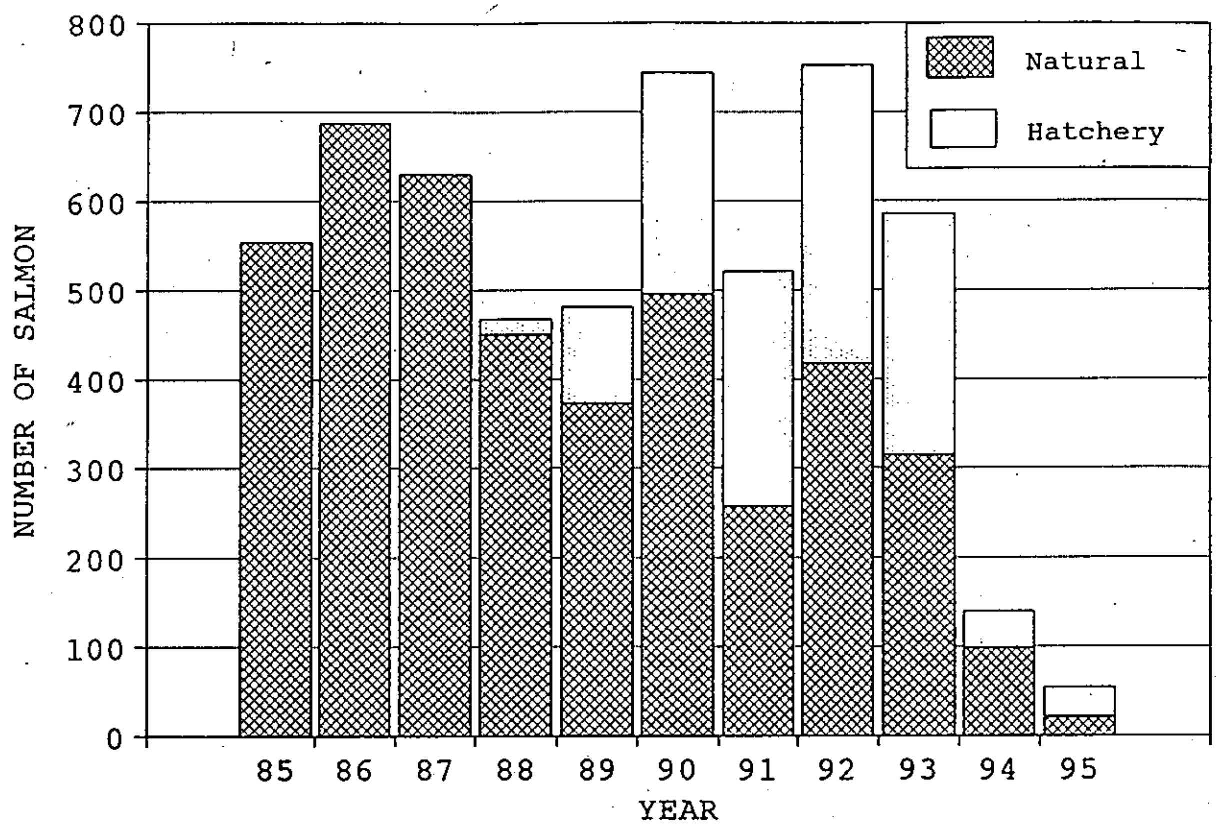

Figure 3. Estimated escapement of natural and hatchery spring chinook salmon to the Tucannon River, 1985-1995.

2.2.3: Pre-spawning mortality

We did not conduct any pre-spawning mortality surveys in the Tucannon River during 1995. The low number of adults expected in the river made the chance of finding a dead fish extremely unlikely. By not conducting pre-spawning mortality surveys, we also reduced the chance of disturbing salmon that might be holding in the river.

2.2.4: Electrophoretics

Results and analysis from electrophoretic samples collected over the study period will be presented in separate, future reports. Collection of electrophoretic samples over the study period included 44 fish; nine natural and 31 hatchery from collected broodstock and four natural fish collected from spawning ground surveys.

SECTION 3: JUVENILE EVALUATION

3.1: Hatchery Rearing and Releases

3.1.1. Juvenile rearing

Before tagging, we measured the length and weight of juvenile salmon reared at Lyons Ferry. Mean fork length, sample size, coefficient of variation, and K-factor for fish in Pond One on 28 June was 86.2 mm, 209, 7.3, and 1.23, respectively. Mean fork length, sample size, coefficient of variation, and K-factor for fish in Pond Two on 28 June was 84.8 mm, 184, 11.76, and 1.25, respectively. No statistical difference was detected in the mean length between the two ponds.

The fish were tagged from 12-22 September with three different CWT and Visual Implant Elastomer tags (VI): right red, left green and right green. On 11 October, we sampled two ponds at Lyons Ferry which both contained fish with the right red VI tag. Fish from this mark group were eventually released from the Tucannon Hatchery acclimation pond. Mean fork length, sample size, coefficient of variation, and K-factor for fish in Pond 15 were 108.6 mm, 306, 10.8, and 1.27, respectively. Mean fork length, sample size, coefficient of variation, and K-factor for fish in Pond 16 were 114.2 mm, 320, 12.2, and 1.26, respectively. The mean lengths of fish sampled from each pond were statistically different ($t=5.54$, $p<0.0001$). Plotted histograms (not shown) of the two raceways indicated that Pond 16 was clearly bi-modal in length distribution, and that Pond 15 was slightly bi-modal. Although mean fish length in the two ponds were statistically different, we pooled the data so we could compare mean length frequency distributions between the three mark groups. Pooled mean fork length, coefficient of variation, and K-factor for this mark group was 111.4 mm, 11.8, and 1.27, respectively (Figure 4).

On 18 October, we sampled the two remaining tag groups at Tucannon Hatchery (Figure 4). Mean fork length, sample size, coefficient of variation, and K-factor for fish with the left green VI tag were 112.5 mm, 297, 11.3, and 1.18, respectively. Mean fork length, sample size, coefficient of variation, and K-factor for fish with the right green VI tag were 116.7 mm, 299, 13.0, and 1.21, respectively. We found significantly different mean lengths between the left green and right green mark groups ($t=3.68$, $P=0.0002$).

While the lengths of fish marked with left and right green VI tags were significantly different, we are unsure if any biological difference exists between them. There were 5,301 left green VI tag fish, and 35,615 right green VI tag fish. We are unsure if we obtained equally representative samples of these two groups because the population size within each was so different.

