TUCANNON RIVER SPRING CHINOOK SALMON HATCHERY EVALUATION PROGRAM

1996 ANNUAL REPORT

by

Joseph Bumgarner
Glen Mendel
Debbie Milks
Lance Ross
Jerry Dedloff
Michelle Varney

Washington Department of Fish and Wildlife
Hatcheries Program/Assessment and Developement Division
600 Capitol Way North
Olympia, Washington 98501-1091

to

U.S. Fish and Wildlife Service
Lower Snake River Compensation Plan Office
4696 Overland Road, Room 560
Boise, Idaho 83702
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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 April 1996 to April 1997.

Two adult collection traps were operated daily by hatchery personnel from 8 April through 19 September 1996. Our collection goal for hatchery broodstock was 50 natural and 50 hatchery salmon throughout the duration of the run. Total spring chinook captured at the Tucannon Hatchery weir/trap was 135 (76 natural, 59 hatchery). Eighty fish (35 natural, 45 hatchery) were collected for broodstock, 50 fish (40 natural, 10 hatchery) were passed upstream, and 5 died in the trap. Of the 135 fish captured in both traps, 30 were captured in the concrete hatchery trap and 105 in the river trap. Twenty-eight of 59 (47.5%) hatchery fish and two of 72 (2.6%) natural fish were captured in the concrete hatchery trap. Hatchery fish had no apparent preference for entering either trap, but natural fish preferred the instream river trap.

Broodstock spawning at Lyons Ferry FH occurred weekly from 20 August to 17 September, with peak eggtake on 10 September. Eighteen natural and nineteen hatchery females were spawned for a total eggtake of 117,287. Total mortality from green egg to ponding was 36,962 (31.5%), leaving 80,325 fry for production. A total of 20,292 dead eggs were picked at eye-up for an initial mortality of 17.3%. An additional 13,416 fry were lost when a valve on one of the incubator stacks clogged with sediment. An additional 3,254 sacfry were lost before ponding. Total mortality from green egg to ponding was 36,962 (31.5%), leaving 80,325 fry ponded on 18 March.

Of the fifty fish passed upstream in 1996, seven natural (21.8%; five females, two males) and three hatchery (30.0%; two females, one male) salmon were recovered as mortalities on the upstream side of the weir. During 1992 and 1993, and most recently 1996, we documented relatively high rates (17-24%) of pre-spawning mortality in the river. We speculate that much of the pre-spawning mortality is linked with either physical damage, gas bubble trauma, or both caused by high spill at Snake and Columbia River dams. In addition, our data shows that hatchery females are more affected by this problem than males, or natural females.

We surveyed the spawning grounds on the Tucannon River and North Fork Asotin Creek in 1996. We located 69 redds and recovered 46 natural and 14 hatchery carcasses on the spawning grounds in the Tucannon River. Based on the redd counts, broodstock collected and pre-spawning mortalities, we estimate the total escapement to the Tucannon River to be 247 fish. No redds or carcasses were located on North Fork Asotin Creek.

Evaluation staff tracked four spring chinook that were radio tagged by the University of Idaho at Bonneville Dam and returned to the Tucannon River. All four fish (3 males, 1 female) survived into the spawning season. Movements of the radio tagged female, along with temperature data in the lower Tucannon River suggest her migration upriver into the Tucannon was blocked for most of summer by a thermal barrier.

Because of the poor adult returns in 1994 and 1995, we initiated a captive broodstock program with 1995 brood juveniles. Two hundred juveniles from 15 unique families were reared separately until mid-September, 1996. Following the improved returns of spring chinook in 1996, and a better run forecasted for 1997, we discontinued the captive broodstock program and combined the fish with the general population. Mortality of the captive brood reared fish were low (≈3.0%), and were similar to the main group of fish.

A total of 42,160 smolts were released from the acclimation pond at Tucannon Hatchery over 43 days from 7 march to 18 April. An additional 10,045 smolts were released from the Curl Lake acclimation ponds, and 9,811 were released directly into the Tucannon River. Each release group (by location) had unique coded-wire tags and Visual Implant elastomer tags. A portion of each release group was also PIT tagged to continue our study of release types. PIT tag detections at Snake and Columbia River dams suggest no difference in relative survival between a direct stream or an acclimated release.

Subyearling and yearling chinook salmon parr production in the Tucannon River was estimated at 0 and 632 fish, respectively, from snorkel surveys. We also operated a downstream migrant trap to estimate natural smolt migration. We estimate that 5,000 to 9,000 natural smolts migrated past the trap during the 1995/1996 season.

Estimated smolt-to-adult survivals for the 1991 brood of natural and hatchery salmon were both 0.03%, well below the established mitigation goal of 0.87%. On average, adult-to-adult survival for hatchery fish is four times greater than natural fish. The hatchery population has generally been able to replace themselves; the natural fish have not.

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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 Hatchery[1] was constructed and Tucannon Hatchery was modified. One objective of these hatcheries is to compensate for the loss of 1,152 Tucannon River spring chinook salmon[2], caused by 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, and 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 April 1996 through April 1997. It also includes the 1995/1996 smolt trapping record.

Lyons Ferry is located at the confluence of the Palouse River and the Snake River at river kilometer (Rk) 90. The hatchery uses pathogen free well water (constant temperature 51.8 °F). The Tucannon Hatchery (Rk 58) operates a trapping facility for collection of returning adult salmon and has a large acclimation raceway for release of yearling progeny (Figure 1). Well water and river water are available at Tucannon Hatchery. 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 additional rearing. A portion of each year's brood are released on-station from the acclimation pond at Tucannon Hatchery, following 3-4 weeks of acclimation with Tucannon River water (3-4 weeks); the remainder are released upstream of the hatchery either directly to the river, or at portable acclimation sites. The 1995 brood production goal was 132,000 fish for release as yearlings at 15 fish per pound (FPP).

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1 The term "Lyons Ferry" refers to Lyons Ferry Hatchery.

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

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

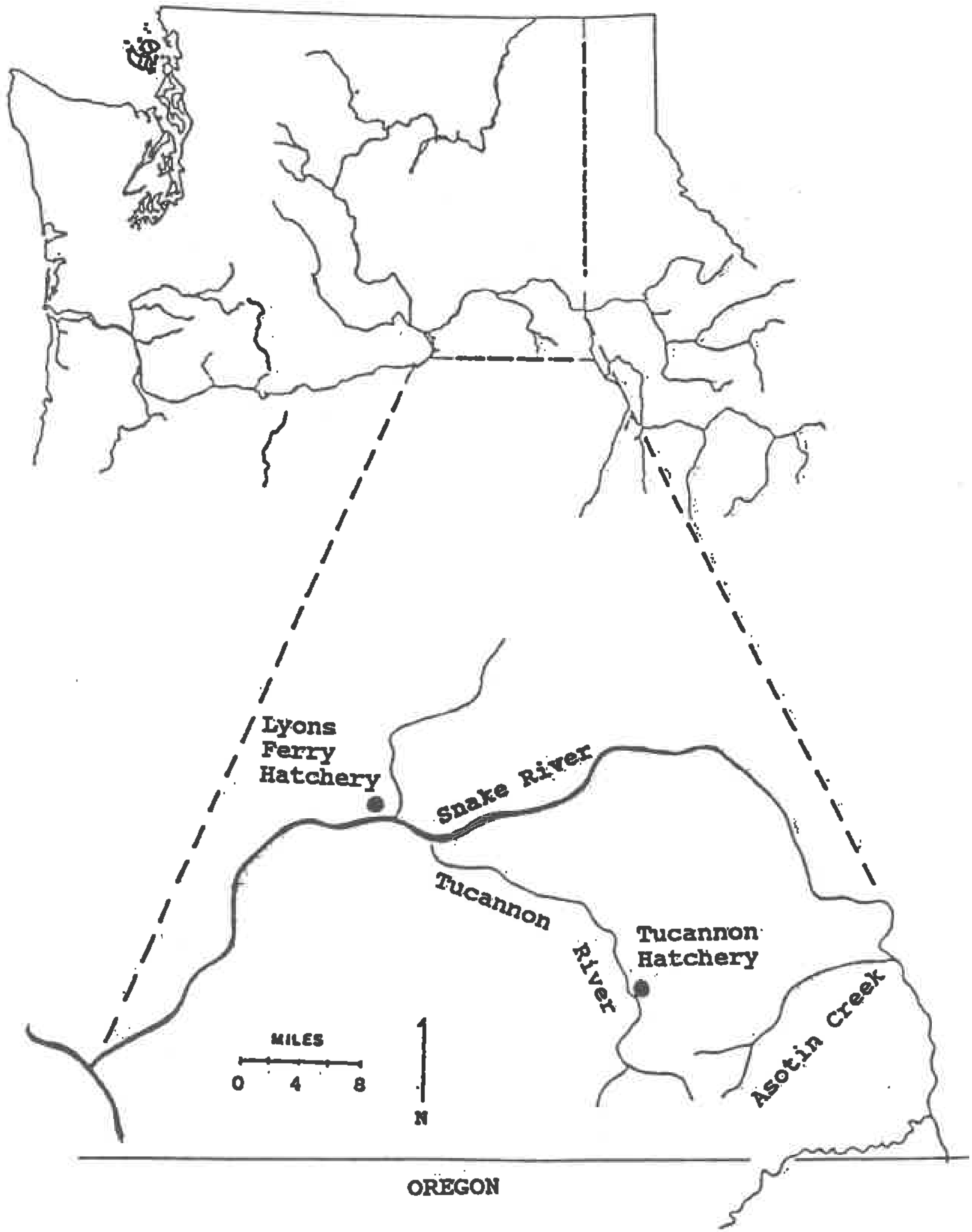

Figure 1. Location of the Tucannon River, and Lyons Ferry and Tucannon Hatcheries within the Lower Snake River Basin.

1.2: Tucannon River Watershed Characteristics

The Tucannon River is a third-order stream that flows through varied habitats which affect 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 (Table 1).

Table 1. Descriptions of five strata within the Tucannon River basin.

Strata	Land Ownership/ Usage	Spring Chinook Habitat	River Kilometer/ Description
Lower	Private Agriculture/Ranching	Not-Usable (temperature limited)	(0.0-21.0) Mouth to HWY 12 Br.
Marengo	Private Agriculture/Ranching	Marginal (temperature limited)	(20.1-39.9) Hwy 12 Br. to Marengo Br.
Hartsock	Private Agriculture/Ranching	Fair to Good	(39.9-55.5) Marengo Br. to Cummings Br.
HMA (Habitat Mgt Area)	State/Forest Service Recreational	Good	(55.5-74.5) Cummings Br. to Panjab Br.
Wilderness	Forest Service Recreational	Excellent	(74.5-86.3) Panjab Br. to Ruckerts Camp

We installed nine continuous-reading thermographs to record daily minimum and maximum water temperatures throughout the year in the Tucannon River. In addition, river discharges are periodically measured at Tucannon Hatchery (Rk 58), the Tucannon smolt trap Location (RK 21), and Smith Hollow Bridge (Rk 12.7). Temperatures and discharge measurements are on file at our Dayton office.

SECTION 2: ADULT SALMON EVALUATION

2.1 Hatchery Operations

2.1.1: Broodstock trapping

Two adult collection traps were operated daily by hatchery personnel from 8 April through 19 September 1996. Bedload movement from flooding in 1996 precluded use of the old weir and made the old trapping site nearly inoperable. An 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 old concrete trap. The outlet flow of water from the hatchery was modified to provide attraction water through the concrete trap. Our collection goal for hatchery broodstock was 50 natural and 50 hatchery salmon throughout the duration of the run. Returning hatchery salmon are identified by the lack of adipose-fins and presence of a coded-wire tag (CWT).

