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Tucannon River Spring Chinook Salmon Hatchery Evaluation Program 2008 Annual Report

by Michael P. Gallinat and Lance A. Ross

Washington Department of
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Acknowledgments

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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. With co-manager agreement, the conventional supplementation production goal was increased in 2006 from 132,000 to 225,000 fish for release as yearlings at a size of 30 g/fish (15 fish per pound). 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 May 2008 to April 2009.

Five hundred salmon were captured in the TFH trap in 2008 (90 natural adults, 24 natural jacks, 118 hatchery adults, and 268 hatchery jacks). Of these, 134 (42 natural, 92 hatchery) were collected and hauled to LFH for broodstock and the remaining fish were passed upstream. During 2008, three salmon that were collected for broodstock died prior to spawning.

Spawning of supplementation fish occurred between 2 September and 23 September, with a peak eggtake occurring on 16 September. A total of 193,324 eggs were collected from 17 natural and 43 hatchery-origin female Chinook. Egg mortality to eye-up was 2.6% (5,036 eggs), with an additional loss of 4,363 (2.3%) sac-fry. Total fry ponded for production in the rearing ponds was 183,925.

WDFW staff conducted spawning ground surveys in the Tucannon River between 27 August and 30 September, 2008. One hundred forty-one redds and 168 carcasses were found above the adult trap and 58 redds and 78 carcasses were found below the trap. Based on redd counts, broodstock collection, and in-river pre-spawning mortalities, the estimated escapement for 2008 was 1,191 spring Chinook (403 natural adults, 131 natural jacks and 185 hatchery-origin adults, 472 hatchery jacks).

Evaluation staff operated a downstream migrant trap to provide juvenile outmigration estimates. During the 2007/2008 emigration, we estimated that 30,228 (BY 2006) natural spring Chinook smolts emigrated from the Tucannon River.

Smolt-to-adult return rates (SAR) for natural origin salmon average about five times higher than for hatchery origin salmon. However, hatchery salmon survive almost 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 657 hatchery-origin fish returned in 2008. We are currently conducting an experiment to examine size at release as a possible means to improve SAR of hatchery origin spring Chinook.

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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 authorize hatchery construction and production in Washington, Idaho, and Oregon as a mitigation tool (USACE 1975). In Washington, Lyons Ferry Hatchery (LFH) was constructed and Tucannon Fish Hatchery (TFH) was modified. Under the mitigation negotiations, local fish and wildlife agencies determined through a series of conversion rates of McNary Dam counts that 2,400 (2%) spring Chinook annually escaped into the Tucannon River. The agencies also estimated a 48% cumulative loss rate to juvenile downstream migrants passing through the four lower Snake River dams. As such, 1,152 fish of Tucannon River origin spring Chinook needed to be compensated for, with the expectation that the other 1,248 (52%) would come from natural production. The agencies also determined through other survival studies at the time that a smolt-to-adult survival rate of 0.87% was a reasonable expectation for spring and summer Chinook salmon. Based on that it was determined that 132,000 fish should be produced by the hatchery program to meet compensation needs. 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 was 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 smolts 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 Tucannon Spring Chinook Evaluation Program from May 2008 through April 2009.

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) to allow take for this program, but those permits have since expired. A Hatchery and Genetic Management Plan (HGMP) has been submitted as the application for a new Section 4 (d) Permit for this program. This report summarizes all work performed by WDFW's LSRCP Tucannon Spring Chinook Salmon Evaluation Program during 2008. Numbers of direct and indirect takes of listed Snake River spring Chinook (Tucannon River stock) and fall Chinook salmon (Snake River stock) for the 2008 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 in late September/October 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). Adults returning to TFH are transported to LFH and held until spawning. Juveniles are reared at TFH through the winter until release in the spring on a combination of well, spring, and river water. River water is the primary water source, 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.