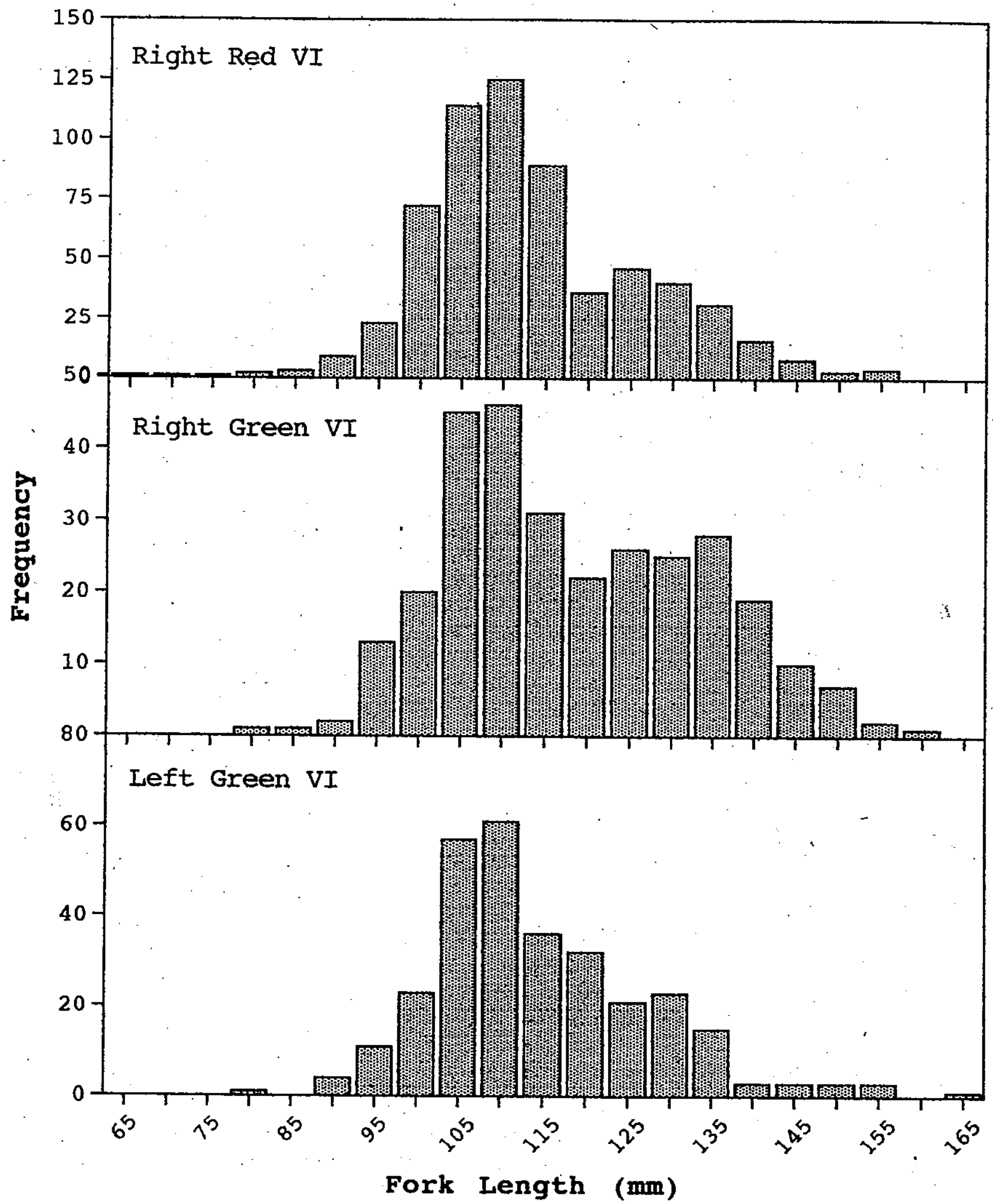

Figure 4. Length frequency distributions of the 1994 brood hatchery salmon sampled at Lyons Ferry and Tucannon hatcheries on 11 and 18 October, 1995.

All fish from the population were marked, so we had an actual count of the number of fish in the population once tagging was complete. We found that there were 11,140 fewer fish than originally estimated to be in the ponds. Feeding rates and schedules at the hatchery are based on the number of pounds of fish in the pond. Because this weight was over-estimated at ponding in February, the fish were overfed for six months of their rearing, causing faster growth than normal. We believe this contributed to the bimodal length distribution and a higher than normal incidence of precocious males in the population.

From October 1995 through March 1996, an estimated 778 fish died at the Tucannon Hatchery. We examined 686 of the dead fish for possible causes of death, and to recover any PIT tags which may have been present. Of the fish examined, 62% were precocious males (Table 6). We could not accurately estimate the number of precocious males in the population. However, based on visual observations and limited sampling (Section 3.1.3, Releases), we think precocious males represented roughly 1% of the population (≈1,300 fish). We presently do not know how long these precocious males will live, or if they will contribute to future populations.

Table 6. Numbers and (percent) of precocious males sampled from the Tucannon Hatchery from October 1995 to March 1996.

Sample dates	Fish sampled	Precocious males (%)
10/11 - 10/31	153	20 (13.1)
11/01 - 12/12	71	35 (49.3)
12/13 - 01/16	210	201 (95.7)
01/17 - 03/01	187	147 (78.6)
03/02 - 03/25	65	25 (38.5)
Total	686	428 (62.4)

3.1.2: Disease incidence and treatments

Prophylactic feed treatments for BKD were not given to the 1994 brood juvenile spring chinook salmon, and none were scheduled for the 1995 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. No other fish health problems were noted for either brood and no treatments were given.

3.1.3: Smolt acclimation and releases (1994 brood)

Acclimation: Lyons Ferry staff transported an estimated 130,847 yearling salmon to the main acclimation pond and two raceways at the Tucannon Hatchery on 11 October (89,948 fish) and 13 October (40,899 fish), 1995. Mixed well and river water was used to rear the fish during the winter. All fish were entirely on river water by 25 February to ensure that fish imprinted to the Tucannon River instead of the hatchery water supply. About 35,000 fish from the Tucannon Hatchery raceways were scheduled for acclimation at either Curl Lake or Winchester Cr. portable acclimation ponds. However, due to road damage caused by the flood in early February, pond setup and transport of fish to Winchester Cr. was impossible. All 35,000 were acclimated at Curl Lake instead (Figure 5). Fish at the Curl Lake acclimation site were allowed to acclimate about two weeks. About 5,000 salmon from the raceways were acclimated on river water for about one month at Tucannon Hatchery before being transported upriver and released directly into the river.

Releases: Release strategies in 1996 were similar to those in 1995. We planned a six week volitional release beginning 2 March for approximately 90,000 smolts in the acclimation pond at Tucannon Hatchery. All fish released from the Tucannon acclimation pond were VI tagged with a red elastomer on the right side (Appendix C). A total of 35,369 juveniles were cycled (≈15,000/cycle) in two week intervals through the small portable acclimation ponds at Curl Lake. All fish released from the Curl Lake acclimation site were VI tagged with green elastomer on the right side. Juvenile fish were also released directly into the river at Curl Lake (2,006; Rk 66), Panjab Br (2,006; Rk 75), and Camp Wooten (1,251; Rk 68). These fish were VI tagged with a green elastomer on the left side. Both release strategies (acclimated and direct stream) were used again this year to continue our study to evaluate differences in relative survival between the two release types. Section 3.1.4 discusses the results from the 1995 release (1993 brood) groups.

Length and weight samples collected from our PIT tagging study (Section 3.1.5) were used as pre-release samples for each group (Table 7). We also collected Organosomatic Index (OSI), blood plasma cortisol, and ATP-ase samples from each release group. The percentage of precocious males in each of the released populations was probably overestimated. Most of the precocious males were bloated to such an extent that they had difficulty swimming so they could not avoid capture as easily as other fish in the pond. Bi-modal length distributions documented earlier in the rearing cycle were not observed in the release groups. The volitional release from the main acclimation pond was delayed until 16 March due to flood control work in the river. Hatchery personnel estimated that 95% of the fish volitionally migrated from the pond before 22 April.

