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Tucannon River Spring Chinook Salmon Hatchery Evaluation Program 2007 Annual Report

by Michael P. Gallinat and Lance A. Ross

Washington Department of
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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 of the Plan is to compensate for the estimated annual loss of 1,152-spring Chinook (Tucannon River stock) caused by hydroelectric projects on the Snake River. The conventional supplementation production goal was revised in 2006 to 225,000 fish for release as yearlings at 30 g/fish (15 fish per pound). 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 2007 to April 2008.

Two hundred twenty-four salmon were captured in the TFH trap in 2007 (98 natural adults, 14 natural jacks, 53 hatchery adults, and 59 hatchery jacks); 88 were collected and hauled to LFH for broodstock and the remaining fish were passed upstream. During 2007, five salmon that were collected for broodstock died prior to spawning.

Spawning of supplementation fish in 2007 at LFH occurred between 28 August and 18 September, with a peak eggtake occurring on 18 September. A total of 124,543 eggs were collected from 27 natural and 9 hatchery-origin fish. Egg mortality to eye-up was 3.9% (4,953 eggs), with an additional loss of 2,408 (2.0%) sac-fry. Total fry ponded for production in the rearing ponds was 117,182.

WDFW staff conducted spawning ground surveys in the Tucannon River between 29 August and 27 September, 2007. Thirty-two redds and 14 carcasses were found above the adult trap and 49 redds and 44 carcasses were found below the trap. Based on redd counts, broodstock collection, and in-river pre-spawning mortalities, the estimated escapement for 2007 was 344 fish (190 natural adults, 8 natural jacks and 113 hatchery-origin adults, 33 hatchery jacks).

Evaluation staff operated a downstream migrant trap to provide juvenile outmigration estimates. During the 2006/2007 emigration, we estimated that 17,579 (BY 2005) natural 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 consistently average about five times higher than for hatchery salmon. However, hatchery salmon survive about three times greater than natural salmon from parent to adult progeny. Due to the low SAR for hatchery fish, the mitigation goal of 1,152 salmon of Tucannon River stock was not achieved as only 146 hatchery-

origin fish returned in 2007. Beginning with the 2006 brood year, the annual smolt goal was increased from 132,000 to 225,000 to help offset the higher mortality of hatchery-origin fish after they leave the hatchery. In conjunction with this we are also conducting an experiment to examine size at release as a possible means to improve SAR of hatchery fish.

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Introduction

Program Objectives

Legislation under the Water Resources Act of 1976 authorized the establishment of the Lower Snake River Compensation Plan (LSRCP) to help mitigate for the losses of salmon and steelhead runs due to construction and operation of the Snake River dams and included hatcheries in Washington, Idaho, and Oregon (USACE 1975). In Washington, 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, which is funded by the Bonneville Power Administration (BPA) through its Fish and Wildlife Program. The project goal is to rear captive salmon selected from the supplementation program (1997-2002 brood years) to adults, rear their progeny, and release approximately 150,000 smolts (30 g/fish) annually into the Tucannon River between 2003-2007. These smolt releases, in combination with the hatchery supplementation program (goal = 132,000 smolts; 30 g/fish) and natural production, are expected to produce 600-700 returning adult spring Chinook to the Tucannon River each year from 2005 through 2010 (WDFW et al. 1999). In an attempt to increase adult returns and come closer to achieving the LSRCP mitigation goal, the co-managers have agreed to increase the conventional supplementation program goal to 225,000 yearling smolts beginning with the 2006 brood year. This report summarizes work performed by the WDFW Spring Chinook Evaluation Program from April 2007 through April 2008.

ESA Permits

The Tucannon River spring Chinook population is currently listed as “threatened” under the Endangered Species Act (ESA) as part of the Snake River Spring/Summer Chinook Salmon evolutionary significant unit (ESU)(25 March 1999; FR 64(57): 14517-14528). The WDFW was issued Section 10 Permits (#1126 and #1129) in the past as required when working with ESA protected populations. Those permits have since expired. A Hatchery and Genetic Management Plan (HGMP) has been submitted as the application for a new Section 10 Permit for this program. This report summarizes all work performed by WDFW’s LSRCP Spring Chinook Salmon Evaluation Program during 2007. Numbers of direct and indirect takes of listed Snake

River spring Chinook (Tucannon River stock) and fall Chinook salmon (Snake River stock) for the 2007 calendar year are presented in Appendix A (Tables 1-3).

Facility Descriptions

Lyons Ferry Hatchery is located on the Snake River (rkm 90) at its confluence with the Palouse River and has eight deep wells that produce nearly constant 11° C water (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 final rearing and 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. A combination of well, spring, and river water is used at TFH. River water is used as the main mixture, which allows for a more natural winter temperature profile. In February, the fish are transported to Curl Lake Acclimation Pond (AP), a 0.85 hectare natural bottom lake with a mean depth of 2.7 m, and volitionally released during April.

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 36% grazed rangeland, 33% dry cropland, 23% forest, 6% WDFW, and 2% other use (Tucannon Subbasin Summary 2001). Five unique strata have been distinguished by predominant land use, habitat, and landmarks (Figure 1; Table 1) and are referenced throughout this report.

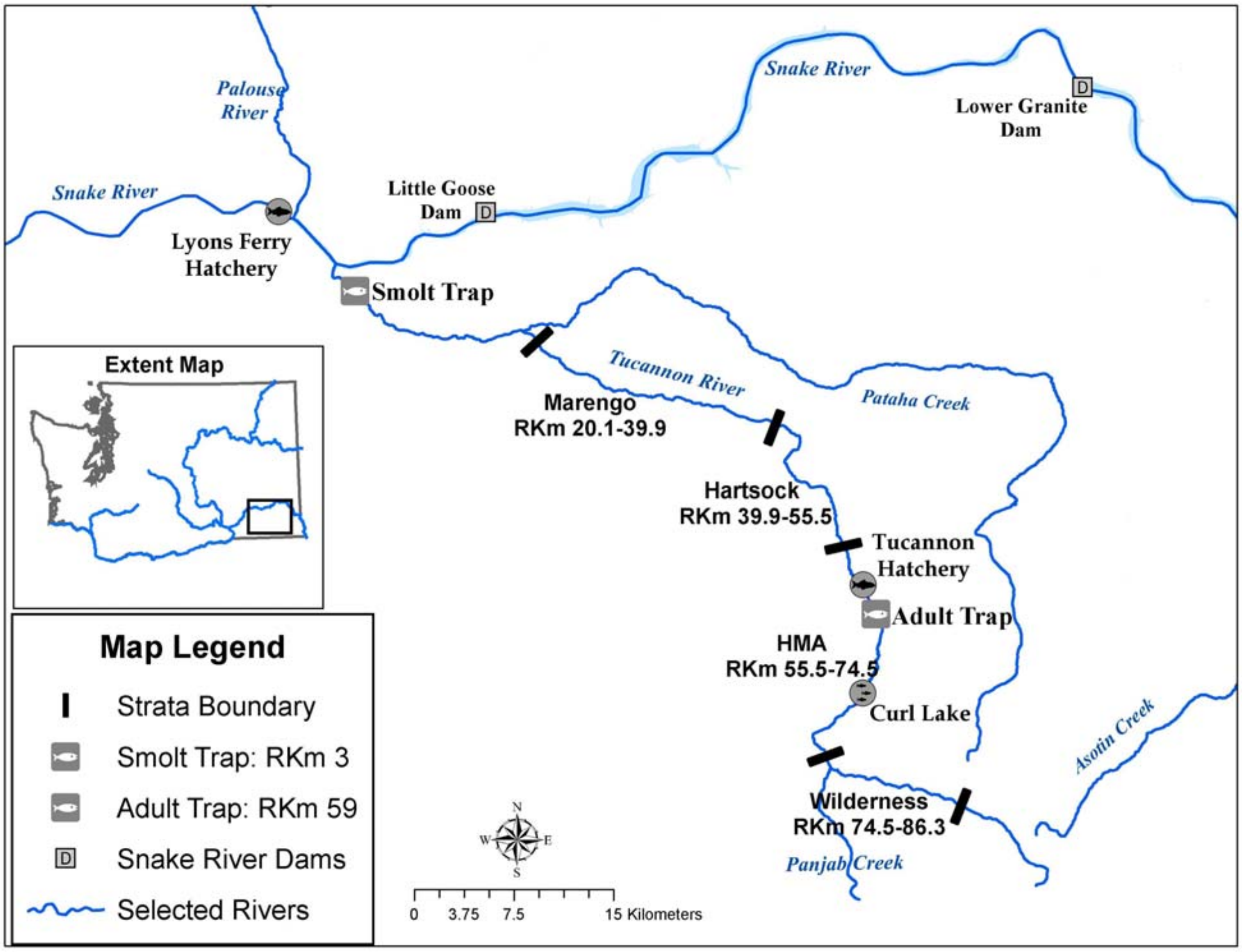

Figure 1. Location of the Tucannon River, and Lyons Ferry and Tucannon Hatcheries within the Snake River Basin.

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

Strata	Land Ownership/Usage	Spring Chinook Habitat	River Kilometer[a]
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 & Federal/Recreational	Good to Excellent	55.5-74.5
Wilderness	Federal/Recreational	Excellent	74.5-86.3

[a] Rkm descriptions: 0.0–mouth at the Snake River; 20.1-Territorial Rd.; 39.9–Marengo Br.; 55.5-HMA Boundary Fence; 74.5-Panjab Br.; 86.3-Rucherts Camp.

Evaluation program staff deployed 16 continuous recording thermographs throughout the Tucannon River to monitor daily minimum and maximum water temperatures (temperatures are recorded every hour) from June through October. Data from each of these water temperature recorders are stored as electronic files in our Dayton office. During 2007, maximum water temperatures where spring Chinook juveniles were rearing ranged from 16.3° C (61.4° F) in the upper HMA stratum (rkm 74.5) to 23.6° C (74.5° F) in the lower Hartsock stratum (rkm 43.3)(Figure 2).

The upper lethal temperature for Chinook fry is 25.1° C (77.2° F) while the preferred temperature range is 12-14° C (53.6-57.2° F) (Scott and Crossman 1973; McCullough 1999). The optimum range of temperature in freshwater, which controls the rate of growth and survival of young, is 13-17° C (55.4-62.6° F) (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 23.9° C (75° F) (or average mean temperature of 20° C (68.0° F)). Based on the preferred and optimum temperature limits, fish returning to the upper watershed have the best chance for survival (Figure 2).

Recent initiatives to improve habitat within the Tucannon Basin, such as the Tucannon River Model Watershed Program, are intended to: 1) restore and maintain natural stream stability; 2) reduce water temperatures; 3) reduce upland erosion and sediment delivery rates; 4) improve and re-establish riparian vegetation; and 5) increase amounts of large woody debris. Theurer et al. (1985) estimated that improving riparian cover and channel morphology in the Tucannon River mainstem would increase Chinook-rearing capacity present in the early 1980s by a factor of 2.5. Habitat restoration efforts should increase habitat utilization by spring Chinook salmon in the marginal sections of the Hartsock and Marengo strata of the Tucannon River and increase fish survival.

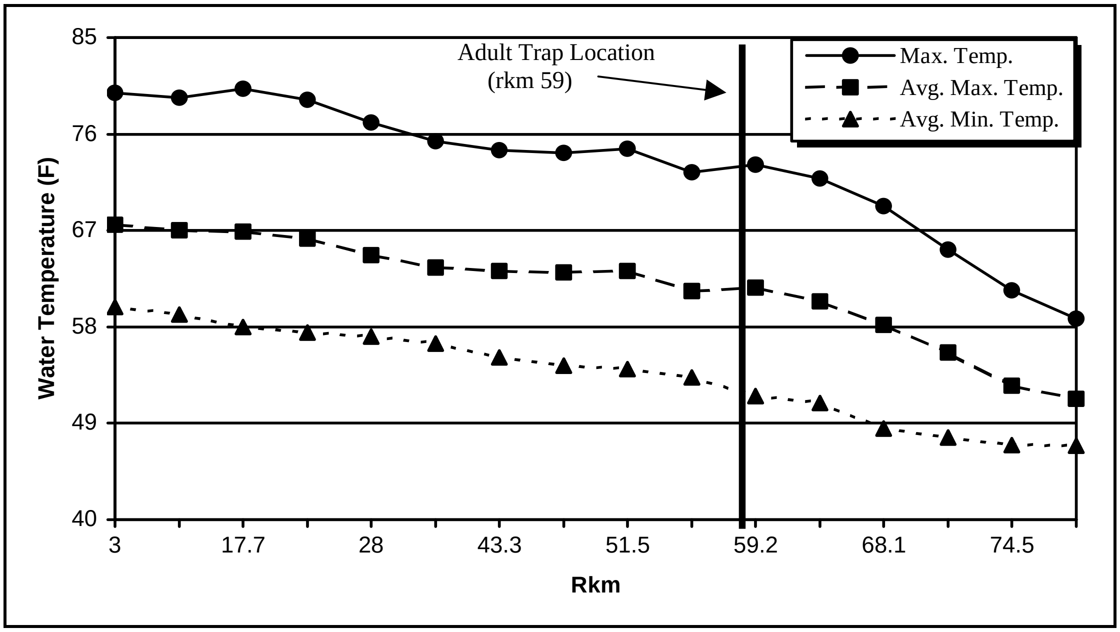

Figure 2. Maximum temperature, average maximum temperature, and average minimum temperature recorded by thermographs at 16 selected sites along the Tucannon River, June-October, 2007.

Adult Salmon Evaluation

Broodstock Trapping

The annual collection goal for broodstock was revised, beginning in 2006, to 85 natural and 85 hatchery adults collected throughout the duration of the run to meet the new smolt production/release goal of 225,000. Additional jack salmon may 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 coded-wire tag (CWT) in the snout or presence of a visible implant elastomer tag. Adipose clipped fish were killed outright as strays, as we no longer utilize that mark for management within the Tucannon River.

