Tucannon River Spring Chinook Salmon Hatchery Evaluation Program

2001 Annual Report

by

Michael P. Gallinat
Lance Ross
Michelle Varney

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

Prepared for:

U.S. Fish and Wildlife Service
Lower Snake River Compensation Plan Office
1387 S. Vinnell Way, Suite 343
Boise, Idaho 83709
Cooperative Agreements: 1411-01-J042

FPA02-10

September 2002

Acknowledgments

The Tucannon River Spring Chinook Salmon Hatchery Evaluation Program is the result of efforts by many individuals within the Washington Department of Fish and Wildlife (WDFW) and from other agencies.

We would like to express sincere gratitude to Butch Harty, Lyons Ferry Complex Manager, for his coordination efforts. We thank Hatchery Specialists Doug Maxey and Steve Jones for their cooperation with hatchery sampling, providing information regarding hatchery operations and hatchery records, and their input on evaluation and research activities. We also thank all additional hatchery personnel who provide the day-to-day care of the spring chinook and for their assistance with hatchery spawning, sampling, and record keeping.

We thank Lynn Anderson and the Coded-Wire Tag Lab staff for their assistance in coded-wire tag verification and Julie Hooff for tagging the supplementation and captive brood fish. We also thank John Sneva for reading scales, and Steve Roberts for providing information on fish health issues that arose during the year.

We thank the University of Idaho for providing data regarding their radio tagging studies on the Columbia and Snake rivers.

We thank Mark Schuck, Joe Bumgarner, Glen Mendel, Todd Pearsons, and Jim Scott for providing critical reviews of the draft report.

This project was funded by the United States Fish and Wildlife Service through the Lower Snake River Compensation Plan Office.

Abstract

Lyons Ferry Hatchery (LFH) and Tucannon Fish Hatchery (TFH) were built/modified under the Lower Snake River Fish and Wildlife Compensation Plan. One objective was to compensate for the estimated annual loss of 1,152 spring chinook (Tucannon River stock) caused by hydroelectric projects on the Snake River. The standard supplementation production goal is 132,000 fish for release as yearlings at 30 g/fish or 15 fish per pound (fpp). The captive brood production goal is 150,000 yearlings at 30 g/fish. This report summarizes activities of the Washington Department of Fish and Wildlife Lower Snake River Hatchery Evaluation Program for Tucannon River spring chinook for the period April 2001 to April 2002.

Six hundred eighty-one fish were captured in the TFH trap in 2001 (404 natural adults, 1 natural jack, 181 hatchery adults, and 95 hatchery jacks); 106 were collected and hauled to LFH for broodstock and the remaining fish were passed upstream.

During 2001, all fish collected for broodstock were spawned. Prespawning mortality has been low since broodstock began being held at LFH in 1992, and is generally less than 10% each year.

Spawning in 2001 at LFH occurred between August 28 and September 18, with peak eggtake on September 11. A total of 184,127 eggs were collected. Egg mortality to eye-up was 2,225 eggs, with an additional loss of 6,698 sac-fry. Total fry ponded for production in the rearing ponds was 174,934. One hundred twenty-five mature 1997 brood year females from the captive broodstock program were spawned in 2001. Mean fecundity was 1,990 eggs/female based on 105 fully spawned females; egg survival was 69%. Forty-one mature 1998 brood year females were also spawned in 2001. Mean fecundity based on 39 fully spawned females was 1,160 eggs/female; egg survival was 81%.

One wild male spring chinook salmon that was radio tagged at Bonneville Dam entered the Tucannon River in 2001. This fish had also been PIT tagged as a juvenile at the Tucannon River smolt trap. Growth rate from capture at the smolt trap to radio tagging at Bonneville Dam averaged 27.3 mm/month.

WDFW staff conducted spawning ground surveys in the Tucannon River between August 29 and October 3, 2001. One hundred sixty-eight redds and 112 carcasses were found above the adult trap and 130 redds and 114 carcasses were found below the trap in 2001 Based on annual redd counts, broodstock collection, and in-river pre-spawning mortalities, the estimated escapement for 2001 was 1,012 fish (892 adults and 120 jacks).

Length and weight samples were collected twice during the rearing cycle for 2000 BY juveniles at TFH and Curl Lake Acclimation Pond. All 2000 BY juveniles were marked in October at

LFH, transported to TFH, and transported again in February to Curl Lake for acclimation and volitional release during March and April.

Snorkel surveys were conducted during the summer of 2001 to determine the population of subyearling and yearling spring chinook in the Tucannon River. We estimated 44,618 subyearlings (BY 2000) and 397 yearlings (BY 1999) were present in the river. Evaluation staff also operated a downstream migrant trap. During the 2000/2001 emigration, we estimated that 8,157 (BY 1999) wild spring chinook smolts emigrated from the Tucannon River.

Monitoring survival rate differences between natural and hatchery reared salmon continues. Smolt-to-adult return rates (SAR) for natural salmon continue to average about five times higher than for hatchery salmon. However, hatchery salmon survive about five times greater than natural salmon from parent to adult progeny. Natural fish survival remains below the replacement level, while hatchery fish survival is nearly three times above it. Due to the low SAR for hatchery fish, the mitigation goal of 1,152 salmon of Tucannon River stock was not achieved.

Table of Contents

List of Tables

List of Figures

List of Appendices

Introduction

Program Objectives

Congress authorized implementation of the Lower Snake River Fish and Wildlife Compensation Plan (USACE 1975). As a result, Lyons Ferry Hatchery (LFH) was constructed and Tucannon Fish Hatchery (TFH) was modified. One objective of these hatcheries is to compensate for the estimated annual loss of 1,152 Tucannon River spring chinook salmon adults caused by hydroelectric projects on the Snake River. In 1984, Washington Department of Fish and Wildlife (WDFW) began to evaluate the success of these two hatcheries in meeting the mitigation goal, and identifying factors that would improve performance of the hatchery fish. The WDFW also initiated the Tucannon River Spring Chinook Captive Broodstock Program in 1997 that is currently funded by the Bonneville Power Administration (BPA). The project goal is to rear captive salmon selected from the supplementation program (1997-2001 BY's) to adults, rear their progeny, and release approximately 150,000 smolts annually into the Tucannon River between 2003-2007. These smolt releases, in combination with the current hatchery supplementation program (goal = 132,000 smolts) and wild production, are expected to produce 600-700 returning adult spring chinook to the Tucannon River each year from 2005-2010. This report summarizes work performed by the WDFW Spring Chinook Evaluation Program from April, 2001 through April, 2002.

Facility Descriptions

Lyons Ferry Hatchery is located on the Snake River (rkm 90) at its confluence with the Palouse River (Figure 1). It is used for adult broodstock holding and spawning, and early life incubation and rearing. All juvenile fish are marked and returned to TFH for acclimation. Tucannon Fish Hatchery, located at rkm 59 on the Tucannon River, has an adult collection trap on site (Figure 1). Juveniles rear at TFH through winter. In February, the fish are transported to Curl Lake Acclimation Pond (AP) and volitionally released. The yearly supplementation production goal is 132,000 fish for release as yearlings at 30 g/fish or 15 fish per pound (fpp). The captive brood production goal is 150,000 yearling smolts at 30 g/fish.

Tucannon River Watershed Characteristics

The Tucannon River empties into the Snake River between Little Goose and Lower Monumental dams approximately 622 rkm from the mouth of the Columbia River (Figure 1). Stream elevation rises from 150 m at the mouth to 1,640 m at the headwaters (Bugert et al. 1990). Total watershed area is approximately 1,295 km^2. Local habitat problems related to logging, road building, recreation, and agriculture/livestock grazing have limited the production potential of spring chinook in the Tucannon River. Land use in the Tucannon watershed is approximately 37% cropland, 35% rangeland, and 27% forest (McCullough 1999). Five unique strata have been distinguished by predominant land use, habitat, and landmarks (Table 1).

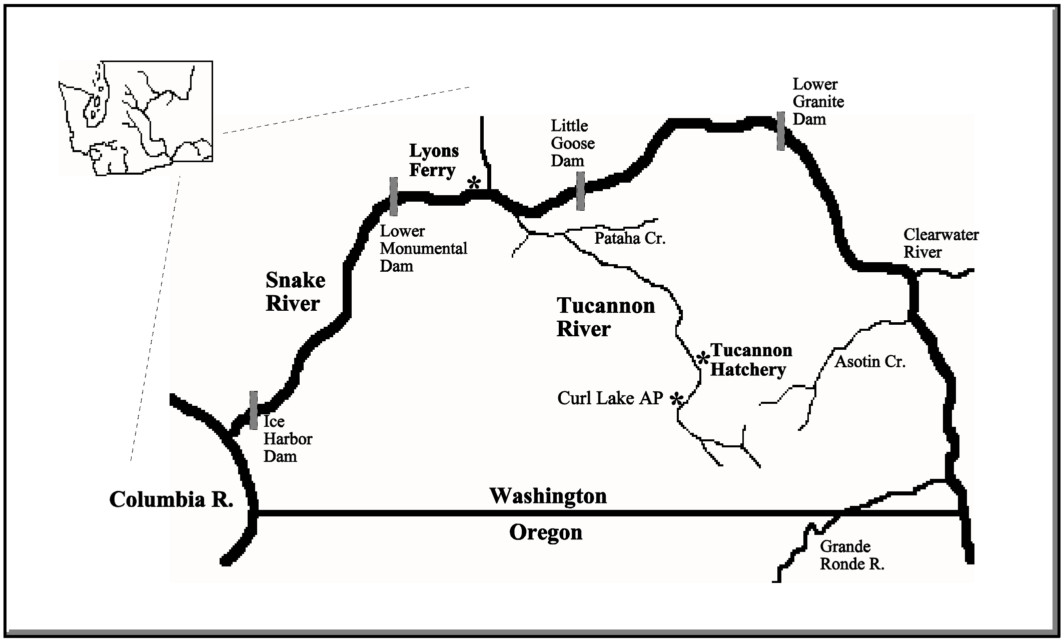

Figure 1. Location of the Tucannon River, Lyons Ferry, and Tucannon hatcheries within the Snake River Basin.

Table 1. Description of five strata within the Tucannon River.

Strata	Land Ownership/Usage	Spring Chinook Habitat	River Kilometer
Lower	Private/Agriculture & Ranching	Not-Usable (temperature limited)	0.0-20.1
Marengo	Private/Agriculture & Ranching	Marginal (temperature limited)	20.1-39.9
Hartsock	Private/Agriculture & Ranching	Fair to Good	39.9-55.5
HMA	State & Forest Service/Recreational	Good/Excellent	55.5-74.5
Wilderness	Forest Service/Recreational	Excellent	74.5-86.3

Program staff deployed 15 continuous recording thermographs throughout the Tucannon River to monitor daily minimum and maximum water temperatures (temperatures are recorded every 1 to 1.2 hours) from May through October. Data from each of these water temperature recorders are kept on an electronic file in our Dayton office. During 2001, maximum temperatures near the mouth (rkm 3) of the Tucannon River reached 80EF (26.7EC) on 3 different days. Maximum temperatures where spring chinook juveniles were rearing during the hottest part of the summer ranged from 60.7EF (15.9EC) in the upper HMA stratum (rkm 74.5) to 74.5EF (23.6EC) in the lower Hartsock stratum (rkm 43.3)(Figure 2).

The upper lethal temperature for chinook fry is 77.2EF (25.1EC) while the preferred temperature range is 53.6-57.2EF (12-14EC) (Scott and Crossman 1973). The optimum range of temperature in freshwater, which controls the rate of growth and survival of young, is 55.4-62.6EF (13-17EC) (Becker 1983). Theurer et al. (1985) estimated that spring chinook production in the Tucannon River would be zero for all stream reaches having maximum daily July water temperatures greater than 75EF (23.9EC) (or average mean temperature of 68.0EF (20EC)). Based on the preferred and optimum temperature limits, fish returning to the upper watershed have the best chance for survival, and recovery efforts should be maximized in this area (Figure 2).

It is hoped that recent initiatives to improve habitat within the Tucannon Basin, such as the Tucannon River Model Watershed Program, will: 1) restore and maintain natural stream stability; 2) reduce water temperatures; 3) reduce upland erosion and sediment delivery rates; and 4) improve and re-establish riparian vegetation. Theurer et al. (1985) estimated that improving riparian cover and channel morphology in the Tucannon River mainstem would increase chinook rearing capacity by a factor of 2.5. Habitat restoration efforts should permit increased utilization of habitat by spring chinook salmon in the marginal sections of the middle reaches of the Tucannon River and increase fish survival.