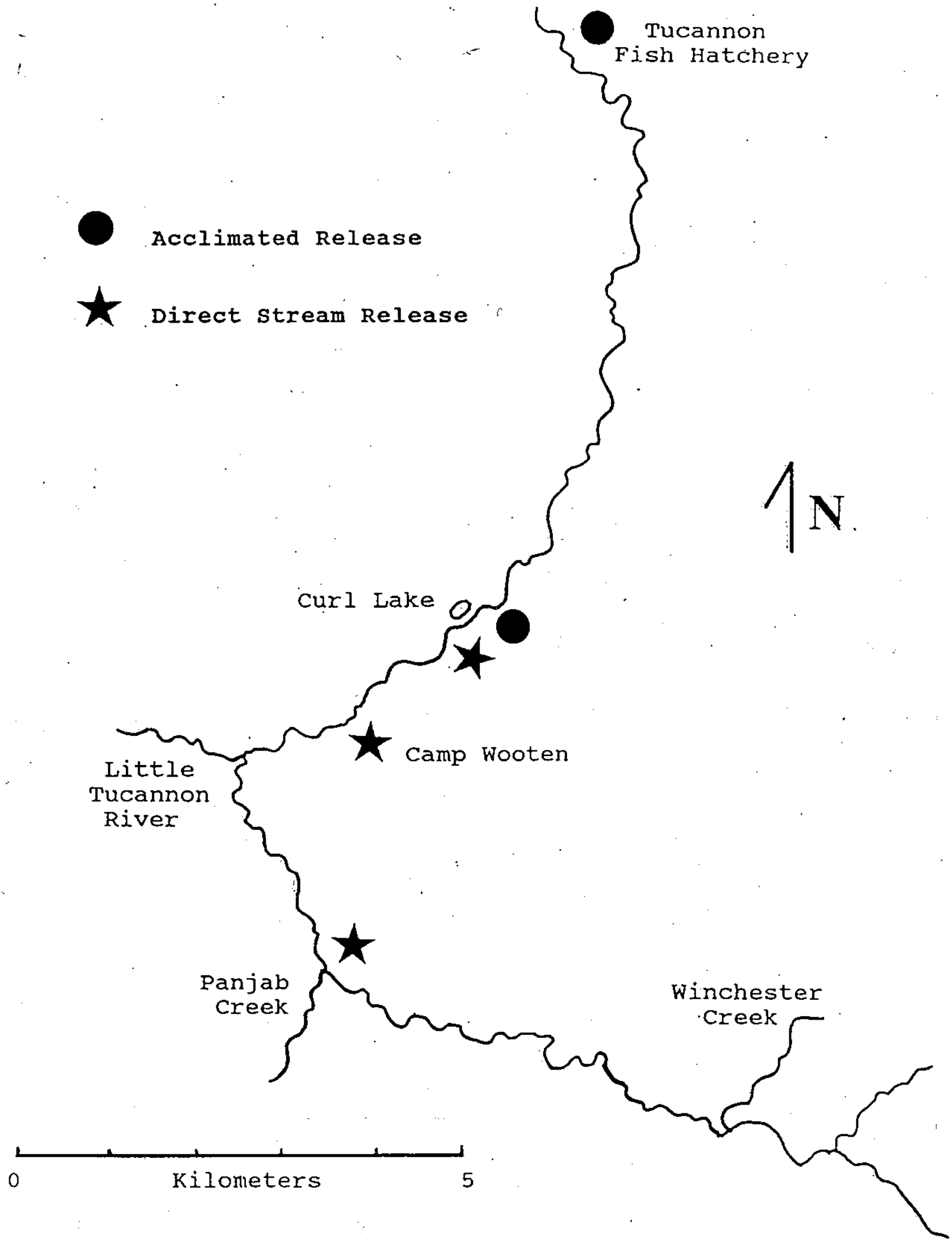

Figure 5. Locations of release sites (acclimated and direct) in the Tucannon River, 1996.

3.1.4: Juvenile migration studies (1995 PIT tagging)

We began a Passive Integrated Transponder (PIT) tag study with the 1993 brood in February 1995 to determine if small remote acclimation ponds located in the upper Tucannon River watershed produced higher relative juvenile survivals than direct stream releases in the same areas (Bumgarner et al, 1995). Comparing these release strategies will help address the concerns about the spawning distribution of adults, and potential harmful effects of the Tucannon Hatchery weir. Performance of the PIT tagged fish were evaluated by detections at Lower Monumental, McNary, John Day and Bonneville dams.

Table 7. Characteristics of fish released into the Tucannon River, 1996.

Release Location	Tucannon Hatchery	Curl Lake	Curl Lake	Tucannon R.
Sample Date	3/06	3/18	3/28	3/15
Release Date	3/16-4/22	3/27-3/28	4/09-4/10	3/27-3/28
Release Number	89,437	14,447	14,065	5,263
Characteristic				
Smolt (%)	**(4.5)**	**(23.8)**	**(15.8)**	**(14.0)**
n	20	120	79	70
length	152.0	150.9	157.7	159.7
CV	9.6	10.4	9.6	7.8
K-factor	1.07	1.07	1.10	1.12
Transitional (%)	**(94.5)**	**(72.2)**	**(83.2)**	**(79.7)**
n	378	365	417	405
length	131.4	134.5	132.8	135.5
CV	9.7	10.1	9.4	10.4
K-factor	1.20	1.15	1.18	1.23
Precocious (%)	**(0.5)**	**(3.8)**	**(1.0)**	**(5.3)**
n	2	19	5	26
length	110.0	124.9	136.4	121.9
CV	9.0	9.0	11.4	11.1
K-factor	1.77	1.43	1.33	1.65
Total				
n	400	504	501	501
length	132.3	138.0	136.8	138.2
CV	10.4	11.5	11.6	12.0
K-factor	1.20	1.14	1.18	1.24

Between 6-10 March 1995, 1,000 hatchery fish (five subgroups of about 200 each) were PIT tagged at Tucannon Hatchery. Three of the five groups were transported to the small portable acclimation ponds (Curl Lake; two 4'x 4'x 20' troughs:

Winchester Cr.; two 8' diameter circular ponds), and two groups were released directly into the stream close to the acclimation sites. Each release group (direct stream or acclimated) consisted of approximately 2,100 fish. In addition, 200 juveniles from the main acclimation pond at Tucannon Hatchery were PIT tagged before the volitional release. PIT tagged fish from the main acclimation pond represent the standard release, and we believed they would have the highest relative survival.

Fish that were released directly into the stream near Curl Lake performed better than releases from small acclimation ponds at roughly the same location (Table 8). However, fish released (either direct or acclimated) highest in the Tucannon River performed the worst of all groups. We speculate that high river flows and a difficult migration corridor in the upper river caused additional mortality among those release groups. During release snorkelers at the upper sites observed many disoriented fish being swept downstream in the strong current. Fish released from the Curl Lake site (both acclimated and direct stream) under the same flow conditions, appeared to have a controlled descent downstream. Fish released from Curl Lake performed as well as, if not better than, fish from the main acclimation pond at the Tucannon Hatchery. The one month volitional release from the main acclimation pond at Tucannon Hatchery differs from the forced release at the other locations. The differences may have affected the observed detections at the dams.

Table 8. Cumulative unique detection summaries of PIT tagged salmon released from various location on the Tucannon River in 1995 at downstream Snake and Columbia Dams.

Release Site (type)	Release date	River kilometer	Number released	Cumulative detections
Tucannon Hatchery (acclimated)	3/15-4/15	58	200	45 (22.5%)
Curl Lake (acclimated)	3/20	66	202	41 (20.3%)
Curl Lake (direct stream)	3/20	66	197	56 (28.4%)
Winchester Cr. (acclimated)	3/20	78	198	27 (13.6%)
Lady Bug Flat (direct stream)	3/20	77	197	34 (17.3%)
Winchester Cr.[a] (acclimated)	4/02	78	199	29 (14.6%)

a Second cycle of two week acclimation.

3.1.5: Juvenile migration studies (1996 PIT tagging)

We continued our PIT tag study in 1996 with 1994 brood year fish 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. PIT tag release sites and group size (2,100/release group) were to be identical to 1995; however, the floods in February 1996 caused considerable road damage along the Tucannon River. Due to the poor road conditions, security concerns raised by incidents in 1995, and the poor success of the Winchester Cr. and Ladybug Flat Campground releases in 1995, we abandoned those sites in 1996. The two acclimation ponds that were at Winchester Cr. were installed at the Curl Lake acclimation site.

PIT tagged fish were released directly into the stream at Curl Lake (Rk 66) and Panjab Bridge (RK 74) on 27 March. The PIT tagged group released at Panjab Bridge does not have an associated acclimated group for comparison; however, we thought it useful to release a study group in the upper watershed to compare with the 1995 results.

Since we installed both circular ponds and troughs at Curl Lake, we PIT tagged fish in each for comparison. Approximately 35,000 fish were designated by mark group to be released at Curl Lake acclimation sites, requiring three cycles of fish to complete the release. This allowed us to compare early and late release groups from the same location. We released the early and late PIT tagged fish on 27 March and 10 April. The PIT tag release group size from the troughs was approximately 5,100 fish, instead of the planned 2,100. A divider screen broke during the first release attempt which forced us to release all fish from the trough, instead of the desired 2,100. Release group sizes for the second release were the same as the first (5,100). In addition, 100 (tagged 31 October) and 400 (tagged 6 March) juveniles from the main acclimation pond at Tucannon Hatchery were PIT tagged before the volitional release. We also PIT tagged 19 precocious males on 7 March. A PIT tag interrogation unit was to be placed at the outlet of the pond to monitor the volitional release and obtain active travel time information to our smolt trap and downstream mainstem dams. However, technical problems with the interrogation unit could not be fixed before the release was complete.

In conjunction with the PIT tagging study, we collected blood plasma cortisol (stress indicator) samples from each release group in 1995 and 1996. ATP-ase samples were collected from each release group in 1996 only. A more complete and detailed report of the PIT tag study, with results from the cortisol and ATP-ase data, from 1995 and 1996 will be presented in a subsequent report.