In 1996, 135 salmon were captured in the Tucannon Hatchery traps. Eighty fish were collected for broodstock, 50 fish were passed upstream for natural spawning, and five fish (one natural male, four hatchery jacks) died in the traps (Appendix A).

Of the 135 fish captured in both traps, 30 were captured in the concrete hatchery trap and 105 in the river trap. Twenty-eight of 59 (47.5%) hatchery fish and two of 72 (2.6%) natural fish were captured in the concrete hatchery trap. We found a statistical difference in the total number of fish caught in each trap ($\chi^2 = 38.6$, $p<0.001$). Hatchery fish had no apparent preference for entering either trap, but natural fish preferred the instream river trap. Data collected in 1995 supports this difference in trap preference (suggested there was some trap preference between the natural and hatchery fish, Bumgarner et al. 1996). Natural fish are readily bypassing the hatchery effluent, while about half of the hatchery fish returning are attracted to the hatchery effluent. We believe continued releases of hatchery juveniles in the watershed from portable acclimation sites or directly to the river upstream of the hatchery should encourage returning hatchery adults to spawn at upstream locations.

2.1.3: Broodstock Pre-Spawning Mortality

Five of 80 (6.25%) salmon collected for broodstock died from unknown causes before spawning in 1996. Two natural females and three hatchery fish died (2 males, 1 female[1]). The percent of pre-spawning mortality in 1996 is comparable to the mortality experienced since we began holding broodstock at Lyons Ferry in 1992 (Table 2). Pre-spawning mortalities prior to holding broodstock at Lyons Ferry were considerably higher.

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1 The Coded-wire tag from the hatchery female indicated this fish was released from the Umatilla River.

Table 2. Numbers of pre-spawning mortalities and percent of the number collected for broodstock at Tucannon Hatchery and held either at Tucannon Hatchery (1985-1991) or Lyons Ferry (1992-1996).

Year	Natural			Percent of Collected	Hatchery			Percent of Collected
	male	female	jack		male	female	jack	
1985	3	10	0	59.1	-	-	-	-
1986	15	10	0	21.6	-	-	-	-
1987	10	8	0	17.8	-	-	-	-
1988	7	22	0	25.0	-	-	9	100.0
1989	8	3	1	17.9	5	8	22	34.3
1990	12	6	0	30.0	14	22	3	52.0
1991	0	0	1	2.4	8	17	32	64.0
1992	0	4	0	8.5	2	0	0	4.0
1993	1	2	0	6.0	2	1	0	6.4
1994	1	0	0	2.8	0	0	0	0.0
1995	1	0	0	10.0	0	0	3	9.1
1996	0	2	0	5.7	2	1	0	6.7

2.1.3: Spawning

Spawning at Lyons Ferry FH occurred weekly from 20 August to 17 September, with peak eggtake on 10 September (Table 3). To ensure enough males would be available throughout spawning, all males were live spawned (with the exception of the final spawn) according to the spawning protocol (Appendix B). All of the adipose fin clipped hatchery salmon spawned for broodstock in 1996 were of Tucannon/Lyons Ferry origin.

One spawned female, initially identified as natural origin, was later determined by scale pattern analysis to be a fish of unknown hatchery origin. Freshwater scale patterns from this fish were similar to other Tucannon Hatchery fish (John Sneva, WDFW, pers. comm.). From 1988-1996, 475 hatchery fish were collected for broodstock, of which 6 (1.2%) were strays. Therefore, we feel the probability of this unidentified fish being non-Tucannon origin is small. Progeny from this fish were included as part of the hatchery production.

Table 3. Spawning, egg collection, and holding mortalities of Tucannon natural and hatchery spring chinook salmon at Lyons Ferry FH in 1996.

Week Ending	Natural salmon spawned male	Natural salmon spawned female	Natural salmon mortality male	Natural salmon mortality female	Estimated Eggs taken	Hatchery salmon spawned male	Hatchery salmon spawned female	Hatchery salmon mortality male	Hatchery salmon mortality female	Estimated Eggs taken
13 Jul				1				1		
20 Jul				1				1		
03 Aug									1	
31 Aug		1			3,098		2			5,710
07 Sep		3			10,791		7			19,763
14 Sep	4	6			21,376	2	7			20,932
21 Sep	11	8			28,014	21	3			7,603
Totals[a]	15	18		2	63,279	23	19	2	1	54,008

a Most males were live-spawned and tallied as spawned on the day they were killed.

A total of 117,287 eggs were collected. Egg picking at eye-up was completed on 2 December, with 17.3% mortality (20,292 dead eggs); leaving 96,996 eggs. Unfortunately, a valve on one of the incubator stacks clogged with sediment on 26 December, considerably reducing the flow of fresh water. All live eggs and sacfry from five females in that stack died (13,416 total). An additional 3,254 sacfry were lost before ponding. Total mortality from green egg to ponding was 36,962 (31.5%), leaving 80,325 fry ponded on 18 March.

2.1.4: Holding, disease incidence and treatments

Salmon captured for broodstock were hauled from the traps to Lyons Ferry each day fish were collected. Fish were injected with 0.5 cc/4.5 kg of fish weight of both erythromycin and oxytetracycline when trapped, and twice again with erythromycin before spawning. Three year-old salmon (jacks) were injected with half the dosage to prevent toxicity. Drip treatments of formalin (1:7,000 dilution for 2 hours) were applied to adults every other day to control fungus. No disease outbreaks occurred in the adult salmon in 1996. Fertilized eggs were disinfected and water hardened for one hour in iodophor (100 ppm) before being placed in the incubation stacks. Formalin treatments (1,700 ppm) were given every day to control fungus on the incubating eggs.

2.1.5: Fecundity, age and sex structure

Eighteen natural and 19 hatchery females were spawned in 1996 (Table 2). Seventeen of the 18 natural females spawned were age 4_2 (mean fecundity = 3,509 eggs, sd=534.3; mean Post-eye to hypural-plate (PE) length = 57.7 cm, sd=2.76). The age 5_2 natural female was 61 cm (PE length) and had 3,617 eggs. Hatchery females consisted entirely of age 4_2 fish (mean fecundity = 2,843 eggs, sd=490.3; mean PE length = 57.6 cm sd=2.57).

Sex ratio of natural and hatchery salmon collected for broodstock was 1.33:1 and 0.80:1 females/male, respectively. Age composition of all natural fish collected for broodstock (Appendix C) was 96.0% age 4, and 4.0% age 5. Age composition of hatchery fish collected for broodstock was 15.6% age 3, and 84.4% age 4. Age composition of broodstock was not similar to previous years. Generally, 20-25% of the natural fish are five year-olds. This shift in age composition from previous years was expected because of poor returns in the previous two years.

2.2 In River Evaluation

2.2.3: Pre-spawning mortality

We conducted pre-spawning mortality surveys on 25 June and 2 July. We also randomly searched for carcasses while conducting snorkel, habitat, and electrofishing surveys. We did not find any salmon carcasses on pre-spawning mortality surveys, but we did find one dead hatchery female on 8 August while snorkeling. The carcass was about 8km downstream of the weir. No apparent cause of death could be determined from external examination of the fish, though the head had some fungus on it.

Fifty fish (40 natural, 10 hatchery) were passed upstream of the weir in 1996. Of the fish passed upstream, seven natural (21.8%; five females, two males) and three hatchery (30.0%; two females, one male) salmon were recovered as mortalities on the upstream side of the weir. All pre-spawning mortalities on the weir were recovered by 29 July. Of the ten total pre-spawning mortalities, eight died by the first week of July, or within three to four weeks of the earliest day they were passed. All mortalities had fungus patches on the head and tail, which likely contributed to the cause of death. Fungus patches had grown over areas where injuries had been documented on some the fish. We do not believe that the traps were responsible for these injuries as many of the injuries appeared older.

During 1992 and 1993, and most recently 1996, we documented relatively high rates of pre-spawning mortality in the river (Table 4), as compared with other years (1990, 1991, ≈1%). Pre-spawning mortality during these three years ranged from 17-24 percent of the fish passed upstream. We speculate that much of the pre-spawning mortality is linked with either physical damage or gas bubble trauma or both caused by high spill at Snake and Columbia River dams. Our data shows that hatchery females are more affected by this problem than males, or natural females. In cooperation with other agencies, we will attempt to collect more specific data regarding injuries to fish as they arrive at the Tucannon traps in 1997.

Table 4. Numbers of fish passed upstream of the Tucannon weir/trap by July 10, recovered mortalities from fish passed upstream, general injury location on examined carcasses, and the total number and percent of female pre-spawning mortalites (upstream of the weir) for that year.

	1992		1993		1996	
	#	%	#	%	#	%
Fish passed upstream	376		304		42	
Total mortality	61	16.2	54	17.8	10	23.8
Fish with injuries (fungus)	26	42.6	25	46.3	10	100.0
Injuries (head region)	17	27.9	22	40.7	10	100.0
Injuries (non-head region)	9	14.8	3	5.6	0	0.0
Female prespawning mortalites[a]	50	82.0	36	66.7	7	70.0

a Hatchery females pre-spawning mortalities were as follows: 38 in 1992, 30 in 1993, and two in 1996. Ten hatchery fish were passed upstream in 1996.

2.2.2: Spawning ground surveys

We surveyed salmon spawning grounds in North Fork Asotin Creek (Table 5) on 7 and 28 September. No salmon redds, carcasses or live adult salmon were seen on either survey. Counts from redd surveys since 1984 indicate that the North Fork Asotin spring chinook salmon run has been extirpated. Any adult salmon that return in the future will probably be strays from nearby systems.

Table 5. Number of salmon redds, live fish, and carcasses observed on North Fork Asotin Creek from 1984-1996.

Year	Number of Redds	Number of Live Fish	Carcasses
1984	21	12	5
1985	8	7	1
1986	1	3	0
1987	3	6	0
1988	1	0	0
1989	0	0	0
1990	2	0	0
1991	0	0	0
1992	0	0	0
1993	2	0	1
1994	0	0	0
1995	0	0	0
1996	0	0	0

We surveyed the spawning grounds in the Tucannon River (Table 6) 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 28 August to 4 October. We located 69 redds and recovered 46 natural and 14 hatchery carcasses in 1996.

Sex ratios of natural and hatchery salmon carcasses collected from the Tucannon River (pre-spawning mortalities and spawning ground surveys) were 0.8:1 and 1.5:1 females/male, respectively. Age composition of all natural fish carcasses from the river was 2.0% age 3_2 and 98.0% age 4_2. Age composition of hatchery fish carcasses from the river was 21.0% age 3_2 and 79.0% age 4_2. The sex ratio comparisons between broodstock collection and river carcasses are different because female tend to stay close to their redds and their carcasses are more readily recovered following spawning. Age composition data between the broodstock collection and river carcass recoveries were similar for both natural and hatchery salmon.

Table 6. Numbers of salmon redds observed and general location of natural and hatchery salmon carcasses recovered during spawning ground surveys on the Tucannon River 1996.

Stratum	River kilometer	Number of redds	Carcasses recovered: Natural male	Natural female	Hatchery male	Hatchery female
Wilderness	86-78					
	78-75	1				
HMA	75-73		1			
	73-68	3		1		1
	68-66					
	66-62	2	1	2		
	62-59					
	59-58	5	4	2	1	1
-Tucannon Fish Hatchery Weir-						
	58-56	23	5	11	4	3
Hartsock	56-52	21	1	9	1	
	52-47	10	5	1		1
	47-43	1			1	
	43-40	2	1	1		1
Marengo	40-34					
Lower	34-0	1		1		
Totals	86-0	69	18	28	7	7

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.; 0:Tucanon River mouth.