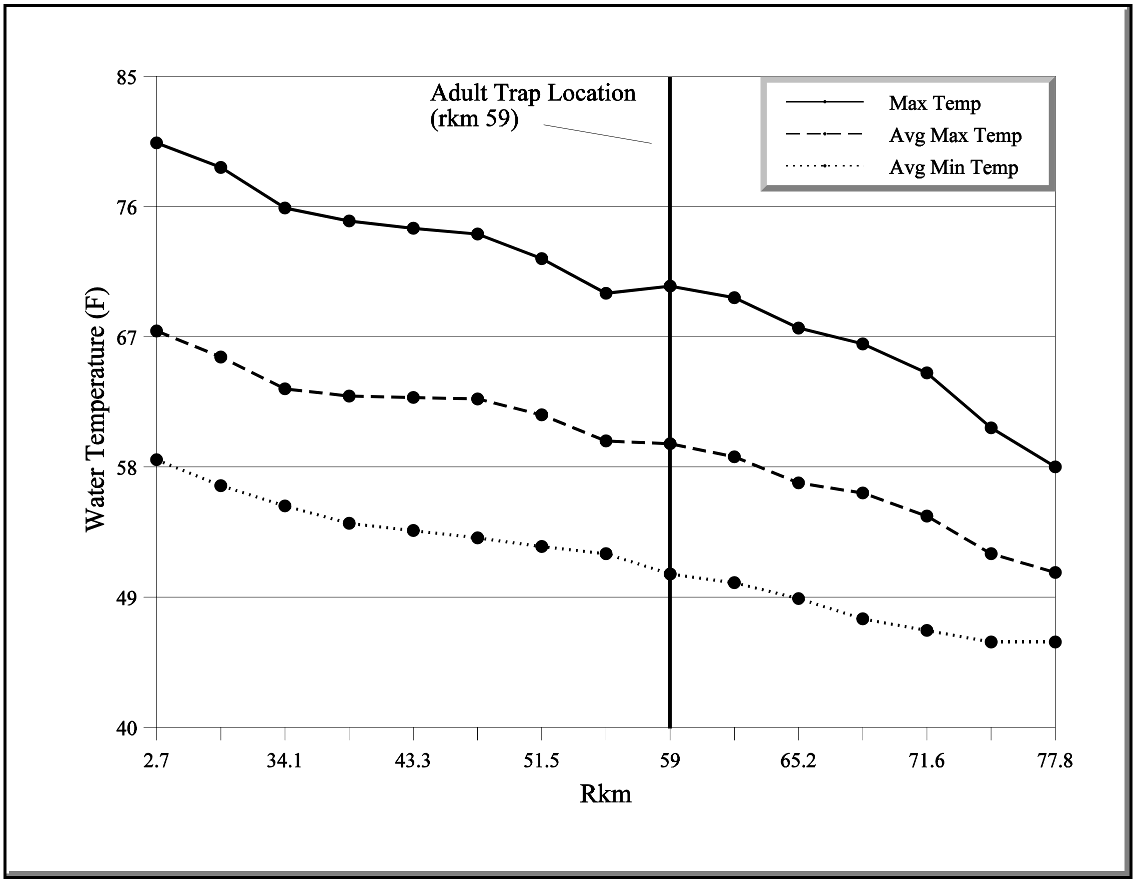

Figure 2. Maximum temperature, average maximum temperature, and average minimum temperature recorded by thermographs at 15 selected sites along the Tucannon River, May-October, 2001.

Adult Salmon Evaluation

Broodstock Trapping

The annual collection goal for broodstock is 50 natural and 50 hatchery adults collected throughout the duration of the run. Additional jack salmon may also be collected to contribute to the broodstock if necessary. Jack contribution to the broodstock can be no more than their percentage in the overall run. Returning hatchery salmon were identified by lack of the adipose fin.

The TFH adult trap began operation in April with the first spring chinook captured May 9. The trap was operated through September. A total of 681 fish entered the trap (404 natural adults, 1 natural jack, 181 hatchery adults, and 95 hatchery jacks), and 106 were collected and hauled to LFH for broodstock (Table 2, Appendix A). Fish not collected for broodstock were passed upstream. Adults collected for broodstock were injected with erythromycin and oxytetracycline (0.5 cc/4.5 kg); jacks were given half dosages. Fish received formalin drip treatments during holding at 167 ppm every other day at LFH to control fungus.

Based on previous year returns, we anticipated catching unmarked Umatilla origin hatchery fish. We decided prior to broodstock trapping that scale samples would be collected from all unmarked fish for scale pattern analysis in the hope of identifying hatchery origin fish. Unmarked fish collected for broodstock were injected with a Passive Integrated Transponder (PIT) tag for individual identification. If scale analysis determined that a "wild" fish collected for broodstock was actually of hatchery origin, that fish would have been identified by its PIT tag number and killed. None of the fish collected for broodstock were determined to be of hatchery origin, however, two fish passed upstream were later found to have been hatchery origin based on scale pattern analysis.

Table 2. Numbers of spring chinook salmon captured, trap mortalities, fish collected for broodstock, or passed upstream to spawn naturally at the TFH trap from 1986-2001.

Year	Captured at Trap		Trap Mortality		Broodstock Collected		Passed Upstream	
	Natural	Hatchery	Natural	Hatchery	Natural	Hatchery	Natural	Hatchery
1986	247	0	0	0	116	0	131	0
1987	209	0	0	0	101	0	108	0
1988	276	9	0	0	116	9	151	0
1989	258	102	0	0	67	102	89	0
1990	252	216	0	1	60	75	192	140
1991	109	202	0	0	41	89	68	113
1992	242	305	8	3	47	50	187	252
1993	191	257	0	0	50	47	141	210
1994	36	34	0	0	36	34	0	0
1995	10	33	0	0	10	33	0	0
1996	76	59	1	4	35	45	40	10
1997	99	160	0	0	43	54	56	106
1998 [a]	50	43	0	0	48	41	1	1
1999 [b]	4	136	0	1	4	132	0	0
2000 [c]	25	180	0	17	12	69	13	94
2001	405	276	0	0	52	54	353	222

[a] Two males (one natural, one hatchery) captured were transported back downstream to spawn in the river.
[b] Three hatchery males that were captured were transported back downstream to spawn in the river.
[c] 17 stray LV and ADLV fish were killed at the trap.

Broodstock Mortality

None of the 106 salmon collected for broodstock died prior to spawning in 2001 (Table 3). Table 3 shows that prespawning mortality in 2001 was comparable to the mortality documented since broodstock began being held at LFH in 1992. Higher mortality was experienced when fish were held at TFH (1985-1991).

Table 3. Numbers of prespawning mortalities and percent of fish collected for broodstock at TFH and held at TFH (1985-1991) or LFH (1992-2001).								
	Natural				Hatchery			
Year	Male	Female	Jack	% of collected	Male	Female	Jack	% of collected
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	8.2	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
1997	0	4	0	9.3	2	2	0	7.4
1998	1	2	0	6.3	0	0	0	0.0
1999	0	0	0	0.0	3	1	1	3.8
2000	0	0	0	0.0	1	2	0	3.7
2001	0	0	0	0.0	0	0	0	0.0

Broodstock Spawning

Spawning at LFH occurred once a week from August 28 to September 18, with peak eggtake on September 11. A total of 184,127 eggs were collected (Table 4). Eggs were initially disinfected and water hardened for one hour in iodophor (100 ppm). Fungus on the incubating eggs was controlled with formalin applied every-other day at 1,667 ppm for 15 minutes. Mortality to eye-up was 1.2% with an additional 3.8% loss of sac-fry, which left 174,934 fish for production. This is above the program release goal of 132,000 smolts due to the lack of pre-spawning mortalities, older age class of spawners, and higher fecundity. A release of marked parr (approximately 21,000) will occur in the spring of 2002 to allow us to stay within our maximum allowed number of smolts released under our Section 10 Permit (150,000).

To prevent any stray fish from contributing to the population, all coded wire tags (CWT) were read prior to spawning. One hatchery male did not have wire and was killed outright. Scales from unmarked fish were read prior to spawning to check for hatchery growth patterns. Carcasses were buried instead of being used for nutrient enhancement due to the detection of Infectious Hematopoietic Necrosis virus in the broodstock.

Table 4. Number of fish spawned, estimated egg collection, and egg mortality of Tucannon River spring chinook salmon at LFH in 2001.

	Natural			Hatchery		
Spawn Date	**Male**	**Female**	**Eggs Taken**	**Male**	**Female**	**Eggs Taken**
8/29	2[a]	1	4,087	1[a]	2	6,513
9/04	12[a]	8	30,917	8	12	38,173
9/11	7[a]	13	43,644	14	9	29,220
9/18	2[a]	7	20,036	2	4	11,537
Totals	**23**	**29**	**98,684**	**25**	**27**	**85,443**
Egg Mortality			1,199			1,026

[a] Denotes live spawned fish.

Eggs were also collected as part of the Tucannon River Captive Broodstock Program. One hundred thirty-seven females from the 1997 BY captive broodstock were mature in 2001. Of those, 125 were spawned (20 were partial spawned), four were green and killed outright, five were pre-spawn mortalities, and three were found dead in the pond (DIP). Eggtake was 233,894 eggs and egg survival was 69%. Mean fecundity was 1,990 eggs/female, based on 105 fully spawned females.

Forty-four females were mature from the 1998 BY captive broodstock. Of those, 41 were spawned (two partial spawned), two were green and killed outright, and there was one DIP. Eggtake was 47,409 eggs with egg survival of 81%. Mean fecundity, based on 39 fully spawned females, was 1,160 eggs/female.

From the total captive brood eggtake of 281,303 eggs, loss to eye-up was 29.0% leaving 199,758 live eggs. An additional 4,494 dead eggs/fry (2.3%) were picked at ponding leaving 195,264 fish for rearing. This is above the program release goal of 150,000 smolts due to higher than expected survival of captive brood adults. A release of marked parr (approximately 21,000) will occur in the spring of 2002 to allow us to stay within our maximum allowed number of smolts released under our Section 10 Permit (150,000). We will conduct captive brood adult outplants in the future to lower our eggtake and stay within our maximum allowed number of smolts released. The Tucannon River Captive Broodstock Program was funded through the BPA and results achieved to date are more thoroughly described in the annual Tucannon River Spring Chinook Captive Broodstock Report (Gallinat and Bumgarner 2002).

Radio Tracking

One radio tagged fish that entered the Tucannon River was tracked in 2001 (Table 5; Appendix B). This fish was tagged by the University of Idaho at Bonneville Dam on April 19 and entered the Tucannon River on May 9. Migration speed after river entry, timing and movements upstream, and spawning success were documented.

Mean travel rate from the lower river to rkm 57 (about 1 kilometer below the Tucannon Hatchery) was 2.72 rkm/day. This rate was similar to upstream migration rates documented in previous years (Mendel et al. 1993; Bumgarner et al. 1997). This fish had also been PIT tagged at the Tucannon River smolt trap on April 22, 1999 at a length of 110 mm. Growth rate from time of original PIT tagging to radio tagging averaged 27.3 mm/month.

Table 5. Radio tagging and recovery data of spring chinook salmon from the Tucannon River in 2001 from the University of Idaho study.

	Tagging Information					Recovery Data			
Channel/ Code	Date	Origin	Sex	FL (cm)	VI tag	Date	Sex	FL (cm)	Spawned
12/73	4/19	Wild	M	76.5	---	10/03	M	---	Yes

Radio tagged fish 12/73 was a wild male and spent most of the summer directly across from Blue Lake (rkm 57.4). It was observed spawning near that location and descended downstream before its decomposing carcass was recovered near Bridge 13 (rkm 48.8) (Figure 3). The radio receiver, which had been located at the adult trap, was downloaded and confirmed that this fish went up the ladder on September 9 and stayed at the trap entrance for twenty-three hours before it swam back downstream to the area that it had been holding. It is unknown why this fish did not enter the trap.

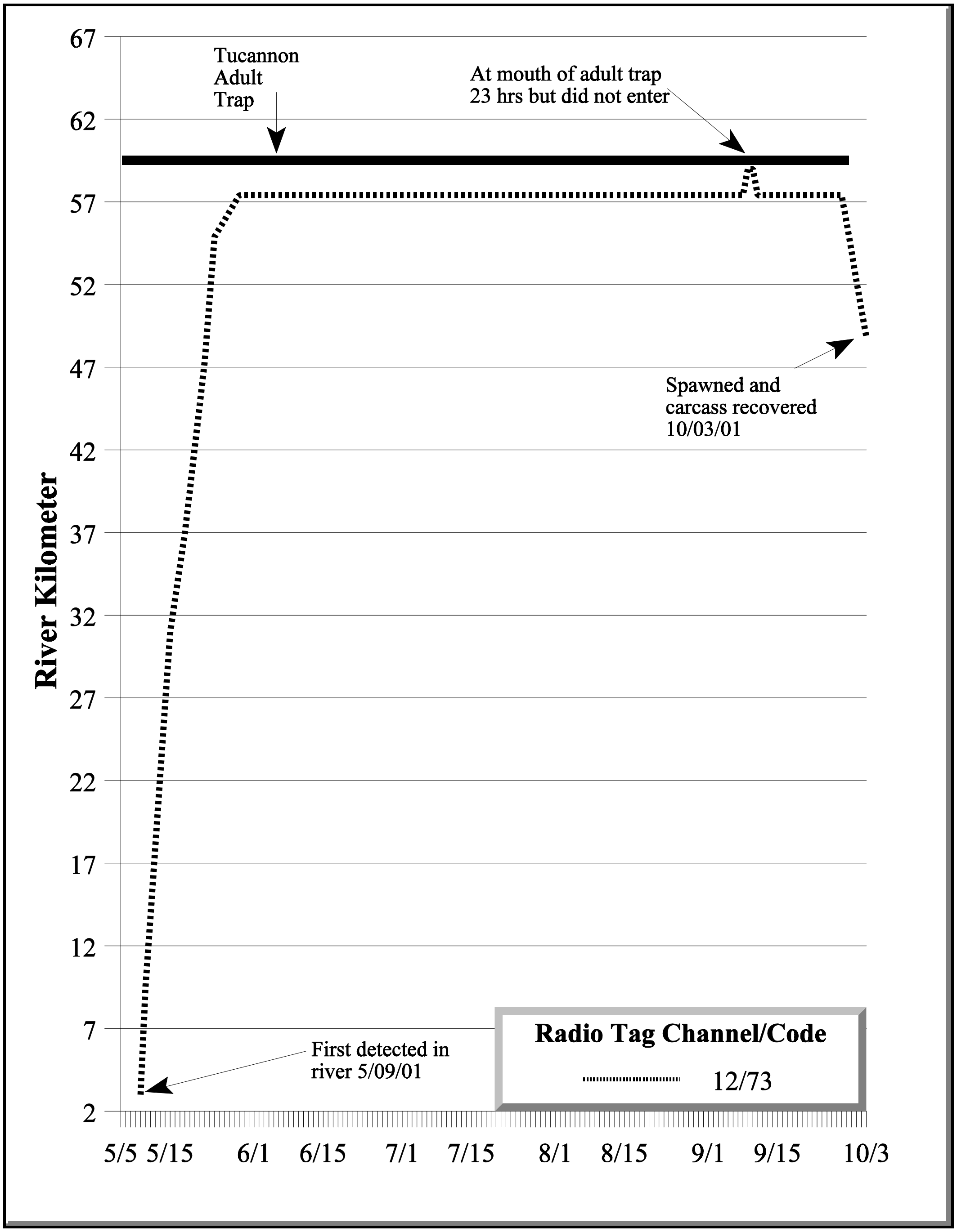

Figure 3. Movements of the radio tagged spring chinook salmon recovered in the Tucannon River, 2001 (based on data collected and presented in Appendix B of this report).