3.2: Natural Rearing and Migration

3.2.1: Snorkel surveys

In 1995 we surveyed parr production at index sites to estimate the density and population size of subyearling and yearling chinook salmon in the Tucannon River. Snorkel surveys were conducted using a total count method (Griffith 1981, Schill and Griffith 1984). Each index site was snorkeled twice, with the second survey conducted within three to 10 days of the first survey. Population size was estimated by multiplying the mean fish density (fish/100 m^2) of each habitat type by the total area of that habitat type (from the most recent habitat inventory) within each stratum. Based on results from the two surveys, we estimate subyearling (1994 brood) and yearling (1993 brood) salmon parr production in the Tucannon River for 1995 was 12,720 and 4,375, respectively (Tables 9 and 10). No statistical difference was detected between the first and second survey population estimates. However, relatively small differences in mean densities (<0.5m^2) can result in population differences of 300-500 fish. The 1995 estimated population of subyearlings in the Tucannon River was well below the 1986-1994 average of 79,000 fish. Little difference was noted in the annual yearling production from previous years estimates (1986-1994: mean=3,460).

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 on the Tucannon River.

<u>1993 brood trapping:</u> We operated the trap intermittently from 1 October 1994 to 23 June 1995. The trap was operated for 5 days in October, 3 in November, 5 in December, 19 in January, 14 in February, 20 in March, 30 in April, 20 in May, and 11 days in June. We stopped trapping on 23 June because catches of natural migrants were low, and other priorities precluded trapping.

During the trapping season we conducted trap efficiency tests to estimate the number of fish passing the trap. To do this we clipped the distal portion of the upper or lower lobe of the caudal fin and transport them 1 km upstream for release. The percentage of marked fish recaptured estimates 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. Total estimated number of fish trapped was then divided by the trapping efficiency to estimate the total number of migrants passing the trap.

Table 9. Subyearling chinook salmon density (mean number of fish per 100 m2), standard deviation, sample size and population estimate by habitat type, Tucannon River, 1995

STRATUM	Survey #1				Survey #2				Combined Surveys			
Habitat Type	Density	s	n	Pop. Est.	Density	s	n	Pop. Est.	Density	s	n	Pop. Est.
WILDERNESS												
Riffle	1.16	0.51	3	576	1.61	1.83	3	799	1.38	1.46	3	685
Run	0.00	0.00	6	0	0.00	0.00	6	0	0.00	0.00	6	0
Pool	12.46	15.79	3	330	10.83	12.26	3	287	11.64	14.00	3	309
Side Channel	7.22	14.43	4	1,154	7.92	15.83	4	1,266	7.57	15.13	4	1,210
Total				2,060				2,352				2,204
HMA												
Riffle	0.42	0.73	3	644	0.49	0.46	3	752	0.45	0.45	3	690
Run	1.55	2.16	3	632	1.37	3.00	3	559	1.46	1.59	3	596
Pool	0.67	0.95	2	48	0.79	0.10	2	56	0.93	0.43	2	67
Side Channel	0.63	0.87	5	64	0.53	1.89	5	54	0.59	0.91	5	60
Boulder	0.00	0.00	3	0	0.43	0.37	3	91	0.21	0.18	3	44
Total				1,388				1,512				1,457
HARTSOCK												
Riffle	2.65	1.79	7	3,553	2.86	2.85	7	3,834	7.64	5.53	6	2,706
Run	7.37	4.27	6	2,611	7.90	7.10	6	2,798	2.76	2.25	7	3,700
Pool	15.32	9.44	5	846	16.56	9.70	5	914	15.94	8.48	5	880
Side Channel	7.60	11.34	4	766	15.06	17.66	4	1,518	11.33	14.05	4	1,142
Total				7,776				9,064				8,428
MARENGO												
Riffle	0.33	0.57	3	463	0.28	0.48	3	393	0.30	0.53	3	162
Run	0.00	0.00	3	0	0.00	0.00	3	0	0.00	0.00	3	0
Pool [a]	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Side Channel	2.60	5.20	4	340	4.49	8.98	4	587	3.55	7.09	4	464
Total				803				980				626
POPULATION TOTALS				12,027				13,908				12,715

a *No pools were sampled in the Marengo Stratum in 1995.*

Table 10. Yearling chinook salmon density (mean number of fish per 100 m2), standard deviation, sample size and population estimate by habitat type, Tucannon River, 1995

STRATUM Habitat Type	Survey #1				Survey #2				Combined Surveys			
	Density	s	n	Pop. Est.	Density	s	n	Pop. Est.	Density	s	n	Pop. Est.
WILDERNESS												
Riffle	1.82	3.15	3	904	1.36	2.35	3	675	1.59	2.75	3	789
Run	2.11	3.95	6	660	3.11	5.45	6	973	2.61	4.69	6	817
Pool	3.05	4.10	3	81	5.21	4.52	3	138	4.13	4.31	3	110
Side Channel	1.52	2.02	4	243	3.94	6.69	4	630	2.73	4.32	4	436
Total				1,888				2,416				2,152
HMA												
Riffle	0.00	0.00	3	0	0.30	0.52	3	460	0.15	0.26	3	230
Run	0.00	0.00	3	0	0.70	0.81	3	286	0.35	0.40	3	143
Pool	6.06	8.57	2	436	1.42	1.13	2	102	3.74	4.85	2	269
Side Channel	15.47	29.63	5	1,579	11.99	21.44	5	1,224	13.73	25.48	5	1,401
Boulder	0.00	0.00	3	0	0.00	0.00	3	0	0.00	0.00	3	0
Total				2,015				2,072				2,043
HARTSOCK												
Riffle	0.00	0.00	7	0	0.05	0.14	7	67	0.05	0.13	6	18
Run	0.00	0.00	6	0	0.10	0.25	6	35	0.03	0.07	7	40
Pool	0.34	0.46	5	19	0.66	1.04	5	36	0.50	0.74	5	28
Side Channel	0.00	0.00	4	0	0.54	1.06	4	54	0.26	0.53	4	26
Total				19				192				112
MARENGO												
Riffle	0.00	0.00	3	0	0.00	0.00	3	0	0.00	0.00	3	0
Run	0.00	0.00	3	0	0.00	0.00	3	0	0.00	0.00	3	0
Pool [a]	--	--	--	--	--	--	--	--	--	--	--	--
Side Channel	0.00	0.00	4	0	1.12	2.25	4	147	0.56	1.12	4	73
Total				0				147				73
POPULATION TOTALS				3,922				4,827				4,380

a *No pools were sampled in the Marengo Stratum in 1995.*

We conducted two mark/recapture trials in June, three in January, and four each in March, April, and May to estimate trap efficiency. Mark/recapture trials were not conducted in October, November, December or February due to low numbers of captured fish. Trapping efficiencies from other months with similar conditions and discharges were used to estimate total emigration from each of these months. We marked and recaptured 718 and 250 natural salmon, respectively, during the 1994/1995 season.

We captured 9,622 natural salmon (includes 250 recaptures) and 24,706 hatchery salmon (both outplanted and hatchery acclimation releases) during the 1994/1995 season. Based on our estimated trapping efficiencies, we estimate 49,650 natural salmon migrated past the trap (Table 11). An estimate of the number of hatchery salmon migrating past the trap was not completed due to uncertainties in trapping efficiency regarding hatchery fish. Hatchery fish are on average 35 mm longer in than natural migrants and are probably not captured at the same rates.

The peak migration of natural salmon based on daily passage estimates was not clearly defined (Figure 6), partly because we had to pull the trap (11 May) during the usual peak migration to modify our Section 10 Permit for trapping mortalities. Long periods of high river flows in 1995 increased the debris load in the trap, so more mortalities occurred than normal. We resumed trapping on 17 May.

Table 11. Estimated natural juvenile migrants passing the downstream migrant trap in the Tucannon River from 1 October 1994 to 23 June 1995.