2.2.3: Radio Telemetry

The University of Idaho radio tagged 703 spring chinook salmon at Bonneville Dam between 4 April and 29 May, 1996. We tracked the movements of four (0.57%) of those tagged salmon as they entered and traveled up the Tucannon River (Figures 2 and 3, Appendix D). Fixed site receivers were located on the Tucannon River at the downstream migrant trap (Rk 21, 16 May to 12 August) and intermittently at each of the adult traps at the Tucannon Hatchery (Rk 58, 10 June to 9 September). During times when fish were actively moving upstream or during spawning, we tracked at least every three days. Tracking was

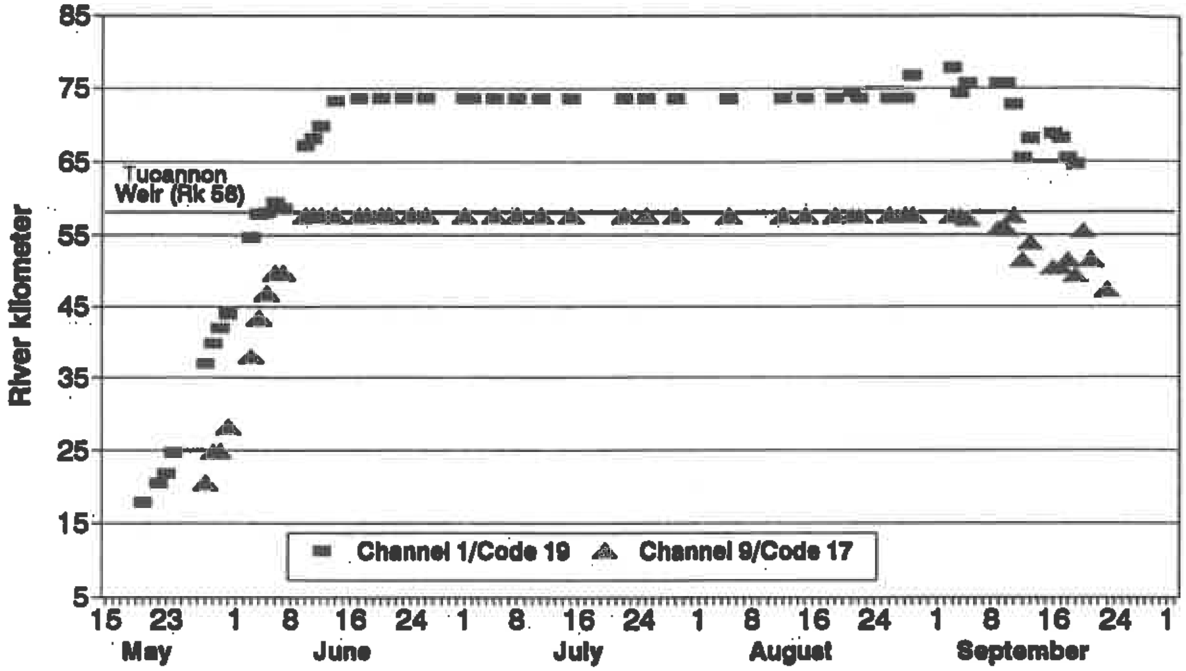

Figure 2. Movements of two University of Idaho radio tagged salmon (channel/code 1/19 and 9/17), tagged and released from Bonneville Dam and tracked in the Tucannon River, 1996.

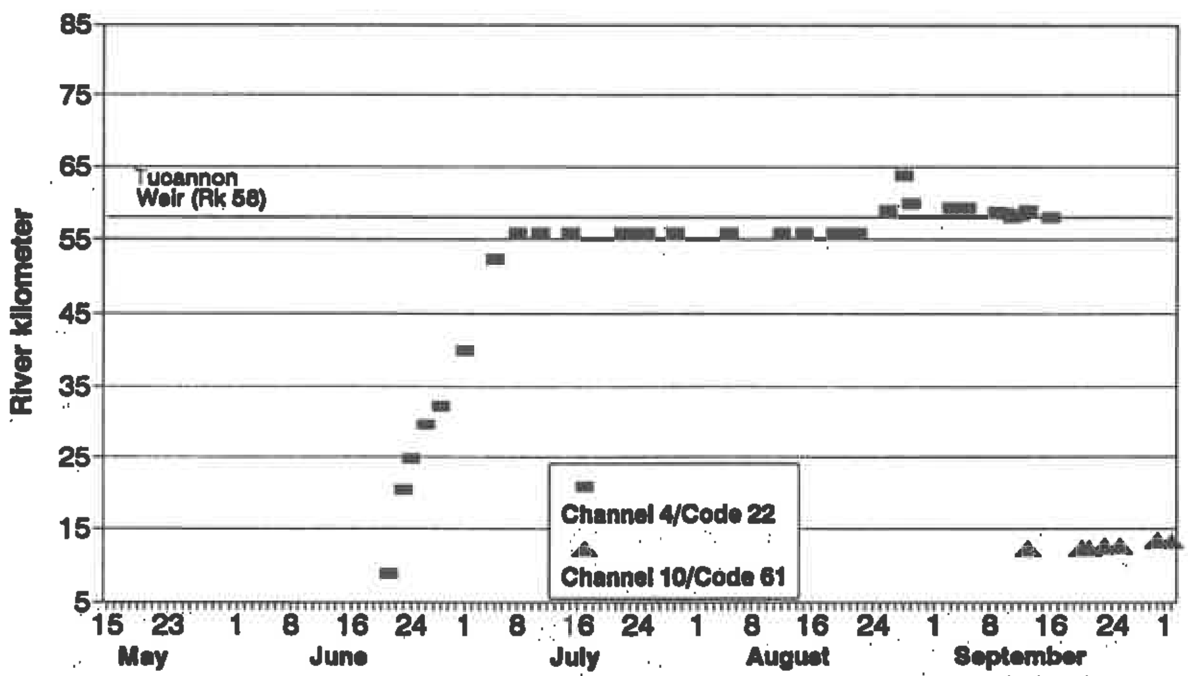

Figure 3. Movements of two University of Idaho radio tagged salmon (channel/code 4/22 and 10/61), tagged and released from Bonneville Dam and tracked in the Tucannon River, 1996.

reduced in mid-summer when fish were holding in one location (mid June - mid August). Salmon holding for long periods of time in one location were precisely located by snorkel observations. This verified if the radio tag was still in the salmon or had been regurgitated. We recovered all four radio tags, and positively identified three of the four carcasses following spawning (Table 7).

Table 7. Radio tagging and recovery data of four spring chinook salmon tagged by the University of Idaho at Bonneville Dam and recovered in the Tucannon River in 1996.

	Tagging Information					Recovery Data				
Channel/ Code	Date	Origin	Sex	F.L. (cm)	VI tag	Date	Sex	F.L. (cm)	VI tag	Spawned
1/19[a]	4/27	wild	F	74.0	JE6	9/19	M	74	none	Yes
4/22	5/12	hat.	M	69.5	MK9	9/16	M	70	MK9	Yes
9/17	5/06	wild	M	66.0	JW0	9/23	M	68	JW0	Yes
10/61	5/23	wild	F	72.5	NN2	10/02	??[b]			

a Fish was initially identified as female at tagging, but was confirmed to be a male upon carcass recovery.

b A redd was located ≈20m from the carcass, but sex was not confirmed from the carcass. Assuming the tagging data is correct, we believe this female spawned.

<u>Upstream migration:</u> Two of the radio tagged salmon (channel/code 1/19 and 9/17) entered the Tucannon River in May; passing the juvenile migrant trap location, 22 and 25 days after tagging, respectively. One radio tagged salmon (4/22) entered the Tucannon River in June; passing the smolt trap 42 days after tagging. Radio tagged fish 1/19, 9/17 and 4/22 quickly moved up the river at an average rate of 2.5 km/day (s=0.47, Figures 2 and 3). All three fish quickly established a "holding site" (remained relatively stationary for weeks with relatively short movements between holding areas; <100m). Passage rates through the lower Tucannon River in 1996 were faster than those documented for radio tagged fish tracked in 1993 (1.6 km/day, s=0.85, N=13).

The fourth radio tagged fish (10/61) probably entered the river in early to mid-September. We had tracked the lower river to the mouth on 5 August, and this fish was not detected. We believe a thermal barrier (maximum temperatures generally above 70°F) was established in the lower Tucannon River by 24 June. Minimum and maximum water temperatures at Rk 3.7 from 21 June (same day 4/22 was detected at Rk 8.8) and 5 August (last day we tracked to the mouth) ranged from 58-69°F and 60-77°F, respectively. Maximum water temperatures at

Rk 3.7 did not remain below 70°F until 8 September, shortly before radio tagged salmon 10/61 was detected at Rk 12.3 on 20 September. Radio tagged salmon 10/61 may have remained in the Snake River until the Tucannon River cooled in late summer.

While the data is limited, fish tagged earlier in the run (1/19 and 9/17), made it to the Tucannon River faster than fish tagged later in the run (4/22 and 10/61). Many factors have been associated with delayed migration. High spill conditions generally result in poor fishway entrance conditions at the dams. Radio telemetry and tracking reports suggest that higher spill levels can cause a fallback rate as high as 25%. Increases in dissolved gases below dams are associated with the increased spill, potentially causing additional trauma to the salmon. All of these factors may have delayed migrating salmon in 1996. Also, salmon not entering the lower Tucannon River before the middle of June may have been forced to stay in the Snake River until the thermal barrier dissipated (Figure 4).

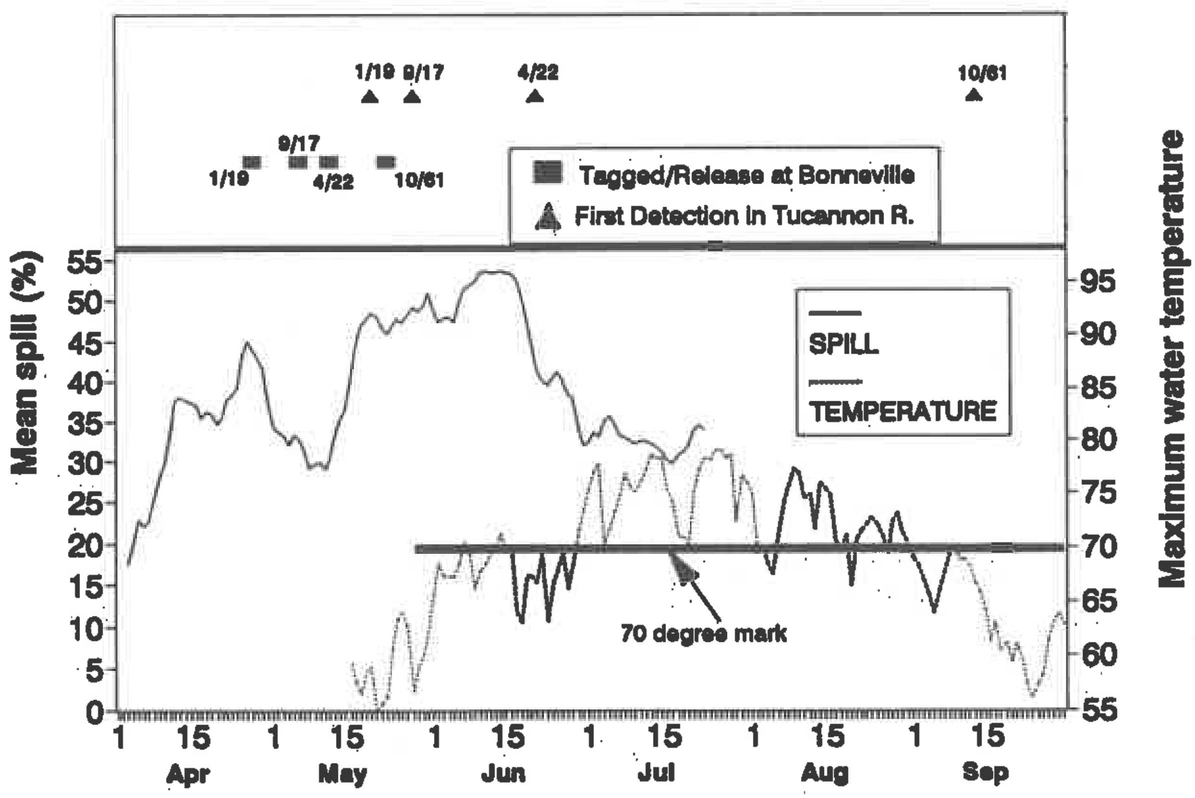

Figure 4. Mean percent spill (Lower Monumental, Ice Harbor, McNary, John Day, and The Dalles dams), maximum daily water temperatures recorded at Rk 3.7 in the Tucannon River in relation to radio tagged salmon (dates of tagging and first detections in Tucannon River), 1996.