The TFH adult trap began operation in February (for steelhead) with the first spring Chinook captured 16 May. The trap was operated through September. A total of 224 fish entered the trap (98 natural adults, 14 natural jacks, 53 hatchery adults, and 59 hatchery jacks), and 54 natural (52 adults, 2 jacks) and 34 hatchery (30 adults, 4 jacks) spring Chinook were collected and hauled to LFH for broodstock (Table 2, Appendix B). 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.

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 1986-2007.

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	267	9	0	0	116	9	151	0
1989	156	102	0	0	67	102	89	0
1990	252	216	0	1	60	75	191	134
1991	109	202	0	0	41	89	68	105
1992	242	305	8	3	47	50	165	202
1993	191	257	0	0	50	47	130	167
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	33	7
1997	99	160	0	0	43	54	47	76
1998 [a]	50	43	0	0	48	41	1	1
1999 [b]	1	139	0	1	1	135	0	0
2000 [c]	28	177	0	17	12	69	13	94
2001	405	276	0	0	52	54	353	222
2002	168	610	0	0	42	65	126	545
2003	84	151	0	0	42	35	42	116
2004	311	155	0	0	51	41	260	114
2005 [d]	131	114	0	3	49	51	82	60
2006 [e]	61	78	0	3	36	53	25	22
2007 [f]	112	112	0	6	54	34	58	72

[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] Seventeen stray LV and AD/LV fish were killed at the trap.
[d] Three AD clipped stray fish were killed at the trap.
[e] One AD/NO WIRE and one AD/LV/CWT stray fish were killed at the trap. The remaining trap mortality was a Tucannon hatchery-origin fish that died due to trapping.
[f] Six AD/NO WIRE stray fish were killed at the trap.

Broodstock Mortality

Five of the 88 salmon collected for broodstock died prior to spawning in 2007 (Table 3). Table 3 shows that prespawning mortality in 2007 was low and comparable to the mortality documented since broodstock holding at LFH began in 1992. Higher mortality was experienced when fish were held at TFH (1986-1991) due to higher water temperatures.

Table 3. Numbers of pre-spawning mortalities and percent of fish collected for broodstock at TFH and held at TFH (1985-1991) or LFH (1992-2007).

	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
2002	0	0	0	0.0	1	1	0	3.1
2003	0	1	0	2.4	0	0	1	2.9
2004	0	3	0	5.9	0	0	1	2.4
2005	2	0	0	4.1	1	2	0	5.9
2006	0	0	0	0.0	1	0	0	1.9
2007	0	2	1	5.6	0	2	0	5.9

Broodstock Spawning

Spawning at LFH was conducted once a week from 28 August to 18 September, with peak eggtake occurring on 18 September. A total of 124,543 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 3.9% with an additional 2.0% (2,408) loss of sac-fry, which left 117,182 fish for production.

To prevent any stray fish from contributing to the population, all CWTs were read prior to spawning. No hatchery strays were found in the broodstock in 2007. Infectious Hematopoietic Necrosis Virus (IHNV) was detected in the broodstock, which prevented carcasses from being used for stream nutrient enrichment.

Table 4. Number of fish spawned and killed, estimated egg collection, and egg mortality of Tucannon River spring Chinook salmon at LFH in 2007.

	Natural			Hatchery		
Spawn Date	**Male[a]**	**Female**	**Eggs Taken**	**Male[a]**	**Female**	**Eggs Taken**
8/28		3	14,778			
9/4		6	21,894	1	5	12,817
9/11		4	13,102	1	3	7,710
9/18	8	14	51,078	10	1	3,164
9/25	16			10		
Totals	**24**	**27**	**100,852**	**22[b]**	**9**	**23,691**
Egg Mortality			4,088			865

[a] Does not include live spawned fish.
[b] Total does not include one hatchery jack not used for spawning.

Natural Spawning

Spawning ground surveys were conducted on the Tucannon River weekly from 29 August to 27 September 2007. Eighty-one redds were counted and 45 natural and 13 hatchery origin carcasses were recovered (Table 5). Thirty-two redds (39.5% of total) and 14 carcasses (24.1% of total) were found above the adult trap.

While conducting redd surveys in 2007, we also snorkeled 11 redds to look for the presence of precocial juveniles spawning with adults. We observed 27 adults (10 females, 17 males) on or near the sampled redds. We observed numerous small fish, and captured with a cast net, 23 juvenile wild and two hatchery spring Chinook in or near the redds. Seventeen of the 23 wild fish (74%) and both hatchery fish were mature males.

During 2007, we estimated redd superimposition rates by placing brightly painted washers around completed redds, and documenting multiple redd constructions during subsequent surveys. We placed brightly painted washers (1.59 cm inside diameter; 4.44 cm outside diameter; 32.7 g mean weight) around 43 completed redds and at the end of spawning ground surveys 36 redds were still visible (7 superimposed) for a 16% decrease (Appendix C). All of the superimposed redds were below the TFH adult trap. Surveyors who participated in this study felt that the washers weren't needed to distinguish between redds since survey protocols require that the same surveyors walk the same sections on a weekly basis. However, if new surveyors were used or surveys weren't conducted as often, bias in redd counts, especially below the adult trap, could easily occur.

Table 5. Numbers and general locations of salmon redds and carcasses recovered on the Tucannon River spawning grounds, 2007 (the Tucannon Hatchery adult trap is located at rkm 59).

			Carcasses Recovered	
Stratum	**Rkm[a]**	**Number of redds**	**Natural**	**Hatchery**
Wilderness	78-84			
	75-78	2	1	
HMA	73-75	1		
	68-73	9	1	
	66-68	3	2	1
	62-66	16	3	4
	59-62	1	1	1
--------------------------Tucannon Fish Hatchery Trap--------------------------				
	56-59	33	28	4
Hartsock	52-56	9	7	2
	47-52	3	1	1
	43-47	4	1	
	40-43			
Marengo	34-40			
	28-34			
Totals	**28-84**	**81**	**45**	**13**

[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.; 28-Enrich Br.

Historical Trends

Two general trends were evident (Figure 3) from the program's inception in 1985 through 1999:

1) The proportion of the total number of redds occurring below the trap increased; and
2) The density of redds (redds/km) decreased in the Tucannon River.

In part, this resulted from a greater emphasis on broodstock collection to keep the spring Chinook population from extinction. However, increases in the SAR rates beginning with the 1995 brood have subsequently resulted in increased spawning above the trap and higher redd densities (Figure 3; Table 6). Also, moving the release location from TFH upstream to Curl Lake AP in 1999 affected the spawning distribution, with higher numbers of fish and redds in the Wilderness and HMA strata compared to previous years (Table 6).

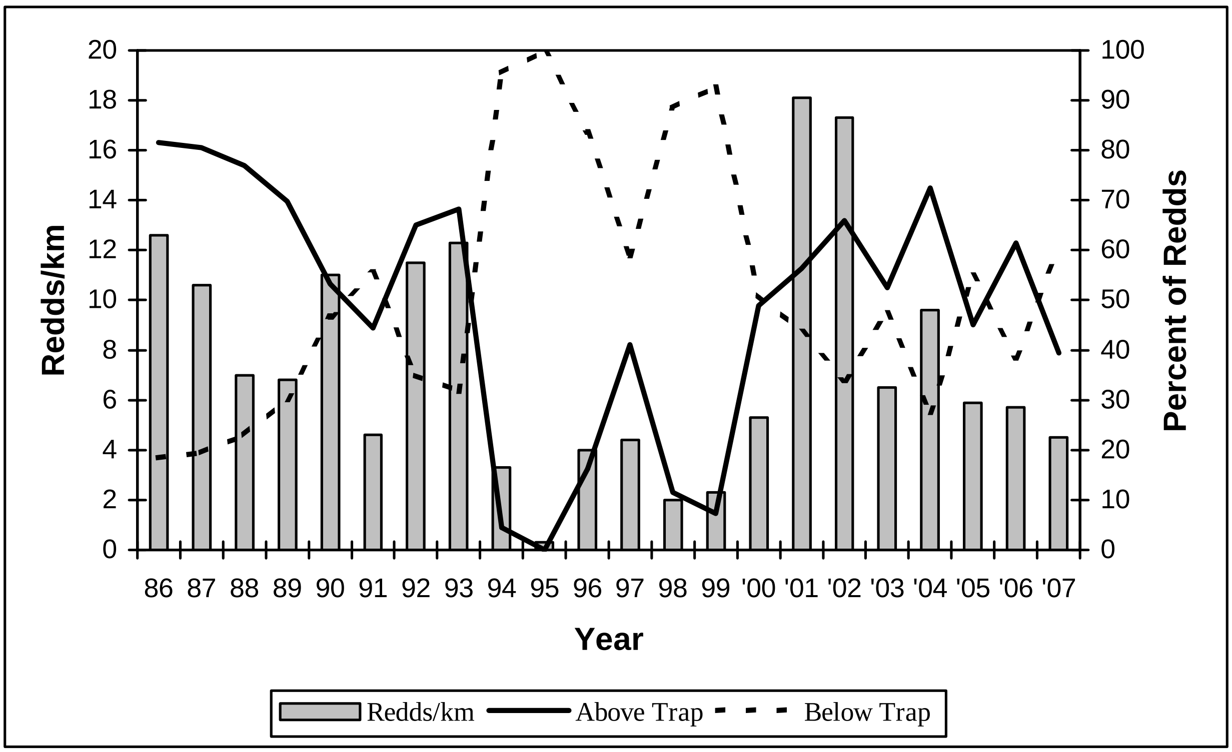

Figure 3. Number of redds/km and percentage of redds above and below the adult trap on the Tucannon River, 1986-2007.

Table 6. **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, 1985-2007.**

	Strata					TFH Adult Trap			
Year	Wilderness	HMA	Hartsock	Marengo	Total Redds	Above	%	Below	%
1985	97 (8.2)	122 (6.2)	–	–	219	–	–	–	–
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	58	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
2002	13 (1.4)	227 (11.9)	46 (2.9)	13 (1.1)	299	197	65.9	102	34.1
2003	0 (0.0)	90 (4.7)	28 (1.8)	0 (0.0)	118	62	52.5	56	47.5
2004	17 (1.9)	124 (6.5)	19 (1.2)	0 (0.0)	160	116	72.5	44	27.5
2005	4 (0.4)	69 (3.6)	25 (1.6)	4 (0.3)	102	46	45.1	56	54.9
2006	2 (0.2)	78 (4.1)	20 (1.3)	1 (0.1)	101	62	61.4	39	38.6
2007	2 (0.2)	63 (3.3)	16 (1.0)	0 (0.0)	81	32	39.5	49	60.5

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

Genetic Sampling

During 2007, we collected 147 DNA samples (operculum punches) from adult salmon (95 natural origin, 36 conventional supplementation hatchery, 7 captive brood progeny and 9 hatchery-origin strays) from hatchery broodstock and carcasses collected from the spawning grounds. These samples were sent to the WDFW genetics lab in Olympia, Washington for analysis.

A total of 228 Tucannon River spring Chinook samples collected in 2006 were genotyped at 14 microsatellite loci (Ogo-2, Ogo-4, Ots-3M, Ssa-197, Oki-100, Ots-201b, Ots-208b, Ssa-408, Omm-1080, Ots-213, Ots-G474, Ots-9, Ots-211, and Ots-212) using an Applied Biosystems 3730 DNA analyzer. Analysis to date provides evidence that the captive broodstock program has been an effective method of preserving overall genetic variation in Tucannon River spring Chinook while providing additional smolts for release (Kassler and Hawkins 2008). Genotypes, allele frequencies, and tissue samples are stored at WDFW's Genetics Laboratory in Olympia.

Age Composition, Length Comparisons, and Fecundity

We determine the age composition of each year's returning adults from scale samples of natural origin fish, and both scales and CWT from hatchery-origin fish. This allows us to annually compare ages of natural and hatchery-reared fish, and to examine trends and variability in 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).