Natural Spawning

Spawning ground surveys were conducted on the Tucannon River weekly from August 29 to October 3, 2001 to count redds and determine the temporal and spatial distribution of spawners. Two hundred ninety-eight redds were counted and 181 natural and 45 hatchery origin carcasses were recovered (Table 6). One hundred sixty-eight redds (56% of total) and 112 carcasses (50% of total) were found above the adult trap.

Table 6. Numbers and general locations of salmon redds and carcasses recovered on the Tucannon River spawning grounds, 2001. (The Tucannon Hatchery adult trap is located at rkm 59.)

Stratum	Rkm[a]	Number of redds	Carcasses Recovered	
			Natural	Hatchery
Wilderness	78-84	0	0	0
	75-78	24	7	1
HMA	73-75	11	6	0
	68-73	46	17	5
	66-68	23	5	0
	62-66	45	21	26
	59-62	19	23	1
	56-59	45	46	8
Hartsock	52-56	37	28	3
	47-52	29	24	1
	43-47	11	4	0
	40-43	7	0	0
Marengo	34-40	1	0	0
Totals	34-84	298	181	45

[a] Rkm descriptions: 84-Sheep Cr.; 78-Lady Bug Flat CG; 75-Panjab Br.; 73-Cow Camp Bridge; 68-Tucannon CG; 66-Curl Lake; 62-Beaver/Watson Lakes Br.; 59-Tucannon Hatchery Intake/Adult Trap; 56-HMA Boundary Fence; 52-Br. 14; 47-Br. 12; 43-Br. 10; 40-Marengo Br.; 34-King Grade Br.

Historical Trends

Since the program's inception in 1985, redd concentrations have shifted downstream. Also, redd densities (redds/km) have declined in recent years (Table 7) due to low returns and a greater emphasis on broodstock collection to keep the spring chinook population above extinction. Number of redds in 2001 increased 224% from 2000 levels and were the most recorded since surveys began in 1985.

Table 7. Number of spring chinook salmon redds and redds/km (in parenthesis) by stratum and year, and the number and percent of redds above and below the TFH adult trap in the Tucannon River, 1985-2001.

	Strata					TFH Adult Trap			
Year	Wilderness	HMA	Hartsock	Marengo	Total Redds	Above	%	Below	%
1985	84 (7.1)	105 (5.3)	–	–	189	–	–	–	–
1986	53 (4.5)	117 (6.2)	29 (1.9)	0 (0.0)	200	163	81.5	37	18.5
1987	15 (1.3)	140 (7.4)	30 (1.9)	–	185	149	80.5	36	19.5
1988	18 (1.5)	79 (4.2)	20 (1.3)	–	117	90	76.9	27	23.1
1989	29 (2.5)	54 (2.8)	23 (1.5)	–	106	74	69.8	32	30.2
1990	20 (1.7)	94 (4.9)	64 (4.1)	2 (0.3)	180	96	53.3	84	46.7
1991	3 (0.3)	67 (2.9)	18 (1.1)	2 (0.3)	90	40	44.4	50	55.6
1992	17 (1.4)	151 (7.9)	31 (2.0)	1 (0.2)	200	130	65.0	70	35.0
1993	34 (3.4)	123 (6.5)	34 (2.2)	1 (0.2)	192	131	68.2	61	31.8
1994	1 (0.1)	10 (0.5)	28 (1.8)	5 (0.9)	44	2	4.5	42	95.5
1995	0 (0.0)	2 (0.1)	3 (0.2)	0 (0.0)	5	0	0.0	5	100.0
1996	1 (0.1)	33 (1.7)	34 (2.2)	0 (0.0)	68	11	16.2	57	83.8
1997	2 (0.2)	43 (2.3)	27 (1.7)	1 (0.2)	73	30	41.1	43	58.9
1998	0 (0.0)	3 (0.2)	20 (1.3)	3 (0.5)	26	3	11.5	23	88.5
1999	1 (0.1)	34 (1.8)	6 (0.4)	0 (0.0)	41	3	7.3	38	92.7
2000	4 (0.4)	68 (3.6)	20 (1.3)	0 (0.0)	92	45	48.9	47	51.1
2001	24 (2.7)	189 (9.9)	84 (5.3)	1 (0.2)	298	168	56.4	130	43.6

Note: – indicates the river was not surveyed in that section during that year.

Genetic Sampling

No electrophoretic samples were collected from spring chinook recovered in the river or from the hatchery during spawning in 2001. We collected 168 DNA samples from adult salmon (99 natural origin and 69 hatchery origin) and 236 samples from captive broodstock spawners. These samples have been sent to the WDFW genetics lab in Olympia for analysis.

Age Composition, Length Comparisons, and Fecundity

One objective of the monitoring program is to track the age composition of each year's return. This allows us to annually compare ages of natural and hatchery reared fish, and to examine long-term trends and variability in the age structure. Overall, hatchery origin fish return at a younger age than natural origin fish (Figure 4). This difference is likely due to smolt size-at-release (hatchery origin smolts are generally 25-30 mm greater in length than natural smolts).

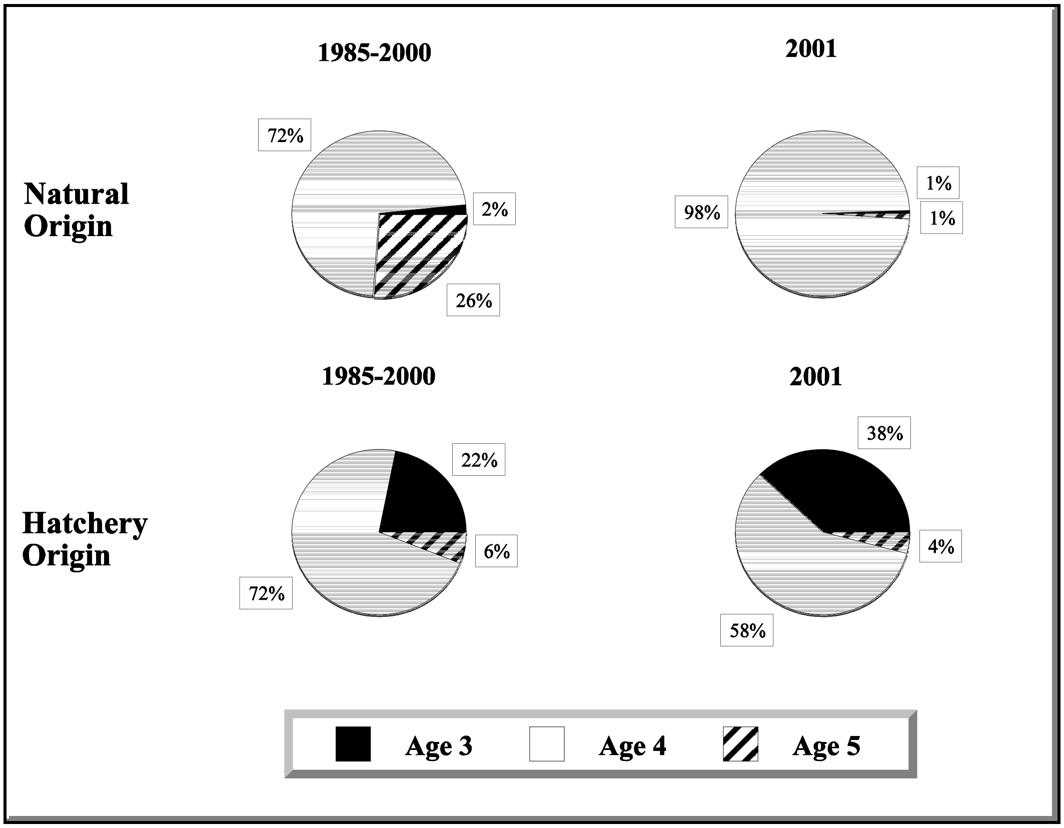

Figure 4. Historical (1985-2000), and 2001 age composition for spring chinook in the Tucannon River.

Age at return during 2001 was not similar to historical data for natural origin fish. Natural returns had fewer 5 year old fish than what is typically observed. This may be attributed to desirable ocean conditions that contributed to higher survival of 4 year old fish. Hatchery fish were composed of more Age 3 and fewer Age 4 fish than historically observed. The increase in hatchery jacks may be due to the release of larger smolts in 2000.

Another comparison we conduct on returning adult natural and hatchery origin fish is the difference between mean post-eye to hypural-plate lengths. We reported in the past (Bumgarner et al. 1994) that hatchery fish were generally shorter than natural origin fish of the same age. For many of the early return years this appeared to be true (Figures 5, 6, 7, and 8). However, overall for all combined return years, there is no difference in mean length between natural and hatchery origin fish, even though they migrate as smolts at significantly different sizes (Bugert et al. 1990; Bugert et al. 1991).

Fecundities (number of eggs/female) of natural and hatchery origin fish from the Tucannon River program have been documented since 1990 (Table 8). A one-way analysis of variance was performed to determine if there were significant differences in mean fecundities at the 95%

confidence level. Natural origin females had significantly higher fecundities than hatchery origin fish for both Age 4 (P<0.001) and 5 year old fish (P<0.001).

Mean size of natural origin eggs in Age 4 spring chinook from the Tucannon River averaged 0.224 g/egg and hatchery origin eggs averaged 0.239 g/egg. This difference was statistically significant at the 95% confidence level (P<0.05). This may help explain why hatchery origin females are less fecund. Mean egg size in Age 5 salmon was 0.271 g/egg for natural origin and 0.270 g/egg for hatchery origin females, but the difference was not significant (P= 0.92).

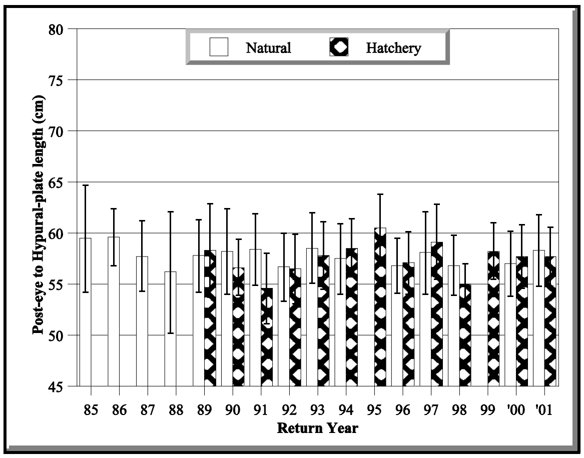

Figure 5. Mean length and SD of Age 4 females.

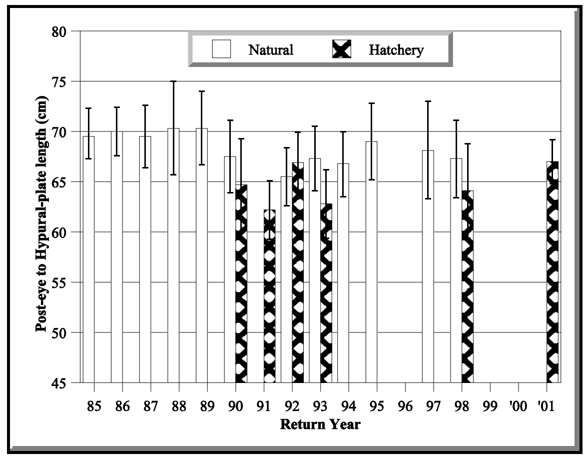

Figure 6. Mean length and SD of Age 5 females.

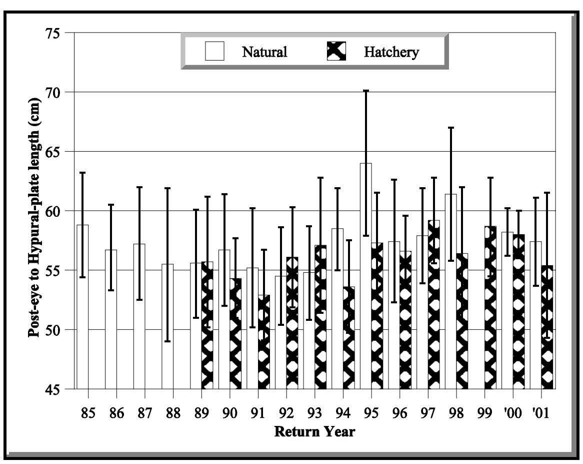

Figure 7. Mean length and SD of Age 4 males.

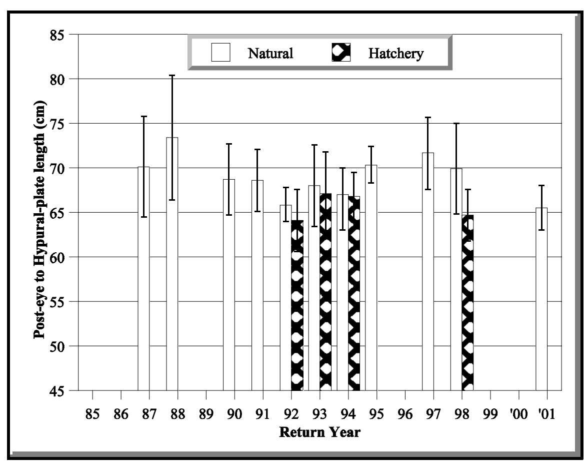

Figure 8. Mean length and SD of Age 5 males.