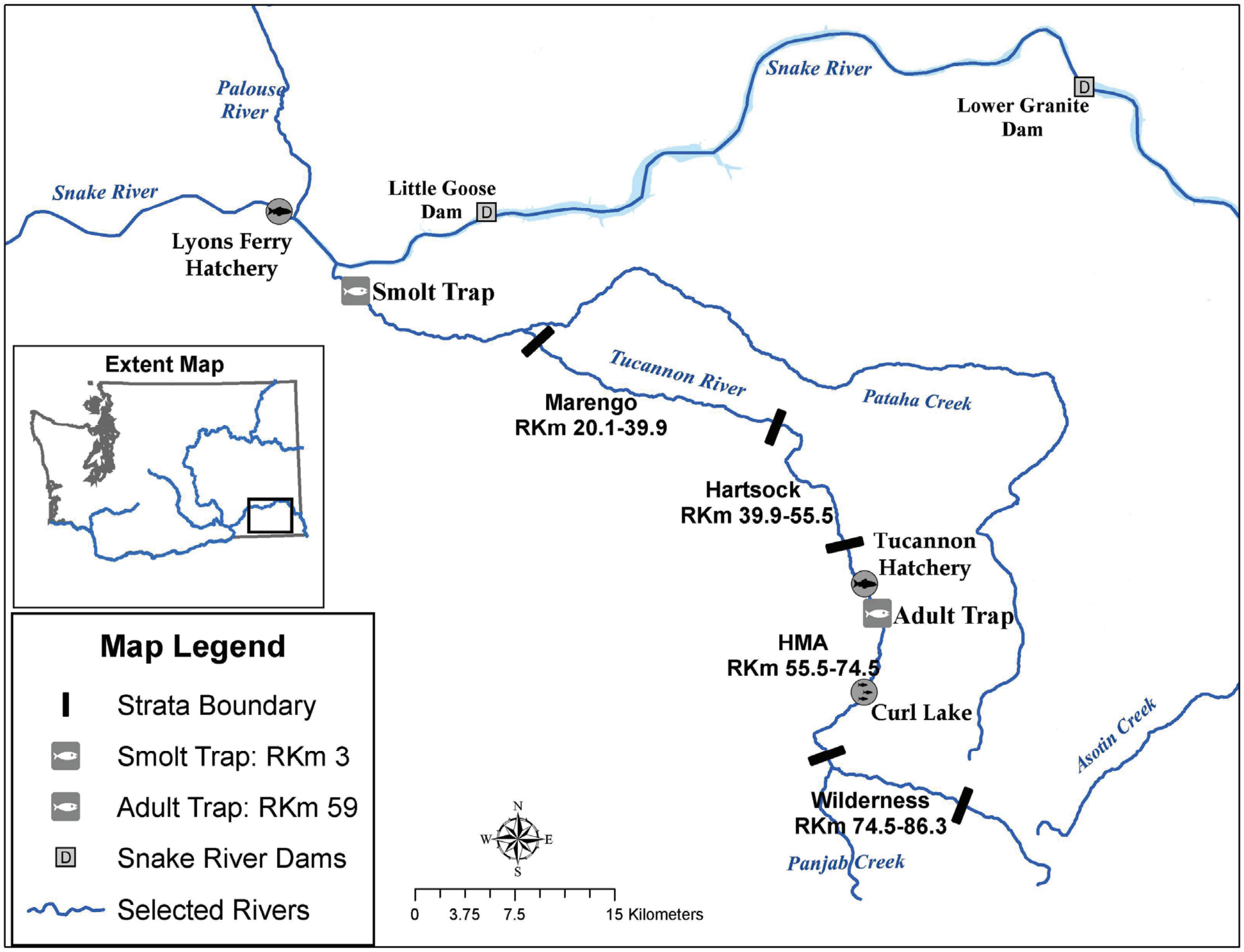

Figure 1. Location of the Tucannon River, and Lyons Ferry and Tucannon Hatcheries within the Snake River Basin.

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

Strata	Land Ownership/Usage	Spring Chinook Habitat[a]	River Kilometer[b]
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] Strata were based on water temperature, habitat, and landowner use.
[b] 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 15 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 2008, maximum water temperatures where spring Chinook juveniles were rearing ranged from 14.1°C in the upper HMA stratum (rkm 74.5) to 20.9°C in the lower Hartsock stratum (rkm 43.3)(Figure 2).

The upper lethal temperature for Chinook fry is 25.1°C while the preferred temperature range is 12-14°C (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 (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 (or average mean temperature of 20°C). Mendel et al. (2007) provide a literature review table of seven day maximum temperature limits for various life stages for Chinook salmon. Based on the preferred and optimum temperature limits, fish returning to the upper watershed have the best chance for survival (Figure 2).

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. These stream reaches also have larger stream widths and water volumes and therefore may potentially provide more habitat and rearing capacity than the upper watershed.

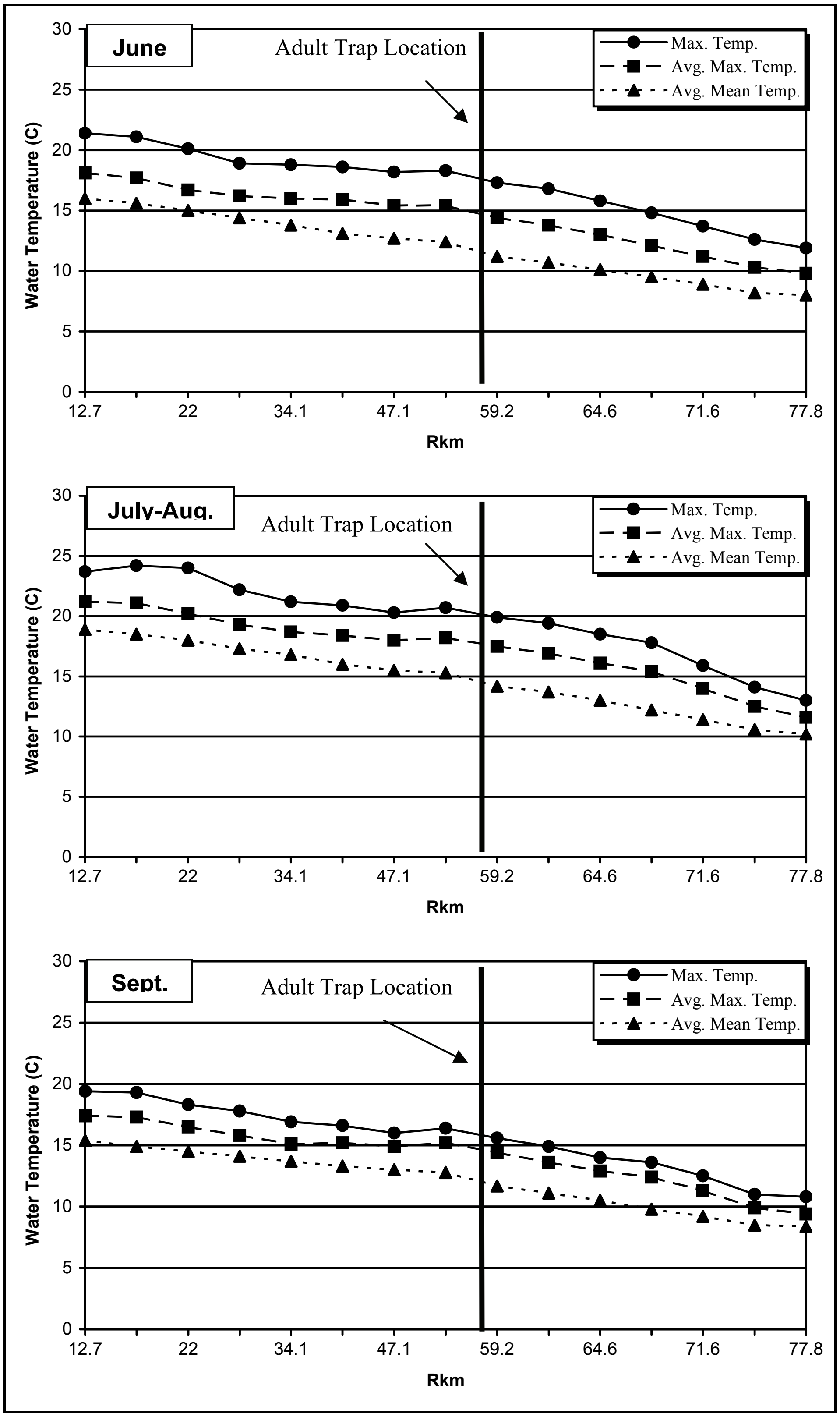

Figure 2. Maximum temperature, average maximum temperature, and average mean temperature recorded by thermographs at 15 selected sites along the Tucannon River for June, July – August, and September, 2008

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 Tucannon 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 500 fish entered the trap (90 natural adults, 24 natural jacks, 118 hatchery adults, and 268 hatchery jacks), and 42 natural (40 adults, 2 jacks) and 92 hatchery (76 adults, 16 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 1986-2008.