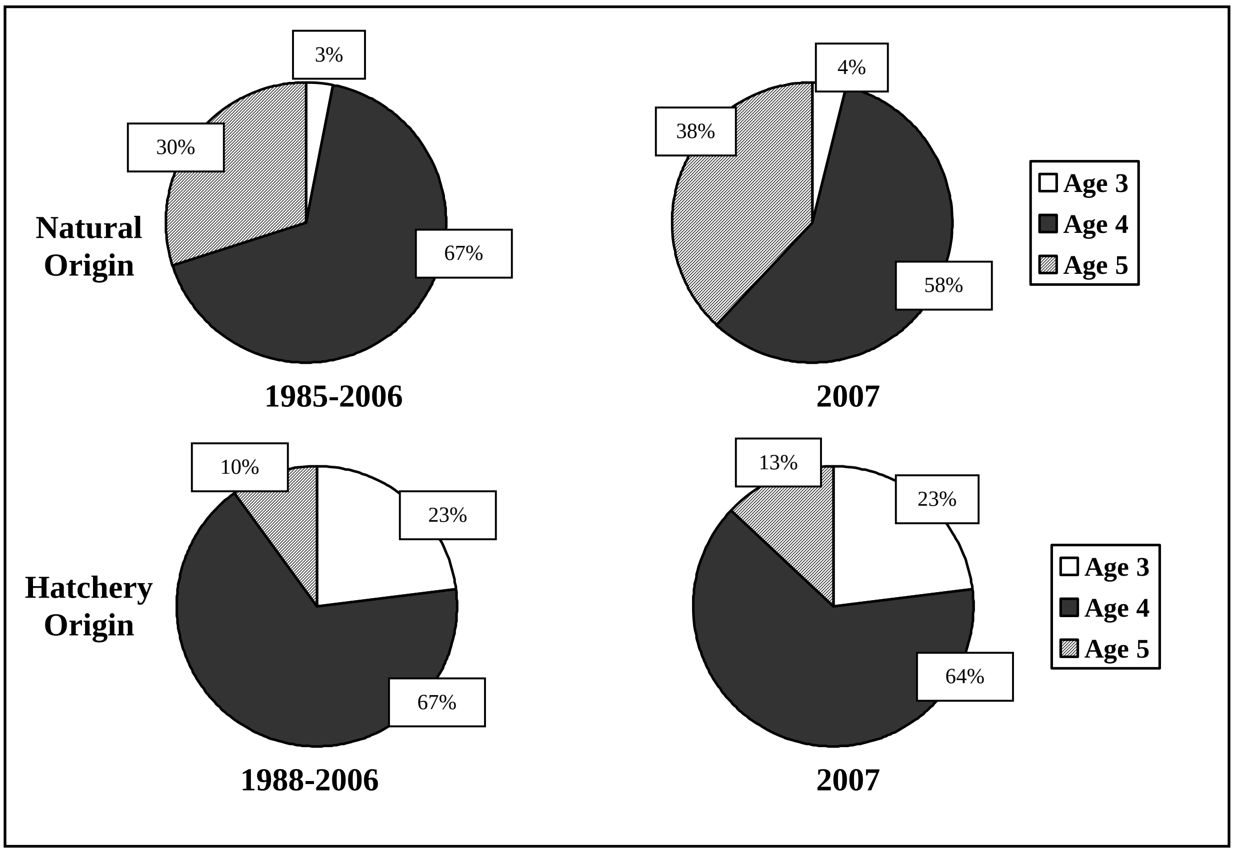

Figure 4. Historical (1985-2006), and 2007 age composition for spring Chinook in the Tucannon River.

Age composition for the 2007 run was similar to the historical age composition for both the hatchery and natural components of the population (Figure 4). Slightly higher proportions of age-5 fish were observed in 2007. This may be due to higher survival rates associated with recent improved ocean conditions.

Another metric we monitor on returning adult natural and hatchery origin fish is size at age, measured as the mean post-eye to hypural-plate lengths. Bumgarner et al. (1994) reported that returning 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. However, we examined size at age for returns using analysis of variance from the program's inception to date, and found no significant difference ($P > 0.05$) in mean length between natural and hatchery-origin fish (Figure 5), even though they migrate as smolts at significantly different sizes (Bugert et al. 1990; Bugert et al. 1991).

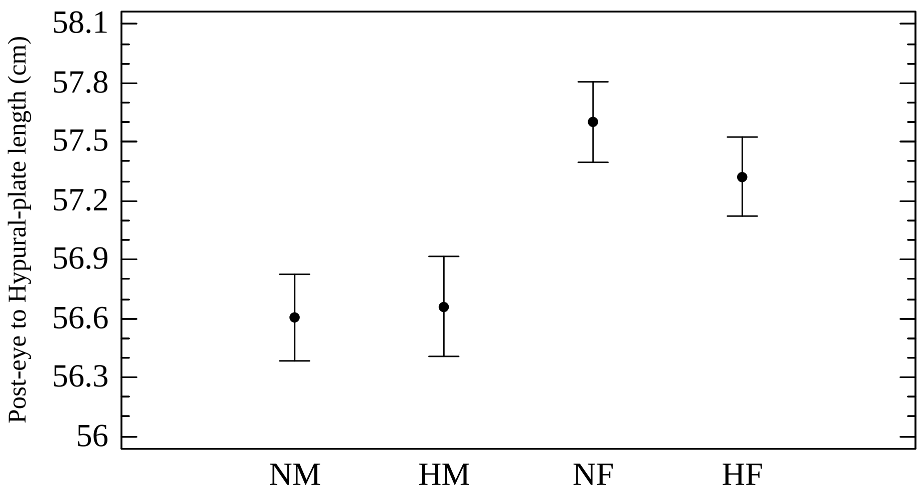

Figure 5. Mean post-eye to hypural-plate length comparisons between Age 4 natural and hatchery-origin males (NM and HM) and natural and hatchery-origin females (NF and HF) with 95% confidence intervals for the years 1985-2007.

Fecundities (number of eggs/female) of natural and hatchery origin fish from the Tucannon River program have been documented since 1990 (Table 7). To estimate fecundity, dead eggs were counted for each female and a subsample of 100 live eyed-eggs was weighed. The total volume of live eggs was also weighed, and divided by the average weight per egg to yield total number of live eggs. This estimate was decreased by 4% to compensate for adherence of water on the eggs (WDFW Snake River Lab, unpublished data). The number of live and dead eggs was summed to provide an estimated total fecundity for each fish. We performed an analysis of variance to determine if there were differences in mean fecundities of hatchery and natural origin fish. The significance level for all statistical tests was 0.05. Natural origin females were significantly more fecund than hatchery origin fish for both age-4 ($P < 0.001$) and age-5 fish ($P < 0.001$).

Mean egg size of natural origin age-4 spring Chinook from the Tucannon River was 0.226 g/egg and hatchery origin eggs averaged 0.235 g/egg. This difference was significant ($P < 0.05$). The larger eggs of the Age 4 hatchery origin females may explain why they are less fecund. Mean egg size in age-5 salmon was 0.270 g/egg for natural origin and 0.282 g/egg for hatchery origin females. Although the difference was not significant ($P = 0.08$), we suspect that egg size contributes to the fecundity difference in age-5 hatchery and natural origin fish as well.

Table 7. Average number of eggs/female (n, SD) by age group of Tucannon River natural and hatchery origin broodstock, 1990-2007.

	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)
2002	3,584	(14, 740.7)	3,368	(24, 563.7)	4,774	(7, 429.1)	No Fish	
2003	3,342	(10, 738.1)	2,723	(2, 107.0)	4,428	(7, 894.7)	3,984	(17, 772.1)
2004	3,376	(26, 686.9)	2,628	(17, 385.9)	5,191	(1, 000.0)	2,151	(1, 000.0)
2005	3,399	(18, 545.9)	2,903	(22, 654.2)	4,734	(7, 1,025.0)	No Fish	
2006	2,857	(17, 559.1)	2,590	(26, 589.8)	3,397	(1, 000.0)	4,319	(1, 000.0)
2007	3,450	(14, 721.1)	2,679	(6, 422.7)	4,310	(12, 1,158.0)	3,440	(2, 997.7)
Mean	**3,471**		**3,076**		**4,395**		**3,654**	
SD	**643.7**		**670.9**		**896.2**		**767.6**	

Coded-Wire Tag Sampling

Broodstock collection, pre-spawn mortalities, and carcasses recovered during spawning ground surveys provide representatives of the annual run that can be sampled for CWT study groups (Table 8). In 2007, based on the estimated escapement of fish to the river, we sampled approximately 44% of the run (Table 9).

Table 8. Coded-wire tag codes of hatchery salmon sampled at LFH and the Tucannon River, 2007.

CWT Code	Broodstock Collected			Recovered in Tucannon River			Totals
	Died in Pond	Killed Outright	Spawned	Dead in Trap	Pre-spawn Mortality	Spawned	
63-28-87		1	5			1	7
63-24-82	2		17			4	23
63-27-78[a]			3			4	7
63-17-91			6				6
-Strays-							
09-20-43[b]						1	1
AD/No wire				6[c]		3	9
Total	2	1	31	6	0	13	53

[a] Captive brood progeny.
[b] ODFW – Rogue River spring Chinook – Cole Rivers Hatchery.
[c] Adipose clipped strays are killed outright at the trap.

Table 9. Spring Chinook salmon (natural and hatchery) sampled from the Tucannon River, 2007.

	2007		
	Natural	**Hatchery**	**Total**
Total escapement to river	198	146	344
Broodstock collected	54	34	88
Fish dead in adult trap	0	6	6
Total hatchery sample	54	40	94
Total fish left in river	144	106	250
In-river pre-spawn mortalities observed	0	0	0
Spawned carcasses recovered	45	13	58
Total river sample	45	13	58
Carcasses sampled	99	53	152

Arrival and Spawn Timing Trends

We monitor peak arrival and spawn timing to determine whether the hatchery program has caused a shift (Table 10). Peak arrival dates were based on the 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 weekly redd count.

Peak arrival to the trap during 2007 was similar to the historical mean (Table 10). Peak spawning date of hatchery fish was within the range found from previous years but the duration of spawning was truncated. The peak of active spawning in the Tucannon River was similar to the historical mean.

Table 10. 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, 1986-2007.

	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
2001	5/23	5/23	9/11	9/04	20	9/12	35
2002	5/29	5/29	9/10	9/03	22	9/11	42
2003	5/25	5/25	9/09	9/02	36	9/12	37
2004	6/04	6/02	9/14	9/07	29	9/08	30
2005	6/01	5/31	9/06	9/06	28	9/14	28
2006	6/12	6/09	9/12	9/12	28	9/8	---[b]
Mean	**5/31**	**6/03**	**9/11**	**9/10**	**28**	**9/14**	**35**
2007	6/04	6/04	9/18	9/04	22	9/12	30

[a] Too few natural salmon were trapped in 1995 and 1999 to determine peak arrival.
[b] Access restrictions during the Columbia Complex Forest Fire prohibited spawning ground surveys during the beginning of spawning.

Total Run-Size

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 2007, 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 2007 was calculated by adding the estimated number of fish upstream of the TFH adult trap (130), the estimated fish below the weir (120) calculated from the fish/redd ratio (3.1), the number of observed pre-spawn mortalities below the weir (0), the number of trap mortalities and stray fish killed at the trap (6), and the number of broodstock collected (88) (Table 11). Run-size for 2007 was estimated to be 344 fish (190 natural adults, 8 natural jacks and 113 hatchery-origin adults, 33 hatchery jacks). Historical estimates since 1985 are provided in Table 11 and Appendix D.

Table 11. Estimated spring Chinook salmon run to the Tucannon River, 1985-2007.

Year[a]	Total Redds	Fish/Redd Ratio[b]	Spawning fish In the river	Broodstock Collected	Pre-spawning Mortalities[c]	Total Run-Size	Percent Natural
1985	219	2.60	569	22	0	591	100
1986	200	2.60	520	116	0	636	100
1987	185	2.60	481	101	0	582	100
1988	117	2.60	304	125	0	429	96
1989	106	2.60	276	169	0	445	76
1990	180	3.39	611	135	8	754	66
1991	90	4.33	390	130	8	528	49
1992	200	2.82	564	97	92	753	56
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	16	232	63
1997	73	2.00	146	97	45	288	47
1998	26	1.94	51	89	4	144	59
1999	41	2.60	107	136	2	245	1
2000	92	2.60	239	81	19	339	24
2001	298	3.00	894	106	12	1,012	71
2002	299	3.00	897	107	1	1,005	35
2003	118	3.10	366	77	1	444	56
2004	160	3.00	480	92	1	573	70
2005	102	3.10	317	100	3	420	69
2006	101	1.60	161	89	3	253	55
2007	81	3.10	250	88	6	344	58

[a] 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.

[b] 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.

[c] Effort in looking for pre-spawn mortalities has varied from year to year with more effort expended during years with poor conditions. Also includes stray fish killed at trap.

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). However, Umatilla River hatchery strays accounted for 8 and 12% of the total Tucannon River run in 1999 and 2000, respectively (Gallinat et al. 2001). The increased number of strays, particularly from the Umatilla River, is a concern since it exceeds the 5% stray rate of hatchery fish deemed acceptable by NOAA Fisheries, and is contrary to WDFW's management intent for the Tucannon River. In addition, the Oregon Department of Fish and Wildlife (ODFW) and the Confederated Tribes of the Umatilla Indian Reservation (CTUIR) did not mark a portion of Umatilla River origin spring Chinook with an RV or LV fin clip (65-70% of releases), or CWT for the 1997-1999 brood years. Because of this action, some stray fish that returned from those brood years were physically indistinguishable from natural origin Tucannon River spring Chinook. Scale samples were collected from adults in those brood years to determine hatchery-origin fish based on scale pattern analysis. However, scale analysis is not as accurate as genetic analysis and in future years we hope to identify a genetic marker that will allow us to separate unmarked Umatilla origin fish (1997-1999 BYs) from natural Tucannon origin fish. Should an accurate marker be identified that allows good separation of Umatilla stock fish, the proportion of hatchery and natural fish (Table 11) may change for the affected years after this analysis is completed. Beginning with the 2000 BY, Umatilla River hatchery-origin spring Chinook were 100% marked. This will help reduce the effect of stray fish by allowing selective removal of strays from the hatchery broodstock. However, strays will still have access to spawning areas below the hatchery trap.

One known origin (CWT) hatchery stray was recovered during 2007. It was an AD clipped Rogue River spring Chinook salmon (CWT 09/20/43) found spawning in the lower Tucannon River. We also recovered nine AD only clipped fish [six (five age-3 and one age-4) that were killed at the adult trap and three (two age-4 and one age-5) recovered below the adult trap on the spawning grounds]. Based on our marks for those age classes (VIE/CWT), and past straying events, we believe those fish were likely Umatilla River strays. After expansions, strays accounted for an estimated 8% of the total 2007 run (Appendix E).

Adult PIT Tag Returns

Final detections of 15 adult spring Chinook that had been PIT tagged as juveniles from the Tucannon River are summarized in Table 12. It is interesting to note that 53% of the detected returning PIT tagged adults overshot the Tucannon River and were detected at Lower Granite Dam. This "overshooting" does not appear to be a hatchery effect since both hatchery and natural-origin fish bypass the Tucannon River. Non-direct homing behavior has been documented for adult Chinook in the Columbia River System (Keefer et al. 2008). However, more research into these events should be conducted to examine whether they are natural straying occurrences, or if it is related to hydropower operations. With the addition of the Lower Tucannon PIT tag array in 2005, we should be able to document whether fish that are detected at Lower Granite Dam eventually make it back to the Tucannon River. Returning adults bypassing the Tucannon River is a concern, especially if they are unable to return to the Tucannon River, and may potentially explain why we have had difficulties increasing this population.