Table 8. Average number of eggs/female (n, SD) by age group of Tucannon River natural and hatchery origin broodstock, 1990-2001.

	Age 4				Age 5			
Year	**Natural**		**Hatchery**		**Natural**		**Hatchery**	
1990	3,691	(13, 577.3)	2,794	(18, 708.0)	4,383	(8, 772.4)	No	Fish
1991	2,803	(5, 363.3)	2,463	(9, 600.8)	4,252	(11, 776.0)	3,052	(1, 000.0)
1992	3,691	(16, 588.3)	3,126	(25, 645.1)	4,734	(2, 992.8)	3,456	(1, 000.0)
1993	3,180	(4, 457.9)	3,456	(5, 615.4)	4,470	(1, 000.0)	4,129	(1, 000.0)
1994	3,688	(13, 733.9)	3,280	(11, 630.3)	4,906	(9, 902.0)	3,352	(10, 705.9)
1995	No	Fish	3,584	(14, 766.4)	5,284	(6, 136.1)	3,889	(1, 000.0)
1996	3,509	(17, 534.3)	2,833	(18, 502.3)	3,617	(1, 000.0)	No	Fish
1997	3,487	(15, 443.1)	3,290	(24, 923.3)	4,326	(3, 290.9)	No	Fish
1998	4,204	(1, 000.0)	2,779	(7, 375.4)	4,017	(28, 680.5)	3,333	(6, 585.2)
1999	No	Fish	3,121	(34, 445.4)	No	Fish	3,850	(1, 000.0)
2000	4,144	(2, 1,111.0)	3,320	(34, 545.4)	3,618	(1, 000.0)	4,208	(1, 000.0)
2001	3,612	(27, 508.4)	3,225	(24, 690.6)	No	Fish	3,585	(2, 842.5)
Mean	3,597		3,166		4,337		3,474	
SD	573.8		670.8		868.1		638.4	

Coded-Wire Tag Sampling

Broodstock collection, pre-spawn mortalities, and carcasses recovered from spawning ground surveys provide representatives of the annual run that can be sampled for CWT study groups (Table 9). Stray fish were predominately from the Umatilla River, Oregon and are discussed in more detail in a later section of this report. In 2001, based on the estimated escapement of fish to the river, we sampled approximately 34.0% of the run (Table 10).

Table 9. Coded-wire tag codes of hatchery salmon sampled at LFH and the Tucannon River, 2001.							
	Broodstock Collected			**Recovered in Tucannon River**			
CWT Code	**Died in Pond**	**Killed Outright**	**Spawned**	**Dead in Trap**	**Pre-spawn Mortality**	**Spawned**	**Totals**
63-03-59						1	1
63-03-60			1			2	3
63-12-11			7		1	26	34
63-61-25			1				1
63-61-32			42		3	9	54
-Strays-							
07-60-40						1	1
09-28-28						1	1
09-28-29						1	1
Lost tags	1[a]		1			1	3
No tags[b]		1				4	5
Total	**1**	**1**	**52**	**0**	**4**	**46**	**104**

[a] This fish was not seen/examined by evaluation staff.

Table 10. Spring chinook salmon (natural and hatchery) sampled from the Tucannon River, 2001.			
	2001		
	Natural	**Hatchery**	**Total**
Total escapement to river	***718***	***294***	***1,012***
Broodstock collected	52	54	106
Fish dead in adult trap	0	0	0
Total hatchery sample	52	54	106
Total fish left in river	***666***	***240***	***906***
In-river prespawn mortality	8	4	12
Spawned carcasses recovered	181	46	227
Total river sample	189	50	239
Carcasses sampled	**241**	**104**	**345**

Arrival and Spawn Timing Trends

Peak arrival and spawn timing have always been monitored to determine if the hatchery program has caused a shift (Table 11). Peak arrival dates were based on greatest number of fish trapped on a single day. Peak spawn in the hatchery was determined by the day when the most females were spawned. Peak spawning in the river was determined by the highest daily redd counts.

Peak arrival during 2001 was slightly earlier for natural and hatchery fish as compared to previous years, but within the expected range compared to peak arrival before hatchery influence (1986-1988). Peak spawning date of hatchery fish in 2001 was also slightly earlier than in previous years, although within the range found from previous years. The duration of active spawning in the Tucannon River was also similar to previous years.

Table 11. Peak dates of arrival of natural and hatchery salmon to the TFH adult trap and peak (date) and duration (number of days) for spawning in the hatchery and river, 1986-2001.

	Peak Arrival at Trap		Spawning in Hatchery			Spawning in River	
Year	**Natural**	**Hatchery**	**Natural**	**Hatchery**	**Duration**	**Combined**	**Duration**
1986	5/27	–	9/17	–	31	9/16	36
1987	5/15	–	9/15	–	29	9/23	35
1988	5/24	–	9/07	–	22	9/17	35
1989	6/06	6/12	9/15	9/12	29	9/13	36
1990	5/22	5/23	9/04	9/11	36	9/12	42
1991	6/11	6/04	9/10	9/10	29	9/18	35
1992	5/18	5/21	9/15	9/08	28	9/09	44
1993	5/31	5/27	9/13	9/07	30	9/08	52
1994	5/25	5/27	9/13	9/13	22	9/15	29
1995[a]	–	6/08	9/13	9/13	30	9/12	21
1996	6/06	6/20	9/17	9/10	21	9/18	35
1997	6/15	6/17	9/09	9/16	30	9/17	50
1998	6/03	6/16	9/08	9/16	36	9/17	16
1999[a]	–	6/16	9/07	9/14	22	9/16	23
2000	6/06	5/22	–	9/05	22	9/13	30
Mean	**5/30**	**6/05**	**9/12**	**9/11**	**28**	**9/15**	**35**
2001	5/23	5/23	9/11	9/04	20	9/12	35

[a] Too few natural salmon were trapped in 1995 and 1999 to determine peak arrival.

Total Run-Size

In general, redd counts have been directly related to total run-size entering the Tucannon River and passage of adult salmon at the TFH adult trap (Bugert et al. 1991). For 2001, we used sex ratios from collected broodstock and sex ratio observations on the spawning grounds to estimate the number of fish/redd. The run-size estimate for 2001 was calculated by adding the estimated number of fish upstream of the TFH adult trap, the estimated fish below the weir based on an estimated fish/redd ratio, the number of pre-spawn mortalities below the weir, and the number of broodstock collected (Table 12). Total run-size for 2001 was estimated at 1,012 fish (892 adults and 120 jacks). The total run for jacks and adults by origin has been estimated since 1985 (Appendix C).

Table 12. Estimated spring chinook salmon run to the Tucannon River, 1985-2001.

Year[b]	Total Redds	Fish/Redd Ratio[a]	Spawning fish In the river	Broodstock Collected	Pre-spawning Mortalities	Total Run-Size	Percent Natural
1985	189	2.85	539	22	0	561	100
1986	200	2.85	570	116	0	686	100
1987	185	2.85	527	101	0	628	100
1988	117	2.85	333	125	0	458	96
1989	106	2.85	302	169	0	471	77
1990	180	3.39	610	135	7	753	66
1991	90	4.33	390	130	8	528	49
1992	200	2.82	564	97	81	753	55
1993	192	2.27	436	97	56	589	54
1994	44	1.59	70	70	0	140	70
1995	5	2.20	11	43	0	54	39
1996	68	2.00	136	80	11	247	66
1997	73	2.00	146	97	45	351	46
1998	26	1.94	51	89	4	144	59
1999	41	2.60	107	136	2	245	1
2000	92	2.60	239	81	2	339	24
2001	298	3.00	894	106	12	1012	71

[a] From 1985-1989 the TFH trap was temporary, thereby underestimating total fish passed upstream of the trap. The 1985-1989 fish/redd ratios were calculated from the 1990-1993 average, excluding 1991 because of a large jack run.

[b] In 1994, 1995, 1998 and 1999, fish were not passed upstream, and in 1996 and 1997, high pre-spawning mortality occurred in fish passed above the trap, therefore; fish/redd ratio was based on the sex ratio of broodstock collected.

Stray Salmon into the Tucannon River

Spring chinook from other river systems (strays) have periodically been recovered in the Tucannon River, though generally at a low proportion of the total run (Bumgarner et al. 2000). Through 1998 the incidence of stray spring chinook salmon was negligible (Table 13). However, in 1999, Umatilla River strays accounted for 8% of the total Tucannon River run, and that rate increased to 12% in 2000. The increase in the number of strays, particularly from the Umatilla River, is a concern since it exceeds the allowable 5% stray rate of hatchery fish as deemed acceptable by National Marine Fisheries Service (NMFS). Beginning with the 1997 brood year releases, the Oregon Department of Fish and Wildlife (ODFW) and Confederated Tribes of the Umatilla Indian Reservation (CTUIR) ceased marking Umatilla River origin spring chinook with an RV or LV fin clip (65-70% of releases). Because of this action, Age 4 fish that returned in 2001 were not distinguishable from wild origin spring chinook from the Tucannon River. For 2001, scale samples were collected from all wild fish collected for broodstock and passed upstream at the adult trap. None of the fish collected for broodstock were determined to be of hatchery origin, however, two fish passed upstream were later found to be of hatchery origin based on scale pattern analysis. Beginning with the 2000 BY, Umatilla River hatchery-origin spring chinook will be 100 % marked. This will help ensure that genetic integrity is maintained for ESA listed spring chinook in the Tucannon River.

Table 13. Summary of identified stray hatchery origin spring chinook salmon which escaped into the Tucannon River (1990-2001).

Year	CWT Code or Fin clip	Agency	Origin (stock)	Release Location / Release River	Number Observed/ Expanded [a]	% of Tuc. Run
1990	074327	ODFW	Carson (Wash.)	Meacham Cr. / Umatilla River	2 / 5	
	074020	ODFW	Rapid River	Lookingglass Cr. / Grande Ronde	1 / 2	
	232227	NMFS	Mixed Col.	Columbia River / McNary Dam	2 / 5	
	232228	NMFS	Mixed Col.	Columbia River / McNary Dam	1 / 2	
				Total Strays	**14**	**1.9**
				Total Umatilla River	**5**	**0.7**
1992	075107	ODFW	Lookingglass Cr.	Bonifer Pond / Columbia River	2 / 6	
	075111	ODFW	Lookingglass Cr.	Meacham Cr. / Umatilla River	1 / 2	
	075063	ODFW	Lookingglass Cr.	Meacham Cr. / Umatilla River	1 / 2	
				Total Strays	**10**	**1.3**
				Total Umatilla River	**4**	**0.5**
1993	075110	ODFW	Lookingglass Cr.	Meacham Cr. / Umatilla River	1 / 2	
				Total Strays	**2**	**0.3**
				Total Umatilla River	**2**	**0.3**
1996	070251	ODFW	Carson (Wash.)	Imeques AP / Umatilla River	1 / 1	
	LV clip	ODFW	Carson (Wash.)	Imeques AP / Umatilla River	1 / 2	
				Total Strays	**3**	**1.2**
				Total Umatilla River	**3**	**1.2**
1997	103042	IDFG	South Fork Salmon	Knox Bridge / South Fork Salmon	1 / 2	
	103518	IDFG	Powell	Powell Rearing Ponds / Lochsa R.	1 / 2	
	RV clip	ODFW	Carson (Wash.)	Imeques AP / Umatilla River	3 / 5	
				Total Strays	**9**	**2.6**
				Total Umatilla River	**5**	**1.4**
1999	091751	ODFW	Carson (Wash.)	Imeques AP / Umatilla River	2 / 3	
	092258	ODFW	Carson (Wash.)	Imeques AP / Umatilla River	1 / 1	
	104626	UI	Eagle Creek NFH	Eagle Creek NFH / Clackamas R.	1 / 1	
	LV clip	ODFW	Carson (Wash.)	Imeques AP / Umatilla River	2 / 2	
	RV clip	ODFW	Carson (Wash.)	Imeques AP / Umatilla River	8 / 13	
				Total Strays	**20**	**8.2**
				Total Umatilla River	**19**	**7.8**
2000	092259	ODFW	Carson (Wash.)	Imeques AP / Umatilla River	4 / 4	
	092260	ODFW	Carson (Wash.)	Imeques AP / Umatilla River	1 / 1	
	092262	ODFW	Carson (Wash.)	Imeques AP / Umatilla River	1 / 3	
	105137	IDFG	Powell	Walton Creek/ Lochsa R.	1 / 3	
	636330	WDFW	Klickitat (Wash.)	Klickitat Hatchery	1 / 1	
	636321	WDFW	Lyons Ferry (Wash.)	Lyons Ferry / Snake River	1 / 1	
	LV clip	ODFW	Carson (Wash.)	Imeques AP / Umatilla River	18 / 31	
	No Ad	ODFW	Carson (Wash.)	Imeques AP / Umatilla River	2 / 2	
				Total Strays	**46**	**13.6**
				Total Umatilla River	**41**	**12.1**
2001	076040	ODFW	Umatilla R.	Umatilla Hatch./Umatilla River	1/7	
	092828	ODFW	Imnaha R. & Tribs.	Lookinglass/Imnaha River	1/3	
	092829	ODFW	Imnaha R. & Tribs.	Lookinglass/Imnaha River	1/3	
				Total Strays	**13**	**1.3**
				Total Umatilla River	**7**	**0.7**

[a] All CWT codes recovered from groups that were 100% marked were given a 1:1 expansion rate. Groups that were not 100% marked were expanded based on the percentage of unmarked fish. The expansion is based on the percent of stray carcasses to Tucannon River origin carcasses and the estimated total run in the river.