Month	Number of migrants	Percent of total
October	250	0.5
November	1,717	3.5
December	6,096	12.3
January	2,183	4.4
February	740	1.5
March	5,144	10.4
April	15,353	30.4
May	14,163	28.5
June	3,976	8.0
Total	49,652	100.0

In the eight month trapping period, we assessed the amount of descaling on 1,429 natural salmon and 479 hatchery salmon. Descaling rates on natural salmon were considerably less that for hatchery salmon (Table 12). Hatchery fish are unaccustomed to maintaining their position in the swifter river currents, and may be more prone to injury and descaling than natural fish. Hatchery fish released from small ponds or directly into the stream were more descaled (44.8%) than fish released from the main acclimation pond at Tucannon Hatchery (27.0%). We suspect that handling and transporting these fish to their release site and a longer downstream migration may have contributed to the higher scale loss. High river flows in 1995 may have also contributed to the increased descaling of hatchery fish released from the acclimation pond at Tucannon Hatchery (27.0%) compared to the 1993/1994 season (9.7%) when river flows were lower.

During the 1993/1994 trapping season, we determined the amount of descaling caused by the trap on natural fish (1.9%) by analyzing the results from our mark/recapture fish. A small sample size from the 1994/1995 trapping season hinders the same analysis. Descaling rate of natural fish captured during the 1994/1995 season suggests it was similar to 1993/1994.

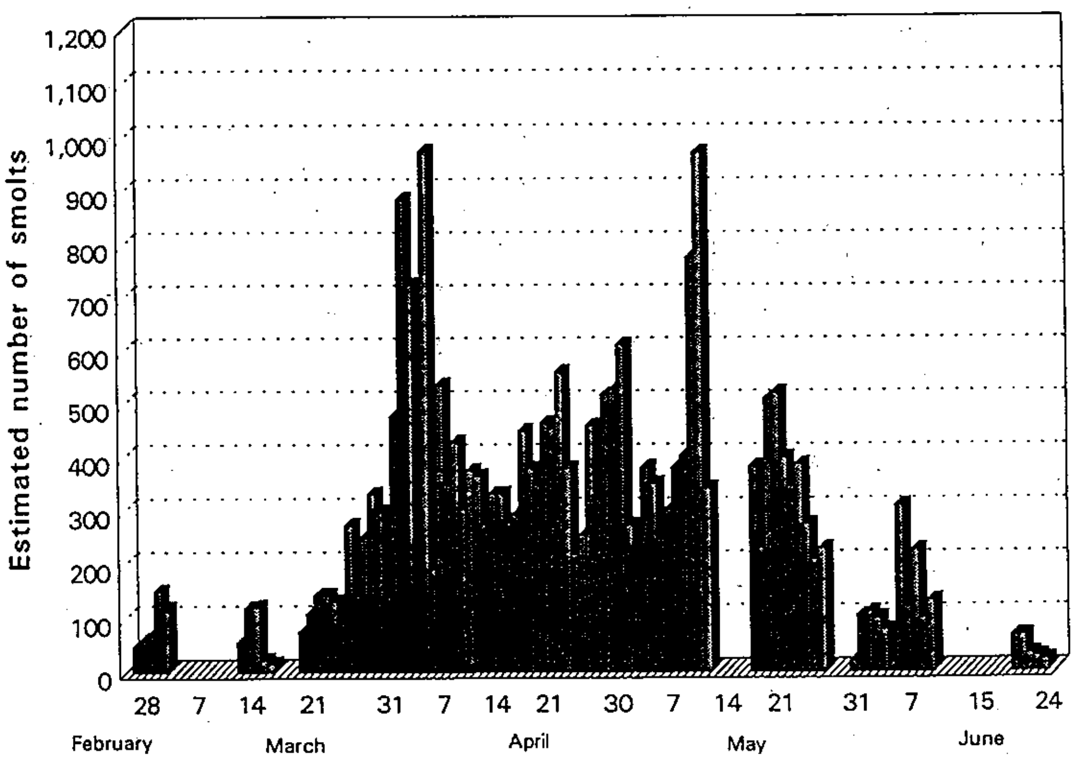

Figure 6. Daily estimated number of natural migrants passing the downstream migrant trap from 26 February to 23 June 1995. Dates of zero estimated migrants indicate days where we did not trap.

Table 12. Summary of observed descaling (percent) for natural and hatchery salmon captured in the downstream migrant trap 1994/1995. Actual number descaled are in parentheses.

Regions	Percent Descaled		
	Natural	Hatchery (acclimated)	Hatchery (outplanted)
One only	1.3 (12)	13.0 (36)	15.9 (32)
Two or more	0.8 (18)	14.0 (39)	28.9 (58)
Total	2.1 (30)	27.0 (75)	44.8 (90)
Total fish checked	1,429	278	201

During the trapping season, dead fish are occasionally found in the trap. Some of the mortalities are accidental, resulting from netting the fish from the live box. We also have observed dead or nearly dead fish floating into the trap. However, most of the mortalities are caused by high debris loads in the trap live box. Debris is removed frequently, but unexpected high debris loads in the river can plug the trap in less than 1/2 hour. In 1995, 32 (0.33%) natural salmon were killed in the trap or from sampling procedures.

We classified approximately 98% of the natural salmon caught as transitionals, and most of the remaining 2% as smolts. Five fish were classified as parr. Two of the parr captured from 21-28 April had recently emerged as fry. The two parr captured in April were 48 and 59 mm in length. The remaining fish captured as parr were captured in October and November and ranged from 62-67 mm in length.

<u>1994 brood trapping:</u> We borrowed a five foot rotary screw trap from the U.S. Fish and Wildlife Service so we could begin smolt trapping earlier in the fall migration season, during low river flows. The smaller rotary screw trap operates more effectively in lower flows than our incline plane trap. We intermittently trapped from 5 September to 19 December with the screw trap.

We captured 279 chinook from 5 September to 19 December, and examined 157 for length, weight, descaling, and smolt index. Of the 157 fish examined, 61 (38.9%) were naturally produced precocious males. Precocious males dominated the catches in September, were less abundant in October, and were rarely captured after that (Table 13). Readable scale samples were collected from 28 of the precocious males captured. Sixteen were Age 1+ (mean fork length 103.3 mm; SD 9.25). Twelve were Age 0+ (mean fork length 91.8 mm; SD 5.45). We do not know if the precocious fish survived the winter to migrate as smolts in 1996.

Table 13. Numbers of total fish captured, and the number of precocious and non-precocious fish sampled in the screw trap from 5 September to 19 December 1995.

Month	Total Captured	Number of fish examined		
		Precocious (%)	Non-precocious (%)	Total
September	44	40 (90.1)	4 (9.9)	44
October	90	19 (32.8)	39 (67.2)	58
November	115	2 (4.3)	44 (95.7)	46
December	30	0 (0.0)	9 (100.0)	9
Total	279	61 (38.9)	96 (61.1)	157

We planned to resume trapping with our incline plane trap in February. The Tucannon River experienced a 30 year flood in early February 1996. Our incline plane trap was caught in the flood and sustained heavy damage. We obtained and installed a new rotary screw trap in April 1996. Sampling summaries and population estimates for smolts emigrating from the Tucannon River during the 1995/1996 migration period will be presented in the 1996 Spring Chinook Annual Report.

SECTION 4: MITIGATION GOALS

4.1: Natural and Hatchery Survival Rates

We have estimated various survival rates for natural and hatchery reared salmon by using egg deposition, juvenile population, smolt migration and adult escapement estimates (Appendix D, Appendix E), as well as proportions of natural and hatchery returns each year by age. We then compared the differences between natural and hatchery production, and their relationship to established mitigation goals.

4.1.1: Smolt-to-adult

Estimated smolt-to-adult survivals for the 1990 brood of natural and hatchery salmon were 0.19% and 0.03%, respectively. The 1990 brood smolt-to-adult survival rate for naturally produced salmon is 630% higher than for salmon produced in the hatchery. The mean smolt-to-adult survival rate (1985-1990 broods) of 0.21% (SD 0.12%) for hatchery produced fish is well below the established mitigation goal of 0.87%. Even the mean smolt-to-adult survival rate (1985-1990 broods) of 0.78% (SD 0.47%) for naturally reared fish is below the guideline set for hatchery production.