Table 12. Returning adult spring Chinook final PIT tag detections from fish originally tagged as juveniles from the Tucannon River.

	Release Data			Adult Return Final Detection Data[a]			
PIT Tag ID	Origin	Length (mm)	Release Date	OBS	OBS Date	Travel Time	Est. Age
5042423B61	H	139	3/25/97	LGR	5/29/99	795.1	4
50470F3608	H	142	3/25/97	LGR	6/17/99	813.7	4
517D1E0552	W	112	4/22/99	BON	4/17/01	726.2	4
5202622F42	W	110	4/22/99	BON	4/19/01	728.1	4
517D1A197C	W	118	4/22/99	LGR	4/21/01	730.0	4
5176172874	W	108	4/29/99	LGR	4/29/01	730.8	4
5200712827	W	103	4/29/99	LGR	5/12/02	1109.2	5
5177201601	H	151	5/6/99	LGR	5/31/01	755.9	4
517D22216B	H	137	5/12/99	LGR	5/15/01	734.3	4
3D9.1BF1677795	W	117	4/29/02	LGR	5/06/04	750.7	4
3D9.1BF16876C6	W	105	4/30/02	ICH	4/25/05	1100.4	5
3D9.1BF167698F	W	96	5/02/02	ICH	4/24/05	1097.1	5
3D9.1BF12F6891	H	136	4/21/03	ICH	5/09/04	392.0	3
3D9.1BF12F7182	H	115	4/21/03	ICH	5/19/04	396.1	3
3D9.1BF149E5EA	H	126	4/21/03	MCN	5/05/05	751.2	4

Abbreviations are as follows: BON – Bonneville Dam, MCN – McNary Dam, ICH – Ice Harbor Dam, LTR – Lower Tucannon River, LGR – Lower Granite Dam.

[a] PIT tag adult detection systems were in operation beginning in 1988 for LGR, 1998 for BON, 2002 for MCN, and 2005 for both ICH and LTR.

Juvenile Salmon Evaluation

Hatchery Rearing, Marking, and Release

Hatchery Rearing and Marking

Conventional supplementation juveniles (2006 BY) were split into two groups for a size at release study (Target: 9 fpp vs. 15 fpp) to evaluate the size at release on survival. Fish were marked with a visible implant elastomer tag (VIE) behind the left eye and tagged with CWTs between 12 and 20 September 2007 (52,929 Blue VIE - 9 fpp target; 54,388 Purple VIE - 15 fpp target). Supplementation fish were transported to TFH between 5 and 8 October. The 2006 BY captive brood juveniles (78,705 fish) were marked between 11 and 13 September with a CWT in the snout and transported to TFH on 3 October 2007.

Length and weight samples were collected twice on the 2006 BY fish during the rearing cycle (Table 13). During January, fish were sampled for length, weight, precocity and mark quality, and were PIT tagged for outmigration comparisons (2,500 conventional 9 fpp; 2,500 conventional 15 fpp; 1,000 captive brood progeny) before transfer to Curl Lake AP.

Table 13. Sample sizes (N), mean lengths (mm), coefficients of variation (CV), condition factors (K), fish/lb (fpp), and precocity of 2006 BY juveniles sampled at TFH and Curl Lake.

Brood/ Date	Progeny Type	Sample Location	N	Mean Length	CV	K	FPP	% Precocity
2006								
1/30/08	“Large” Suppl.	TFH	250	150.9	15.4	1.21	10.2	1.1
1/31/08	“Regular” Suppl.	TFH	250	115.3	10.8	1.13	25.2	0.3
4/08/08	Captive Brood	Curl Lake	250	158.5	18.8	1.28	7.9	0.4
4/16/08	“Large” Suppl.	Curl Lake	250	157.9	17.0	1.24	8.4	0.4
4/16/08	“Regular” Suppl.	Curl Lake	250	145.5	13.6	1.19	11.6	1.2

2006 Brood Release

The 2006 BY pre-smolts were transported to Curl Lake in February 2008 for acclimation and volitional release. Volitional release began 8 April and continued until 22 April when the remaining fish were forced out. Mortalities were low in Curl Lake and an estimated 52,735 (8.4 fpp) and 51,858 (11.6 fpp) conventional supplementation smolts from the “large” and “regular” groups were released, respectively. We also released an estimated 78,176 captive broodstock progeny (Table 14). These are the last releases from the BPA funded Tucannon River Spring Chinook Captive Brood Program. Historical hatchery releases are summarized in Appendix F.

Table 14. Yearling spring Chinook releases in the Tucannon River, 2006 brood year.

Release Year	(BY)	Release Location	Release Date	CWT Code	Total Released	Number CWT	VIE Mark	lbs	Fish/ lb
2008	(06)	Curl Lake	4/08-4/22	63/40/93	52,735	50,309	Left Blue	6,278	8.4
2008	(06)	Curl Lake	4/08-4/22	63/40/94	53,795	51,858	Left Purple	4,638	11.6
2008	(06CB)	Curl Lake	4/08-4/22	63/41/94	78,176	75,283	None	9,896	7.9

Natural Smolt Production

Evaluation staff operated a 1.5 m rotary screw trap at rkm 3 on the Tucannon River from 6 November 2006 through 30 June 2007 to estimate numbers of migrating juvenile natural and hatchery spring Chinook. Numbers of fish species captured by month during the 2007 outmigration can be found in Appendix G. Data such as peak outmigration, efficiency estimates, etc., have not been reported here for simplicity. Those data are available upon request.

Natural spring Chinook emigrating from the Tucannon River (BY 2005) averaged 109 mm (Figure 6). This is in comparison to an average length of 162 mm for hatchery-origin fish (BY 2005) released from Curl Lake Acclimation Pond (Gallinat and Ross 2007).

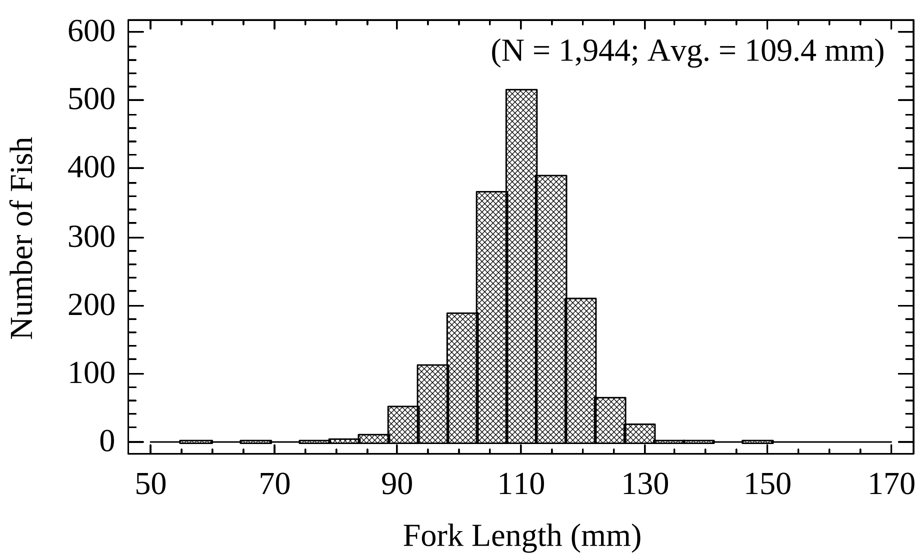

Figure 6. Length frequency distribution of sampled natural spring Chinook salmon captured in the Tucannon River smolt trap, 2006/2007 season.

Each week we attempted to determine trap efficiency by clipping a portion of the caudal fin on a representative subsample of captured migrants and releasing them approximately one kilometer upstream. The percent of marked fish recaptured was used as an estimate of weekly trapping efficiency.

To estimate potential juvenile migrants passing when the trap was not operated for short intervals, such as periods when freshets washed out large amounts of debris from the river, we calculated the mean 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.

In previous reports we attempted to relate trap efficiency to abiotic factors such as stream flow or staff gauge level based on similar juvenile outmigration studies (Groot and Margolis 1991; Seiler et al. 1999; Cheng and Gallinat 2004). We found no significant relationships.

Based on work by Steinhorst et al. (2004), we used a Bailey-modified Lincoln-Peterson estimation with 95% bootstrap confidence intervals by running the Gauss Run-Time computer program for computing outmigration estimates (version 7.0). Bootstrap iterations numbered 1,000. The program allows for the division of the out-migration trapping season into strata with similar capture efficiencies as long as at least seven marked recaptures occurred. Strata with less than seven recaptures were grouped with either the proceeding strata or the following strata depending upon similarity in trapping/flow conditions. Where river conditions were similar, we used best judgment assignment to group the strata.

Historically, we have used a standard Lincoln/Petersen estimation procedure. The Bailey modified formula corrects for bias, but the reader is cautioned about using the estimates as completely comparable. We are reviewing our data from previous years, and may re-calculate our historical estimates with the modified formula. When complete, a fully revised data set will be presented.

A number of assumptions are required to attain unbiased estimates of smolt production. How well the assumptions are met will determine the reliability, accuracy and precision of the estimates. Some of these assumptions are:

- Survival from release to the trap was 100%.
- All marked fish are identified and correctly enumerated.
- Fish do not lose their marks.
- All fish in the tag release group emigrate (i.e., do not residualize in the area of release).
- Marked fish are caught at the same rate as unmarked fish.

We estimate that 17,579 migrant natural-origin spring Chinook (2005 BY) passed the smolt trap during 2006-2007 (Table 15). We also estimated that 61% of the hatchery fish (conventional hatchery supplementation and captive brood progeny) released from Curl Lake AP (2005 BY) passed the smolt trap.

Table 15. Total population estimates (with 95% confidence interval) for natural and hatchery origin (supplementation and captive brood) emigrants from the Tucannon River, 2007.

	Natural	Supplementation	Captive Brood
Total Emigrants	17,579	79,607	66,464
95% C.I.	14,951-20,935	73,998-84,995	61,702-71,431
S.E.	1,545	2,809	2,449

Juvenile Migration Studies

In 2007, we used passive integrated transponder (PIT) tags to study the emigration timing and relative success of our conventional supplementation and captive brood progeny. We tagged 1,002 conventional supplementation and 1,000 captive brood hatchery-origin fish during early February before transferring them to Curl Lake AP for acclimation and volitional release (Table 16). No fish were killed during PIT tagging, though some minor delayed mortality may have occurred after transfer. Cumulative PIT tag detections at hydroelectric projects downstream of the Tucannon River were 47% for conventional supplementation fish (compared to 33% in 2006) and 41% for captive brood origin fish (compared to 28% in 2006). The smolts were released at a larger size in 2007 compared to 2006 (57 g vs. 35 g).

Table 16. Cumulative detection (one unique detection per tag code) and travel time in days (TD) of PIT tagged hatchery spring Chinook salmon released from Curl Lake Acclimation Pond (rkm 65.6) on the Tucannon River at downstream Snake and Columbia River Dams during 2007 (Fish were volitionally released from 4/02/07-4/23/07).

	Release Data			Recapture Data											
Hatchery		Mean		Mean	LMJ		MCJ		JDJ		BONN		Total[a]	
Origin	N	Length	SD	Length	N	TD	N	TD	N	TD	N	TD	N	%
Supplementation	1,002	134.3	15.8	134.5	138	20.8	131	24.2	126	28.5	26	30.3	467	46.6
Captive Brood	1,000	135.1	19.6	135.4	88	22.0	135	25.0	109	28.7	34	30.4	413	41.3

[a]Total includes detections at Ice Harbor Dam and from trawl surveys.
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 probabilities were estimated by the Cormack Jolly-Seber methodology using the Survival Under Proportional Hazards (SURPH) computer model. The data files were created using the PitPro version 4.8 computer program to translate raw PIT Tag Information System

(PTAGIS) data of the Pacific States Marine Fisheries Commission (PSMFC) into usable capture histories for the SURPH program. Estimated survival probabilities from Curl Lake to Lower Monumental Dam were 0.68 (± 0.05) and 0.61 (± 0.06) for supplementation and captive brood progeny, respectively. While survival estimates were slightly lower for captive brood progeny fish the differences were not significant ($P > 0.05$).

Survival Rates

Point estimates of population sizes have been calculated for various life stages (Tables 17 and 18) of natural and hatchery-origin spring Chinook 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-parr-smolt) survival rates for hatchery fish are considerably higher than for naturally reared salmon (Table 19) because they have been protected in the hatchery. However, smolt-to-adult return rates (SAR) of natural salmon were over five times higher than for hatchery-reared salmon (Tables 20 and 21). Hatchery SARs (mean = 0.22%; geometric mean = 0.14%) documented from the 1985-2002 broods were well below the LSRCP survival goal of 0.87%. Hatchery SARs for Tucannon River salmon need to substantially improve to meet the mitigation goal of 1,152 hatchery adult salmon. As reported earlier in this report, we are experimenting with size at release (9 fpp vs. 15 fpp) to improve hatchery SARs.

Table 17. Estimates of *natural* Tucannon spring Chinook salmon abundance by life stage for 1985-2007 broods.