Hatchery Rearing, Marking, and Release

Hatchery Rearing and Marking

Based on recommendations by Gallinat et al. (2001), the adipose clip was abandoned for Tucannon River spring chinook to prevent this listed population from potential harvest in the sport fishery. All 2000 BY supplementation juveniles were marked with a right red elastomer and tagged with CWTs on October 11-18, 2001. Captive brood progeny juveniles (2000 BY) were marked with agency-only wire on October 18, 2001. After tagging, hatchery personnel transported 111,156 supplementation fish (33 fpp) to TFH on October 25, 2001. A total of 3,074 captive brood progeny (14 fpp) were transferred to TFH on November 5, 2001.

Length and weight samples were collected only twice on the 2000 BY fish during the rearing cycle due to an outbreak of Bacterial Kidney Disease (BKD). Handling the fish under such conditions to obtain the information was not considered wise. Samples collected on May 18 and again on February 19 found the captive brood progeny to be out-of-size (Table 14). This was likely due to overfeeding a small number of fish in one raceway. Hatchery managers were notified and feeding rates were adjusted.

Table 14. Summary of sample sizes (N), mean lengths (mm), coefficients of variation (CV), condition factors (K), and fish/lb (fpp) of 2000 BY juveniles sampled at LFH, TFH, and Curl Lake.

Brood/ Date	Progeny Type	Sample Location	N	Mean Length	CV	K	FPP
2000							
5/18/01	Supplementation	LFH	227	87.6	7.3	1.15	58.2
2/19/02	Supplementation	TFH	200	120.5	12.1	1.28	19.5
4/08/02	Supplementation	Curl Lake	206	133.1	13.2	1.19	15.5
5/18/01	Captive Brood	LFH	472	103.5	6.7	1.24	32.7
2/19/02	Captive Brood	TFH	160	163.5	10.8	1.13	8.9

2000 Brood Release

Captive brood progeny (3,055 BY00) were transported to Curl Lake AP on February 21, 2002. A total of 102,289 supplementation juveniles (2000 BY) were transported to Curl Lake on February 22, 2002. The outlet of Curl Lake was opened for volitional release on March 15, and continued until April 23 when fish were forced out, with an estimated release of 102,099 supplementation fish and 3,055 captive brood progeny (Tables 15 and 16). Supplementation fish were at the release goal of 15 fish/lb. Insufficient samples of captive brood progeny were collected at Curl Lake for length and weight analysis, but they were already at 9 fish/lb in February. Due to their large size difference and small number of captive brood progeny released, the 2000 BY captive brood progeny and supplementation fish were not PIT tagged for survival comparisons.

Table 15. Summary of yearling spring chinook supplementation fish released from Curl Lake Acclimation Pond in the Tucannon River, 2000 BY.

Release Year (BY)	Release Dates	CWT Code	VI + CWT	CWT only	VI only	Total Released	Lbs	Fish/lb
2002 (00)	3/15-4/23	63-08-87	92,928	6,638	2,533	102,099	6,587	15.5

Table 16. Summary of yearling captive brood spring chinook progeny released from Curl Lake Acclimation Pond in the Tucannon River, 2000 BY.

Release Year (BY)	Release Dates	CWT Code	Agency Tag	No Tag	Total Released	Lbs	Fish/lb
2002 (00)	3/15-4/23	63	3,031	24	3,055	343	8.9

Natural Parr Production

Program staff surveyed the Tucannon River at index sites in 2001 to estimate the density and population of subyearling (Table 17, Appendix D) and yearling spring chinook salmon. Snorkel surveys were conducted using a total count method (Griffith 1981, Schill and Griffith 1984). Population size was determined by multiplying the mean fish density (fish/100 m^2) by the estimated total area within each stratum. Twenty-five sites were snorkeled in 2001 (August 13 to August 15). Total area snorkeled was approximately 2.5% of the suitable rearing habitat in the Tucannon River. A total of 1,102 subyearling and 10 yearling spring chinook were counted during the surveys. We estimated that 44,618 (± 12,809) subyearling and 397 (± 281) yearling chinook were present in the river.

Table 17. Number of sites, area snorkeled, population estimates, and 95% confidence intervals for subyearling and yearling spring chinook within the Tucannon River, 2001.

Stratum	Number of sites	Area (m^2) snorkeled	Subyearling		Yearling	
			Estimate	C.I.	Estimate	C.I.
Lower	--	--	--	--	--	--
Marengo	3	2,094	961	726	--	--
Hartsock	7	4,368	16,716	10,988	124	164
HMA	10	6,003	25,325	7,180	236	218
Wilderness	5	2,062	1,616	2,321	37	74
Total	**25**	**14,527**	**44,618**	**12,809**	**397**	**281**

Natural Smolt Production

Program staff operated a 5 ft rotary screw trap nearly continuously at rkm 3 on the Tucannon River from October 16, 2000 to June 30, 2001 to estimate numbers of migrating natural and hatchery spring chinook. The smolt trap was pulled for three days during the trapping season (10/21/00, 10/29/00, and 2/06/01). Other data on natural and hatchery spring chinook smolts such as peak outmigration, lengths of smolts, descaling, etc., have not been reported here for simplicity. Those data are available upon request.

We examined the influence of specific abiotic variables on spring chinook emigration during the last four trapping seasons (1997/1998 to 2000/2001) using correlation analysis. Significant relationships were found between the total number of wild spring chinook smolts captured ($\log_{10}$ transformed for normality) emigrating from the Tucannon River and flow (ft^3 /sec) ($r^2 = 0.08$, $P < 0.01$), staff gauge level ($r^2 = 0.10$, $P < 0.01$), time of year ($r^2 = 0.08$, $P < 0.01$), and water temperature ($r^2 = 0.01$, $P < 0.07$). Although these variables are statistically significant, they account for only a small amount of the variability in the number of emigrating fish. This is understandable as smoltification is a physiological process and the resulting outmigration may only be slightly influenced by abiotic factors. No statistically significant relationships were found between the number of emigrating wild spring chinook smolts and secchi disk reading (turbidity indicator).

Similarly, no significant relationships were found between the total number of hatchery spring chinook smolts captured ($\log_{10}$ transformed) and flow, staff gauge level, time of year (week number), water temperature, or secchi disk reading. There was a statistically significant relationship at the 90% level between the number of hatchery spring chinook smolts captured and water temperature ($r^2 = 0.30$, $P < 0.10$).

Each week we attempted to determine trap efficiency by clipping a portion of the caudal fin on a few representative captured migrants and releasing them about one kilometer upstream. The percent of marked fish recaptured was used as an estimate of weekly trapping efficiency. To calculate trapping efficiency during weeks when low numbers of fish were caught we examined the relationship between trap efficiency and the variables flow, staff gauge, number of fish captured, water temperature, and time of year (week). There were no statistically significant relationships between trap efficiency for wild spring chinook and any of the variables examined. The only statistically significant relationship found between trap efficiency for hatchery spring chinook and any of the variables examined was staff gauge level ($r^2 = 0.30$, $P < 0.10$). Despite the low statistical power, we believe that trap efficiency decreases as flow increases.

Flow is the dominant factor affecting downstream migrant trapping operations in any system according to Seiler et al. (1999). Groot and Margolis (1991) state that the rate of downstream migration of chinook fingerlings appears to be both time and size dependent and may also be related to river discharge and the location of fish in the river. They state that during years of low and stable river flow, the rate of downstream migration was negatively correlated with discharge, whereas, when flows were higher and more variable, the rate of migration was positively correlated with discharge.

Mean daily flow data was provided by the U.S.G.S. gauge at Starbuck, WA (rkm 12.7). Correlation analysis indicated a statistically significant relationship between flow and the staff gauge level at the smolt trap at the 99% confidence level ($r^2 = 0.95$). As the U.S.G.S. flow data is computer monitored on a continuous basis, is in relatively close proximity to the smolt trap, and there was a strong statistically significant relationship between the variables, we estimated trap efficiencies with the following equations:

<u>Wild Spring Chinook</u>
Trap Efficiency = 29.932 - 0.037 (Flow)

<u>Hatchery Spring Chinook</u>
Trap Efficiency = 24.994 - 0.046 (Flow)

To estimate potential juvenile migrants passing when the trap was not operated, such as periods when freshets washed out large amounts of debris from the river, we calculated the average number of fish trapped for three days before and three days after non-trapping periods. The mean number of fish trapped daily was then divided by the estimated trap efficiency to calculate fish passage. The estimated number of fish passing each day was then applied to each day the trap was not operated.

We estimated that 8,157, or 51.2% of the 1999 BY parr estimates, passed the smolt trap during 2000-2001. (Table 18). We also estimated that 56% of the hatchery fish released from Curl Lake Acclimation Pond (1999 BY) passed the smolt trap. Tucannon Fish Hatchery personnel noted the occurrence of hatchery spring chinook on May 4, 2001 in Rainbow Lake (rkm 59.2), one of eight public fishing lakes within the WDFW W.T. Wooten Wildlife Area. A water intake screen at the lake inlet adjacent to the Tucannon River experienced a structural problem which resulted in the entrainment of some spring chinook smolts into the lake. Due to the potential recreational harvest impacts on this listed stock, the fishery was closed on May 10, 2001. Efforts to facilitate the voluntary out-migration and a salvage operation at the lake for recovery and release were conducted and the lake was re-opened to fishing on June 30, 2001.

Table 18. Monthly and total population estimates, with 95% confidence intervals, for natural and hatchery origin emigrants from the Tucannon River, 2001.

Month	Natural	+/- 95% C. I.	Hatchery	+/- 95% C. I.
Sept.-Feb.	442	9	0	--
March	140	14	0	--
April	5,549	353	13,770	2,132
May	2,026	121	41,130	2,388
June	0	--	190	18
Total	8,157	497	55,090	4,538
% Survival [a]	51.2		56.4	

[a] Percent survival to smolt based on estimated number of parr from summer snorkel surveys (natural origin) or from TFH release numbers (hatchery origin).

Juvenile Migration Studies

In 2001, WDFW used PIT tags to study the emigration timing and success of wild and hatchery origin spring chinook. The tags allowed us to identify the characteristics of successful smolts. We tagged 158 wild and 301 hatchery origin spring chinook over a four week period (Table 19). No fish were killed during PIT tagging, though it is likely some delayed mortality occurred after release. Detection rates were higher for wild chinook and mean travel days were generally higher for hatchery spring chinook. Detection rates may be higher for wild chinook because they are smaller (25-48 mm less) and more likely to be captured at collection facilities, or their survival was actually slightly higher.

Table 19. Cumulative detection (one unique detection per tag code) and travel time (TD) summaries of PIT tagged spring chinook salmon released from the Tucannon River smolt trap (rkm 3) at downstream Snake and Columbia River dams in 2001.

Release Data				Recapture Data										
					LMJ		MCJ		JDJ		BONN		Total	
Release Date	Origin	N	Mean length	Mean length	N	TD	N	TD	N	TD	N	TD	N	(%)
4/25-26	W	97	109.5	110.0	62	5.9	12	27.7	1	20.8	1	39.9	**76**	**(78.4)**
	H	100	145.0	145.7	59	7.3	14	18.7	2	31.7	0	---	**75**	**(75.0)**
5/02-04	W	44	110.0	110.6	27	4.4	10	16.0	2	18.4	0	---	**39**	**(88.6)**
	H	101	143.1	141.7	47	6.3	20	16.6	2	31.4	2	26.1	**71**	**(70.3)**
5/16-18	W	17	113.8	115.5	8	2.6	4	7.4	0	---	0	---	**12**	**(70.6)**
	H	100	138.4	139.1	46	3.0	15	9.2	0	---	2	18.0	**63**	**(63.0)**

Note: Mean travel times listed are from the total number of fish detected at each dam, not just unique recoveries for a tag code. Abbreviations are as follows: LMJ-Lower Monumental Dam, MCJ- McNary Dam, JDJ-John Day Dam, BONN-Bonneville Dam, TD- Mean Travel Days.

Survival Rates

Point estimates of population sizes have been calculated for various life stages (Table 20 and 21) of natural origin fish from spawning ground and juvenile mid-summer population surveys, smolt trapping, and fecundity estimates. From these two tables, survivals between life stages have been calculated for both natural and hatchery salmon to assist in the evaluation of the hatchery program. These survival estimates provide insight as to where efforts should be directed to improve not only the survival of fish produced within the hatchery, but fish in the river as well.

As expected, juvenile (egg-fry-smolt) survival rates for hatchery fish are considerably higher than for naturally reared salmon (Table 22) because they have been protected in the hatchery. However, smolt-to-adult return rates (SAR) of natural salmon were about five times higher than for hatchery reared salmon (Table 23 and 24). The mean hatchery SAR's (0.18%) documented from the 1985-1996 broods were below the goal SAR of 0.87% established under the LSRCP. Hatchery SAR's for Tucannon River salmon need substantial improvement if we ever hope to meet the mitigation goal of 1,152 salmon.

Table 20. Estimates of *natural* Tucannon spring chinook salmon abundance by life stage for 1985-2001 broods.