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	40	10
1997	99	160	0	0	43	54	56	106
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
2008 [g]	114	386	0	1	42	92	72	293

[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.
[g] One AD/No Wire stray fish was killed at the trap.

Broodstock Mortality

Three of the 134 salmon collected for broodstock died prior to spawning in 2008 (Table 3). Table 3 shows that prespawning mortality in 2008 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 (1992-2008).

	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
2008	1	1	0	4.8	0	0	1	1.1

Broodstock Spawning

Spawning at LFH was conducted once a week from 2 September to 23 September, with peak eggtake occurring on 16 September. During the spawning process, the eggs of two females were split in half and fertilized by two males following a 2 x 2 factorial spawning matrix approach. Factorial mating can have substantial advantages in increasing the genetically effective number of breeders (Busack and Knudsen 2007). To prevent stray fish from contributing to the hatchery population, all CWTs were read prior to spawning. No hatchery strays were found in the broodstock in 2008. Broodstock carcasses were returned to the upper Tucannon River (above rkm 59) for stream nutrient enrichment.

A total of 193,324 eggs were collected (Table 4). Eggs were initially disinfected and water hardened for one hour in an iodophor solution (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 2.6% with an additional 2.3% (4,363) loss of sac-fry, which left 183,925 fish for production.

Table 4. Number of fish spawned and killed, estimated egg collection, and egg mortality of Tucannon River spring Chinook salmon at LFH in 2008.

	Natural			Hatchery		
Spawn Date	**Male**	**Female**	**Eggs Taken**	**Male**	**Female**	**Eggs Taken**
9/02	2[a]	2	6,133	2	1	4,071
9/09	10[a]	8	29,426	8	10	32,774
9/16	18[a]	4	16,388	4	18	55,280
9/23	2	3	11,505	17	14	37,747
Totals	**23[b]**	**17**	**63,452**	**31[c]**	**43**	**129,872**
Egg Mortality			662			4,374

[a] Live spawned fish.
[b] Total natural males used in spawning.
[c] Total does not include 17 hatchery males not used for spawning.

Natural Spawning

Spawning ground surveys were conducted on the Tucannon River weekly from 27 August to 30 September 2008. One hundred ninety-nine redds were counted and 150 natural and 96 hatchery origin carcasses were recovered (Table 5). One hundred forty-one redds (70.9% of total) and 168 carcasses (68.3% of total) were found above the adult trap.

While conducting redd surveys in 2008, we also snorkeled 15 redds to look for the presence of precocial juveniles spawning with adults. We observed 45 adults (14 females, 15 males, and 16 jacks) on or near the sampled redds. We observed numerous precocial parr and captured with a cast net, 9 juvenile wild spring Chinook in or near the redds. Seven of the nine wild fish (78%) were mature males with a mean length of 107 mm (range 90-128 mm). Sex was not determined for the two immature fish, which had a mean length of 84 mm (range 82-86 mm). No hatchery-origin precocial juveniles were collected in 2008.

Table 5. Numbers and general locations of salmon redds and carcasses recovered on the Tucannon River spawning grounds, 2008 (the Tucannon Hatchery adult trap is located at rkm 59).

Stratum	Rkm[a]	Number of redds	Carcasses Recovered	
			Natural	Hatchery
Wilderness	84-86	3	1	0
	78-84	8	4	0
	75-78	19	11	3
HMA	73-75	13	9	6
	68-73	29	33	12
	66-68	29	13	17
	62-66	30	20	13
	59-62	10	13	13
-------------------------Tucannon Fish Hatchery Trap-------------------------				
	56-59	35	35	22
Hartsock	52-56	12	8	5
	47-52	8	2	5
	43-47	2	0	0
	40-43	0	1	0
Marengo	34-40	1	0	0
	28-34	0	0	0
Totals	**28-86**	**199**	**150**	**96**

[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 in Natural Spawning

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 appears to have affected the spawning distribution, with higher numbers of fish and redds in the Wilderness and HMA strata compared to previous years (Table 6).

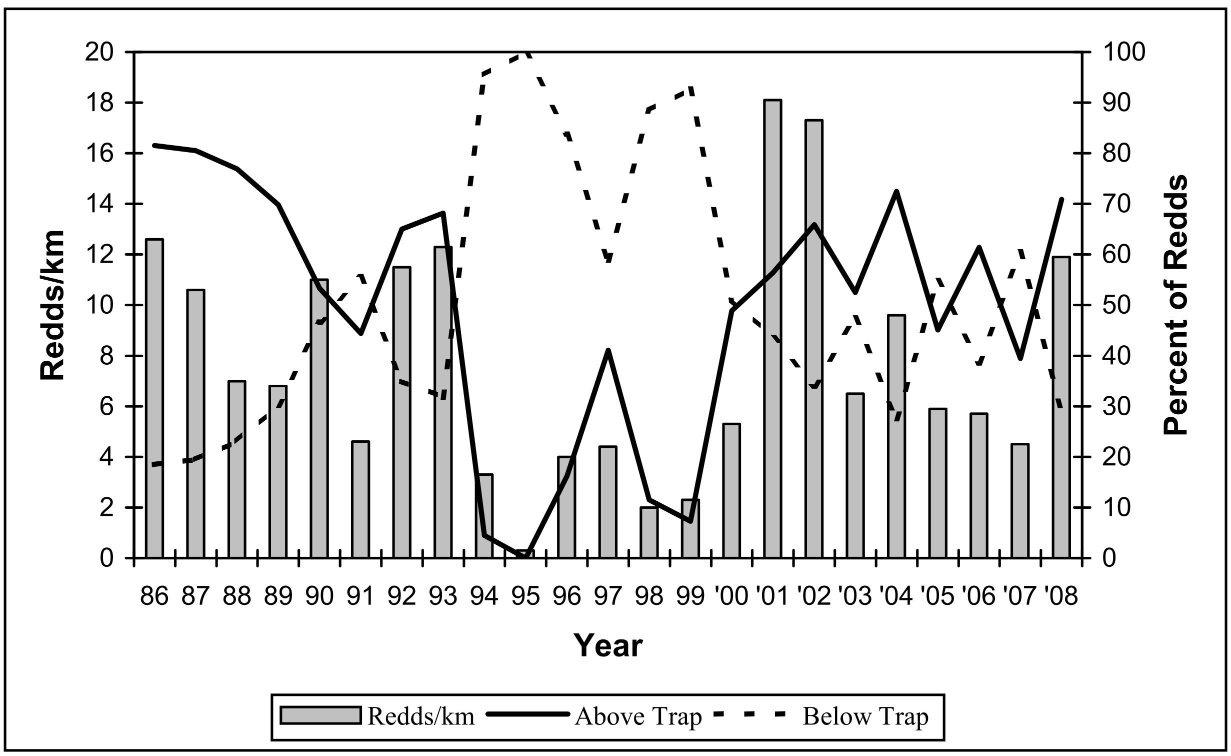

Figure 3. Number of redds/km and percentage of redds above and below the adult trap on the Tucannon River, 1986-2008.