Brood Year	Females in River		Mean Fecundity[a]		Number of Eggs	Number[b] of Parr	Number of Smolts	Progeny[c] (returning adults)
	Natural	Hatchery	Natural	Hatchery				
1985	219	-	3,883	-	850,377	90,200	42,000	392
1986	200	-	3,916	-	783,200	102,600	58,200	468
1987	185	-	4,096	-	757,760	79,100	44,000	238
1988	117	-	3,882	-	454,194	69,100	37,500	527
1989	103	3	3,883	2,606	407,767	58,600	30,000	158
1990	128	52	3,993	2,697	651,348	86,259	49,500	94
1991	51	39	3,741	2,517	288,954	54,800	30,000	7
1992	119	81	3,854	3,295	725,521	103,292	50,800	194
1993	112	80	3,701	3,237	673,472	86,755	49,560	204
1994	39	5	4,187	3,314	179,863	12,720	7,000	12
1995	5	0	5,224	0	26,120	0	75	6
1996	53	16	3,516	2,843	231,836	2,845	1,612	69
1997	39	33	3,609	3,315	250,146	32,913	21,057	799
1998	19	7	4,023	3,035	97,682	8,453	5,508	375
1999	1	40	3,965	3,142	129,645	15,944	8,157	141
2000	26	66	3,969	3,345	323,964	44,618	20,045	446
2001	219	79	3,612	3,252	1,047,936	63,412	38,079	244
2002	104	195	3,981	3,368	1,070,784	72,197	60,530	202
2003	67	51	3,789	3,812	448,275	40,900	23,003	122
2004	117	43	3,444	2,601	514,791	30,809	21,057	8
2005	77	25	3,773	2,903	363,096	21,162	17,579	
2006	65	36	2,887	2,654	283,199	---		
2007	49	32	3,847	2,869	280,311			

[a] 1985 and 1989 mean fecundity of natural females is the average of 1986-88 and 1990-93 brood years.
[b] Number of parr estimated from electrofishing (1985-1989), Line transect snorkel surveys (1990-1992), and Total Count snorkel surveys (1993-2005).
[c] Numbers do not include down river harvest or other out-of-basin recoveries.

Table 18. Estimates of Tucannon spring Chinook salmon abundance (*spawned and reared in the hatchery*) by life stage for 1985-2007 broods.

Brood Year	Females Spawned Natural	Females Spawned Hatchery	Mean Fecundity[a] Natural	Mean Fecundity[a] Hatchery	Number of Eggs	Number of Parr	Number of Smolts	Progeny[b] (returning adults)
1985	4	-	3,883	-	14,843	13,401	12,922	45
1986	57	-	3,916	-	187,958	177,277	153,725	339
1987	48	-	4,096	-	196,573	164,630	152,165	190
1988	49	-	3,882	-	182,438	150,677	146,200	447
1989	28	9	3,883	2,606	133,521	103,420	99,060	243
1990	21	23	3,993	2,697	126,334	89,519	85,800	28
1991	17	11	3,741	2,517	91,275	77,232	74,060	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	132,870	130,069	34
1995	6	15	5,224	0	85,772	63,935	62,272	180
1996	18	19	3,516	2,843	117,287	80,325	76,219	260
1997	17	25	3,609	3,315	144,237	29,650	24,184	181
1998	30	14	4,023	3,035	161,019	136,027	127,939	830
1999	1	36	3,965	3,142	113,544	106,880	97,600	29
2000	3	35	3,969	3,345	128,980	123,313	102,099	175
2001	29	27	3,612	3,252	184,127	174,934	146,922	129
2002	22	25	3,981	3,368	169,364	151,531	123,586	133
2003	17	20	3,789	3,812	140,658	126,400	71,154	77
2004	28	18	3,444	2,601	140,459	128,877	67,542	33
2005	25	24	3,773	2,903	161,345	151,466	149,466	
2006	18	27	2,887	2,654	123,629	112,350	106,530	
2007	27	9	3,847	2,869	124,543	117,182		

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

[b] Numbers do not include down river harvest or other 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 19. 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 Parr**	**Parr to Smolt**	**Egg to Smolt**	**Egg to Parr**	**Parr to Smolt**	**Egg to Smolt**	**Egg to Parr**	**Parr to Smolt**	**Egg to Smolt**
1985	10.6	46.6	4.9	90.3	96.4	87.1	8.5	2.1	17.6
1986	13.1	56.7	7.4	94.3	86.7	81.8	7.2	1.5	11.0
1987	10.4	55.6	5.8	83.8	92.4	77.4	8.0	1.7	13.3
1988	15.2	54.3	8.3	82.6	97.0	80.1	5.4	1.8	9.7
1989	14.4	51.2	7.4	77.5	95.8	74.2	5.4	1.9	10.1
1990	13.2	57.4	7.6	70.9	95.8	67.9	5.4	1.7	8.9
1991	19.0	54.7	10.4	84.6	95.9	81.1	4.5	1.8	7.8
1992	14.2	49.2	7.0	97.0	57.8	56.1	6.8	1.2	8.0
1993	12.9	57.1	7.4	86.3	95.6	82.5	6.7	1.7	11.2
1994	7.1	55.0	3.9	82.2	97.9	80.4	11.6	1.8	20.7
1995	0.0	0.0	0.3	74.5	97.4	72.6	- -	- -	- -
1996	1.2	56.7	0.7	68.5	94.9	65.0	55.8	1.7	- -
1997	13.2	64.0	8.4	20.6	81.6	16.8	1.6	1.3	2.0
1998	8.7	65.2	5.6	84.5	94.1	79.5	9.8	1.4	14.1
1999	12.3	51.2	6.3	94.1	91.3	86.0	7.7	1.8	13.7
2000	13.8	44.9	6.2	95.6	82.8	79.2	6.9	1.8	12.8
2001	6.1	60.1	3.6	95.0	84.0	79.8	15.7	1.4	22.0
2002	6.7	83.8	5.7	89.5	81.6	73.0	13.3	1.0	12.9
2003	9.1	56.2	5.1	89.9	56.3	50.6	9.8	1.0	9.9
2004	6.0	68.3	4.1	91.8	52.4	48.1	15.3	0.8	11.8
2005	5.8	83.1	4.8	93.9	98.7	92.6	16.1	1.2	19.1
2006				90.9	94.8	86.2			
2007				94.1					
Mean	10.1	55.8	5.8	84.0	87.3	72.6	11.1	1.5	12.5
SD	4.7	16.2	2.4	16.0	14.1	17.0	11.2	0.4	4.8

Table 20. Adult returns and SARs of natural salmon to the Tucannon River for brood years 1985-2002.

		Number of Adult Returns, observed (obs) and expanded (exp)[a]							
		Age 3		Age 4		Age 5		SAR (%)	
Brood Year	Estimated Number of Smolts	Obs	Exp	Obs	Exp	Obs	Exp	w/ Jacks	No Jacks
1985	42,000	8	19	110	255	36	118	0.93	0.89
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	30,000	5	12	47	120	23	26	0.53	0.49
1990	49,500	3	8	63	72	12	14	0.19	0.17
1991	30,000	0	0	4	5	1	2	0.02	0.02
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	8.00	8.00
1996	1,612	0	0	27	63	2	6	4.28	4.28
1997	21,057	6	14	234	703	29	82	3.79	3.73
1998	5,508	3	9	86	245	43	121	6.81	6.64
1999	8,157	3	9	44	124	3	8	1.73	1.62
2000	20,045	1	3	148	392	16	51	2.22	2.21
2001	38,079	0	0	73	235	5	9	0.64	0.64
2002	60,530	1	3	68	124	36	75	0.33	0.33
Mean								1.48[c]	1.46[c]
Geometric Mean								0.71[c]	0.70[c]

[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 21. **Adult returns and SARs of hatchery salmon to the Tucannon River for brood years 1985-2002.**

Brood Year	Estimated Number of Smolts	Number of Adult Returns, known and expanded (exp.)						SAR (%)	
		Age 3		Age 4		Age 5			
		Known	Exp.	Known	Exp.	Known	Exp.	w/ Jacks	No Jacks
1985	12,922	9	19	25	26	0	0	0.35	0.20
1986	153,725	79	83	99	238	8	18	0.22	0.17
1987	152,165	9	22	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
1997	24,186	7	13	59	168	0	0	0.75	0.69
1998	127,939	36	103	164	577	39	150	0.65	0.57
1999	97,600	2	7	5	19	1	3	0.03	0.02
2000	102,099	7	27	53	148	0	0	0.17	0.14
2001	146,922	7	19	53	109	1	1	0.09	0.07
2002	123,586	4	8	60	106	7	19	0.11	0.10
Mean								0.22	0.19
Geometric Mean								0.14	0.12

As previously stated, overall survival of hatchery salmon to return as adults was higher than for naturally reared fish because of the early-life survival advantage (Table 19). With the exception of the 1988 and 1997-2000 brood years, naturally produced fish have been below the replacement level (Figure 7; Table 22). Based on adult returns from the 1985-2003 broods, naturally reared salmon produced only 0.6 adults for every spawner, while hatchery reared fish produced 1.7 adults.

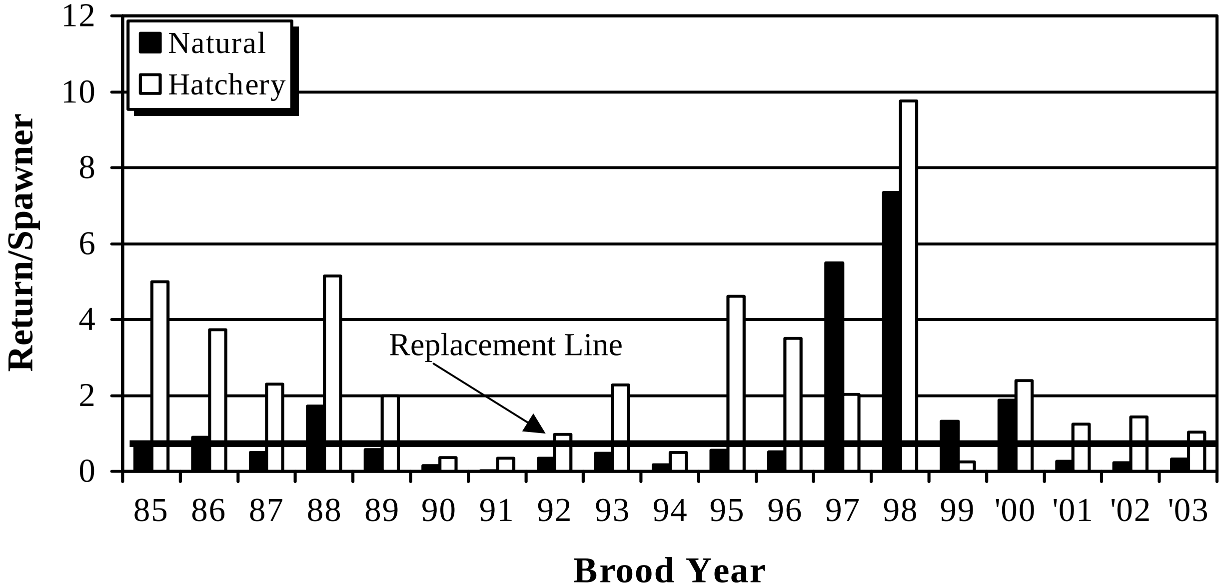

Figure 7. Return per spawner (with replacement line) for the 1985-2003 brood years (2003 incomplete brood year).

Table 22. **Parent-to-progeny survival estimates of Tucannon River spring Chinook salmon from 1985 through 2003 brood years (2003 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	569	392	0.69	9	45	5.00	7.3
1986	520	468	0.90	91	339	3.73	4.1
1987	481	238	0.49	83	190	2.29	4.6
1988	304	527	1.73	87	447	5.14	3.0
1989	276	158	0.57	122	243	1.99	3.5
1990	611	94	0.15	78	28	0.36	2.3
1991	390	7	0.02	72	25	0.35	19.3
1992	564	194	0.34	83	81	0.98	2.8
1993	436	204	0.47	91	207	2.27	4.9
1994	70	12	0.17	69	34	0.49	2.9
1995	11	6	0.55	39	180	4.62	8.5
1996	136	69	0.51	74	260	3.51	6.9
1997	146	799	5.47	89	181	2.03	0.4
1998	51	375	7.35	85	830	9.76	1.3
1999	107	141	1.32	122	29	0.24	0.2
2000	239	446	1.87	73	175	2.40	1.3
2001	894	244	0.27	104	129	1.24	4.5
2002	897	202	0.23	93	133	1.43	6.4
2003	366	122	0.33	75	77	1.03	3.1
Mean			**1.23**			**2.57**	**4.6**
Geometric Mean			**0.56**			**1.69**	**3.1**

Beginning with the 2006 brood year, the annual smolt goal was increased from 132,000 to 225,000 to help offset for the higher mortality of hatchery-origin fish after they leave the hatchery. This should increase adult salmon returns back to the Tucannon River. However, based on current hatchery SARs the increase in production would still not produce enough adult returns to reach the LSRCP mitigation goal. In conjunction with increased smolt production, we are conducting an experiment to examine size at release as a possible means to improve SAR of hatchery fish. These changes in the hatchery production program will likely result in a Proportionate Natural Influence (PNI) of less than 0.5. That level is generally not acceptable for supplementation programs and the Tucannon Spring Chinook Program has generally been above 0.5 (Appendix H). The fishery managers will need to decide whether the hatchery supplementation program is worth the potential adverse genetic risk to the population.

Fishery Contribution and Out-of-Basin Straying

An original goal of the LSRCP supplementation program was to enhance natural returns of salmon to the Tucannon River by providing 1,152 hatchery-reared fish (the number estimated to have been lost due to the construction of the Lower Snake River hydropower system) to the river. Such an increase would allow for limited harvest and increased spawning. However, hatchery and natural adult returns have always been below the mitigation goal (Figure 8). Based on 1985-2003 brood year CWT recoveries reported to the RMIS database (Appendix I), sport and commercial harvest combined accounted for an average of less than 2% of the adult hatchery fish recovered for the 1985-1996 brood years, but increased fishery impacts occurred for the 1997 through 1999 broods (fishery harvest comprised an average of 20% for recoveries). The subsequent cessation of adipose clipping of hatchery production (Gallinat et al. 2001), and additional fishery restrictions, resulted in a less than 1% fishery impact on the 2000-2003 broods (this includes CWT 63-14-29 from the 2001 BY where the lone recovery was from a commercial gillnet). Conventional supplementation fish are now marked with a CWT and a VIE tag behind the left or right eye. Captive brood progeny are marked only with agency-only wire tags or CWTs to distinguish them from supplementation origin fish.