Delayed upstream migration and the thermal barrier in the Tucannon River may also explain why one spring chinook (Tucannon River origin) was captured with fall chinook trapped at Lyons Ferry in September. This fish died on 26 September, concurrent with final spawning days on the Tucannon River. Cool water (53°F) exiting Lyons Ferry may have provided a refuge for this fish throughout the summer. It is unknown if additional salmon destined for the Tucannon River were unable to enter because of high water temperatures in the lower Tucannon River.

<u>Salmon movements:</u> Each of the three radio tagged male salmon in the upper Tucannon River held in one location during most of the summer. Tagged fish generally held in a pool or deep run associated with undercut banks, or woody debris. Movements of these three salmon increased in late August and early September as spawning time approached. Following spawning, two males (1/19 and 9/17) moved downstream, either from weakness after spawning, or to find additional females with which to spawn (Figure 5). Radio tagged male salmon 4/22 also moved downstream as far as the Tucannon weir. Salmon 4/22 was recovered ≈20m upstream of the weir.

In the past we have speculated that the Tucannon weir acted as a barrier and influenced the upstream movement of salmon. Two of the radio tagged salmon remained a short distance below the weir (0.5 to 0.8 km) for most of the summer. One of the fish below the weir eventually passed the trap in late August, consistent with other fish moving upstream as spawning approached. None of the radio tracking data collected in 1996 suggested that the weir was acting as a deterrent to upstream movement.

<u>Spawning:</u> All three males are believed to have spawned (Figure 5). Radio tagged salmon 1/19 was observed actively spawning with a hatchery female in the Wilderness Stratum. While it moved downstream, it passed areas where females and redds were located, but we can't confirm if it spawned again. We also believe radio tagged salmon 4/22 spawned once (was observed on a redd though no female was present at observation time). We believe radio tagged salmon 9/17 spawned with three different females in different locations within a 5 km stretch of river. He was observed either on a redd next to the female, or within close proximity (≈20m) to redds with females on them. We documented similar multiple spawning by a male in 1993 (Bumgarner et al, 1994).

One redd and one carcass (radio tagged salmon 10/61) were located at Rk 13.3. The fish had been partially eaten so we could not determine the sex. We believe the carcass was the radio tagged fish as it was tracked to this same location just two days before. Spring chinook redds are not normally found this low in the river. Because of the late arrival and lower river spawning location, we initially suspected this radio tagged fish to be a summer chinook. However, according to the date it was tagged at Bonneville Dam, it was a spring chinook. The Tucannon River is not known to have a summer chinook run, though we did track one radio tagged summer chinook in the Tucannon River during 1993. The radio tag was recovered at Rk 28.4, but we never found the carcass or located a redd in the general area of holding. Old redds have occasionally been seen in the lower river in fall, but we could never confirm whether they were spring, summer, or fall chinook redds.

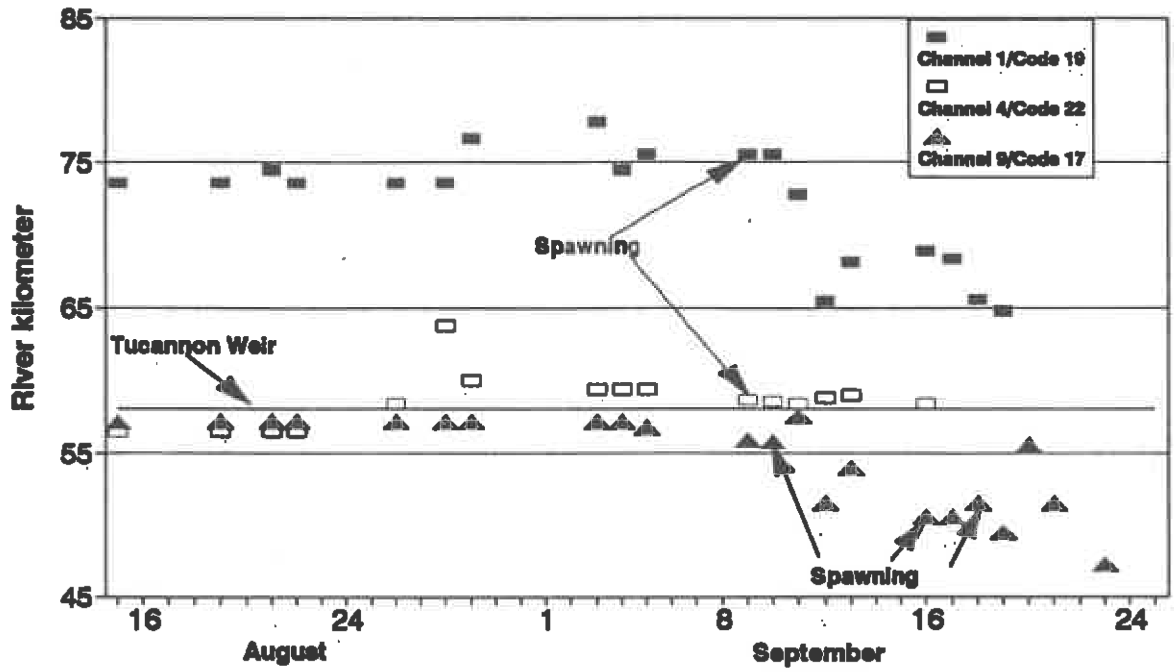

Figure 5. Confirmed spawning activity of three University of Idaho male radio tagged salmon (channel/code 1/19, 4/22, and 9/17) in the Tucannon River, 1996.

2.2.2: Total escapement

We have estimated the total escapement to the Tucannon River for 1985-1996 based on redd counts (Table 7). Escapement estimates in 1996 were calculated by adding the number of fish passed upstream of the Tucannon weir (50), the estimated fish below the weir (assuming 2.0 fish/redd ratio (116)), the number of known pre-spawning mortalities below the weir (1), and the number of broodstock collected (80). The estimated total escapement for 1996 is 247, fourteen fish (9.5%) less than the 261 fish predicted from our escapement model. Our current escapement model estimates that 3.4% of the fish crossing Ice harbor Dam (IHR) will return to the Tucannon River, and that 2.2% of the IHR count will be trapped at the Tucannon weir.

The fish/redd ratio used in our escapement estimate for 1996 is based on the sex ratio of broodstock. Normally, the fish/redd ratio is calculated by the number of fish passed upstream, from which pre-spawn mortalities are subtracted, divided by the number of redds above the weir. This formula produces a 3.6 fish/redd ratio. Using a fish/redd ratio of 3.6 would inflate the run estimate by 93 fish; a 40% increase in estimated run size. By examining the number of live fish observed during spawning ground surveys, we do not believe that an additional 93 fish were present in the river. We therefore used the conservative estimate of 2.0 fish/redd.

Table 8. Estimated spring chinook salmon escapement to the Tucannon River, 1985-1996.

Year	Total Redds Above Weir	Total Redds Below Weir	Fish/ Redd Ratio[b]	Estimated Fish in the River	Broodstock Collected		Pre-Spawning Mortalities		Total Escapement[a]	Percent Natural
					Natural	Hatchery	Natural	Hatchery		
1985	189	- -	2.85	539	22	- -	- -	- -	561	100.0
1986	163	37	2.85	570	116	- -	- -	- -	686	100.0
1987	149	36	2.85	527	101	- -	- -	- -	628	100.0
1988	90	27	2.85	333	126	7	- -	- -	466	96.1
1989	74	32	2.85	302	78	102	- -	- -	482	77.2
1990	96	84	3.36	605	66	68	- -	6	745	66.4
1991	40	50	4.25	383	41	89	- -	8	521	49.1
1992	130	70	2.92	575	47	50	22	50	753	55.4
1993	131	61	2.27	433	50	47	11	43	586	53.6
1994[c]	2	42	1.59	70	36	34	- -	- -	140	70.0
1995[c]	0	5	2.13	11	10	33	- -	- -	54	38.9
1996[d]	11	57	2.00	35	35	45	7	3	247	66.0

a Escapement is 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 the river. The number of broodstock collected and prespawning mortalities were added to give total escapement. By applying the estimated percentage of natural fish above and below the weir, run composition (natural and hatchery was calculated.

b Fish/redd ratios were 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 were 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.

c 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 0.95 female/male sex ratio in 1995 calculated from broodstock collections.

d Due to high pre-spawning loss of fish passed upstream, we are unsure of the actual number of spawners available above the weir. We assumed a fish/redd ratio of 2.00 based on broodstock collection

SECTION 3: JUVENILE EVALUATION

3.1: Hatchery Rearing and Releases

3.1.1. Juvenile rearing

Throughout rearing, we periodically measure lengths and weights for historical comparisons (Table 8). In addition, it provides us the chance to examine the fish, and to test new procedures for pond inventory. The fish were tagged from 9-13 September with three different CWT and Visual Implant Elastomer tags (VI) which were dependent on release site or type: 42,251 right red, Tucannon acclimation pond release; 10,117 left blue, Curl Lake acclimation; 9,878 right blue, direct stream release (Appendix E).

Table 9. Summary of length (mm) and weight (g) data collected on the 1995 brood juveniles at Lyons Ferry and Tucannon Hatcheries in 1996.

Date	Pond/ Group	N	Mean Fork Length	Coefficient of Variation	Mean Weight	Fish/lb	K-factor
6/25	Pond #1	253	72.2	6.13	4.43	102.4	1.17
	Cap Br	1,091	80.2	9.61	6.20	77.4	1.14
7/30	Pond #1	249	81.1	10.81	6.52	69.6	1.22
8/27	Cap Br	864	95.7	10.80	- -	- -	- -
9/03	Pond #1	197	99.7	15.13	12.46	36.4	1.26
10/16-17	Right Red VI	252	103.6	14.13	14.36	31.6	1.29
	Left Blue VI	250	101.5	13.94	13.60	33.4	1.30
	Right Blue VI	263	99.8	12.52	13.50	33.6	1.36

The mean lengths of fish sampled on 25 June (Pond One and captive broodstock tanks) were significantly different ($t=14.5$, $p<0.0001$). Captive broodstock fish were fed intensively during the first few months of rearing, while the fish in Pond One were fed a standard maintenance diet to achieve the release goal of 15 fish/lb. When the decision was made to discontinue the captive broodstock program, feeding schedules and amount fed were cut back so the fish would be in size with the rest of the release population.