4.1.2: Adult-to-adult (parent-to-progeny)

The 1990 brood year estimate of the adult-to-adult survival rate for hatchery reared salmon is 625% higher than for naturally reared salmon. Based on mean adult-to-adult survival of six complete brood years, 4.3 times more hatchery reared salmon from the Tucannon River survive than naturally reared salmon. Hatchery fish have generally been able to replace themselves in the population, whereas the naturally produced fish have not (Figure 7). We believe the overall poor success of the 1990 and 1991 broods are a combination of drought and poor ocean conditions that existed in 1992 and 1993. The data suggests that the hatchery population will return above the replacement line with improved ocean conditions. Unfortunately, we are unsure if the natural population will do the same. Drought conditions over the past decade have contributed in keeping the natural fish below replacement levels. If long-term drought conditions cease, we may see the natural population return above the replacement line. However, other major problems of lost habitat and difficult (both juvenile and adult) migration corridors in the Snake and Columbia Rivers may keep the natural population below the replacement line and headed towards extinction.

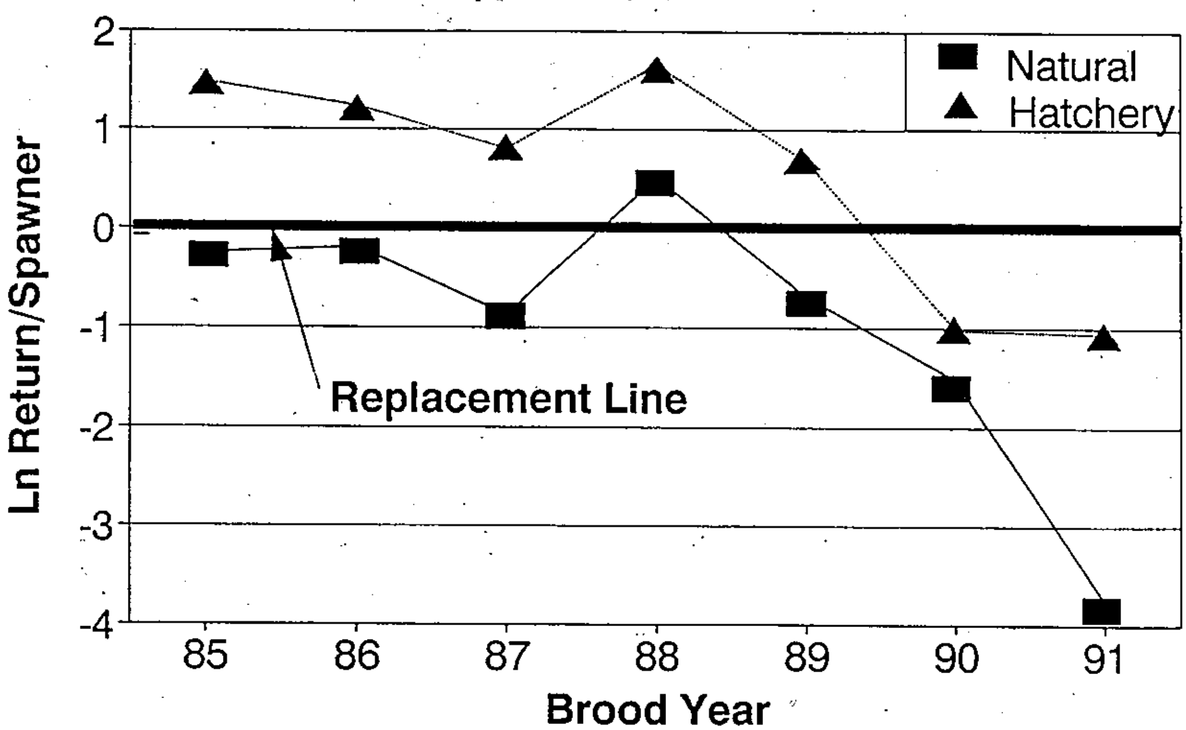

Figure 7. Natural Log (Ln) return/spawner relationship for Tucannon River spring chinook salmon (natural and hatchery) for the brood years 1985-1991. A zero value on the Y-axis represents replacement of returning adults for the same number of spawners.

4.2: Fishery Contribution

One of the original primary goals of the LSRCP supplementation program was to enhance the wild (natural) returns of salmon to the Tucannon River. An increase in the annual run size to the Tucannon River would allow harvest of the portion not needed for annual production of the stock. However, with the continued decline of Snake River spring/summer chinook, and their recent listing under the Endangered Species Act (ESA), the original program goals have temporarily been put on hold. We view the current program goal as conserving and protecting the genetic and demographic basis of this population, thereby enhancing our options for the future. To date, both natural and hatchery returns have been below program goals (1,152 annual run size) and have not allowed a target fishery on salmon in the Tucannon River. Based on CWT recoveries from the 1985-1990 brood years (1,334), most fish have been recovered from the Tucannon River. Few salmon (4.3%) have contributed to other fisheries (Table 14, Appendix F), or have been recovered outside (One at Dworshak Hatchery; 0.08%) the Tucannon River Basin.

Table 14. Estimated fishery/location recoveries and the percent (in parenthesis) of returning adults from coded-wire tagged salmon released from the Tucannon River (1985-1990 brood years).

Brood year Smolts released	1985 (12,922)	1986 (153,725)	1987 (152,165)	1988 (146,239)	1989 (99,057)	1990 (85,797)
Agency (fishery/location)						
WDFW						
(Tucannon River)	60 (98.3)	308 (95.1)	233 (99.1)	464 (94.7)	246 (95.3)	23 (100.0)
(Kalama R., Wind R)		4 (1.2)		4 (0.8)		
(Fishtrap-Snake R.)				1 (0.2)		
(Treaty troll, Area 4b)		2 (0.6)			2 (0.8)	
IDFG						
(Dworshak Hatchery)				1 (0.2)		
ODFW						
(Test net, Zone 4)	1 (1.7)	2 (0.6)		3 (0.6)	2 (0.8)	
(Ceremonial)[a]		4 (1.2)	2 (0.9)	17 (3.5)	8 (3.1)	
CDFO						
(Non-treaty troll)		4 (1.2)				

a Recovery of 1 fish from the 1987 brood year was from the John Day Pool. All other Ceremonial recoveries are from Bonneville Pool.

SECTION 5: RECOMMENDATIONS

We have provided several recommendations which we hope will improve performance of the Tucannon salmon program:

1) 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 provide spawning options for managers.

2) Continue to release (acclimated or direct) hatchery juvenile salmon upstream of the Tucannon Hatchery, and evaluate the effectiveness of these releases.

3) Redesign and construct, or modify existing adult trapping facilities on the Tucannon River to provide a more effective trap.

4) Examine historical data on fish size and evaluate it's effects on precocious male production in the population.

5) Evaluate the 1996 adult run for production potential in 1996 and 1997. Based on this evaluation, make a decision on the 1994 juveniles which are currently being reared for a captive broodstock program.

6) Collect samples and improve estimates of fecundity and eggtake for each individual fish at time of collection. Monitor differences in egg size by age and length of each fish before egg incubation. Improving eggtake estimates will reduce problems associated with estimating the rearing population size, fish size at release, and reduce the incidence of precocious males in the population.

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

Table 1. Spring chinook salmon captured and collected at the Tucannon Hatchery trap in 1995. No salmon were passed upstream of the trap. [Instream Trap = R, Concrete Trap (old) = H]

	Arrived				Collected		Died in Pond	
Date	Natural	Trap	Hatchery	Trap	Natural	Hatchery	Natural	Hatchery
5/17			1	H		1		
5/23			2	H,R		2		
5/27			1	H		1		
5/28	1	R			1			
5/30	1	H			1			
5/31	2	R			2			
6/01			1	H		1		
6/04			3	R		3		
6/05			2	H,R		2		
6/06			1	H		1		
6/08			5	4H,R		5		
6/09			2	H		2		
6/11			4	2H,2R		4		
6/12			1	R		1		
6/15			1	H		1		
6/16			1	H		1		
6/17			1	H		1		
6/25			2	H,R		2		
6/29	1	H						
7/02								1
7/05			1	H		1		
7/10	2	H,R	1	H	2	1		
7/15								1
7/18			1	R		1		
7/24								1
8/02	1	R	1	R	1	1		
8/26							1	
9/07	1	R			1			
9/12	1	R	1	R	1	1		
Totals	**10**	**3H,7R**	**33**	**20H,13R**	**10**	**33**	**1**	**3**

APPENDIX B

TUCANNON SPRING CHINOOK SALMON BROODSTOCK SPAWNING PROTOCOL

This plan was developed to: 1) obtain genetic contribution from all broodstock, 2) obtain high fertilization, and 3) remove stray spawners (verified through scale or CWT analysis). Background information and a complete spawning protocol can be found in Bumgarner et al 1994, Appendix A.