Out-of-basin stray rates of Tucannon River spring Chinook have been low (Appendix I), with an average of 2.5% of the adult hatchery fish straying to other river systems/hatcheries for brood years 1985-2003 (range 0-20%).

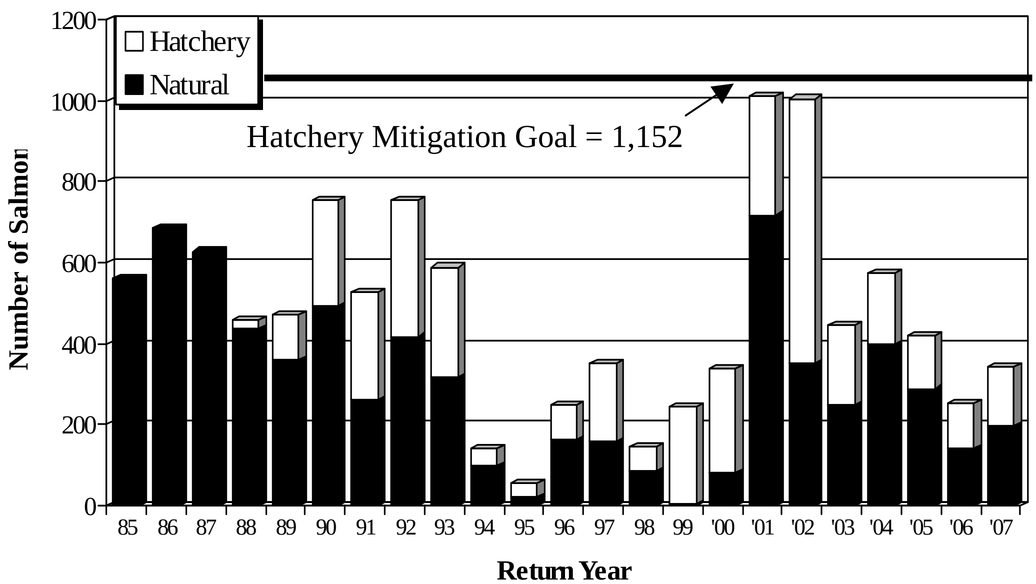

Figure 8. Total escapement for Tucannon River spring Chinook salmon for the 1985-2007 run years.

Adjusted Hatchery SAR

Using CWT recoveries from the RMIS database we adjusted Tucannon River spring Chinook hatchery SARs to include all known recoveries from outside the basin. Even after adjustment, hatchery SARs for the 1985-2002 brood years were still well below the LSRCP survival goal of 0.87% (Table 23). Increased fishing mortality resulted in higher adjusted SARs for the 1997 and 1998 brood years. Since then, management changes (eliminating the adipose finclip, fishery restrictions) should allow more fish to escape back to the Tucannon River.

Table 23. Hatchery SARs adjusted for recoveries from outside the Tucannon River subbasin as reported in the RMIS database. (Data downloaded from RMIS database on 5/09/08).

Brood Year	Estimated Number of Smolts	Expanded Return to Tucannon	Expanded Other Returns[a]	Grand Total of CWT Hatchery Origin Recoveries	Original Hatchery SAR (%)	Adjusted Hatchery SAR (%)
1985	12,922	45	1	46	0.35	0.36
1986	153,725	339	15	354	0.22	0.23
1987	152,165	190	2	192	0.12	0.13
1988	146,200	447	26	473	0.31	0.32
1989	99,057	243	12	255	0.25	0.26
1990	85,500	28	0	28	0.03	0.03
1991	74,058	25	6	31	0.03	0.04
1992	87,752	81	19	100	0.09	0.11
1993	138,848	207	11	218	0.15	0.16
1994	130,069	34	0	34	0.03	0.03
1995	62,272	180	2	182	0.29	0.29
1996	76,219	260	4	264	0.34	0.35
1997	24,186	181	40	221	0.75	0.91
1998	127,939	830	216	1,046	0.65	0.82
1999	97,600	29	3	32	0.03	0.03
2000	102,099	175	1	176	0.17	0.17
2001	146,922	129	1	130	0.09	0.09
2002	123,586	133	0	133	0.11	0.11
Mean					**0.22**	**0.25**
Geometric Mean					**0.14**	**0.15**

[a] Includes expanded RMIS CWT recoveries from sources outside the Tucannon River subbasin (i.e., sport and commercial fisheries, Tucannon strays in other river systems, etc.).

Conclusions and Recommendations

Washington's LSRCP hatchery spring Chinook salmon program has failed to return adequate numbers of adults to meet the mitigation goal. This has occurred because SARs of hatchery origin fish have consistently been lower than predicted, even though hatchery returns (recruits/spawner) have generally been at 2-3 times the replacement level. Further, the natural spring Chinook population 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. Ocean conditions and mortality within the mainstem migration corridor have also contributed to poor survival. While this neither was, nor is the desired result of the program, in many ways the hatchery program has helped conserve the natural population by returning adults to spawn in the river. System survivals (in-river, migration corridor, ocean) must increase in the near future for the hatchery program and the natural run to be persistent over the short-term or to be sustainable over the long-term.

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 changed to improve the hatchery program and the natural population. Based on our previous studies and current data involving survival and physical characteristics we recommend the following:

1. 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 are little changed over the program's history. Further, genetic analysis to date indicates little change in the natural population as a result of hatchery actions.

   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. Collect other biological data (length, run timing, spawn timing, DNA samples, smolt trapping, and life stage survival) to document the effects (positive or negative) that the hatchery program may have on the natural population.

2. The success of hatchery origin fish spawning in the river has become an important topic among managers within the Snake River Basin and with NOAA Fisheries. Little data exists on this subject. With the hatchery population in the Tucannon River intermixing with the natural population, we have an opportunity to study the effects of the hatchery spawners in the natural environment.

   Recommendation: Continue to seek funding for a DNA based pedigree analysis study to examine the reproductive success of hatchery fish in the natural environment. Examine the relationship between redd counts and the following-year's smolt numbers and returning adults in context of the proportion of hatchery spawners in the river. Publish the results in peer-reviewed journals.

3. Subbasin and recovery planning for ESA 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 that is consistent with NOAA's Viable Salmonid Population criteria would be helpful in developing and evaluating recovery 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. Determine carrying capacity and productivity of the Tucannon River so that hatchery stocking is appropriate, and hatchery and natural performance is measured against basin capacity. Determine impacts to other species of concern (e.g., steelhead, bull trout).

4. We have documented that hatchery juvenile (egg-parr-smolt) survival rates are considerably higher than naturally reared salmon, and hatchery smolt-to-adult return rates are much lower. We need to identify and address the factors that limit hatchery SARs in order to meet mitigation goals. Beginning with the 2006 brood year, the annual hatchery smolt goal was increased from 132,000 to 225,000 to help offset the higher mortality of hatchery-origin fish after they leave the hatchery. This should increase adult salmon returns back to the river, however, based on current hatchery SARs this would still not produce enough adult returns to reach the LSRCP mitigation goal.

   Recommendation: Conduct an experiment to examine size at release as a possible means to improve SAR of hatchery fish. Continue to evaluate survival rates from other watersheds to see if the LSRCP goal of 0.87% is a realistic goal under existing conditions. Increase PIT tagging to ascertain where the mortality is occurring.

5. Adult Tucannon River spring Chinook appear to be "overshooting" or bypassing the Tucannon River based on limited PIT tag returns. This is occurring for both hatchery and natural origin fish, and thus it doesn't appear to be a hatchery effect.

   Recommendation: Increase PIT tagging of spring Chinook throughout the smolt trapping season and utilize detectors at the dams and on the Tucannon to ascertain if this "overshooting" is due to natural straying, a life history variant (fish rearing in the Snake River), or is due to hydropower operations (fish may not be able to detect the flow of the Tucannon River in the artificially dammed Snake River).

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Appendix A: Annual Section 10 Permit Takes for 2007

Appendix A. Table 1. Summary of maximum annual (calendar year) takes allowed and 2007 takes (in parenthesis) of listed Snake River spring Chinook salmon (Tucannon River Stock) and fall Chinook salmon

TYPE OF TAKE	Wild Fall Juvenile	Wild Spring Adults	Wild Spring Juvenile	Hatchery Spring Juvenile	Captive Brood Progeny
Collect for Transport					
Observe/Harass [a]		250 (27)	4,000 (23)	(2)	
Capture, Handle and Release	6,500 (4,159)		10,500 (2,109)	32,500 (6,133)	(4,687)
Capture, Handle, Tag/Mark, and Release [b]	2,800 (1,334)	28 (0)	1,700 (1,276)	4,300 (3,557)	(3,557)
Lethal Take [c]	100 (0)		125 (0)	200 (0)	
Spawning, Dead, or Dying		400 (45)			
Other Take (specify)					
Indirect Mortality	50 (113)		50 (28)	100 (8)	(6)
Incidental Take [d]			0		
Incidental Mortality [d]			0		

[a] Refers to the number of fish observed during snorkel surveys (summer and fall precocial surveys).
[b] Refers to the number of fish PIT tagged and marked at the smolt trap.
[c] Refers to the number of fish collected for organosomatic index samples.
[d] Refers to the number of fish collected or killed during electrofishing surveys.

Appendix A. Table 2. Summary of maximum annual (calendar year) takes allowed and 2007 takes (in parenthesis) of listed Snake River spring Chinook salmon (Tucannon River Stock).

TYPE OF TAKE	Wild Adults	Wild Jacks	Hatchery Adults	Hatchery Jacks	Wild Juvenile	Hatchery Juvenile
Collect for Transport [a]	325 (52)	NA (2)	325 (30)	NA (4)		
Observe/Harass (Total of all fish trapped)	325 (98)	NA (14)	325 (53)	NA (59)		
Capture, Handle and Release [b]	325 (46)	NA (12)	325 (23)	NA (55)		
Capture, Handle, Tag/Mark, and Release						150,000 (149,466 05 BY; 107,317 06BY)
Lethal Take (Broodstock)	50 (50)	NA (1)	100 (22)	NA (4)		
Spawning, Dead, or Dying [c]	5 (0)	NA (0)	10 (6)	NA (0)		
Other Take (specify)						
Indirect Mortality [d]	10 (2)	NA (1)	10 (2)	NA (0)		
Incidental Take						
Incidental Mortality						

[a] Refers to the number fish collected for the hatchery broodstock.
[b] Refers to the number of fish released upstream or downstream of the trap following capture.
[c] Refers to the number of fish that may die in the trap before release or taken for broodstock
[d] Refers to the number of fish (collected for broodstock) that may die in transport or during broodstock holding.

Appendix A. Table 3. Summary of maximum annual (calendar year) takes allowed and 2007 takes of listed Snake River spring Chinook salmon (Tucannon River Stock - Captive Broodstock Program).

TYPE OF TAKE	Take Limits	1997 Brood	1998 Brood	1999 Brood	2000 Brood	2001 Brood	2002 Brood
Brood Collection [a]	1,200	1,200	1,200	1,200	1,200	1,200	1,200
Capture, Handle, Tag and Release [b]	450	433	438	409	450	450	300
Lethal Take (Broodstock) [c]	450	NA	NA	NA	NA	NA	NA
Egg collection [d]	294,000	NA	NA	NA	NA	NA	NA
Egg/Fry Release [e]	40,000	NA	NA	NA	NA	NA	NA
Capture, Handle, Tag/Mark, and Release [f]	150,000	90,056 (CB 05BY); 78,705 (CB 06BY)					

[a] The program will take 1,200 fry (80/family unit) to start captive brood.

[b] Up to 450 fish will be selected from the original 1,200 fish to be reared to adulthood. These fish will tagged by family unit and combined into larger rearing ponds until maturity.

[c] All fish selected for captive brood may reach adulthood before dying; therefore there is the potential that 450 fish will be taken for broodstock.

[d] An estimated 294,000 eggs will be collected on an annual basin once full production is reached.

[e] Up to 40,000 eyed eggs may be placed in remote site incubators in the Wilderness Stratum of the Tucannon River.

[f] Depending on survival, an estimated 150,000 captive brood origin smolts will be released into the Tucannon River. Additional smolts may also be released into Asotin Creek upon approval by NMFS and co-managers and captive brood adult outplants may be utilized to stay within captive brood eggtake goals.

Appendix B: Spring Chinook Captured, Collected, or Passed Upstream at the Tucannon Hatchery Trap in 2007

Appendix B. Spring Chinook salmon captured, collected, or passed upstream at the Tucannon Hatchery trap in 2007. (Trapping began in February; last day of trapping was September 30).