Brood year	Females in river		Mean [a] fecundity		Number of eggs	Number [b] of fry	Number of smolts	Progeny [c] (returning adults)
	natural	hatchery	natural	hatchery				
1985	270	-	3,883	-	1,048,410	90,200	35,600	412
1986	309	-	3,916	-	1,210,044	102,600	58,200	468
1987	282	-	4,095	-	1,155,072	79,100	44,000	238
1988	168	-	3,882	-	652,176	69,100	37,500	527
1989	133	4	3,883	2,606	526,863	58,600	25,900	158
1990	196	108	3,993	2,694	1,073,904	64,100	49,500	94
1991	104	68	3,741	2,517	560,220	54,800	26,000	7
1992	168	129	3,854	3,295	1,072,527	103,292	50,800	194
1993	156	109	3,701	3,237	930,189	86,755	49,600	204
1994	38	5	4,187	3,314	175,676	12,720	6,900	12
1995	7	0	5,284	3,604	36,568	0	75	6
1996	61	14	3,516	2,843	254,278	2,845	1,612	66
1997	40	34	3,609	3,315	257,070	32,913	21,057	717
1998	24	5	4,023	3,075	111,727	8,453	5,508	9
1999	1	40	3,965	3,142	129,645	15,944	8,157	
2000	43	73	3,969	3,345	414,852	44,618		
2001	367	118	3,612	3,252	1,709,340			

a 1985 and 1989 mean fecundity of natural females is average of 1986-88 and 1990-93.
b Number of fry estimated from electrofishing (1985-1989), Line transect snorkel surveys (1990-1992), and Total Count snorkel surveys (1993-1999).
c Numbers do not include down river harvest estimates or out-of-basin recoveries.

Table 21. Estimates of Tucannon spring chinook salmon abundance (*spawned and reared in the hatchery*) by life stage for 1985-2001 broods.

Brood year	Females spawned natural	Females spawned hatchery	Mean [a] fecundity natural	Mean [a] fecundity hatchery	Number of eggs	Number of fry	Number of smolts	Progeny [b] (returning adults)
1985	4	-	3,883	-	14,843	13,401	12,922	46
1986	57	-	3,916	-	187,958	177,277	153,725	327
1987	48	-	4,095	-	196,573	164,630	152,165	189
1988	49	-	3,882	-	182,438	150,677	145,146	447
1989	28	9	3,883	2,606	133,521	103,420	99,057	243
1990	21	23	3,993	2,694	126,334	89,519	85,797	28
1991	17	11	3,741	2,517	91,275	77,232	74,058	25
1992	28	18	3,854	3,295	156,359	151,727	87,752[c]	81
1993	21	28	3,701	3,237	168,366	145,303	138,848	207
1994	22	21	4,187	3,314	161,707	148,148	130,069	34
1995	6	15	5,284	3,604	85,772	63,935	62,272	180
1996	18	19	3,516	2,843	117,287	81,326	76,219	260
1997	17	25	3,609	3,315	144,237	29,650	24,186	181
1998	30	14	4,023	3,075	161,019	136,027	127,939	103
1999	1	36	3,969	3,142	111,961	106,880	97,600	
2000	3	35	3,969	3,345	128,980	123,313	102,139	
2001	29	27	3,612	3,252	184,127	174,934		

[a] 1985 and 1989 mean fecundity of natural females is average of 1986-88 and 1990-93, 1999 mean fecundity of natural fish is the based on the mean of 1986-1998 .

[b] Numbers do not include down river harvest estimates or out of basin recoveries.

[c] Number of smolts is less than actual release number. 57,316 parr were released in October 1993, with an estimated 7% survival. Total number of hatchery fish released from the 1992 brood year was 140,725. We therefore use the listed number of 87,752 as the number of smolts released.

Table 22. Percent survival by brood year for juvenile salmon and the multiplicative advantage of hatchery reared salmon over naturally reared salmon in the Tucannon River.

	Natural			Hatchery			Hatchery Advantage		
Brood Year	**Egg to fry**	**Fry to smolt**	**Egg to smolt**	**Egg to fry**	**Fry to smolt**	**Egg to smolt**	**Egg to fry**	**Fry to smolt**	**Egg to smolt**
1985	8.6	39.5	3.4	90.3	96.4	87.1	10.5	2.4	25.6
1986	8.5	56.7	4.8	94.3	86.7	81.8	11.1	1.5	17.0
1987	6.8	55.6	3.8	83.8	92.4	77.4	12.3	1.7	20.4
1988	10.6	54.3	5.7	82.6	97.0	80.1	7.8	1.8	14.1
1989	11.1	44.2	4.9	77.5	95.8	74.2	7.0	2.2	15.1
1990	6.0	77.2	4.6	70.9	95.8	67.9	11.8	1.2	14.8
1991	9.8	47.4	4.6	84.6	95.9	81.1	8.6	2.0	17.6
1992	9.6	49.2	4.7	97.0	57.8	56.1	10.1	1.2	11.9
1993	9.3	57.1	5.3	86.3	95.6	82.5	9.3	1.7	15.6
1994	7.2	54.2	3.9	82.2	97.9	80.4	11.4	1.8	20.6
1995	0.0	0.0	0.2	74.5	97.4	72.6	-	-	- -
1996	1.1	56.7	0.6	68.5	94.9	65.0	62.3	1.7	- -
1997	12.8	64.0	8.2	20.6	81.6	16.8	1.6	1.3	2.0
1998	7.6	65.2	4.9	84.5	94.1	79.5	11.1	1.4	16.2
1999	12.3	51.2	6.3	94.1	91.3	86.0	7.7	1.8	13.7
2000	10.8			95.6	82.8	79.2	8.9		
2001				95.0					
Mean	8.3	51.5	4.4	81.3	90.8	73.0	12.8	1.7	15.7
SD	3.6	16.9	2.0	17.9	10.2	17.0	14.0	0.4	5.5

Table 23. Adult returns and SAR's of **natural** salmon to the Tucannon River for brood years 1985-1996.

Brood Year	Estimated number of smolts	Number of Adult Returns, observed and expanded (exp) [a] Age 3 obs	Age 3 exp	Age 4 obs	Age 4 exp	Age 5 obs	Age 5 exp	SAR (%) w/jacks	SAR (%) no jacks
1985	35,600	8	20	110	274	36	118	1.16	1.10
1986[b]	58,200	1	2	115	376	28	90	0.80	0.80
1987	44,000	0	0	52	167	29	71	0.54	0.54
1988	37,500	1	3	136	335	74	189	1.41	1.40
1989	25,900	5	12	47	120	23	26	0.61	0.56
1990	49,500	3	8	63	72	12	14	0.19	0.17
1991	26,000	0	0	4	5	1	2	0.03	0.03
1992	50,800	2	2	84	159	16	33	0.38	0.38
1993	49,560	1	2	62	127	58	75	0.41	0.41
1994	6,000	0	0	8	10	1	2	0.20	0.20
1995	75	0	0	1	1	2	5	8.0[c]	8.0[c]
1996	1,612	0	0	27	63	2	6	4.28	4.28
Mean of 1985-1996 broods								**0.91**	**0.90**

[a] Expanded numbers are calculated from the proportion of each known age salmon recovered in the river and from broodstock collections in relation to the total estimated return to the Tucannon River. Expansions do not include down river harvest or Tucannon River fish straying to other systems.

[b] One known (expanded to two) age 6 salmon was recovered.

[C] 1995 SAR not included in mean.

Table 24. Adult returns and SAR's of **hatchery** salmon to the Tucannon River for brood years 1985-1996.

Brood Year	Estimated number of smolts	Number of Adult Returns, known and expanded (exp.) Age 3 known	Age 3 exp.	Age 4 known	Age 4 exp.	Age 5 known	Age 5 exp.	SAR (%) w/jacks	SAR (%) no jacks
1985	12,922	9	20	25	26	0	0	0.36	0.20
1986	153,725	79	84	99	225	8	18	0.21	0.16
1987	152,165	9	21	70	151	8	17	0.12	0.11
1988	146,200	46	99	140	295	26	53	0.31	0.24
1989	99,057	7	15	100	211	14	17	0.25	0.23
1990	85,500	3	6	16	20	2	2	0.03	0.03
1991	74,058	4	5	20	20	0	0	0.03	0.03
1992	87,752	11	11	50	66	2	4	0.09	0.08
1993	138,848	11	15	93	174	15	18	0.15	0.14
1994	130,069	2	4	21	25	4	5	0.03	0.02
1995	62,272	13	16	117	160	2	4	0.29	0.26
1996	76,219	44	60	100	186	5	14	0.34	0.26
Mean of 1985-1996 broods								**0.18**	**0.15**

We found a significant relationship between survival calculated from CWT returns through the Regional Mark Information System (RMIS) database and size of smolts at release, with larger fish (6-10 fish/lb) having higher survival ($r^2 = 29.3$, $P<0.01$) (Table 25; Appendix E). However, years in which smaller fish (14-19 fish/lb) were released also coincided with poor ocean conditions, drought years, and flood events within the Tucannon River watershed. Decreasing the release size of smolts has allowed hatchery fish to more closely resemble wild fish and decrease the incidence of precocious fish and returning jacks, but overall survival appears to have decreased. An experimental release of fish at 15/lb and 10/lb during the same year would provide a direct comparison of differences in survival, age structure, length, and fecundity of adult returns.

Table 25. Estimated survival for selected sizes at release (fpp) based on a fitted square root correlation model of individual coded wire tag (CWT) recoveries of hatchery fish from the RMIS database (1985-1996 brood year releases).

Size at Release (FPP)	Predicted Survival	95% Confidence Limits	95% Prediction Limits
6.0	0.27	0.18 - 0.37	0.03 - 0.73
9.0	0.22	0.16 - 0.30	0.02 - 0.65
12.0	0.18	0.14 - 0.24	0.01 - 0.58
15.0	0.15	0.11 - 0.19	0.00 - 0.52
18.0	0.12	0.08 - 0.16	0.00 - 0.46
25.0	0.06	0.02 - 0.11	0.00 - 0.34
36.0	0.01	0.00 - 0.07	0.00 - 0.21

While SAR's were lower for hatchery salmon, overall survival of hatchery salmon to return as adults was higher than naturally reared fish because of the early-life survival advantage provided by the hatchery (Table 22). With the exception of the 1988 and 1997 brood years, naturally produced fish remain below the replacement level (Figure 9; Table 26). Based on adult returns from the 1985-1997 broods, naturally reared salmon produced 0.9 adults for every spawner, while hatchery reared fish produced 2.5 adults.

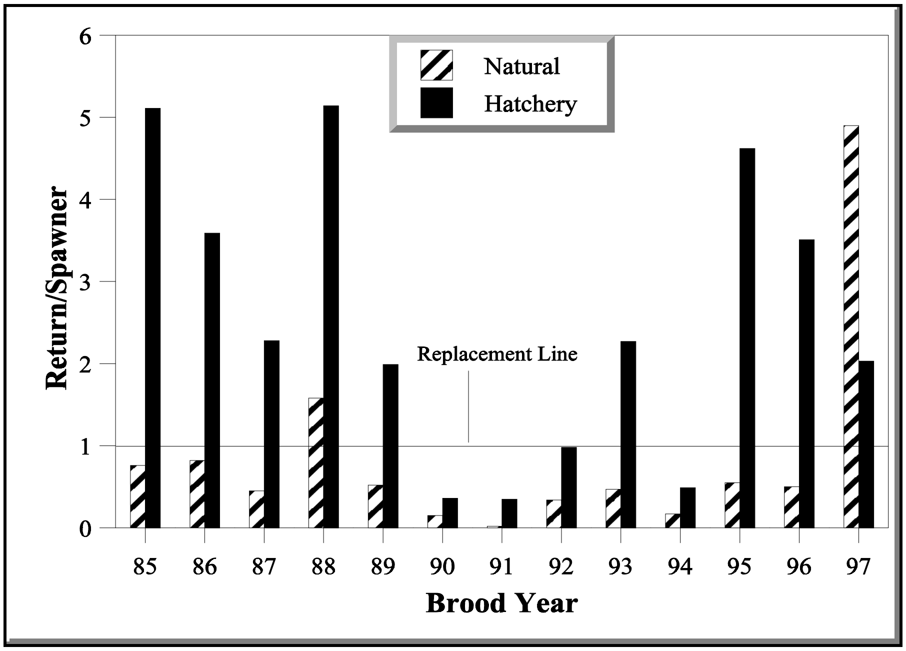

Figure 9. Return per spawner ratio (with replacement line) for the 1985-1997 brood years.

Table 26. Parent-to-progeny survival estimates of Tucannon River spring chinook salmon from 1985 through 1997 brood years (1997 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 Natural advantage**
1985	539	412	0.76	9	46	5.11	6.7
1986	570	468	0.82	91	327	3.59	4.4
1987	527	238	0.45	83	189	2.28	5.1
1988	333	527	1.58	87	447	5.14	3.3
1989	302	158	0.52	122	243	1.99	3.8
1990	611	94	0.15	78	28	0.36	2.4
1991	390	7	0.02	72	25	0.35	17.5
1992	564	194	0.34	83	81	0.98	2.9
1993	436	204	0.47	91	207	2.27	4.8
1994	70	12	0.17	69	34	0.49	2.9
1995	11	6	0.55	39	180	4.62	8.4
1996	138	69	0.50	74	260	3.51	7.0
1997	146	717	4.91	89	18	2.03	0.4
Mean			**0.86**			**2.52**	**2.9**

Fishery Contribution

An original goal of the LSRCP supplementation program was to enhance wild (natural) returns of salmon to the Tucannon River by providing 1,152 hatchery reared fish to the system. Such an increase would allow for limited harvest of the stock and increased spawning. Unfortunately, hatchery adult returns have been below the program goal. Moreover, natural escapement, with the exception of the 2001 run, has further declined (Figure 10). Based on 1985-1996 brood year CWT recoveries from the RMIS database (Appendix E), harvest has accounted for approximately 5.5% of the hatchery adult fish recovered annually and accounted for as high as 40% of the returns for one brood year based on a small number of recoveries. While exploitation has been relatively low, fishing mortality is one form of mortality fisheries managers can control. Adipose clipped hatchery fish have traditionally been targeted in the sport fishery. This hatchery fin clip was abandoned for Tucannon River spring chinook starting with the 2000 brood year to mitigate fishing mortality on this ESA listed population. Supplementation fish are now marked with a CWT and a red visible implant elastomer tag behind the right eye. Captive brood progeny are marked only with agency-only wire tags to distinguish them from supplementation origin fish. Out-of-basin stray rates of Tucannon River spring chinook have been low (Appendix E), with an average of 3.8% of the adult hatchery fish straying to other river systems/hatcheries for brood years 1985-1996 (range 0-20%).