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, 1985-2008.**

	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
2008	30 (2.7)	146 (7.7)	22 (1.4)	1 (0.1)	199	141	70.9	58	29.1

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

Genetic Sampling

During 2008, we collected 300 DNA samples (operculum punches) from adult salmon (150 natural origin, 88 conventional supplementation hatchery, 59 captive brood progeny and 3 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. Genotypes, allele frequencies, and tissue samples are stored at WDFW's Genetics Laboratory. Genetic samples are being compared between 1986 and samples collected through 2008 to determine if there has been a loss of genetic diversity since the hatchery program began. The results will be published in an appropriate journal.

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 CWTs 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 may be due to smolt size-at-release (hatchery origin smolts are generally 25-30 mm greater in length than natural smolts).

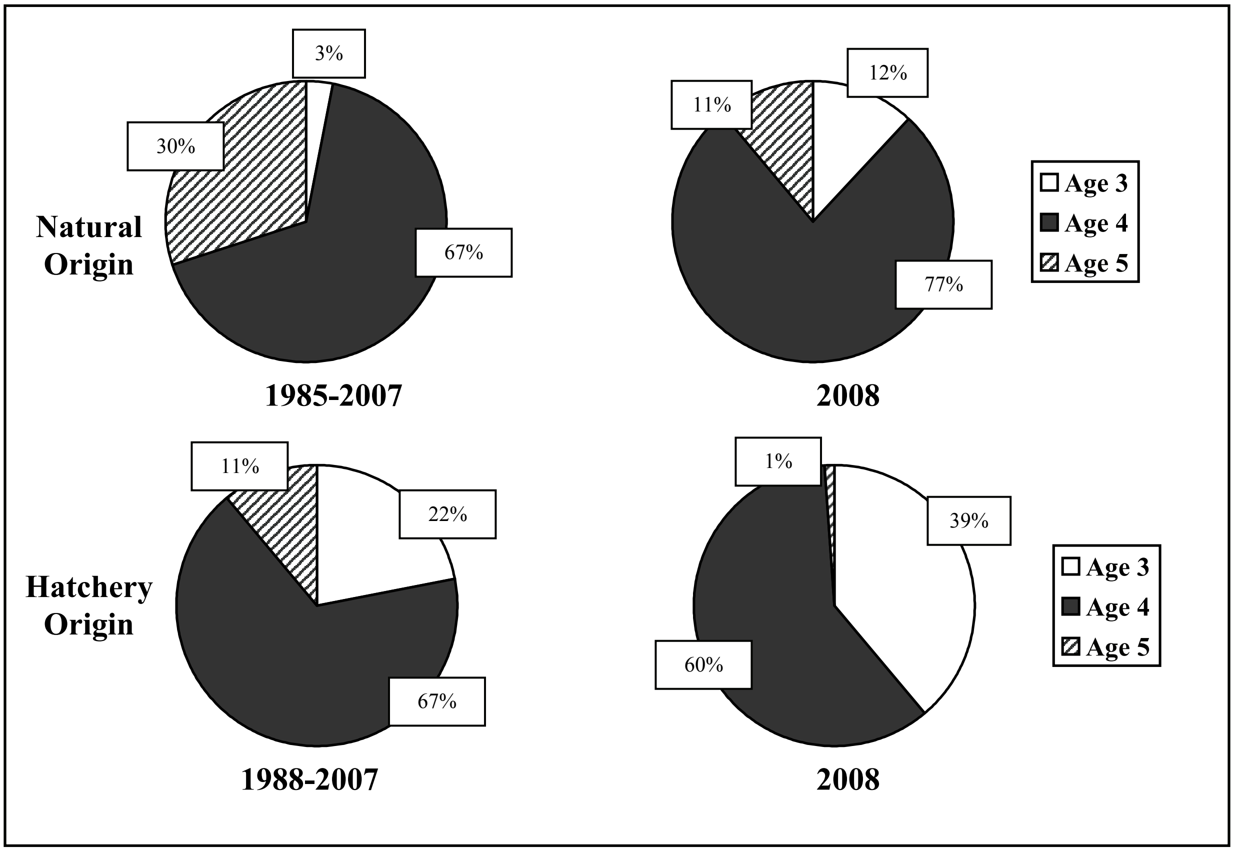

Figure 4. Historical (1985-2007), and 2008 age composition for spring Chinook in the Tucannon River.

Age composition for the 2008 run showed a higher proportion of age 3 fish for both hatchery and natural origins (Figure 4). This is due to a combination of higher survival rates associated with recent improved ocean conditions and the fact that the hatchery fish (05 BY) were released at a larger size (57 g/fish) than the 30 g/fish goal in an attempt to increase survival rates.

Another metric monitored on returning adult natural and hatchery origin fish is size at age, measured as the mean post-orbital to hypural-plate (POH) lengths. We examined size at age for returns using analysis of variance from the program's inception to date, and found a significant difference ($P < 0.05$) in mean POH length between natural and hatchery-origin female fish but not males (Figure 5).