	Captured in Trap		Collected for Broodstock		Passed Upstream		Killed Outright		Trap Mortality	
Date	**Natural**	**Hatchery**	**Natural**	**Hatchery**	**Natural**	**Hatchery**	**Natural**	**Hatchery**	**Natural**	**Hatchery**
5/16	3	1	1	1	2					
5/17	3	2	2	2	1					
5/18	1	2	1	1		1				
5/19	1				1					
5/20	1				1					
5/21	1	1	1	1						
5/23	2	2	1		1	2				
5/24	2	3	1	1	1	2				
5/25	7	4	7			4				
5/29	5	4		1	5	3				
5/31	9	1	3		6	1				
6/1	6	5	6	1		4				
6/2	7				7					
6/3	3				3					
6/4	22	13	13	3	9	10				
6/5	5	11	2	5	3	5		1		
6/6	2	2	2	1		1				
6/8		4		2		2				
6/11	2	6	1	3	1	2		1		
6/12	1				1					
6/14	2	4			2	4				
6/15	2				2					
6/18		1				1				
6/19	1	2		1	1	1				
6/20	1	3			1	3				
6/21	3	10	2	1	1	9				
6/22	2	3			2	1		2		
6/25		4				3		1		
6/26		1		1						
6/27	1				1					
6/28		2				2				
6/29	2	2	1		1	2				
7/2	3	3	2		1	3				
7/3		1				1				
7/5	1	2			1	2				
7/6		3		1		1		1		
7/9	1	1			1	1				
7/10	1				1					
7/18		1				1				
7/19	1				1					
7/25		1		1						
8/13	1		1							
8/29		1		1						
8/30	1		1							
8/31		2		2						
9/3	2		2							
9/5	2		2							
9/7	2		2							
9/10		1		1						
9/11		1		1						
9/14	1	1	1	1						
Total	**113**	**111**	**55**	**33**	**58**	**72**	**0**	**6**	**0**	**0**
Final Total[1]	**112**	**112**	**54**	**34**	**58**	**72**	**0**	**6**	**0**	**0**

[a] Corrected numbers after spawning. One collected wild male was actually a hatchery-origin fish.

Appendix C: Results from the 2007 Tucannon River Spring Chinook Redd Superimposition Study

Appendix C. Results from the 2007 Tucannon spring Chinook redd superimposition study.

Redd No.	Rkm	No. Redds Marked	No. Redds Visible At End of Surveys	Comments
2-1	75.8	1	1	No change.
2-2	74.2	1	1	No change.
2-1, 3-3	65.3	2	2	No change.
4-3	65.1	1	1	No change.
3-5, 4-4	64.7	2	2	No change.
3-6, 3-7	64.6	2	2	No change.
3-8, 4-5	64.2	2	2	Same female?
4-6	64.1	1	1	No change.
3-9	62.3	1	1	No change.
1-1, 3-1, 4-1	59.2	3	1	Washers covered up.
2-2, 3-2, 3-3, 4-2, 4-3	59.1	5	5	No change.
3-4, 4-4	58.9	2	2	No change.
3-5, 4-5	58.8	2	1	Washers covered up.
2-3, 4-6	58.8	2	1	Washers covered up.
3-7, 3-8, 4-8	57.7	3	2	Washers covered up.
1-2, 2-4	56.5	2	1	Washers covered up.
2-5, 3-10, 4-13	56.1	3	2	Washers covered up.
2-6, 3-12	55.9	2	2	No change.
1-1, 4-2	54.8	2	2	No change.
2-1, 3-1	53.9	2	2	No change.
4-4	52.7	1	1	No change.
2-2	52.8	1	1	No change.
Totals		**43**	**36**	**16% decrease**

Appendix D: Total Estimated Run-Size of Tucannon River Spring Chinook Salmon (1985-2007)

Appendix D. Total estimated run-size of spring Chinook salmon to the Tucannon River, 1985-2007. (Includes breakdown of conventional hatchery supplementation and captive brood hatchery program components).

Run Year	Natural Jacks	Natural Adults	Total Natural	Hatchery Jacks	Hatchery Adults	Total Hatchery	Total Conventional Suppl.	Total Captive Brood	Total Run-Size
1985	0	591	591	0	0	0	0	0	591
1986	6	630	636	0	0	0	0	0	636
1987	6	576	582	0	0	0	0	0	582
1988	19	391	410	19	0	19	19	0	429
1989	2	334	336	83	26	109	109	0	445
1990	0	494	494	22	238	260	260	0	754
1991	3	257	260	99	169	268	268	0	528
1992	12	406	418	15	320	335	335	0	753
1993	8	309	317	6	266	272	272	0	589
1994	0	98	98	5	37	42	42	0	140
1995	2	19	21	11	22	33	33	0	54
1996	2	145	147	15	70	85	85	0	232
1997	0	134	134	3	151	154	154	0	288
1998	0	85	85	16	43	59	59	0	144
1999	0	3	3	60	182	242	242	0	245
2000	14	68	82	16	241	257	257	0	339
2001	9	709	718	111	183	294	294	0	1,012
2002	9	341	350	11	644	655	655	0	1,005
2003	3	245	248	27	169	196	196	0	444
2004	0	400	400	22[a]	151	173	170	3	573
2005	3	286	289	8	123[b]	131	117	14	420
2006	7	133	140	4[c]	109[c]	113	109	4	253
2007	8	190	198	33	113[d]	146	127	19	344

[a] Three of which are captive brood progeny.
[b] Fourteen of which are captive brood progeny.
[c] Two of which are captive brood progeny.
[d] Nineteen of which are captive brood progeny.

Appendix E: Stray Hatchery-Origin Spring Chinook Salmon in the Tucannon River (1990-2007)

Appendix E. Summary of identified stray hatchery origin spring Chinook salmon that escaped into the Tucannon River (1990-2007).

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**	**1.3**
				Total Umatilla River	**3**	**1.3**
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	
	Ad clip	ODFW	Carson (Wash.)	Imeques AP / Umatilla River	2 / 2	
				Total Strays	**46**	**13.6**
				Total Umatilla River	**41**	**12.1**

[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.

Appendix E (continued). Summary of identified stray hatchery origin spring Chinook salmon that escaped into the Tucannon River (1990-2007).

Year	CWT Code or Fin clip	Agency	Origin (stock)	Release Location / Release River	Number Observed/ Expanded [a]	% of Tuc. Run
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**
2002	054208	USFWS	Dworshak	Dworshak NFH/Clearwater R.	1/29	
	076039	ODFW	Umatilla R.	Umatilla Hatch./Umatilla River	1/8	
	076040	ODFW	Umatilla R.	Umatilla Hatch./Umatilla River	2/16	
	076041	ODFW	Umatilla R.	Umatilla Hatch./Umatilla River	2/16	
	076049	ODFW	Umatilla R.	Umatilla Hatch./Umatilla River	1/8	
	076051	ODFW	Umatilla R.	Umatilla Hatch./Umatilla River	1/8	
	076138	ODFW	Umatilla R.	Umatilla Hatch./Umatilla River	1/8	
	105412	IDFG	Powell	Clearwater Hatch./Powell Ponds	1/4	
				Total Strays	**97**	**9.7**
				Total Umatilla River	**64**	**6.4**
2003	100472	IDFG	Salmon R.	Sawtooth Hatch./Nature's Rear.	1/1	
				Total Strays	**1**	**0.2**
				Total Umatilla River	**0**	**0.0**
2004	Ad clip	Unknown	Unknown[b]	Unknown	6/17	
				Total Strays	**17**	**3.0**
				Total Umatilla River[b]	**17**	**3.0[b]**
2005	Ad clip	Unknown	Unknown[c]	Unknown	3/6	
				Total Strays	**6**	**1.4**
				Total Umatilla River[c]	**6**	**1.4[c]**
2006	109771	IDFG	Sum. Ch. - S Fk Sal.	McCall Hatch./S. Fk. Salmon R.	1/1	
	093859	ODFW	Umatilla R.	Umatilla Hatch./Umatilla River	1/1	
	Ad clip	Unknown	Unknown[d]	Unknown	3/6	
				Total Strays	**8**	**3.2**
				Total Umatilla River[d]	**7**	**2.8**
2007	092043	ODFW	Rogue R. – Cole H.	Cole Rivers Hatchery/Rogue R.	1/1	
	Ad clip	Unknown	Unknown[e]	Unknown	9/27	
				Total Strays	**28**	**8.1**
				Total Umatilla River[e]	**27**	**7.8**

[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. Rogue River strays were not expanded due to their distance from the Tucannon River subbasin.

[b] Based on the mark (Ad clip, no wire), brood year (2000), historical stray rates, and large number of releases (670,570) we believe these fish are probable Umatilla River origin strays.

[c] Based on the mark (Ad clip, no wire), brood years (2001 and 2002), historical stray rates, and large number of releases (602,347 BY01 and 701,798 BY02) we believe these fish are probable Umatilla River origin strays.

[d] Based on the mark (Ad clip, no wire, brood year (2002), historical stray rates, and large number of releases (701,798 BY02) we believe these fish are probable Umatilla River origin strays.

[e] Based on the mark (Ad clip, no wire), brood years, historical stray rates, and number of releases we believe these fish are probable Umatilla River origin strays.

Appendix F: Historical Hatchery Releases (1985-2006 Brood Years)

Appendix F. Historical hatchery spring Chinook releases from the Tucannon River, 1985-2006 brood years. (Totals are summation by brood year and release year.)

Release Year	Brood	Release Type[a]	Release Date	CWT Code[b]	Number CWT	Ad-only marked	Additional Tag/location/cross[c]	Lbs	Fish/lb
1987	1985	H-Acc	4/6-10	34/42	12,922			2,172	6
Total					**12,922**				
1988	1986	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
		"	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	1987	H-Acc	4/11-13	49/50	151,100	1,065		16,907	9
Total					**151,100**	**1,065**			
1990	1988	H-Acc	3/30-4/10	55/01	68,591	3,007		6,509	11
Total					**139,050**	**6,096**			
1991	1989	H-Acc	4/1-12	14/61	75,661	989		8,517	9
Total					**97,779**	**1,278**			
1992	1990	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	1991	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	1992	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
Total					**56,679**	**637**			
1994	1992	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					**79,151**	**4,258**			
1995	1993	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	56/15	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	56/15	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	1994	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**			

Appendix F (continued). Historical hatchery spring Chinook releases from the Tucannon River, 1985-2006 brood years. (Totals are summation by brood year and release year.)

Release Year	Brood	Release Type[a]	Release Date	CWT Code[b]	Number CWT	Ad-only marked	Additional Tag/location/cross[c]	Lbs	Fish/lb
1997	1995	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					**62,016**	**128**			
1998	1996	H-Acc	3/11-4/17	03/60	14,308	27	Mixed	902	15.9
		C-Acc	3/11-4/18	61/25	23,065	62	"	1,498	15.8
		"	"	61/24	24,554	50	"	1,557	15.8
		Direct	4/03	03/59	14,101	52	"	863	16.4
Total					**76,028**	**191**			
1999	1997	C-Acc	3/11-4/20	61/32	23,664	522	Mixed	1,550	15.6
Total					**23,664**	**522**			
2000	1998	C-Acc	3/20-4/26	12/11	125,192	2,747	Mixed	10,235	12.5
Total					**125,192**	**2,747**			
2001	1999	C-Acc	3/19-4/25	02/75	96,736	864	Mixed	9,207	10.6
Total					**96,736**	**864**			
2002	2000	C-Acc	3/15-4/23	08/87	99,566	2,533[e]	VI, RR, Mixed	6,587	15.5
Total					**99,566**	**2,533[e]**			
2002	2000CB	C-Acc	3/15/4/23	63	3,031	24[f]	CB, Mixed	343	8.9
Total					**3,031**	**24[f]**			
2002	2001	Direct	5/06	14/29	19,948	1,095	Mixed	170.5	123.4
Total					**19,948**	**1,095**			
2002	2001CB	Direct	5/06	14/30	20,435	157	CB, Mixed	124.8	165
Total					**20,435**	**157**			
2003	2001	C-Acc	4/01-4/21	06/81	144,013	2,909[e]	VI, RR, Mixed	11,389	12.9
Total					**144,013**	**2,909[e]**			
2003	2001CB	C-Acc	4/01-4/21	63	134,401	5,995[f]	CB, Mixed	10,100	13.9
Total					**134,401**	**5,995[f]**			
2004	2002	C-Acc	4/01-4/20	17/91	121,774	1,812[e]	VI, RR, Mixed	10,563	11.7
Total					**121,774**	**1,812[e]**			
2004	2002CB	C-Acc	4/01-4/20	63	42,875	1,909[f]	CB, Mixed	3,393	13.2
Total					**42,875**	**1,909[f]**			
2005	2003	C-Acc	3/28-4/15	24/82	69,831	1,323[e]	VI, RR, Mixed	5,603	12.7
Total					**69,831**	**1,323[e]**			
2005	2003CB	C-Acc	3/28-4/15	27/78	125,304	4,760[f]	CB, Mixed	9,706	13.4
Total					**125,304**	**4,760[f]**			
2006	2004	C-Acc	4/03-4/26	28/87	67,272	270[e]	VI, RR, Mixed	5,040	13.4
Total					**67,272**	**270[e]**			
2006	2004CB	C-Acc	4/03-4/26	28/65	127,162	5,150[f]	CB, Mixed	8,648	15.3
Total					**127,162**	**5,150[f]**			
2007	2005	C-Acc	4/02-4/23	35/99	144,833	4,633[e]	VI, RR, Mixed	18,683	8.0
Total					**144,833**	**4,633[e]**			
2007	2005CB	C-Acc	4/02-4/23	34/77	88,885	1,171[f]	CB, Mixed	12,170	7.4
Total					**88,885**	**1,171[f]**			

Appendix F (continued). Historical hatchery spring Chinook releases from the Tucannon River, 1985-2006 brood years. (Totals are summation by brood year and release year.)