Fish collected on 3 September was 36.4 fish/lb. Hatchery staff did pound counts in the same pond two days earlier and came up with 46 fish/lb, equal to nearly an eight millimeter difference in fork length if the conversion is made. Examination of our sample data indicated a bi-modal distribution in length. Bi-modal distributions have been documented in the past so we are unsure if this distribution existed in the pond, or if our sample was biased. A standardized sampling procedure for both the evaluation crew and hatchery staff would eliminate discrepancies in fish size.

3.1.2: Captive broodstock rearing

Because of the poor adult returns in 1994 and 1995, we initiated a captive broodstock program with 1995 brood juveniles. We felt it would provide an "insurance policy" in case the run in 1996 was again critically low, endangering the stock from potential recovery. Fifteen individual rearing tanks were set up in a raceway at Lyons Ferry. Two hundred juveniles from 15 unique families were reared separately in each tank until mid-September, 1996. Following the improved returns of spring chinook in 1996, and a better run forecasted for 1997, we discontinued the captive broodstock program and combined the fish with the general population.

Selection of progeny for the captive broodstock program was determined by the origin of females, and subsequent crosses with either natural or hatchery males. After the selection had been made and as fish were being placed into the tank, it became apparent that some of the progeny from two females were deformed (missing maxilla, eyes, snout, extra fins or eyes, and odd coloration). One female at the beginning of spawning season had been fertilized with fresh semen and cryopreserved semen (as a backup male). We had originally speculated the deformed fish may have been caused by the frozen semen, but then the other female (spawned with semen from two fresh males) showed similar deformities. We have no explanation for the cause of the deformities.

During ponding of the captive broodstock from these two females, we attempted to exclude any deformed fish. Immediately before tagging, we sampled all fish from Tank 15 to record the incidence of deformities in that tank. Tank 1 had been combined with other tanks before we could sample. During tag retention sampling at Tucannon Hatchery on 16,17 October, and on release sampling in March, we recorded the incidence of abnormalities remaining in the population (Table 9).

Table 10. Incidence and type of deformities from captive broodstock Tank 15 on 10 August, and entire population of chinook at Tucannon Hatchery on 16,17 October, 1996, and 3, 19, and 20 March, 1997.

Description	Tank 15 (August)		Tuc. Hat (October)		Tuc. Hat (March)	
	#	%	#	%	#	%
Normal	100	64.5	2,953	99.7	1,968	99.19
Missing eye	18	11.6	3	0.09	7	0.35
Snout[a]	7	4.5	2	0.06	1	0.05
Fin	2	1.3	1	0.03	1	0.05
Discoloration	28	18.1	4	0.14	7	0.35

a Snout deformities include missing/truncated snout and missing maxilla or jaws.

We did not closely monitor the rearing of the captive broodstock population. Amounts of food fed daily or weekly were not kept separate for each rearing tank, but combined as a whole. However, losses from each rearing tank were kept separate. With the exception of Tank 1 and Tank 15, percent losses and monthly mortality were similar to the main group of fish in Pond One (Table 10).

3.1.3: Disease incidence and treatments

Prophylactic feed treatments for BKD were not given to the 1995 brood juvenile spring chinook salmon, and none were scheduled for the 1996 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.). No other fish health problems were noted for either brood and no treatments were given

Table 11. Number of mortalities and percent mortalities of chinook salmon from Pond One and captive broodstock tanks from initial ponding, (13-22 February) to 9 September, 1996.

Pond/Tank Number	Population (Feb. 1996)	Mortalites by month								Ending Population	Percent Survival
		Feb	Mar	Apr	May	Jun	Jul	Aug	Sep		
Pond 1	60,935	383	1090	156	55	42	26	36	14	59,133	97.0
Tank 1	200	5	6	2	4	3	2			178	89.0
Tank 2	200					1	4	3		192	96.0
Tank 3	200	2		2		1				195	97.5
Tank 4	200		1		1		1		1	196	98.0
Tank 5	200		1				1			198	99.0
Tank 6	200	1	1	2	2			7	3	185	92.5
Tank 7	200		2	1				1		196	98.0
Tank 8	200									200	100.0
Tank 9	200		2				1	1		196	98.0
Tank 10	200	1					1			198	99.0
Tank 11	200		3	1			1			195	97.5
Tank 12	200			3						197	98.5
Tank 13	200		4		1		2			193	96.5
Tank 14	200		7	1		2				190	95.0
Tank 15	200		15	6	7	3	3	1		165	82.5
All Tanks	3,000	9	42	18	15	10	16	13	4	2,873	95.8
Tanks 2-14	2,600	4	21	10	4	4	10	12	4	2,530	97.3
Tanks 1&15	400	5	21	8	11	6	6	1		343	85.8

3.1.4: Smolt acclimation and releases (1994 brood)

Acclimation: Lyons Ferry staff transported an estimated 42,248 fish to the main acclimation pond and 19,985 fish to two raceways at the Tucannon Hatchery on 9 October 1996. Fish were reared on well water most of the winter. On 18 February 1997, hatchery staff started mixing river water with well water. All fish were rearing entirely on river water by 24 February to ensure that the fish imprinted to the Tucannon River instead of the hatchery water supply. About 10,000 fish from the Tucannon Hatchery raceways were scheduled for acclimation in portable tanks at Curl Lake, and 10,000 were scheduled for direct stream release near Curl Lake and Panjab Bridge. Fish at the Curl Lake acclimation site were acclimated from 3 March until release on 24-25 March. Direct stream release fish were acclimated on river water for 29 days at Tucannon Hatchery before being transported upriver and released.

Releases: Release strategies in 1997 were similar to those in 1996. We planned a six week volitional release beginning 1 March for the ≈42,000 smolts in the acclimation pond at Tucannon Hatchery. Releases of fish from the main acclimation pond began on 7 March, and continued until 18 April. All fish released from the Tucannon acclimation pond were VI tagged with a red elastomer on the right side (Appendix E). Hatchery personnel noted that fish began leaving the Tucannon Hatchery acclimation pond on 17 March. They estimated that 50% of the fish left the pond by the end of March, and 95% left before 18 April.

A total of 10,095 juveniles were released from the acclimation ponds at Curl Lake. All fish released from the Curl Lake acclimation site were VI tagged with blue elastomer on the right side. Juvenile fish were also released directly into the river at Big 4 Campground (4,948; Rk 65), and Panjab Bridge (4,901; Rk 75). These fish were VI tagged with a blue elastomer on the left side. Both release strategies (acclimated and direct stream) were used in 1997 to continue our study to evaluate differences in relative survival between the two release types. Section 3.1.4 discusses the juvenile detection results from the 1995 and 1996 releases.

Length and weight samples collected from our PIT tagging study (Section 3.1.5) were used as pre-release samples for each group (Table 11). We also collected Organosomatic Index (OSI), blood plasma cortisol, and ATP-ase samples from each release group. Bi-modal length distributions documented earlier in the rearing cycle were not observed in the release groups.

3.1.5: Juvenile migration studies (1995 and 1996 PIT tagging)

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 produced higher relative juvenile survivals than direct stream releases in the same areas. These release strategies are being evaluated to determine best management strategies regarding adult spawning, and potential harmful effects of the Tucannon Hatchery weir. Detailed descriptions of site locations, specific release groups, and events that occurred during tagging and releases of PIT tagged fish in 1995 and 1996 are described in Bumgarner et al, 1995, 1996.

Results in 1996 were in contrast to the 1995 results (Table 12), where direct stream releases generally outperformed the acclimated releases at the same location. In 1996, all study groups regardless of release location or release date, were detected at downstream dams at nearly the same frequency, indicating no differences in survival.

Fish that were released directly into the stream near Curl Lake performed better than fish released from small acclimation ponds at roughly the same location (Table 12). However, fish released (either direct or acclimated) highest in the Tucannon River performed the worst. We speculate that high river flows and a difficult migration corridor in the upper river may have caused additional mortality among those release groups. Snorkelers at the upper sites observed many disoriented fish being swept downstream in the strong current during release in 1995. 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 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.

Eighty-one of the 2,035 fish tagged for the studies were precocious males; many of which were bloated to such an extent it was impossible to insert the PIT tag without causing some damage. Fourteen of the 18 mortalities (0.67% of the total) were from these precocious males. Precocious fish were tagged to determine if they would migrate with the other fish. None of the 81 precocious males were detected at downstream dams.

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 summary report.

3.1.6: Juvenile migration studies (1997 PIT tagging)

In 1997, we continued our PIT tagging study with the 1995 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 (5000/release group) were identical to 1996. Performance of the PIT tagged fish will be evaluated based on detections at Lower Monumental, McNary, John Day and Bonneville dams, as in previous years.

PIT tagged fish were released directly into the stream at Big 4 Campground and Panjab Bridge on 25 March. PIT tagged fish were also released from the Curl Lake acclimation ponds on the same day. PIT tagged fish at Tucannon Hatchery were allowed to volitionally leave the pond from 7 March - 18 April. 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 and 1996 results. As in 1995 and 1996, mortalities associated with PIT tagging were very low. One fish (0.05%) died from PIT tagging in 1997.

Table 12. Characteristics of fish released into the Tucannon River, 1997.

Release Location	Tucannon Hat.	Curl Lake	Big 4 C.G.	Panjab Br.
Release Type	Acclimated	Acclimated	Direct	Direct
Sample Date	3/03	3/19	3/20	3/20
Release Date	3/07-4/18	3/24-25	3/25	3/25
Release Number	42,200	10,095	4,948	4,901
Characteristic				
Smolt (%)	(12.2)	(5.8)	(8.4)	(7.2)
n	61	28	42	36
length	153.3	166.4	174.7	172.5
CV	12.3	13.6	5.6	6.6
K-factor	1.25	1.14	1.15	1.14
Transitional (%)	(85.4)	(91.5)	(89.6)	(90.4)
n	427	444	447	452
length	120.9	123.9	125.7	129.2
CV	8.5	8.0	7.54	8.4
K-factor	1.28	1.16	1.17	1.16
Parr (%)	(2.4)	(2.7)	(1.8)	(2.4)
n	12	13	9	12
length	95.3	100.2	109.6	116.8
CV	10.7	8.5	8.3	7.4
K-factor	1.22	1.00	1.07	1.13
Precocious (%)	(0.0)	(0.0)	(0.2)	(0.0)
n	0	0	1	0
length	---	---	145	---
CV	---	---	---	---
K-factor	---	---	1.28	---
Total				
n	500	485	499	500
length	124.3	125.7	129.5	132.1
CV	13.2	12.2	13.0	11.9
Fish/lb	17.5	18.8	16.9	16.3
K-factor	1.28	1.15	1.17	1.16

Table 13. Cumulative unique detection summaries of PIT tagged salmon released from various locations on the Tucannon River in 1995 and 1996 at downstream Snake and Columbia River Dams. All precocious tagged fish were removed from the release numbers.