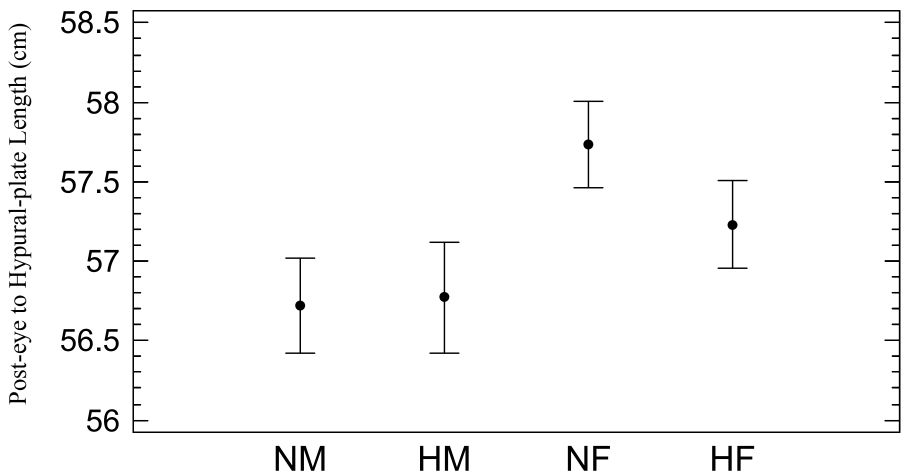

Figure 5. Mean POH length comparisons between Age 4 natural and hatchery-origin males (NM and HM) and natural and hatchery-origin females (NF and HF) with 95% confidence intervals for the years 1985-2008.

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 mass 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 ($P < 0.001$).

Table 7. Average number of eggs/female (n, SD) by age group of Tucannon River natural and hatchery origin broodstock, 1990-2008.

	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)
2008	3,698	(16, 618.9)	2,993	(40, 539.4)	4,285	(1, 000.0)	4,430	(1, 000.0)
Mean	**3,487**		**3,067**		**4,394**		**3,671**	
SD	**643.3**		**657.5**		**892.0**		**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 2008, based on the estimated escapement of fish to the river, we sampled approximately 32% of the run (Table 9).

Table 8. Coded-wire tag codes of hatchery salmon sampled at LFH and the Tucannon River, 2008.

CWT Code	Broodstock Collected: Died in Pond	Broodstock Collected: Killed Outright	Broodstock Collected: Spawned	Recovered in Tucannon River: Dead in Trap	Recovered in Tucannon River: Pre-spawn Mortality	Recovered in Tucannon River: Spawned	Totals
63-24-82			1			1	2
63-28-65[a]		9	27			16	52
63-28-87		5	32			22	59
63-34-77[a]		2	1			19	22
63-35-99	1	1	13			34	49
R.R./No wire[b]						1	1
-Strays-							
09-20-45[c]						1	1
09-43-58[d]						1	1
09-44-60[e]						1	1
AD/No wire[f]				1			1
Total	1	17	74	1	0	96	189

[a] Captive brood progeny.
[b] This was an age-3 Right Red VIE/No wire fish which would make it tag code 63-35-99.
[c] ODFW – Rogue River spring Chinook – Cole Rivers Hatchery.
[d] ODFW – Grande Ronde River spring Chinook – Lookingglass Hatchery.
[e] ODFW – Umatilla River spring Chinook – Umatilla Hatchery.
[f] Adipose clipped strays are killed outright at the trap.

Table 9. Spring Chinook salmon (natural and hatchery) sampled from the Tucannon River, 2008.

	2008 Natural	2008 Hatchery	2008 Total
Total escapement to river	534	657	1,191
Broodstock collected	42	92	134
Fish dead in adult trap	0	1	1
Total hatchery sample	42	93	135
Total fish left in river	492	564	1,056
In-river pre-spawn mortalities observed	0	0	0
Spawned carcasses recovered	150	96	246
Total river sample	150	96	246
Carcasses sampled	192	189	381

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 was later than the historical mean as most salmon runs in the Columbia Basin were later than normal during 2008 (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 date.

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, 1986-2008.

	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]
2007	6/04	6/04	9/18	9/04	22	9/12	30
Mean	**5/31**	**6/03**	**9/12**	**9/09**	**27**	**9/14**	**34**
2008	6/16	6/20	9/09	9/16	21	9/11	34

[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.

Half of the total run for both natural and hatchery-origin fish arrive at the adult trap by 12 June (Figure 6). After this date, the hatchery fish tend to arrive at the trap at a slightly faster rate than natural origin fish.

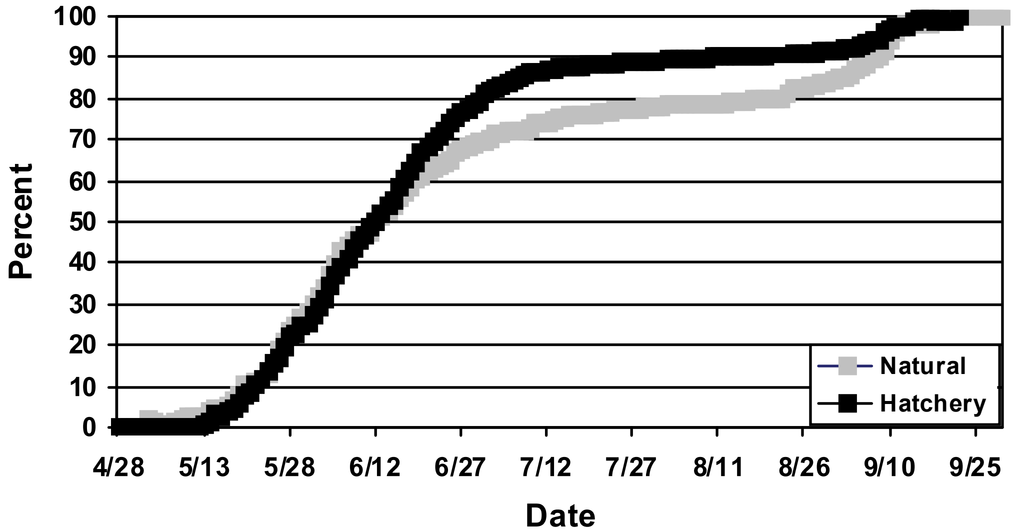

Figure 6. Mean percent of total run captured by date at the Tucannon Fish Hatchery adult trap on the Tucannon River for both natural and hatchery origin Tucannon River spring Chinook salmon, 1993-2008.