Release Year	Brood	Release Type[a]	Release Date	CWT Code[b]	Number CWT	Ad-only marked	Additional Tag/location/cross[c]	Lbs	Fish/lb
2008	2006	C-Acc	4/08-4/22	40/93	50,309	2,426[e]	VI, LB, Mixed	6,278	8.4
2008	2006	C-Acc	4/08-4/22	40/94	51,858	1,937[e]	VI, LP, Mixed	4,638	11.6
Total					**102,167**	**4,363[e]**			
2008	2006CB	C-Acc	4/08-4/22	41/94	75,283	2,893[f]	CB, Mixed	9,896	7.9
Total					**75,283**	**2,893[f]**			

[a] Release types are: Tucannon Hatchery Acclimation Pond (H-Acc); Portable Acclimation Pond (P-Acc); Curl Lake Acclimation Pond (C-Acc); and Direct Stream Release (Direct).
[b] All tag codes start with agency code 63.
[c] Codes listed in column are as follows: BWT - Blank Wire Tag; CB - Captive Brood; 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, LP – Left Purple; 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.
[e] VI tag only.
[f] No wire.

Appendix G: Numbers of Fish Species Captured by Month in the Tucannon River Smolt Trap During the 2007 Outmigration

Appendix G. Numbers of fish species captured by month in the Tucannon River smolt trap during the 2007 outmigration sampling period (November 6, 2006 – June 30, 2007).

Species	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Total
Wild spring Chinook	130	144	71	88	450	1,549	493	2	2,927
Conventional hatchery spring Chinook						4,930	4,749	11	9,690
Captive brood hatchery spring Chinook					1	3,401	4,837	5	8,244
Fall Chinook				3	21	518	2,080	2,871	5,493
Coho salmon					6	72	129	11	218
Bull trout	7	1						1	9
Steelhead - smolts	58	96	34	22	39	141	1,745	60	2,195
Steelhead – parr							83	254	337
Hatchery endemic steelhead – R.R. VIE							3		3
Hatchery endemic steelhead – L.G. VIE						146	1,810	77	2,033
Pacific lamprey - ammocoetes	43	75	67	25	168	5	7	2	392
Pacific lamprey - macropthalmia	2	13	41	3	51				110
Pacific lamprey - adults						1	3		4
Grass pickerel							1	1	2
Smallmouth bass	1	2	2	1	6	38	70	31	151
Bluegill		1	1			1		16	19
Pumpkinseed sunfish								7	7
Peamouth								7	7
Chiselmouth	3	28	20			76	1,670	644	2,441
Speckled dace						1	2		3
Longnose dace				1			8	3	12
Northern pikeminnow	2	2	1			23	101	17	146
Bridgelip sucker		3	2	1	3	9	55	36	109
Brown bullhead		1	4	2	1			5	13
American shad		1	33						34
Redside shiner							5	1	6
Sculpin sp.								1	1

Appendix H: Proportionate Natural Influence (PNI) for the Tucannon Spring Chinook Population (1985-2007)

Appendix H. Proportionate Natural Influence (PNI)[a] for the Tucannon River spring Chinook population (1985-2007). Note: Pre-spawn and trap mortalities are excluded from the analysis.

Spawned Hatchery Broodstock			River Spawning Fish			
Year	Total	% Natural (PNOB)	Total	% Hatchery (PHOS)	PNI	PNI < 0.50
1985	8	100.00	569	0.00	1.00	
1986	91	100.00	520	0.00	1.00	
1987	83	100.00	481	0.00	1.00	
1988	90	100.00	304	3.29	0.97	
1989	122	45.08	276	2.54	0.95	
1990	62	48.39	611	29.13	0.62	
1991	71	56.34	390	43.85	0.56	
1992	82	45.12	564	40.43	0.53	
1993	87	51.72	436	41.74	0.55	
1994	69	50.72	70	11.43	0.82	
1995	39	23.08	11	0.00	1.00	
1996	75	44.00	136	23.53	0.65	
1997	89	42.70	146	46.58	0.48	*
1998	86	52.33	51	27.45	0.66	
1999	122	0.82	107	98.13	0.01	*
2000	73	10.96	239	70.71	0.13	*
2001	104	50.00	894	26.40	0.65	
2002	93	45.16	897	65.66	0.41	*
2003	75	54.67	366	43.99	0.55	
2004	88	54.55	480	27.29	0.67	
2005	95	49.47	317	24.29	0.67	
2006	88	40.91	161	35.40	0.54	
2007	82	62.20	250	42.40	0.59	

[a] PNI = PNOB/(PNOB + PHOS).
PNOB = Percent natural origin fish in the hatchery broodstock.
PHOS = Percent hatchery origin fish among naturally spawning fish.

Appendix I: Recoveries of Coded-Wire Tagged Salmon Released Into the Tucannon River for the 1985-2003 Brood Years

Appendix I. 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 1985-2003 brood years. (Data downloaded from RMIS database on 5/09/08.)

Brood Year	1985		1986		1987	
Smolts Released	12,922		147,037		151,100	
Fish/Lb	6.0		10.0		9.0	
CWT Codes[a]	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	84	28	130
Kalama R., Wind R.						
Fish Trap - F.W.						
Treaty Troll			1	2		
Lyons Ferry Hatch.[b]	32	38	136	280	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						
IDFG						
Hatchery						
Total Returns	33	39	172	379	82	203
Tucannon (%)	97.4		96.0		99.0	
Out-of-Basin (%)	0.0		0.0		0.0	
Commercial Harvest (%)	2.6		1.8		0.0	
Sport Harvest (%)	0.0		1.1		0.0	
Treaty Ceremonial (%)	0.0		1.1		1.0	
Survival	0.30		0.26		0.13	

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

Appendix I (continued). 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 1985-2003 brood years. (Data downloaded from RMIS database on 5/09/08.)

Brood Year	1988		1989		1990	
Smolts Released	139,050		97,779		85,737	
Fish/Lb	11.0		9.0		11.0	
CWT Codes[a]	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	370	61	191	2	6
Kalama R., Wind R.						
Fish Trap - F.W.	1	1				
Treaty Troll			2	2		
Lyons Ferry Hatch.[b]	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				
IDFG						
Hatchery						
Total Returns	204	482	124	258	21	25
Tucannon (%)	94.6		95.3		100.0	
Out-of-Basin (%)	0.4		0.0		0.0	
Commercial Harvest (%)	0.6		1.6		0.0	
Sport Harvest (%)	0.8		0.0		0.0	
Treaty Ceremonial (%)	3.5		3.1		0.0	
Survival	0.35		0.26		0.03	

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

Appendix I (continued). 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 1985-2003 brood years. (Data downloaded from RMIS database on 5/09/08.)

Brood Year	1991		1992		1992	
Smolts Released	72,461		56,679		79,151	
Fish/Lb	15.0		36.0		14.0	
CWT Codes[a]	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.[b]	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						
IDFG						
Hatchery						
Total Returns	26	30	4	5	69	102
Tucannon (%)	80.0		40.0		81.4	
Out-of-Basin (%)	10.0		20.0		15.7	
Commercial Harvest (%)	0.0		40.0		0.0	
Sport Harvest (%)	0.0		0.0		2.0	
Treaty Ceremonial (%)	10.0		0.0		0.9	
Survival	0.04		0.01		0.13	

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

Appendix I (continued). 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 1985-2003 brood years. (Data downloaded from RMIS database on 5/09/08.)

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[a]	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.[b]	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						
IDFG						
Hatchery						
Total Returns	117	287	24	32	132	187
Tucannon (%)	96.2		100.0		98.9	
Out-of-Basin (%)	1.7		0.0		1.1	
Commercial Harvest (%)	0.0		0.0		0.0	
Sport Harvest (%)	1.0		0.0		0.0	
Treaty Ceremonial (%)	1.0		0.0		0.0	
Survival	0.21		0.02		0.30	

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

Appendix I (continued). 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 1985-2003 brood years. (Data downloaded from RMIS database on 5/09/08.)

Brood Year	1996		1997		1998	
Smolts Released	76,028		23,509		124,093	
Fish/Lb	16.0		16.0		13.0	
CWT Codes[a]	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	43	139	17	85	147	680
Kalama R., Wind R.						
Fish Trap - F.W.						
Treaty Troll						
Lyons Ferry Hatch.[b]	96	99	44	46	83	83
F.W. Sport					3	14
Non-treaty Ocean Troll					1	2
ODFW						
Test Net, Zone 4					1	1
Treaty Ceremonial					5	5
Three Mile, Umatilla R.						
Spawning Ground					1	1
Fish Trap - F.W.	1	1	2	2	8	10
F.W. Sport					2	4
Hatchery	2	2	1	1		
Columbia R. Gillnet			7	22	32	85
Columbia R. Sport			2	15	17	94
CDFO						
Non-treaty Ocean Troll						
Mixed Net & Seine						
Ocean Sport						
USFWS						
Warm Springs Hatchery						
Dworshak NFH						
IDFG						
Hatchery	1	1	1	1		
Total Returns	143	242	74	172	300	979
Tucannon (%)	98.3		76.2		77.9	
Out-of-Basin (%)	1.7		2.3		1.2	
Commercial Harvest (%)	0.0		12.8		9.0	
Sport Harvest (%)	0.0		8.7		11.4	
Treaty Ceremonial (%)	0.0		0.0		0.5	
Survival	0.32		0.73		0.79	

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

Appendix I (continued). 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 1985-2003 brood years. (Data downloaded from RMIS database on 5/09/08.)

Brood Year	1999		2000		2001	
Smolts Released	97,600		102,099		146,922	
Fish/Lb	10.6		15.5		12.9	
CWT Codes[a]	02/75		08/87		06/81	
Release Year	2001		2002		2003	
Agency (fishery/location)	Observed Number	Estimated Number	Observed Number	Estimated Number	Observed Number	Estimated Number
WDFW						
Tucannon River	2	12	13	37	6	26
Kalama R., Wind R.						
Fish Trap - F.W.						
Treaty Troll						
Lyons Ferry Hatch.[b]	6	6	39	39	51	51
F.W. Sport						
Non-treaty Ocean Troll						
ODFW						
Test Net, Zone 4						
Treaty Ceremonial						
Three Mile, Umatilla R.						
Spawning Ground						
Fish Trap - F.W.						
F.W. Sport						
Hatchery						
Columbia R. Gillnet	1	3	1	1		
Columbia R. Sport						
CDFO						
Non-treaty Ocean Troll						
Mixed Net & Seine						
Ocean Sport						
USFWS						
Warm Springs Hatchery						
Dworshak NFH						
IDFG						
Hatchery						
Total Returns	9	21	53	77	57	77
Tucannon (%)	86.0		98.7		100.0	
Out-of-Basin (%)	0.0		0.0		0.0	
Commercial Harvest (%)	14.0		1.3		0.0	
Sport Harvest (%)	0.0		0.0		0.0	
Treaty Ceremonial (%)	0.0		0.0		0.0	
Survival	0.02		0.08		0.05	

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

Appendix I (continued). 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 1985-2003 brood years. (Data downloaded from RMIS database on 5/09/08.)

Brood Year	2001		2002[c]		2003	
Smolts Released	21,043		123,586		71,154	
Fish/Lb	123.4		11.7		12.7	
CWT Codes[a]	14/29		17/91		24/82	
Release Year	2002		2004		2005	
Agency (fishery/location)	Observed Number	Estimated Number	Observed Number	Estimated Number	Observed Number	Estimated Number
WDFW						
Tucannon River			11	47		
Kalama R., Wind R.						
Fish Trap - F.W.						
Treaty Troll						
Lyons Ferry Hatch.[b]			52	52	1	1
F.W. Sport						
Non-treaty Ocean Troll						
ODFW						
Test Net, Zone 4						
Treaty Ceremonial						
Three Mile, Umatilla R.						
Spawning Ground						
Fish Trap - F.W.						
F.W. Sport						
Hatchery						
Columbia R. Gillnet	1	1				
Columbia R. Sport						
CDFO						
Non-treaty Ocean Troll						
Mixed Net & Seine						
Ocean Sport						
USFWS						
Warm Springs Hatchery						
Dworshak NFH						
IDFG						
Hatchery						
Total Returns	1	1	63	99	1	1
Tucannon (%)	0.0		100.0		100.0	
Out-of-Basin (%)	0.0		0.0		0.0	
Commercial Harvest (%)	100.0		0.0		0.0	
Sport Harvest (%)	0.0		0.0		0.0	
Treaty Ceremonial (%)	0.0		0.0		0.0	
Survival	0.00		0.08		0.00	

[a] WDFW agency code prefix is 63.
[b] Fish trapped at TFH and held at LFH for spawning.
[c] Data for the 2002 brood year is incomplete.

Appendix I (continued). 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 1985-2003 brood years. (Data downloaded from RMIS database on 5/09/08.)

Brood Year	2003					
Smolts Released	130,064					
Fish/Lb	13.4					
CWT Codes[a]	27/78 CB					
Release Year	2005					
Agency (fishery/location)	Observed Number	Estimated Number	Observed Number	Estimated Number	Observed Number	Estimated Number
WDFW						
Tucannon River	1	4				
Kalama R., Wind R.						
Fish Trap - F.W.						
Treaty Troll						
Lyons Ferry Hatch.[b]						
F.W. Sport						
Non-treaty Ocean Troll						
ODFW						
Test Net, Zone 4						
Treaty Ceremonial						
Three Mile, Umatilla R.						
Spawning Ground						
Fish Trap - F.W.						
F.W. Sport						
Hatchery						
Columbia R. Gillnet						
Columbia R. Sport						
CDFO						
Non-treaty Ocean Troll						
Mixed Net & Seine						
Ocean Sport						
USFWS						
Warm Springs Hatchery						
Dworshak NFH						
IDFG						
Hatchery						
Total Returns	1	4				
Tucannon (%)	100.0		0.0		0.0	
Out-of-Basin (%)	0.0		0.0		0.0	
Commercial Harvest (%)	0.0		0.0		0.0	
Sport Harvest (%)	0.0		0.0		0.0	
Treaty Ceremonial (%)	0.0		0.0		0.0	
Survival	0.00		0.00		0.00	

[a] WDFW agency code prefix is 63.
[b] Fish trapped at TFH and held at LFH for spawning.
[c] Data for the 2002 brood year is incomplete.