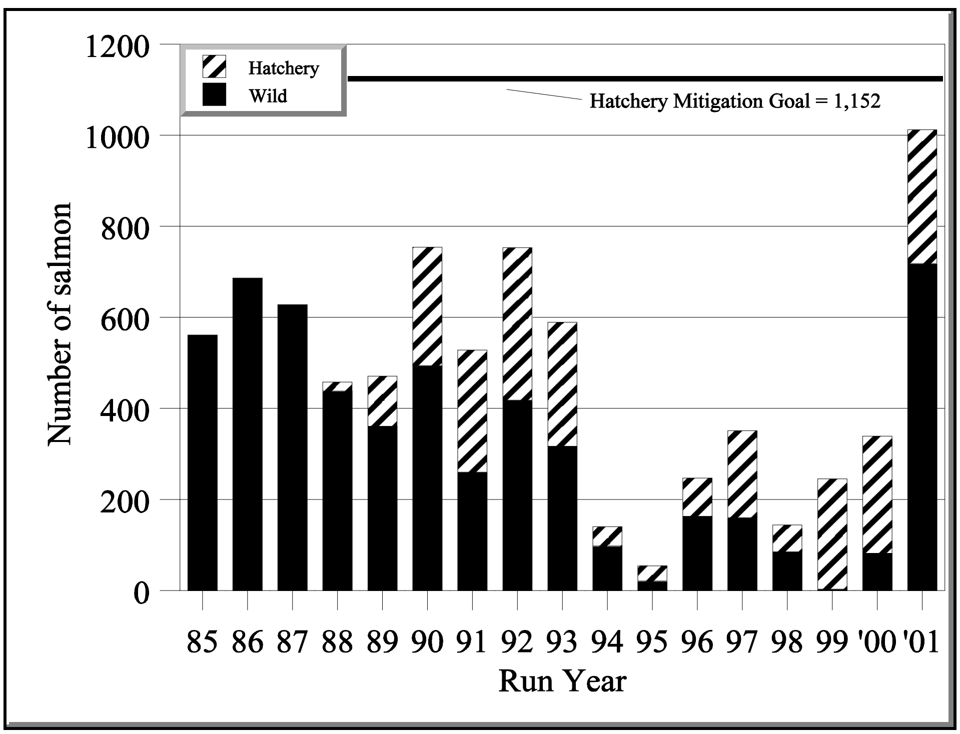

Figure 10. Total escapement for Tucannon River spring chinook salmon for the 1985-2001 run years.

Conclusions and Recommendations

Washington's LSRCP hatchery spring chinook salmon program has failed to return adequate numbers of adults to meet the mitigation goal of the program. The program has failed because SARs of hatchery origin fish have consistently been below the assumed SAR of hatchery smolts as described under the LSRCP, even though hatchery returns have generally been at 2-3 times the replacement level. Further, the natural population of spring chinook salmon in the river has declined and remained below the replacement level for most years, with the majority (95%) of the mortality occurring between the green egg and smolt stages. Mortality within the migration corridor has also contributed to the decline. The end result has been a slow but steady replacement of the natural population with the hatchery stock. While this neither was, nor is the desired result of the hatchery program, in many ways the hatchery program has helped conserve the natural population within the river by returning enough adults to allow some spawning in the river. System survivals (in-river, ocean) must increase in the future for the program to reach its full potential, and the spring chinook run be returned to historical levels.

Until that time, the evaluation program will continue to document and study life history survivals, genotypic and phenotypic traits, and examine procedures within the hatchery that can be improved to benefit the program. Based on our previous studies and current data involving survival and physical characteristics we recommend the following:

1. Monitoring of water temperatures in the Tucannon River has expanded with assistance from the local Conservation District with more emphasis being placed on instream and riparian restoration work within the river. These water temperature data series will continue to document the physical environment of the river as it changes over time. The desired change (cooling of the river) will likely benefit the natural spring chinook population in the river.

   Recommendation: Continue to assist the local Conservation District with long term monitoring of water temperatures in the Tucannon River. Within the next 5 years, provide a complete summary of water temperature data collected from the Tucannon River since program inception.

2. We continue to see annual differences in phenotypic characteristics of returning salmon (i.e., hatchery fish are generally younger in age and less fecund than natural origin fish), yet other traits such as run and spawn time have changed little over the program's history. Further, genetic analysis to date indicates little difference between the natural and hatchery populations.

   Recommendation: Continue to collect as many carcasses as possible for the most accurate age composition data. Continue to assist hatchery staff with picking eyed eggs to obtain fecundity estimates for each spawned female. Continue to collect other biological data (lengths, run timing, spawn timing, DNA samples, juvenile parr production, smolt trapping, and life stage survival) to continue the documentation of effects (positive or negative) that the hatchery program may have on the natural population.

3. Documenting the success of hatchery origin fish spawning in the river has become an increasingly frequent topic among managers within the Snake River Basin and with National Marine Fisheries Service. Little, if any, data to date exists on this subject. With the hatchery population in the Tucannon River slowly replacing the natural population, we are offered an opportunity to study the effects of the hatchery spawners in the natural environment.

   Recommendation: Participate in a reproductive success study for spring chinook being developed jointly by NMFS/WDFW personnel. Continue to use snorkel surveys during the summer months to estimate spring chinook parr production in the river. Examine the relationship between redd counts and the following years parr production, smolt numbers and returning adults in context of the proportion of hatchery spawners in the river.

4. The new adult trap was installed in 1998 around the TFH water intake dam. In 1998 and 1999, no fish were intentionally passed above the trap for natural spawning in the river. However, each year redds and fish have been found during spawning ground surveys. An estimator for the number of fish that bypass the trap each year is needed to allow managers to estimate the total run to the river more accurately.

   Recommendation: Mark (opercle punch) all fish captured and released at the TFH adult trap. Document the number of recaptures in the trap during the season to document fall back rate. Examine all carcasses recovered above the trap during spawning and carcass surveys for marks to estimate trapping efficiency.

5. Subbasin and recovery planning for listed species in the Tucannon River will identify factors limiting the spring chinook population and strategies to recover the population. Development of a recovery goal for the population would be helpful to develop and evaluate strategies for habitat, hydropower, harvest and hatcheries.

   Recommendation: Assist subbasin planning in the development of a recovery goal for spring chinook in the Tucannon River.

6. Smolt and adult detection capabilities for PIT tagged salmon within the Columbia and Snake River basins is becoming more widespread. These capabilities can help estimate survival rates for release groups to aid in evaluation of program success.

   Recommendation: Utilize the SURPH2 PIT tag model software and present summaries of juvenile survival rates in future reports. Collect interrogation data on adult detections to estimate SAR. Increase sample size of PIT tags if necessary, and document stray Tucannon fish above lower Granite Dam.

Literature Cited

Becker, G. C. 1983. Fishes of Wisconsin. University of Wisconsin Press.

Bugert, R., P. LaRiviere, D. Marbach, S. Martin, L. Ross, D. Geist. 1990. Lower Snake River Compensation Plan Salmon Hatchery Evaluation Program 1989 Annual Report to U.S. Fish and Wildlife Service, AFF 1/LSR-90-08, Cooperative Agreement 14-16-0001-89525. Washington Department of Fisheries, Olympia, Washington.

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, AFF 1/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.

Bumgarner, J.D., G. Mendel, L. Ross, D. Milks, J. Dedloff, and M. Varney. 1997. Lower Snake River Compensation Plan Tucannon River Spring Chinook Salmon Hatchery Evaluation Program 1996 Annual Report to U.S. Fish and Wildlife Service, Cooperative Agreement 14-48-0001-96539. Washington Department of Fish and Wildlife, Olympia, Washington. Report # H97-07

Bumgarner, J., L. Ross, and M. Varney. 2000. Lower Snake River Compensation Plan Tucannon River Spring Chinook Salmon Hatchery Evaluation Program 1998 and 1999 Annual Reports to U.S. Fish and Wildlife Service, Cooperative Agreements 1448-14110-98-J057 and CA-14110-9-J070. Washington Department of Fish and Wildlife, Olympia, Washington. Report # FPA00-17.

Gallinat, M.P. J.D. Bumgarner, L. Ross, and M. Varney. 2001. Tucannon River Spring Chinook Salmon Hatchery Evaluation Program 2000 Annual Report to U.S. Fish and Wildlife Service, Cooperative Agreement 1411-09-J070. Washington Department of Fish and Wildlife, Olympia, Washington. Report # FPA01-05.

Gallinat, M.P. and J.D. Bumgarner. 2002. Tucannon River Spring Chinook Salmon Captive Broodstock Program - FY2001 Annual Report. Washington Department of Fish and Wildlife. Report to BPA. Project #2000-019-00.

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

Groot, C., and L. Margolis. 1991. Pacific salmon life histories. UBC Press. Vancouver, B.C. 564 p.

McCullough, D.A. 1999. A review and synthesis of effects of alterations to the water temperature regime on freshwater life stages of salmonids, with special reference to chinook salmon. EPA/910/R-99/010. 279 pp.

Mendel, G., J. Bumgarner, K. Petersen, R. Bugert, L. Ross, D. Milks, J. Dedloff, J.B. Shaklee, and C. Knutson. 1993. Lower Snake River Compensation Plan Tucannon River Spring Chinook Salmon Hatchery Evaluation Program 1993 Annual Report to U.S. Fish and Wildlife Service, Cooperative Agreement 14-16-0001-92542, Washington Dept. of Fisheries, Olympia, Washington.

Scott, W. B., and E. J. Crossman. 1973. Freshwater fishes of Canada. Fisheries Research Board of Canada Bulletin 184.

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.

Seiler, D., L. Kishimoto, and S. Neuhauser. 1999. 1998 Skagit River wild 0+ chinook production evaluation. Washington Department of Fish and Wildlife. Rept. 98504-1091. Olympia, Wa. 73 pp.

Theurer, F.D., I. Lines, and T. Nelson. 1985. Interaction between vegetation, water temperature, and salmonid habitat in the Tucannon River. Water Resources Bull. 21(1): 53-64.

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

Appendix A

Spring chinook captured, collected, or passed upstream at the Tucannon Hatchery trap in 2001

Appendix A . Spring chinook salmon captured, collected, or passed upstream at the Tucannon Hatchery trap in 2001. (Trapping began April 27; last day of trapping was September 30).

	Captured in trap		Collected for broodstock		Passed upstream	
Date	**Natural**	**Hatchery**	**Natural**	**Hatchery**	**Natural**	**Hatchery**
5/09	10		10			
5/10	3				3	
5/12	3	1			3	1
5/13	7	1			7	1
5/14	8	1	8	1		
5/15	15	5			15	5
5/16	4	1	4	1		
5/17	8	4	8	4		
5/18	8	2	7	2	1	
5/19	17	10			17	10
5/20	20	3			20	3
5/21	28	8	4	8	24	
5/22	26	9			26	9
5/23	47	20	1	20	46	
5/24	23	7			23	7
5/25	16	8	1	8	15	
5/26	9	8			9	8
5/27	14	8			14	8
5/28	16	17			16	17
5/29	9	11			9	11
5/30	5	10			5	10
5/31	1	10	1	3		7
6/01	7	10			7	10
6/02	5	15			5	15
6/03	3	5			3	5
6/04	3	1			3	1
6/05	5	2	1	2	4	
6/06		1				1
6/07		10		4		6
6/08	2	3			2	3
6/09		4				4
6/10	3	3			3	3
6/11		2				2
6/12		2				2
6/13	3	1	3	1		
6/14		4				4
6/15	4	1			4	1
6/16	2	2			2	2
6/17	3	4			3	4
6/18		4				4
6/19		1				1
6/20	6	3			6	3
6/21	3	4			3	4
6/22	2	3			2	3
6/23	2				2	
6/24	1	2			1	2
6/25		3				3
6/26		2				2
6/28	1	6			1	6
6/29		2				2
6/30		3				3
7/01	1	5			1	5
7/02		1				1

Appendix A (continued) . Spring chinook salmon captured, collected, or passed upstream at the Tucannon Hatchery trap in 2001. (Trapping began April 27; last day of trapping was September 30).