Total Run-Size

Redd counts have a strong direct relationship to total run-size entering the Tucannon River and passage of adult salmon at the TFH adult trap (Bugert et al. 1991). During 2008, we noted high numbers of fish above the trap that lacked opercle punch scars. It became apparent during redd surveys and carcass collections that fish had been able to jump over the dam and bypass the adult trap because of high flows. We calculated separate bypass rates for both jacks and adults since their ability to bypass the trap was different. We calculated the number of jacks and adults that bypassed the adult trap by solving for the following equation:

$$\text{Number of fish that bypassed adult trap} = \frac{\text{Number of fish without opercle punches} \times \text{Fish passed above trap}}{\text{Number of fish with opercle punches}}$$

We added the calculated number of fish that bypassed the trap (195 jacks, 258 adults) to the number of fish that were passed upstream by hatchery staff (281 jacks, 84 adults) for a total of 818 fish above the trap. The number of fish above the trap divided by the number of redds above the trap (199) calculated out to 4.1 fish per redd. Using the fish per redd estimate for above the trap we multiplied that estimate by the number of redds below the trap (58) to calculate number of fish below the trap (238). A hanging plastic curtain was installed at the TFH adult trap by hatchery staff during the winter of 2008 to inhibit salmon and steelhead from bypassing the adult trap during high flows.

The run-size estimate for 2008 was calculated by adding the estimated number of fish upstream of the TFH adult trap (818), the estimated fish below the weir (238) calculated from the fish/redd ratio (4.1), the number of observed pre-spawn mortalities below the weir (0), the number of trap mortalities and stray fish killed at the trap (1), and the number of broodstock collected (134) (Table 11). Run-size for 2008 was estimated to be 1,191 fish (403 natural adults, 131 natural jacks and 185 hatchery-origin adults, 472 hatchery jacks). This is not only the highest estimated adult return to date, but it also had the highest estimated adults per redd since 1991 (Table 11). Historical estimates since 1985 are provided in Table 11 and Appendix C.

Table 11. Estimated spring Chinook salmon run to the Tucannon River, 1985-2008.

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	34	250	66
1997	73	2.00	146	97	108	351	46
1998	26	1.94	51	89	4	144	59
1999	41	2.60	107	136	2	245	1
2000	92	2.60	239	81	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
2008	199	4.10	1,056	134	1	1,191	45

[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) are periodically 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 proportion 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 completely accurate 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 on samples we have retained. Beginning with the 2000 BY, Umatilla River hatchery-origin spring Chinook were 100% marked. This will help reduce the effect of Umatilla fish by allowing their selective removal from the hatchery broodstock. However, strays will still have access to spawning areas below the hatchery trap. The addition of Carson stock spring Chinook releases into the Walla Walla River may also increase the number into the Tucannon River (Glen Mendel, WDFW, personal communication). WDFW will continue to monitor the Tucannon River and emphasize the need for external marks and CWT for Walla Walla River releases.

Three known origin (CWT) and one AD only/no wire hatchery strays were recovered during 2008. Because of the bypass problem, two stray jacks were recovered during redd surveys above the adult trap. One was an AD/RV clipped Umatilla River spring Chinook (CWT 09/44/60) and the other was a Grande Ronde River spring Chinook (CWT 09/43/58). We also recovered a stray hatchery female from the Rogue River (CWT 09/20/45) below the adult trap. An Ad only/no wire stray (age-2) was killed outright by hatchery staff at the adult trap. Based on our marks (VIE/CWT), and past straying events, we believe this fish was either a Umatilla or Walla Walla stray. After expansions, strays accounted for an estimated 2.0% of the total 2008 run (Appendix D).

Adult PIT Tag Returns

Eighteen Tucannon River spring Chinook adults originally tagged as juveniles have been detected returning to the Columbia River System (Table 12).

Table 12. Number of Tucannon River spring Chinook juvenile fish PIT tagged by origin and year and adult returns detected (%) in the Columbia River System by origin.

Tag Year	PIT Tagged Hatchery	PIT Tagged Natural	PIT Tagged Captive Brood	Detected H Adult Returns	Detected N Adult Returns	Detected CB Adult Returns
1995	100	---	---	0	---	---
1996	1,923	---	---	0	---	---
1997	1,984	---	---	2 (0.10%)	---	---
1998	1,999	---	---	0	---	---
1999	336	374	---	2 (0.06%)	5 (1.34%)	---
2000	---	---	---	---	---	---
2001	301	158	---	0	0	---
2002	319	320	---	0	3 (0.93%)	---
2003	1,010	---	1,007	3 (0.30%)	---	0
2004	1,012	---	1,029	0	---	0
2005	993	93	993	0	1 (1.08%)	0
2006	1,001	70	1,002	0	0	0
2007	1,202	504	1,000	0	2 (0.40%)	0
2008	4,989	1,584	997	0	0	0
Totals	**17,169**	**3,103**	**6,028**	**7 (0.04%)**	**11 (0.35%)**	**0 (0.0%)**

It is interesting to note that 50% of the detected returning PIT tagged adults overshot the Tucannon River and were detected at Lower Granite Dam (Table 13). This "overshooting" behavior does not appear to be a hatchery effect since both hatchery and natural-origin fish bypassed the Tucannon River. To date, none of the Tucannon spring Chinook detected at lower Granite Dam have been documented returning to 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. Additional PIT tag detectors should be installed at Lower Monumental and Little Goose dams to help decipher fish movements through the dams. With the addition of the Lower Tucannon PIT tag array in 2005, this should enable us to document whether Tucannon spring Chinook 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 13. 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	5/19/04	750.7	4
3D9.1BF16876C6	W	105	4/30/02	ICH	5/04/05	1100.4	5
3D9.1BF167698F	W	96	5/02/02	ICH	5/03/05	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
3D9.1BF1A2EF4B	W	104	12/07/05	LGR	6/16/08	921.9	5
3D9.1BF26D36B8	W	114	4/24/07	LTR	5/09/08	381.5	3
3D9.1BF26D389C	W	114	4/24/07	LTR	5/27/08	400.1	3

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

Conventional supplementation juveniles (2007 BY) were split into two groups (Target: 30 g/fish vs. 50 g/fish) for a study to evaluate the effect of size at release on survival. Fish were marked with a visible implant elastomer tag (VIE) behind the left eye and tagged with CWTs between 10 and 17 September 2008 (55,893 Blue VIE – 50 g/fish target; 59,949 Purple VIE – 30 g/fish target). Supplementation fish were transported to TFH between 26 and 27 September 2008.

Brood year 2007 fish were sampled twice during the rearing cycle (Table 14). During February, fish were sampled for length, weight, precocity and mark quality, and were PIT tagged for outmigration comparisons (2,500 per group) before transfer to Curl Lake AP. Length, weight, and precocity samples were repeated in April prior to release.