Release site	Release type	Pond type	Release date	River kilometer	Release number	Cumulative detection
1995 Detections						
Tucannon FH	acclim.	raceway	3/15-4/15	58	200	45 (22.5%)
Curl Lake	acclim.	raceway	3/20	66	202	41 (20.3%)
Curl Lake	direct	- -	3/20	66	197	56 (28.4%)
Winchester Cr.	acclim.	circular	3/20	78	198	25 (12.6%)
Winchester Cr.	acclim.	circular	3/31	78	197	29 (14.6%)
Ladybug Flat C.G. (campground)	direct	- -	3/20	77	199	34 (17.3%)
1996 Detections						
Tucannon FH	acclim.	raceway	3/16-4/22	58	496	121 (24.4%)
Curl Lake	acclim.	raceway	3/27	66	241	61 (24.4%)
Curl Lake	acclim.	circular	3/27	66	243	70 (28.8%)
Curl Lake	direct	- -	3/27	66	242	71 (29.3%)
Curl Lake	acclim.	raceway	4/10	66	250	71 (28.4%)
Curl Lake	acclim.	circular	4/10	66	246	60 (24.4%)
Panjab Cr.	direct	- -	3/27	72	235	55 (23.4%)

3.2: Natural Rearing and Migration

3.2.1: Snorkel surveys

In 1996, total count snorkel surveys (Griffith 1981, Schill and Griffith 1984) were conducted at 70 index sites scattered throughout four strata on the Tucannon River (Wilderness, HMA, Hartsock, Marengo). Surveys are conducted to estimate chinook salmon parr densities and derive a population estimate for the Tucannon River. Each site was snorkeled only once in 1996 because of the expected low numbers of subyearling chinook salmon (five redds counted in 1995, and flood damage in February 1996). Each snorkel site represents a particular habitat type (riffle, run, pool, side channel). 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) within each stratum. Chinook salmon parr production in the Tucannon River for 1996 was estimated at 0 subyearlings and 632 yearlings. We did not electrofish for chinook in 1996.

3.2.2: Downstream migrant trap operations (1995/1996)

An important objective of our evaluation is to estimate the magnitude, duration, periodicity, and peak of natural salmon emigration from the Tucannon River. To accomplish this objective, we operated a rotary screw trap at Rk 21.1 for the 1995/1996 outmigration.

We borrowed a rotary screw trap from the U.S. Fish and Wildlife Service (USFWS) so we could begin smolt trapping earlier in the fall migration season. Low river flows in the fall have prohibited us from operating our incline plane trap, but the smaller rotary screw trap operates effectively in lower flows. We had planned to use our incline plane trap for the spring outmigration. However, it was damaged beyond repair for the season in a thirty-year flood in February 1996. So we purchased a five foot rotary screw trap and installed it by 9 April, 1996. We operated the rotary screw trap for 20 days in September 1995, 20 in October, 15 in November, 6 in December, 16 in April 1997, 18 in May, and 20 in June until 21 June.

Trapping efficiency and smolt estimate: Several times during trapping, we attempted to estimate trapping efficiency. 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 percent of marked fish recaptured was used to estimate trapping efficiency. To estimate the number of fish migrating while the trap is not operating, 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 total number of migrants passing the trap.

We conducted one mark/recapture trial for natural salmon in September and October and three trials in April and May, to estimate trap efficiency. Mark/recapture trials were not conducted in November, December, or June 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 each of these months. We marked and recaptured 148 and 17 natural salmon, respectively, during the 1995/1996 trapping season.

We captured 485 natural salmon (includes 17 recaptures) and 2,492 hatchery salmon during the 1995/1996 season. Based on our mean estimated trapping efficiencies (due to poor recapture rates), we estimate 6,890 natural salmon migrated past the trap. This number does not include the estimated number of precocious fish that passed the trap (Bumgarner et al. 1996), but does include a rough estimate of the number of fish that may have passed the trap during January, February, and March based on historical data. However, because of the uncertainties and inconsistencies in trapping efficiencies calculated, we estimate that 5,000-9,000 natural salmon could have migrated past the trap during the 1995/1996 season. Peak migration of natural salmon could not be determined due to flooding, an inoperable trap, and the low numbers of fish captured in the spring. An estimate of the number of hatchery salmon migrating past the trap was not completed due to uncertainties in trapping efficiency of hatchery fish. We also did not start operating the rotary screw trap until one month after the releases of hatchery fish in the upper watershed.

Descaling: During the trapping period, we attempt to assess the amount of descaling caused by the trap. To quantify scale loss, each side of a smolt was divided into five regions (Koski et al. 1986). A region was considered "descaled" if 40% or more of the scales were missing. A second classification is "scattered" descaling, which occurred when at least 10% of the scales were missing from one side of the fish.

We assessed the amount of descaling on 355 natural salmon (61 precocious) and 603 hatchery salmon. Descaling rates on natural salmon migrants were considerably less than that for hatchery salmon (Table 13), though precocious fish caught primarily in September and October were descaled at nearly the same percentage as hatchery fish. We do not know why precocious fish are more descaled. We speculate that fish reared in the hatchery are unaccustomed to maintaining position in the swifter currents of the river, and are therefore injured and descaled more easily than natural fish. Outplanted hatchery fish (released from small ponds or directly into the stream) were descaled (17.9%) at a slightly higher percentage than fish released from the main acclimation pond at Tucannon FH (14.0%). Transport of these fish to their release site, and a longer downstream migration distance may have contributed to the additional scale loss observed in this group.

We were unable to determine the amount of descaling caused by the rotary screw trap on natural fish during the 1995/1996 season. Because of the way fish enter and are captured in the trap, we believe that the screw trap will cause less descaling than the incline plane trap.

Table 14. Summary of descaling rates between natural and hatchery salmon captured in the downstream migrant trap 1995/1996.

Regions[a]	Percent Descaled			
	Natural		Hatchery	
	Migrants	precocious	Acclimated[b]	Outplanted[b]
One only	1.0	3.3	4.5	6.4
Two or more	0.0	6.5	9.5	11.5
One or more	1.0	9.8	14.0	17.9

a Fish which were scattered descaled on one side were considered to be descaled in one region.

b Acclimated hatchery fish were released from Tucannon FH, and outplanted hatchery fish consisted of both direct stream releases and remote acclimation pond releases.

<u>Trapping Mortalities:</u> During the trapping season, dead fish are occasionally found in the trap. Some die accidentally during netting from the live box, and some dead fish have been observed floating into the trap. However, most of the mortalities are caused by high debris loads in the trap live box. Debris is generally kept low as the trap is checked frequently. Four natural salmon and 11 hatchery salmon were killed in the trap or from sampling procedures during the 1995/1996 outmigration. This represents 0.8% of the natural fish and 0.4% of the hatchery fish that were captured and handled.

3.2.3: Downstream migrant trap operations (1996/1997)

In the past, we have intermittently operated our smolt trap during the fall and winter to document and estimate the number of chinook migrating at that time of year. However, because no juvenile subyearling chinook were observed during summer snorkel surveys, we assumed few, if any, would be captured during that period. In addition, trapping during the fall and winter months can be labor intensive, reducing time for other evaluations. We therefore did not trap during the fall/winter of 1996.

We installed a rotary screw trap at Rk 3.0 on 28 March, 1997. We planned to operate the trap for five nights/week until the end of June. PIT tag recoveries (hatchery chinook and steelhead) will also provide migration timing from release location and to downstream detection locations (Snake and Columbia River dams). Sampling summaries for smolts emigrating from the Tucannon River during the spring of 1997 will be presented in future annual reports.

3.2.4: Morphometric, meristic, electrophoretic, and other studies

No morphometric, meristic or electrophoretic samples were collected from any juveniles or adults during 1996. Eighty fish were sacrificed for Organosomatic Index or plasma cortisol samples during juvenile releases (in conjunction with PIT tag study).

SECTION 4: MITIGATION GOALS

4.1: Natural and Hatchery Survival

We have estimated survivals at various life stages for natural and hatchery reared salmon by calculating egg deposition, juvenile population, smolt migration and adult escapement estimates (Appendix F, Appendix G), as well as proportions of natural and hatchery returns by age each year. We then compared the differences between natural and hatchery production, and their relationship to established mitigation goals.

Estimated smolt-to-adult survivals for the 1991 brood of natural and hatchery salmon were both 0.03%. The mean smolt-to-adult survival rate (1985-1992 broods, 1992 incomplete) of 0.17% (sd=0.12%) for hatchery produced fish is below the established mitigation goal of 0.87%. Even the mean smolt-to-adult survival (1985-1992 broods, 1992 incomplete) of 0.63% (sd=0.48%) for naturally reared fish is below the guideline set for the hatchery production. Based on mean adult-to-adult survival of seven complete brood years (Appendix F), four times more hatchery reared salmon survive to return than naturally reared salmon. Hatchery fish have generally been able to replace themselves in the population, whereas naturally produced fish have not (Figure 6).

We calculated how many eggs or smolts are required to produce two returning adults with either naturally or hatchery produced fish. Data collected from the 1985-1991 brood years suggests it would required on average at least 6,521 eggs in the river to produce 300 naturally reared smolts which would produce two returning natural adults. Over those same years, it required on average only 1,436 eggs in the hatchery to produce 1,110 smolts, which would return two hatchery fish.

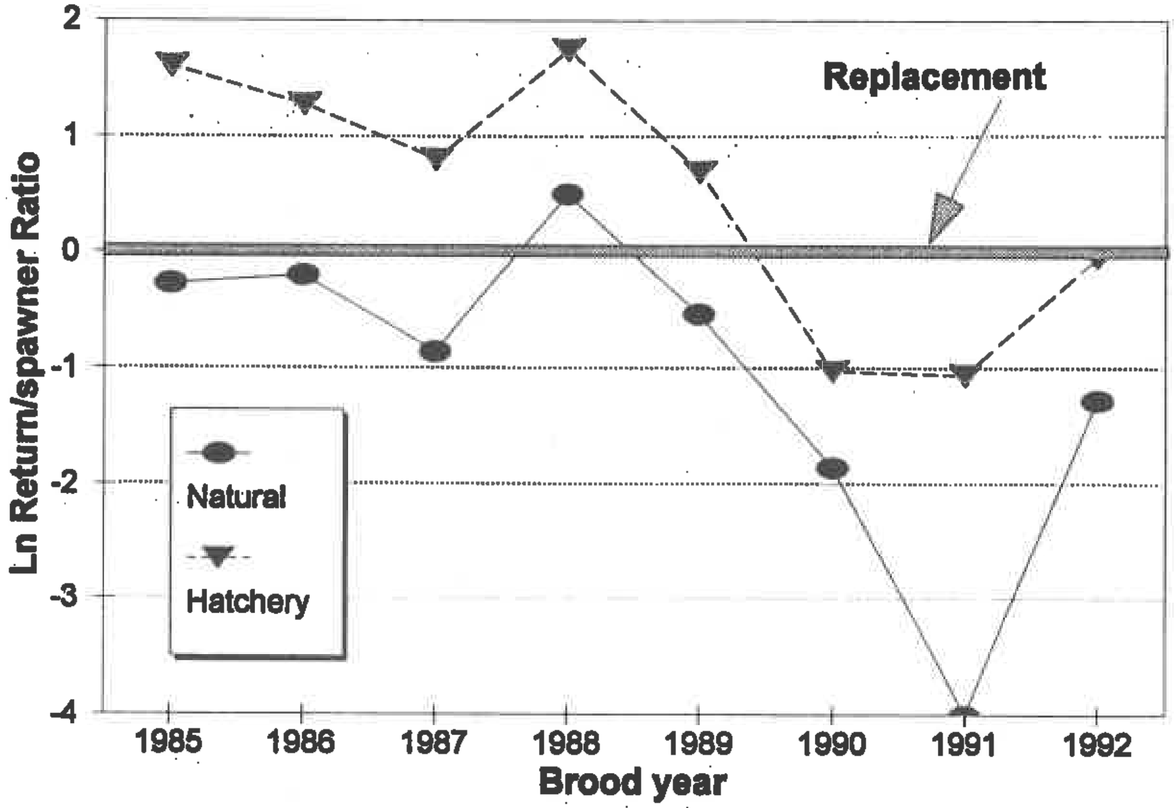

Figure 6. Natural Log (Ln) return/spawner relationship for Tucannon River spring chinook salmon (natural and hatchery) for the brood years 1985-1991. A zero value on the Y-axis represents replacement of returning adults for the same number of spawners. (1992 brood year is incomplete)

SECTION 5: RECOMMENDATIONS

We provide here several recommendations which we hope will improve the Tucannon salmon program:

1) Increase the collection and preservation of sperm, particularly from natural salmon. Continue to investigate and/or develop new technology for short term egg and sperm storage to increase genetic contribution and provide spawning options for managers.