We will use the following guidelines for matings:

- 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 ≤ 30 seconds later. The two lots of eggs from each female will be incubated separately in a single, divided tray. Live and dead eggs will be counted from each egg lot.

- 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 stray males (identified later) will be destroyed or shipped out of the Snake River Basin, if the stray male was the primary male used in fertilizing that lot of eggs. All eggs from stray females will be destroyed or shipped out of basin.

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

- Fresh semen will have priority for matings over cryopreserved semen unless use of available semen will cause a particular male to be the primary male in matings with more than three females.

- Hatchery x hatchery matings will be minimized as much as possible. However, it is more important to maximize the number of individual adults contributing genetic material than it is to minimize HxH crosses.

- Only progeny from one of two egg lots from any particular female may be used for captive brood/rearing. This is to ensure that 15 families, from 15 different females, are included in the program. Priority for egg lots to use in the captive rearing program shall be WxW and WxH, instead of HxH. During incubation, we will examine the results of the matings and select egg lots that will have progeny (~200 per lot) included in the captive brood program. We will attempt to maximize the number of different individual females and males, and we will emphasize those lots with WxW and WxH crosses.

APPENDIX C

Coded-wire tag information from juvenile releases (1991-1994 broods) and adult recoveries (1995) from Tucannon spring chinook salmon.

Table 1. Summary of salmon yearling releases for the Tucannon River, 1991-1994 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
1991	11	11	4/06-12	93	16,745	1,116		63-46-47[b]
(1993)	17	17			55,716	3,714		63-46-25[c]
					74,058	4,937	15	
1992	25	18	10/22-25	93	24,883	698	36	63-48-23[c]
(1994)			4/11-18	94	35,405	2,591	14	63-48-10[d]
	20	27	10/22-25	93	24,685	694	36	63-48-24[b]
			10/22-25	93	7,111	200	36	63-48-56
			4/11-18	94	35,469	2,718	14	63-49-05[e]
			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[b]
(1995)			3/15-4/15	95	45,147	3,166	14	63-53-43[f]
		5	3/20-4/3	95	18,304	1,217	15	63-56-18
	26	21	3/20-4/3	95	14,632	972	15	63-56-17[c]
			3/15-4/15	95	45,148	3,166	14	63-53-44[g]
					138,848			
1994	26	43	3/16-4/22	96	89,437	5,123	17.7	63-56-29[h]
(1995)			3/27-4/19	96	35,369	2,628	15.2	63-57-29[i]
			3/27-4/28	96	5,263	396	13.3	63-43-23[j]
					130,069			

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 Hatchery cross progeny have red elastomer tags behind right eye.
c Natural cross progeny have red elastomer tags behind left eye.
d Natural cross progeny released from the acclimation pond have yellow elastomer tags behind the left eye.
e Hatchery cross progeny released from the acclimation pond have yellow elastomer tags behind the right eye.
f Hatchery cross progeny released from the acclimation pond have green elastomer tags behind the right eye.
g Natural cross progeny released from the acclimation pond have green elastomer tags behind the left eye.
h Mixed cross progeny released from the acclimation pond have red elastomer VI tag behind the right eye.
i Mixed cross progeny released from the Curl Lake portable acclimation ponds) have green elastomer VI tag behind the right eye.
j Mixed cross progeny released directly into the river have green elastomer VI tag behind the left eye.

Appendix C (continued).

Table 2. Spring chinook salmon (natural and hatchery) sampled from the Tucannon River, 1995

Total escapement to Tucannon River:	54	
Broodstock collected	-43[a]	
Fish dead in trap	- 0	
	===	
Total	11	
In-river CWT sampled fish:		
Prespawning mortality	0	
Spawned carcasses recovered	8	(8 natural)
	===	
Spawning ground CWT sample	8	
Total number of carcasses sampled in 1995	**51**	

a Four of 43 broodstock collected were prespawning mortalities (3 hatchery, 1 natural).

Table 3. Summary of all hatchery salmon sampled from the Tucannon River, 1995.

CWT code	Broodstock collected	Dead in trap	Pre-spawn mortality	Spawned in river	Total
63-40-21	1				1
63-43-11	1				1
63-46-25	11				11
63-46-47	9				9
63-48-10	5		1		6
63-49-05	3		2		5
Strays	0				0
Lost or no tags	0				0
Total	**30**		**3**		**33**

APPENDIX D

Estimated survival rates at various life stages for natural and hatchery reared Tucannon spring chinook salmon.

Table 1. Known and (expanded) returns and survival rates (based on escapement estimates and age composition) of **natural** salmon to the Tucannon River for brood years 1985-1991 (1991 incomplete).

Brood Year	Estimated number of smolts migrating	Age 3	Age 4	Age 5	Smolt to Adult Survival
1985	35,600	9 (23)	110 (282)	36 (117)	0.44 (1.19)
1986[a]	58,200	1 (3)	116 (378)	28 (89)	0.25 (0.81)
1987	44,000	0 (0)	52 (164)	21 (58)	0.17 (0.50)
1988	37,500	1 (3)	126 (343)	74 (199)	0.54 (1.45)
1989	25,900	5 (14)	40 (107)	23 (56)	0.26 (0.57)
1990	49,500	3 (8)	63 (72)	12 (14)	0.16 (0.19)
1991	26,000	0 (0)	4 (5)	- (--)	0.02 (0.02)

a One known (expanded to two) age six salmon was recovered.

Table 2. Known and (expanded) returns and survival rates (based on escapement estimates and age composition) of **hatchery** salmon to the Tucannon River for brood years 1985-1991 (1991 incomplete).

Brood Year	Estimated number of smolts migrating	Age 3	Age 4	Age 5	Smolt to Adult Survival
1985	12,922	9 (18)	24 (26)	0 (0)	0.26 (0.34)
1986	153,725	80 (85)	98 (219)	8 (17)	0.12 (0.21)
1987	152,165	8 (18)	70 (150)	8 (18)	0.06 (0.12)
1988	146,200	46 (98)	140 (296)	25 (53)	0.14 (0.31)
1989	99,057	7 (15)	100 (211)	14 (17)	0.12 (0.25)
1990	85,800	3 (6)	16 (20)	2 (2)	0.02 (0.03)
1991	74,058	4 (5)	20 (20)	- (--)	0.03 (0.03)

Appendix D continued.

Table 3. Summary of juvenile survival rates by brood year for naturally reared salmon in the Tucannon River.

Brood Year	Percent egg-to-fry	Percent fry-to-smolt	Percent egg-to-smolt
1985	8.6	39.5	3.4
1986	8.5	56.7	4.8
1987	6.8	55.6	3.8
1988	10.6	53.8	5.7
1989	11.1	44.2	4.9
1990	6.0	77.2	4.7
1991	10.2	54.2	4.9
1992	9.6	49.2	4.7
1993	10.7	57.1	6.1
1994	7.2	--	--

Table 4. Summary of juvenile survival rates by brood year for Tucannon River salmon spawned and reared at the Tucannon and Lyons Ferry hatcheries.

Brood Year	Percent egg-to-fry	Percent fry-to-smolt	Percent egg-to-smolt
1985	90.3	96.4	78.1
1986	94.7	86.7	82.1
1987	83.8	92.4	77.4
1988	82.6	97.0	80.1
1989	77.5	95.8	74.2
1990	70.9	95.8	67.9
1991	84.6	95.9	81.1
1992	97.0	57.8 [a]	56.1 [a]
1993	88.1	95.6	84.2
1994	89.1	80.4 [b]	90.3
1995	76.2	--	--

a The total number of fish actually release was 140,725. We released 57,316 in the fall of 1993, but estimated only 4,343 of those survived to migrate as smolts. Therefore the number of hatchery smolts released was adjusted based on smolt trapping estimates.

b An overage of 11,140 was discovered in the hatchery population at time of tagging. This overage is reflected in the lower fry-smolt survival rate.