Table 14. Sample size (N), mean length (mm), coefficient of variation (CV), condition factor (K), mean weight (g), and precocity of 2007 BY juveniles sampled at TFH and Curl Lake.

Brood/ Date	Progeny Type	Sample Location	N	Mean Length (mm)	CV	K	Mean Wt. (g)	% Precocity
2007								
2/09/09	50 g Target	TFH	250	158.9	12.3	1.19	49.7	1.6
2/09/09	30 g Target	TFH	250	121.2	10.6	1.14	21.0	2.2
4/08/09	50 g Target	Curl Lake	252	160.4	17.7	1.27	57.3	1.2
4/08/09	30 g Target	Curl Lake	252	141.2	17.7	1.20	37.3	0.4

The 2007 BY pre-smolts were transported to Curl Lake in February 2009 for acclimation and volitional release. Volitional release began 13 April and continued until 22 April when the remaining fish were forced out. Mortalities were low in Curl Lake and releases are given in Table 15. Historical hatchery releases are summarized in Appendix E.

Table 15. Yearling spring Chinook releases from Curl Lake in the Tucannon River, 2007 brood year.

Release Year	Release Date	CWT Code	Total Released	Number CWT	VIE Mark	Size Total (kg)	Size Mean (g)
2009	4/13-4/22	63/46/88	55,480	55,266	Left Blue	3,162	57
2009	4/13-4/22	63/46/87	59,201	58,044	Left Purple	2,190	37

Smolt Trapping

Evaluation staff operated a 1.5 m rotary screw trap at rkm 3 on the Tucannon River from 8 October 2007 through 2 July 2008 to estimate numbers of migrating juvenile natural and hatchery spring Chinook. Numbers of fish species captured by month during the 2008 outmigration can be found in Appendix F. The main outmigration of natural origin spring Chinook occurred during the spring but a small outmigration event also occurred in the fall (Figure 7).

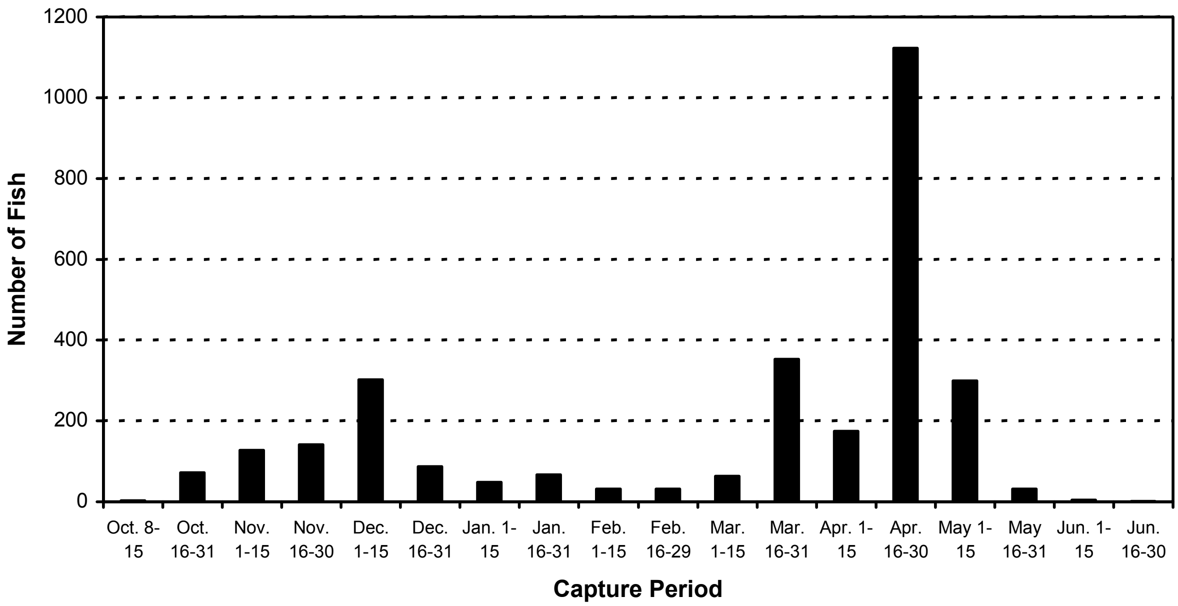

Figure 7. Emigration timing of natural spring Chinook salmon captured during smolt trap operations (rkm 3) on the Tucannon River for the 2007-08 migration year.

Natural spring Chinook emigrating from the Tucannon River (BY 2006) averaged 106 mm (Figure 8). This is in comparison to a mean length of 146 mm for the 30 g/fish target size group and 158 mm for the 50 g/fish target size group of hatchery-origin fish (BY 2006) released from Curl Lake Acclimation Pond (Gallinat and Ross 2008).

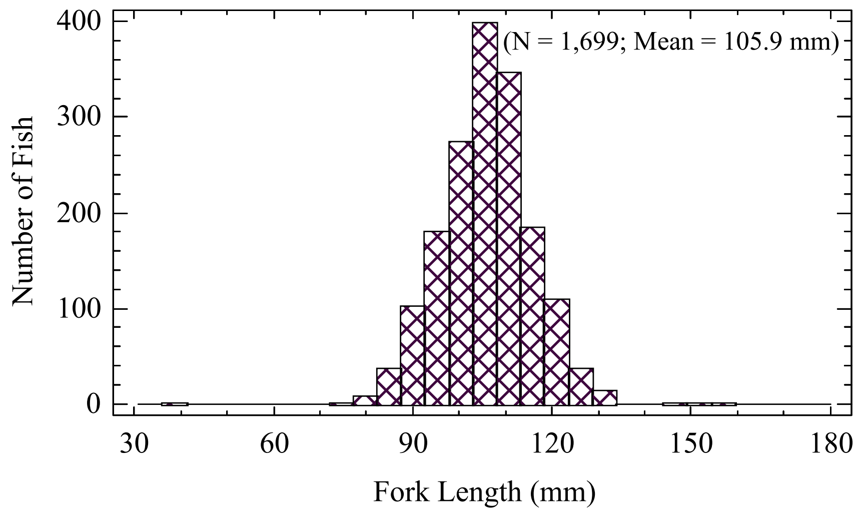

Figure 8. Length frequency distribution of sampled natural spring Chinook salmon captured in the Tucannon River smolt trap, 2007/2008 season.