2) Evidence gathered from adult trapping indicates that many returning hatchery fish are homing to the hatchery effluent water. In response to this, we should continue to shift more of the releases to the upper watershed, and acclimate and release less fish at the Tucannon Hatchery. Additional upstream portable acclimation sites need to be examined.

3) Continue to evaluate the effectiveness of releasing hatchery juvenile salmon upstream of the Tucannon Hatchery.

4) Examine possibilities at Tucannon Hatchery for exercising fish during the last few months before release to better prepare them for their downstream migration in the Tucannon, Snake and Columbia rivers.

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

7) Examine hatchery inventory methods (i.e. pound counts, length and weight samples), provide possible improved methods to reduce potential error in the numbers of fish released, estimated egg takes, juvenile ponding, etc.

8) Collect data on distribution of spawning adults in the Tucannon River. Evaluate effectiveness of hatchery outplant strategies and modify if necessary for future returns.

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APPENDIX A

Spring chinook salmon captured, collected, or passed upstream at the Tucannon Hatchery traps in 1996. The only days reported are days when fish arrived, were collected or passed upstream. First day of trapping was 8 April, last day of trapping was 19 September. [Instream Trap = R, Concrete Trap (old) = H]

	Arrived				Collected		Passed Upstream	
Date	Natural	Trap	Hatchery	Trap	Natural	Hatchery	Natural	Hatchery
5/21			1	R		1		
5/22	1	R			1			
5/23	1	R			1			
5/24			1	H		1		
5/25			1	H		1		
5/26	2	R			2			
5/28	1	R	3	H	1	3		
5/30	2	R			2			
6/01	3	R			3			
6/03	4	R	1	H	4	1		
6/04	4	R	2	R,H	1	2	3	
6/05	1	R	1	H		1	1	
6/06	8	R			2		6	
6/07	5	R	1	H	1		4	1
6/08	2	R	1	R	1	1	1	
6/10	2	R	5	R,4H		4	2	1
6/11	2	R	1	H	1	1	1	
6/12	4	3R,H			1		3	
6/13	2	R					2	
6/14	1	R	2	R		1	1	1
6/15			2	R		2		
6/17	3	R	3	2R,H	1	2	2	1
6/18	2	R	1	H	1	1	1	
6/19	1	R	2	R,H		1	1	1
6/20	1	R	5	3R,2H		4	1	1
6/21			2	R,H		1		1
6/22			2	R		2		
6/24			2	R		1		1
6/26	1	R	2	R		2	1	
6/27	2	R			1		1	
6/28[a]	1	R	2	R,H		1	1	
7/01			5	2R,3H		3		2
7/02			2	H		2		
7/05[b]	1	R	2	R		2		
7/06[a]			2	R		1		
7/08	1	R	1	R	1	1		
7/12[a]			2	R		1		
7/16	1	R			1			
8/15	1	R			1			

Appendix A cont,

Date	Arrived				Collected		Passed Upstream	
	Natural	Trap	Hatchery	Trap	Natural	Hatchery	Natural	Hatchery
8/26	1	R					1	
8/27	2	R	1	H	2	1		
8/30	1	R			1			
9/03	1	R			1			
9/05[a]			1	H				
9/09	3	R			2		1	
9/10	2	R			2			
9/11	1	H					1	
9/12	3	R					3	
9/13	2	R					2	
Totals	76	74R,2H	59	31R,28H	35	45	40	10

a One of the hatchery fish arriving died in the trap.
b One of the natural fish arriving died in the trap.

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).

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 $\leq$ 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 crosse

APPENDIX C

Number, mean post-eye to hypural-plate length (standard deviation), 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, 1996.

Origin Age	Sampled at hatchery Male	 Female	 % Age	Sampled from river Male	 Female	 % Age	Total Male	 Female	 % Age
Natural[b]									
Age 3_2	--	--	0.0	1 37.0 (----)	--	1.8	1 37.0 (----)	--	1.2
Age 4_2	15 58.3 (5.50)	17 57.7 (2.76)	97.0	20 56.8 (4.89)	33[c] 56.3 (2.63)	98.2	35 57.4 (5.14)	50[c] 56.8 (2.73)	97.7
Age 5_2	--	1 61.0 (----)	3.0	--	--	0.0	--	1 61.0 (----)	1.2
Hatchery[d]									
Age 3_2	7 37.1 (2.54)	--	15.6	5[e] 35.0 (---)	—	25.0	12[d] 36.9 (2.47)	—	18.5
Age 4_2	18 56.4 (3.18)	20 57.8 (2.69)	84.4	5[e] 58.5 (2.08)	10 56.1 (3.81)	75.0	22 56.8 (3.09)	30 57.2 (3.15)	81.5
Age 5_2	--	--	0.0	--	--	0.0	--	--	0.0

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 years in the ocean, two in freshwater;

b Lengths or scales were not collected from two females that died in the pond at Lyons Ferry.

c Radio tagged (10/61), recorded as female when tagged at Bonneville Dam, fork length would suggest a four year old fish, no length or sex data recorded when carcass was recovered.

d One male had been partially head eaten, and no readable scales were recovered, so no length or age were available.

e Lengths were not available from four age 3_2 males, and one age 4_2 male.

APPENDIX D

Movements of four radio tagged spring chinook salmon in the Tucannon River tagged and released by the University of Idaho at Bonneville Dam, 1996

Channel /Code	Date	River kilometer	Location	Comments
1/19	4/27		Bonneville Dam	Tagged (Wild male 74cm)
	5/20	18.0	↓ Fletcher's Br.	
	5/22	20.4	Smolt trap	
	5/23	21.8	Mom's Cafe	
	5/24	24.7	1.2mi. ↑ Hwy 12 Br.	
	5/28	37.0	↓ Marengo, MP 9.3	
	5/29	39.8	~100m ↓ Marengo	
	5/30	42.0	10m ↓ Br. 9, in pool	
	5/31	43.9	↓ Br. 11, at log weir	
	6/03	54.7	Cattle guard ↓ Wooten MGR's house	
	6/04	58.0	Between old weir and instream trap	
	6/05	58.1	In instream trap	Released upstream at 1345
	6/06	59.2	Tailrace of Tucannon Hatchery intake	
	6/07	58.7	Upper end of Rainbow lake	
	6/10	67.3	Between FS Guard Station and MP 28	
	6/11	68.2	1/4mi. ↑ Camp Wooten Br.	
	6/12	70.0	↑ C. W. at 2nd cattle guard, ↑ HMA 16	
	6/14	73.2	200m ↑ Cow Camp Br.	
	6/17	73.6	Lower end of CG11 near HMA 21	
	6/20-8/19	73.6	same place	7/02 Snorkled, saw fish
	8/21	74.5	↑ Panjab Br., in cascade	
	8/22-28	73.6	Returned to HMA 21, under debris pile	
	8/29	76.7	1.35mi. ↑ Panjab Br.	moving upstream
	9/03	77.8	Snorkel site, Wilderness 12	Saw fish, wild male
	9/04	74.5	30m ↓ Panjab Creek	
	9/05	75.6	200m ↓ Wilderness 5	
	9/09	75.6	170m ↓ Wilderness 5,	Spawning with a female on redd
	9/10	75.6	Same place	Redd complete, hatchery female
	9/11	72.8	L.E. of CG ↓ Cow Camp Br.	Saw fish
	9/12	65.5	Between HMA 12 and C. L. outlet	
	9/13	68.2	0.2mi. ↓ Camp Wooten	Saw fish
	9/16	68.9	10m ↓ 1st cattle guard, ↑ C.W.	Saw fish
	9/17	68.4	60m ↓ HMA 15	Saw fish
	9/18	65.6	60m ↓ Curl Lake outlet	
	9/19	64.8	Recovered fish and tag at Big 4 outlet	Recovered (wild male)
10/61	5/23		Bonneville Dam	Tagged (Wild female 72.5cm)
	9/13	12.3	Below Smith Hollow Br.	
	9/20-9/21	12.3	Same location	
	9/23-9/25	12.5		
	9/30	13.3	500m above Smith Hollow Br.	Spawned ???
	10/02	13.3	Recovered fish and tag	Recovered Carcass

Appendix D continued,

Channel /Code	Date	River kilometer	Location	Comments
9/17	5/06		Bonneville Dam	Tagged(Wild male 66cm)
	5/28	20.4	Smolt trap	
	5/29	24.7	300m ↓ English's house	
	5/30	24.8	Across from English's house	
	5/31	28.2	Between Enrich Br. and Robertson's	
	6/03	38.1	MP 10, ↓ Marengo	
	6/04	43.3	MP 13, near Br. 10	
	6/05	46.8	250m ↑ Br. 12	
	6/06	49.7	Between Hartsock and Dice's	
	6/07	49.7	Same location	
	6/10	57.6	↑ HMA4 and ↓ old adult weir	
	6/11-9/03	57.6	Same location	Snorkeled twice, couldn't see fish
	9/04	57.6	10m ↑ old location in RB pool	
	9/05	57.2	HMA3	
	9/09	55.9	30m ↑ Cummings Creek Br.	
	9/10	55.8	50m ↓ Cummings Creek Br.	On redd (1 female, 1 other wild male)
	9/11	57.6	150m ↓ old hatchery trap	near redd--didn't spawn there
	9/12	51.5	15m ↑ Br. 14	
	9/13	53.9	Behind Russel's	
	9/16	50.5	300m ↑ quonset hut ↑ Dice's	On a redd with a female
	9/17	50.5	Same location	
	9/18	51.5	20m ↑ Br. 14, on a redd and a TD	
	9/19	49.4	~400-500m ↑ Br. 13--fish alone	
	9/20	55.6	L.E. CG 1 with a female, near redd 3-1	
	9/21	51.5	30m ↑ Br. 14	
	9/23	47.2	Recovered fish and tag; 150m ↑ Br. 12	Recovered(Wild male)
4/22	5/12		Bonneville Dam	Tagged(Hatchery male 69.5cm)
	6/21	8.8	Between Rubenser's and Fletchers	
	6/23	20.7	Smolt trap	
	6/24	24.7	↓ Merle English's	
	6/26	29.6	↓ MP 5, ↑ Broughton's silo	
	6/28	32.2	↑ MP 6, ↓ King Grade	
	7/01	39.9	Marengo Br.	
	7/05	52.4	↑ Br. 14, behind Smith's house	
	7/08-7/11	57.2	HMA 3	
	7/15	57.3	Just ↑ HMA 3	
	7/22-8/22	57.3	Same location	Fish seen on 5 different dates
	8/26	58.1	In adult instream trap	
	8/28	63.8	150m ↑ Beaver/Watson intake	
	8/29	60.0	60m ↑ day use area, ↑ CG6	
	9/03	59.4	New road to Deer lake, log pool	
	9/04-05	59.4	Same location	
	9/09	58.7	150m ↓ HMA 6--on redd with female	On redd
	9/10	58.6	~100m ↓ redd from 9/9	
	9/11	58.1	At Tucannon Hatchery weir	
	9/12	58.3	90m ↑ Tucannon Hatchery Br.	
	9/13	59.0	On redd from 9/9, another fish on redd 3-1	On redd
	9/16	58.1	Recovered 20m ↑ Tucannon Hatchery weir	Recovered (Hatchery male)

APPENDIX E

Coded-wire tag information from juvenile releases (1985-1995 broods) and adult recoveries (1996) of Tucannon spring chinook salmon.