	Captured in trap		Collected for broodstock		Passed upstream	
Date	**Natural**	**Hatchery**	**Natural**	**Hatchery**	**Natural**	**Hatchery**
7/03		1				1
7/04		3				3
7/05	4	2			4	2
7/06	2	2			2	2
7/07		1				1
7/09		2				2
7/10		2				2
7/11	1				1	
7/15		1				1
7/16	1	1			1	1
7/22		2				2
8/07		2				2
8/28	1		1			
8/29	1		1			
9/02	5				5	
9/04	2	1			2	1
9/06	5	1			5	1
9/10	9				9	
9/12	4		1		3	
9/13	5				5	
9/14	7	2			7	2
9/15	4				4	
9/17	1		1			
Totals	**405**	**276**	**52**	**54**	**353**	**222**

Appendix B

Movements of the radio tagged spring chinook recovered in the Tucannon River, 2001

Appendix B. Movements of the radio tagged spring chinook recovered in the Tucannon River, 2001. The fish was tagged and released by the University of Idaho at Bonneville Dam. Abbreviations used: **pp** = pinpoint, to locate fish within 10-20 m of stream side, **CG** = campground, **COL** = Columbia River, **HMA** = #'s refer to snorkel index sites, **SNR** = Snake River, **Rkm** = river kilometer, **RB, LB** = right bank, left bank

Chan/ Code Date	Tuc Rkm	Location	Comments
12/73			
4/19	COL	Bonneville Dam	Tagged (natural male, 76.5 cm)
5/09	3.0	Smolt Trap	Fixed Site
5/10	9.5	Fletcher's Bridge	
5/15	31.0	Broughton's/Tucannon Rd.	
5/18	37.0	Hovrud's Silt Basin	
5/22	47.4	Above Bridge 12	pp, in large pool
5/24	54.9	HMA Headquarter's; Below C.G. 1	
5/29	57.4	Across from Blue Lake	Set up receiver at Hatchery Intake
6/21	57.4	Across from Blue Lake	
7/06	57.4	Across from Blue Lake	pp under log near pool
8/15	57.4	Across from Blue Lake	
9/05	57.4	Across from Blue Lake	
9/09	59.0	Hatchery Intake	Fixed Site, fish stayed at trap entrance 23 hrs.
9/10	59.0	Hatchery Intake	Fixed Site
9/17	57.4	Across from Blue Lake	
9/20	57.4	Across from Blue Lake	
9/25	57.4	Across from Blue Lake	pp
10/03	48.8	100 meters above Bridge 13	Recovered tag, fish spawned; natural male

Appendix C

Estimated Total Run-Size of Tucannon River Spring Chinook Salmon (1985-2001)

Appendix C. Total estimated run-size of spring chinook salmon to the Tucannon River, 1985-2001.

Run Year	Wild Jacks	Wild Adults	Total Wild	Hatchery Jacks	Hatchery Adults	Total Hatchery	Total Run-Size
1985	0	561	561	0	0	0	561
1986	7	679	686	0	0	0	686
1987	6	622	628	0	0	0	628
1988	20	418	438	20	0	20	458
1989	2	359	361	84	26	110	471
1990	0	494	494	21	239	260	754
1991	3	257	260	99	169	268	528
1992	12	406	418	15	320	335	753
1993	8	309	317	6	266	272	589
1994	0	98	98	5	37	42	140
1995	2	19	21	11	22	33	54
1996	2	161	163	15	69	84	247
1997	0	160	160	4	187	191	351
1998	0	85	85	16	43	59	144
1999	0	3	3	60	182	242	245
2000	14	68	82	16	241	257	339
2001	9	709	718	111	183	294	1012

Appendix D

Numbers and density estimates (fish/100 m^2) of juvenile salmon counted by snorkel surveys in the Tucannon River in 2001

Appendix D. Numbers and density estimates of subyearling and yearling natural salmon, and yearling hatchery chinook counted by snorkel surveys in the Tucannon River, 2001.

			Number of Salmon				Density (fish/100m^2)		
			Natural		Hatchery	Snorkeled Area (m^2)	Natural		Hatchery
Stratum	Site	Date	0+	> 1+	> 1+		0+	> 1+	> 1+
Marengo	TUC01	8/13	11	0	0	604	1.82	0.00	0.00
„	TUC02	8/13	12	0	0	837	1.43	0.00	0.00
	TUCO3	8/13	2	0	0	653	0.31	0.00	0.00
Hartsock	TUC04	8/13	9	0	0	733	1.23	0.00	0.00
„	TUCO5	8/13	17	0	0	637	2.67	0.00	0.00
	TUC06	8/13	6	0	0	579	1.04	0.00	0.00
	TUC07	8/13	114	0	0	803	14.20	0.00	0.00
	TUC08	8/13	58	0	0	669	8.67	0.00	0.00
	TUC09	8/14	65	1	0	583	11.15	0.17	0.00
	TUC10	8/14	77	1	0	364	21.15	0.27	0.00
HMA	TUC11	8/14	103	1	0	646	15.94	0.15	0.00
„	TUC13	8/14	92	0	0	649	14.18	0.00	0.00
	TUC14	8/14	138	2	0	690	20.00	0.29	0.00
	TUC16	8/14	59	0	0	438	13.47	0.00	0.00
	TUC17	8/14	70	1	0	629	11.13	0.16	0.00
	TUC19	8/14	37	0	0	571	6.48	0.00	0.00
	TUC20	8/14	45	0	0	535	8.41	0.00	0.00
	TUC21	8/14	74	3	0	699	10.59	0.43	0.00
	TUC22	8/15	48	0	0	573	8.38	0.00	0.00
	TUC23	8/15	14	0	0	573	2.44	0.00	0.00
Wilderness	TUC24	8/15	41	0	0	530	7.74	0.00	0.00
„	TUC25	8/15	8	1	0	428	1.87	0.23	0.00
	TUC26	8/15	2	0	0	405	0.49	0.00	0.00
	TUC27	8/15	0	0	0	378	0.00	0.00	0.00
	TUC28	8/15	0	0	0	321	0.00	0.00	0.00
Totals			**1,102**	**10**	**0**	**14,527**			

Appendix E

Recoveries of coded-wire tagged salmon released into the Tucannon River for the 1985-1996 brood years

Appendix E. Observed and estimated recoveries of coded-wire tagged salmon released into the Tucannon River with percent return to the Tucannon Basin, out-of-basin returns, and estimated survival and exploitation rates for the 1985-1996 brood years. (Data from RMIS database.)

Brood Year	1985		1986		1987	
Smolts Released	12,922		147,037		151,100	
Fish/Lb	6.0		10.0		9.0	
CWT Codes[1]	34/42		33/25, 41/46, 41/48		49/50	
Release Year	1987		1988		1989	
Agency (fishery/location)	**Observed Number**	**Estimated Number**	**Observed Number**	**Estimated Number**	**Observed Number**	**Estimated Number**
WDFW						
Tucannon River			30	21	28	160
Kalama R., Wind R.						
Fish Trap - F.W.						
Treaty Troll			1	2		
Lyons Ferry Hatch.[2]	32	60	136	287	53	71
F.W. Sport			1	4		
ODFW						
Test Net, Zone 4	1	1	1	1		
Treaty Ceremonial			2	4	1	2
Three Mile, Umatilla R.						
Spawning Ground						
Fish Trap - F.W.						
F.W. Sport						
Hatchery						
CDFO						
Non-treaty Ocean Troll			1	4		
Mixed Net & Seine						
Ocean Sport						
USFWS						
Warm Springs Hatchery						
Dworshak NFH						
Total Returns	33	61	172	323	82	233
Tucannon (%)	98.4		95.4		99.1	
Out-of-Basin (%)	0.0		0.0		0.0	
Harvest (%)	1.6		4.6		0.9	
Survival	0.47		0.22		0.15	

[1] WDFW agency code prefix is 63.
[2] Fish trapped at TFH and held at LFH for spawning.

Appendix E. Observed and estimated recoveries of coded-wire tagged salmon released into the Tucannon River with percent return to the Tucannon Basin, out-of-basin returns, and estimated survival and exploitation rates for the 1985-1996 brood years. (Data from RMIS database.)

Brood Year	1988		1989		1990	
Smolts Released	139,050		97,779		85,737	
Fish/Lb	11.0		9.0		11.0	
CWT Codes[1]	01/42, 55/01		01/31, 14/61		37/25, 40/21, 43/11	
Release Year	1990		1991		1992	
Agency (fishery/location)	**Observed Number**	**Estimated Number**	**Observed Number**	**Estimated Number**	**Observed Number**	**Estimated Number**
WDFW						
Tucannon River	107	378	61	191	2	6
Kalama R., Wind R.						
Fish Trap - F.W.	1	0				
Treaty Troll			2	2		
Lyons Ferry Hatch.[2]	83	86	55	55	19	19
F.W. Sport	1	4				
ODFW						
Test Net, Zone 4	3	3	2	2		
Treaty Ceremonial	8	17	4	8		
Three Mile, Umatilla R.						
Spawning Ground						
Fish Trap - F.W.						
F.W. Sport						
Hatchery						
CDFO						
Non-treaty Ocean Troll						
Mixed Net & Seine						
Ocean Sport						
USFWS						
Warm Springs Hatchery						
Dworshak NFH	1	1				
Total Returns	204	489	124	258	21	25
Tucannon (%)	94.9		95.3		100.0	
Out-of-Basin (%)	0.2		0.0		0.0	
Harvest (%)	4.9		4.7		0.0	
Survival	0.35		0.26		0.03	

[1] WDFW agency code prefix is 63.
[2] Fish trapped at TFH and held at LFH for spawning.

Appendix E. Observed and estimated recoveries of coded-wire tagged salmon released into the Tucannon River with percent return to the Tucannon Basin, out-of-basin returns, and estimated survival and exploitation rates for the 1985-1996 brood years. (Data from RMIS database.)

Brood Year	1991		1992		1992	
Smolts Released	72,461		56,679		79,151	
Fish/Lb	15.0		36.0		14.0	
CWT Codes[1]	46/25, 46/47		48/23, 48/24, 48/56		48/10, 48/55, 49/05	
Release Year	1993		1993		1994	
Agency (fishery/location)	**Observed Number**	**Estimated Number**	**Observed Number**	**Estimated Number**	**Observed Number**	**Estimated Number**
WDFW						
Tucannon River					11	34
Kalama R., Wind R.						
Fish Trap - F.W.						
Treaty Troll						
Lyons Ferry Hatch.[2]	24	24	2	2	45	49
F.W. Sport						
ODFW						
Test Net, Zone 4						
Treaty Ceremonial	1	3			1	1
Three Mile, Umatilla R.						
Spawning Ground	1	3			2	4
Fish Trap - F.W.			1	1	5	9
F.W. Sport					2	2
Hatchery						
CDFO						
Non-treaty Ocean Troll						
Mixed Net & Seine			1	2		
Ocean Sport						
USFWS						
Warm Springs Hatchery					3	3
Dworshak NFH						
Total Returns	26	30	4	5	69	102
Tucannon (%)	80.0		40.0		81.4	
Out-of-Basin (%)	10.0		20.0		15.7	
Harvest (%)	10.0		40.0		2.9	
Survival	0.04		0.01		0.13	

[1] WDFW agency code prefix is 63.
[2] Fish trapped at TFH and held at LFH for spawning.

Appendix E. Observed and estimated recoveries of coded-wire tagged salmon released into the Tucannon River with percent return to the Tucannon Basin, out-of-basin returns, and estimated survival and exploitation rates for the 1985-1996 brood years. (Data from RMIS database.)

Brood Year	1993		1994		1995	
Smolts Released	135,952		130,034		62,016	
Fish/Lb	14.0-15.0		13.0-18.0		17.0-19.0	
CWT Codes[1]	56/15, 56/17-18, 53/43-44		43/23, 56/29, 57/29		59/36, 61/40, 61/41	
Release Year	1995		1996		1997	
Agency (fishery/location)	**Observed Number**	**Estimated Number**	**Observed Number**	**Estimated Number**	**Observed Number**	**Estimated Number**
WDFW						
Tucannon River	42	138	3	8	36	92
Kalama R., Wind R.						
Fish Trap - F.W.						
Treaty Troll						
Lyons Ferry Hatch.[2]	66	138	21	24	94	93
F.W. Sport						
ODFW						
Test Net, Zone 4						
Treaty Ceremonial	3	3				
Three Mile, Umatilla R.						
Spawning Ground	3	3			1	1
Fish Trap - F.W.	1	1				
F.W. Sport						
Hatchery	1	1			1	1
CDFO						
Non-treaty Ocean Troll						
Mixed Net & Seine						
Ocean Sport	1	3				
USFWS						
Warm Springs Hatchery						
Dworshak NFH						
Total Returns	117	287	24	32	132	187
Tucannon (%)	96.2		100.0		98.9	
Out-of-Basin (%)	1.7		0.0		1.1	
Harvest (%)	2.1		0.0		0.0	
Survival	0.21		0.02		0.30	

[1] WDFW agency code prefix is 63.
[2] Fish trapped at TFH and held at LFH for spawning.

Appendix E. Observed and estimated recoveries of coded-wire tagged salmon released into the Tucannon River with percent return to the Tucannon Basin, out-of-basin returns, and estimated survival and exploitation rates for the 1985-1996 brood years. (Data from RMIS database.)

Brood Year	1996		1997		1998	
Smolts Released	76,028		23,509		124,093	
Fish/Lb	16.0		16.0		13.0	
CWT Codes[1]	03/59-60, 61/24-25		61/32		12/11	
Release Year	1998		1999		2000	
Agency (fishery/location)	**Observed Number**	**Estimated Number**	**Observed Number**	**Estimated Number**	**Observed Number**	**Estimated Number**
WDFW						
Tucannon River	41	131	1	3		
Kalama R., Wind R.						
Fish Trap - F.W.						
Treaty Troll						
Lyons Ferry Hatch.[2]	95	98	3	3		
F.W. Sport						
ODFW						
Test Net, Zone 4						
Treaty Ceremonial						
Three Mile, Umatilla R.						
Spawning Ground						
Fish Trap - F.W.	1	1				
F.W. Sport						
Hatchery	2	2	1	1		
CDFO						
Non-treaty Ocean Troll						
Mixed Net & Seine						
Ocean Sport						
USFWS						
Warm Springs Hatchery						
Dworshak NFH						
Total Returns	139	232	5	7		
Tucannon (%)	98.7		Incomplete Returns		Incomplete Returns	
Out-of-Basin (%)	1.3					
Harvest (%)	0.0					
Survival	0.31					

[1] WDFW agency code prefix is 63.
[2] Fish trapped at TFH and held at LFH for spawning.