APPENDIX E

Table 1. Estimates of natural Tucannon spring chinook salmon abundance by life stage for 1985-1995 broods.

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	93
1991	98 / 67	3,741 / 2,517	535,257	54,800	26,000	21
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	49,652	
1994	38 / 5	4,187 / 3,314	175,676	12,720		
1995	5 / 0	5,284 / - -	26,420			

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.

c Number of fry (parr) estimated from electrofishing (1985-1989), Line transect snorkel surveys (1990-1992), and Total Count snorkel surveys (1993-1995).

d Number of smolts estimated from smolt trapping.

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

f Smolt trapping was not allowed this year. An estimated number of smolts was calculated using mean fry-to-smolt survival from previous years.

APPENDIX F

Contribution of 1985-1991 broods Tucannon River spring chinook salmon to various fisheries and returns to the Tucannon River. Estimated recoveries were obtained from PSMFC CWT database, and differ slightly from our more refined technique of estimated returns.

Table 1. Observed and estimated recoveries of 1985 brood salmon released (12,922) from Tucannon Hatchery on 6 to 10 April 1987.

Year	Recovery Location	Agency	Observed	Estimated
1988	Tucannon Hatchery	WDFW	9	14
1989	Tucannon Hatchery	WDFW	23	46
	Test Fishery Net (Zone 4)	ODFW	1	1
Totals for tagcode: 63-34-42			33	61

Table 2. Observed and estimated recoveries of 1986 brood salmon released from Tucannon Hatchery on 11 to 13 April 1988. (Tagcode 63-41-46: 46,484 released). (Tagcode 63-41-48: 50,332 released). (Tagcode 63-33-25: 51,221 released).

Year	Recovery Location	Agency	Observed	Estimated
1989	Tucannon Hatchery	WDFW	20	22
1990	Tucannon Hatchery	WDFW	19	66
	Tucannon Spawning Ground	WDFW	5	
	Test Fishery Net (Zone 4)	ODFW	1	1
	Treaty Ceremonial (Bonn. Pool)	ODFW	1	2
1991	Tucannon Hatchery	WDFW	1	1
	Spawning Ground	WDFW	2	14
Totals for tagcode 63-41-46			49	105
1989	Tucannon Hatchery	WDFW	33	37
	Tucannon Spawning Ground	WDFW	1	
1990	Tucannon Hatchery	WDFW	17	60
	Tucannon Spawning Ground	WDFW	11	
	Freshwater Sport (Kalama R.)	WDFW	1	4
	Ocean Troll (Non-treaty)	CDFO	1	4
	Treaty Ceremonial (Bonn. Pool)	ODFW	1	2
1991	Tucannon Hatchery	WDFW	2	2
	Tucannon Spawning Ground	WDFW	1	7
Totals for tagcode 63-41-48			68	116
1989	Tucannon Hatchery	WDFW	21	22
	Treaty Troll (Area 4b)	WDFW	1	2
1990	Tucannon Hatchery	WDFW	22	76
	Spawning Ground	WDFW	10	
1991	Tucannon Hatchery	WDFW	1	1
Totals for tagcode 63-33-25			55	101

Appendix F (continued).

Table 3. Observed and estimated recoveries of 1987 brood salmon released (151,100) from Tucannon Hatchery on 11 to 13 April 1989.

Year	Recovery Location	Agency	Observed	Estimated
1990	Tucannon Hatchery	WDFW	5	23
	Tucannon Spawning Ground	WDFW	3	
1991	Tucannon Hatchery	WDFW	45	45
	Tucannon Spawning Ground	WDFW	20	143
1992	Tucannon Hatchery	WDFW	3	3
	Tucannon Spawning Ground	WDFW	5	17
	Treaty Ceremonial (John Day Pool)	ODFW	1	2
Totals for tagcode 63-49-50			**82**	**233**

Table 4. Observed and estimated recoveries of 1988 brood salmon released from Tucannon Hatchery from 30 March to 10 April 1990. (Tagcode 63-01-42: 70,459 released). (Tagcode 63-55-01: 68,591 released).

Year	Recovery Location	Agency	Observed	Estimated
1990	Fish Trap (Snake River)	WDFW	1	
1991	Tucannon Hatchery	WDFW	25	26
	Tucannon Spawning Ground	WDFW	4	29
1992	Tucannon Hatchery	WDFW	19	20
	Tucannon Spawning Ground	WDFW	47	162
	Test Fishery Net (Zone 4)	ODFW	1	1
	Treaty Ceremonial (Bonn. Pool)	ODFW	3	7
1993	Tucannon Hatchery	WDFW	4	4
	Tucannon Spawning Ground	WDFW	7	22
	Test Fishery Net (Zone 4)	ODFW	1	1
	Treaty Ceremonial (Bonn. Pool)	ODFW	1	2
Totals for tagcode 63-01-42			**113**	**273**
1990	Hatchery (Dworshak NFH)	IDFG	1	1
1991	Tucannon Hatchery	WDFW	12	12
1992	Tucannon Hatchery	WDFW	20	21
	Tucannon Spawning Ground	WDFW	38	131
	Freshwater Sport (Wind R.)	WDFW	1	4
	Test Fishery Net (Zone 4)	ODFW	1	1
	Treaty Ceremonial (Bonn. Pool)	ODFW	2	4
1993	Tucannon Hatchery	WDFW	3	3
	Tucannon Spawning Ground	WDFW	11	34
	Treaty Ceremonial (Bonn. Pool)	ODFW	2	4
Totals for tagcode 63-55-01			**91**	**216**

Appendix F (continued).

Table 5. Observed and estimated recoveries of 1989 brood salmon released from Tucannon Hatchery on 1 to 12 April 1991. (Tagcode 63-14-61: 75,661 released). (Tagcode 63-01-31: 22,118 released).

Year	Recovery Location	Agency	Observed	Estimated
1992	Tucannon Hatchery	WDFW	4	4
	Tucannon Spawning Ground	WDFW	2	7
1993	Tucannon Hatchery	WDFW	31	31
	Tucannon Spawning Ground	WDFW	41	128
	Test Fishery Net (Zone 4)	ODFW	2	2
	Treaty Ceremonial (Bonn. Pool)	ODFW	2	4
1994	Tucannon Hatchery	WDFW	9	9
Totals for tagcode 63-14-61			**91**	**184**
1993	Tucannon Hatchery	WDFW	6	6
	Tucannon Spawning Ground	WDFW	18	56
	Treaty Ceremonial (Zone 4)	ODFW	2	4
	Treaty Troll (Area 4b)	WDFW	2	2
1994	Tucannon Hatchery	WDFW	5	5
Totals for tagcode 63-01-31			**33**	**73**

Table 6. Observed and estimated recoveries of 1990 brood salmon released from Tucannon Hatchery from 30 March to 10 April 1992. (Tagcode 63-37-25: 13,480 released). (Tagcode 63-40-21: 51,149 released). (Tagcode 63-43-11: 21,108 released).

Year	Recovery Location	Agency	Observed	Estimated
1994	Tucannon Hatchery	WDFW	1	1
TOTALS FOR TAGCODE 63-37-25			**1**	**1**
1993	Tucannon Hatchery	WDFW	1	1
	Spawning Ground	WDFW	1	3
1994	Tucannon Hatchery	WDFW	9	9
TOTALS FOR TAGCODE 63-40-21			**11**	**13**
1993	Tucannon Spawning Ground	WDFW	1	3
1994	Tucannon Hatchery	WDFW	6	6
TOTALS FOR TAGCODE 63-43-11			**7**	**9**

Appendix F (continued).

Table 7. Observed and estimated recoveries of 1991 brood salmon released from Tucannon Hatchery on 6 to 12 April 1991. (Tagcode 63-46-25: 55,716 released). (Tagcode 63-46-47: 16,745 released).

Year	Recovery Location	Agency	Observed	Estimated
1994	Tucannon Hatchery	WDFW	1	1
1995	Treaty Ceremonial (Bonn. Pool)	ODFW	1	3
Totals for tagcode 63-46-25			**2**	**4**
1994	Tucannon Hatchery	WDFW	3	3
Totals for tagcode 63-46-47			**3**	**3**