Table 1. Summary of salmon yearling releases for the Tucannon River, 1985-1995 brood years. Totals are summation by brood year, not by release year.

Release (Brood) Year	Release type[a]	Release Date	CWT Code[b]	Number CWT	Ad-only marked	Additional tag/location/cross[c]	lbs	fish/lb
1987 (85)	H-Acc	4/6-10	34/42	12,922			2,172	6
Total				12,922				
1988 (86)	H-Acc	3/7	33/25	12,328	512		1,384	10
	"	"	41/46	12,095	465		1,256	10
	"	"	41/48	13,097	503		1,360	10
	H-Acc	4/13	33/25	37,893	1,456		3,735	10
	"	"	41/46	34,389	1,321		3,571	10
	"	"	41/48	37,235	1,431		3,867	10
Total				147,037	5,688			
1989 (87)	H-Acc	4/11-13	49/50	151,100	1,065		16,907	9
Total				151,100	1,065			
1990 (88)	H-Acc	3/30-4/10	55/01	68,591	3,007		6,509	11
	"	"	01/42	70,459	3,089		6,686	11
Total				139,050	6,096			
1991 (89)	H-Acc	4/1-12	14/61	75,661	989		8,517	9
	"	"	01/31	22,118	289		2,490	9
Total				97,779	1,278			
1992 (90)[c]	H-Acc	3/30-4/10	40/21	51,149		BWT, RC, WxW	4,649	11
	"	"	43/11	21,108		BWT, LC, HxH	1,924	11
	"	"	37/25	13,480		Mixed	1,225	11
Total				85,737				
1993 (91)	H-Acc	4/6-12	46/25	55,716	796	VI, LR, WxW	3,714	15
	"	"	46/47	16,745	807	VI, RR, HxH	1,116	15
Total				72,461	1,603			
1993 (92)	Direct	10/22-25	48/23	24,883	251	VI, LR, WxW	698	36
	"	"	48/24	24,685	300	VI, RR, HxH	694	36
	"	"	48/56	7,111	86	, , Mixed	200	36
1994 (92)	H-Acc	4/11-18	48/10	35,405	871	VI, LY, WxW	2,591	14
	"	"	49/05	35,469	2,588	VI, RY, HxH	2,718	14
	"	"	48/55	8,277	799	, , Mixed	648	14
Total				135,830	4,895			

Appendix E, (continued).

Release (Brood) Year	Release type[a]	Release Date	CWT Code[b]	Number CWT	Ad-only marked	Additional tag/location/cross[c]	lbs	fish/ lb
1995 (93)	H-Acc	3/15-4/15	53/43	45,007	140	VI, RG, HxH	3,166	14
	"	"	53/44	42,936	2,212	VI, LG, WxW	3,166	14
	P-Acc	3/20-4/3	56/16	11,661	72	VI, RR, HxH	782	15
	"	"	56/17	10,704	290	VI, LR, WxW	733	15
	"	"	56/18	13,705	47	, , Mixed	917	15
	Direct	3/20-4/3	56/16	3,860	24	VI, RR, HxH	259	15
	"	"	56/17	3,542	96	VI, LR, WxW	243	15
	"	"	56/18	4,537	15	, , Mixed	303	15
Total				135,952	2,896			
1996 (94)	H-Acc	3/16-4/22	56/29	89,437		VI, RR, Mixed	5,123	17.7
	P-Acc	3/27-4/19	57/29	35,334	35	VI, RG, Mixed	2,628	15.2
	Direct	3/27	43/23	5,263		VI, LG, Mixed	369	13.3
Total				130,034	35			
1997 (95)	H-Acc	3/07-4/18	59/36	42,160	40	VI, RR, Mixed	2,411	17.5
	P-Acc	3/24-3/25	61/41	10,045	50	VI, RB, Mixed	537	18.8
	Direct	3/24	61/40	9,811	38	VI, LB, Mixed	593	16.6
Total				62,144	128			

a Release types are: Tucannon Hatchery Acclimation Pond (H-Acc); Portable Acclimation Pond (P-Acc); and Direct Stream Releases (Direct).

b All tag codes start with agency code 63.

c Codes listed in column are as follows: BWT-Blank Wire Tag; VI-Visual Implant (elastomer); LR-Left Red, RR-Right Red, LG-Left Green, RG-Right Green, LY-Left Yellow, RY-Right Yellow, LB-Left Blue, RB-Right Blue; Crosses: WxW-wild x wild progeny, HxH-hatchery x hatchery progeny, Mixed-wild x hatchery progeny.

d No tag loss data due to presence of both CWT and BWT in fish.

Appendix E (continued).

Table 2. Spring chinook salmon (natural and hatchery) sampled from the Tucannon River, 1996

Estimated total escapement to Tucannon River:	247	
Broodstock collected	-80[a]	(35 natural, 45 hatchery)
Fish dead in trap	- 5	(1 natural, 4 hatchery)
	===	
Total fish left in river	160	
In-river CWT sampled fish:		
Prespawning mortality	11	(7 natural, 4 hatchery)
Spawned carcasses recovered	60	(46 natural, 14 hatchery)
	===	
Spawning ground CWT sample	71	
Total number of carcasses sampled in 1996	156	

a Five of 80 broodstock collected were prespawning mortalities (3 hatchery, 2 natural)

Table 3. Summary of all hatchery salmon sampled from the Tucannon River, 1996.

CWT	Broodstock Collected			Tucannon River			
code	Spawned	DIPs	KO	Dead in trap	Pre-spawn mortality	Spawned	Total
63-48-10	14	1			1	1	17
63-48-23	2						2
63-48-55	4					1	5
63-49-05	12		1		2	5	20
63-53-43	3			1			4
63-53-44	2			2[a]			4
63-56-18	2						2
Strays		1[b]				1[c]	2
Lost tags		1				1	2
No tags	1				1	4	6
Not sampled	1[d]			1			2
Total	41	3	1	4	4	13	66

a Fish not sampled, but VI tag indicated it to be tagcode 63-53-44.
b Umatilla spring chinook salmon, tagcode 7-2-51.
c Left Ventral clip, no adipose clip, head taken but no CWT found.
d No adipose clip, sampled as wild fish during spawning, but scale patterns indicate fish to be of hatchery origin.

APPENDIX F

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

Table 1. Adult returns and survival rates (based on escapement estimates and age composition) of natural salmon to the Tucannon River for brood years 1985-1992 (1992 incomplete).

Brood Year	Estimated number of smolts migrating	Number of Adult Returns, known (expanded) Age 3	Age 4	Age 5	Smolt to Adult Survival
1985	35,600	8 (20)	110 (274)	36 (115)	0.43 (1.15)
1986[a]	58,200	1 (2)	117 (374)	28 (89)	0.25 (0.80)
1987	44,000	0 (0)	52 (164)	22 (60)	0.17 (0.51)
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)	1 (2)	0.02 (0.03)
1992	50,800	2 (2)	85 (158)	-- (--)	0.17 (0.32)

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

Table 2. Adult returns and survival rates (based on escapement estimates and age composition) of hatchery salmon to the Tucannon River for brood years 1985-1992 (1992 incomplete).

Brood Year	Estimated number of smolts migrating	Number of Adult Returns, known (expanded) Age 3	Age 4	Age 5	Smolt to Adult Survival
1985	12,922	9 (20)	24 (25)	0 (0)	0.26 (0.33)
1986	153,725	80 (85)	101 (226)	8 (17)	0.12 (0.21)
1987	152,165	8 (18)	70 (150)	8 (17)	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)
1992	87,752	11 (11)	51 (68)	-- (--)	0.07 (0.09)

Appendix F continued.

Table 3. Summary of juvenile survival rates by brood year for naturally and hatchery reared salmon in the Tucannon River and at Lyons Ferry Hatchery.

Brood Year	Natural Fish (Percent) egg-to-fry	fry-to-smolt	egg-to-smolt	Hatchery Fish (Percent) egg-to-fry	fry-to-smolt	egg-to-smolt
1985	8.6	39.5	3.4	90.3	96.4	78.1
1986	8.5	56.7	4.8	94.7	86.7	82.1
1987	6.8	55.6	3.8	83.8	92.4	77.4
1988	10.6	53.8	5.7	82.6	97.0	80.1
1989	11.1	44.2	4.9	77.5	95.8	74.2
1990	6.0	77.2	4.7	70.9	95.8	67.9
1991	10.2	54.2	4.9	84.6	95.9	81.1
1992	9.7	49.2	4.7	97.0	57.8	56.1
1993	10.7	57.1	6.1	88.1	95.6	84.2
1994	7.2	54.2	3.9	88.3	86.1	90.3
1995	0.0	0.0	0.0	74.5	97.2	72.4

Table 4. Adult-to-Adult survival estimates of Tucannon River spring chinook salmon from 1985 through 1992 brood years (1992 incomplete).

	Natural Salmon			Hatchery Salmon			
Brood Year	Number of Spawners	Number of Returns	Return/ Spawner	Number of Spawners	Number of Returns	Return/ Spawner	Hatchery to wild Advantage
1985	539	409	0.76	9	45	5.00	6.6
1986	570	465	0.82	91	328	3.60	4.4
1987	528	224	0.42	83	185	2.23	5.3
1988	334	545	1.63	78	447	5.73	3.5
1989	302	177	0.53	122	243	1.99	4.1
1990	605	94	0.16	78	28	0.36	2.3
1991	383	7	0.02	72	25	0.35	17.5
1992	575	160	0.28	83	79	0.95	3.4
Total	**3,836**	**2,081**	**0.54**	**616**	**1,380**	**2.24**	**4.1**

APPENDIX G

Table 1. Estimates of natural Tucannon spring chinook salmon abundance by life stage for 1985-1996 broods.

Brood year	Females [a] in river (natural/hatchery)	Mean [b] fecundity (natural/hatchery)	Number of eggs	Number [c] of fry	Number [d] of smolts	Returning [e] adults
1985	270 / - -	3,883 / - -	1,048,410	90,200	35,600	409
1986	309 / - -	3,916 / - -	1,210,044	102,600	58,200	467
1987	282 / - -	4,095 / - -	1,154,790	79,100	44,000	224
1988	168 / - -	3,882 / - -	652,176	69,100	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	94
1991	98 / 67	3,741 / 2,517	535,257	54,800	26,000	7
1992	163 / 131	3,854 / 3,295	1,059,847	103,292	50,800	160
1993	126 / 106	3,701 / 3,237	807,598	86,755	49,652	
1994	38 / 5	4,187 / 3,314	175,676	12,720	6,890	
1995	5 / 0	5,224 / - -	26,120	0		
1996	64 / 20	3,516 / 2,843	280,463			

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.