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.

We estimated outmigration based on the approach of Steinhorst et al. (2004). This involved using a Bailey-modified Lincoln-Peterson estimation with 95% bootstrap confidence intervals by running the Gauss Run-Time computer program (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 preceding or following strata, depending upon similarity in trapping/flow conditions. Where river conditions were similar, we used our best judgment to group the strata.

In the past we used the 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.

A hole was discovered in the trap live box at the end of the season that likely occurred during the high flow event of 19 May to 23 May. For this reason estimates for the 2007/2008 outmigration season should be considered minimal estimates as some fish may have escaped through the hole. We estimate that 30,228 migrant natural-origin spring Chinook (2006 BY) passed the smolt trap during 2007-2008 (Table 16). We also estimated that 45% of the hatchery fish (conventional hatchery supplementation and captive brood progeny) released from Curl Lake AP (2006 BY) passed the smolt trap. This low hatchery estimate may be due to lower capture probabilities or higher residualism rates in the upper watershed.

Table 16. Total population estimates (with 95% confidence interval) for natural and hatchery origin (conventional supplementation and captive brood) emigrants from the Tucannon River, 2008.

	Natural	Conventional 30 g Target	Conventional 50 g Target	Captive Brood
Total Emigrants	30,228	17,603	18,252	46,439
95% C.I.	21,534-46,614	11,371-31,275	11,311-33,598	32,205-69,028
S.E.	6,850	4,482	5,020	11,098

Juvenile Migration Studies

In 2008, we used passive integrated transponder (PIT) tags to study the emigration timing and relative success of our conventional hatchery supplementation and captive brood progeny. We tagged 5,000 conventional hatchery supplementation fish (2,500 of the 30 g/fish and 2,500 of the 50 g/fish target size release groups) and 1,000 captive brood hatchery-origin fish during early February before transferring them to Curl Lake AP for acclimation and volitional release (Table 17). There were nine mortalities from the 30 g/fish target group, two mortalities from the 50 g/fish target group, and three mortalities from the captive brood progeny after tagging. Cumulative PIT tag detections at hydroelectric projects downstream of the Tucannon River were 32% for the 30 g/fish target size group, 31% for the 50 g/fish target size group and 27% for the captive brood progeny.

Table 17. Cumulative detection (one unique detection per tag code) and travel time in days (TD) of PIT tagged conventional hatchery supplementation (30g and 50g fish) and captive brood progeny released[a] from Curl Lake AP (rkm 65.6) on the Tucannon River at downstream Snake and Columbia River dams during 2008.

	Release Data				Recapture Data													
Hatch.		Mean		Mean	LMJ		ICH		MCJ		JDJ		BONN		Total	
Origin	N	Length	S.D.	Length	N	TD	N	TD	N	TD	N	TD	N	TD	N	%
30 g	2,491	118.9	12.7	121.0	317	33.5	189	33.1	182	35.5	90	40.1	13	39.4	791	31.7
50 g	2,498	149.6	20.9	148.4	271	31.4	181	31.3	198	33.8	111	39.0	21	38.5	782	31.3
C.B.	997	---	---	---	82	29.9	64	29.5	78	34.1	35	35.7	6	43.7	265	26.6

[a] Fish were volitionally released from 4/08/08 – 4/22/08.
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, ICH- Ice Harbor 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) 2.2 computer model. The data files were created using the PitPro version 4.1 computer program to translate raw PIT Tag Information System (PTAGIS) data of the Pacific States Marine Fisheries Commission into usable capture histories for the SURPH program. Estimated survival probabilities from Curl Lake to Lower Monumental Dam were 0.26 (S.E. = 0.018) for 30 g fish, 0.30 (S.E. = 0.024) for 50 g fish and 0.13 (S.E. = 0.022) for captive brood smolts. Survival probabilities to Lower Monumental Dam were not significantly different between the 30 g/fish and 50 g/fish release size groups ($P \geq 0.05$). Survival probabilities were significantly different ($P \leq 0.05$) between captive brood smolts and conventional hatchery supplementation smolts (both 30g/fish and 50 g/fish release groups).

Size at Release Evaluation

Domestication selection within hatcheries can lead to genetic divergence of wild and hatchery salmon from the same evolutionary significant unit (ISAB 2002). This is the result of selective pressures in the hatchery being different from the wild. Kostow (2004) stated that hatchery fish may be made to "look more like" wild fish without behaving like them or surviving like them. Although domestication selection is unavoidable, there are strategies to minimize the deleterious effects of hatchery rearing on survival in the wild. Changing hatchery practices may allow the production emphasis to shift from quantity to quality in an attempt to improve hatchery efficiency where it counts most; the improvement of post-release survivorship (Brown and Laland 2001).

In order to release Tucannon River spring Chinook at 30 g/fish hatchery staff must hold back growth of fish in the hatchery. While a target goal of 30 g/fish more closely mimics the migrating size of wild spring Chinook smolts (approximately 18 g/fish), the wild component of the population is not surviving in adequate numbers to sustain the population (Gallinat and Ross 2008). The natural environment in the Snake and Columbia river systems has changed from that in which the salmon evolved and adapted. Man's activities, such as dam building, logging, agriculture, and industry have greatly affected the ecosystem. Hatchery fish may also have difficulty adjusting to and locating food in their new environment upon release into the wild, resulting in post-release mortality (Rondorf et al. 1985). Releasing fish at a larger size would likely increase smolt survival (Tipping 1997), but this may also increase the numbers of precocious males and possibly change the age structure of the returning adult population. Although precocious maturation of males is associated with stream-resident populations in headwater tributaries, suggesting it is a characteristic of stream-type Chinook, many precocious males mature outside the normal spawning time of sea-run fish (Groot and Margolis 1991). If this occurs, then their contribution to the next generation may be small overall and the amount of production from fish released at a larger size may be equal to, or even greater than, fish released at a smaller size if survival is greater for the larger fish.

To examine whether smolts released at a larger size decreases the proportion of age 4 and 5 adults, we used analysis of variance to compare smolt-to-adult return survival rates by age at return for smolts released at 36 g or larger and smaller than 36 g for the 1985-2003 brood years.

Although the mean SAR for age-3 returning fish was higher for smolts released at the larger size there was not a statistically significant difference between the means of the two variables at the 95% confidence level (Figure 9).

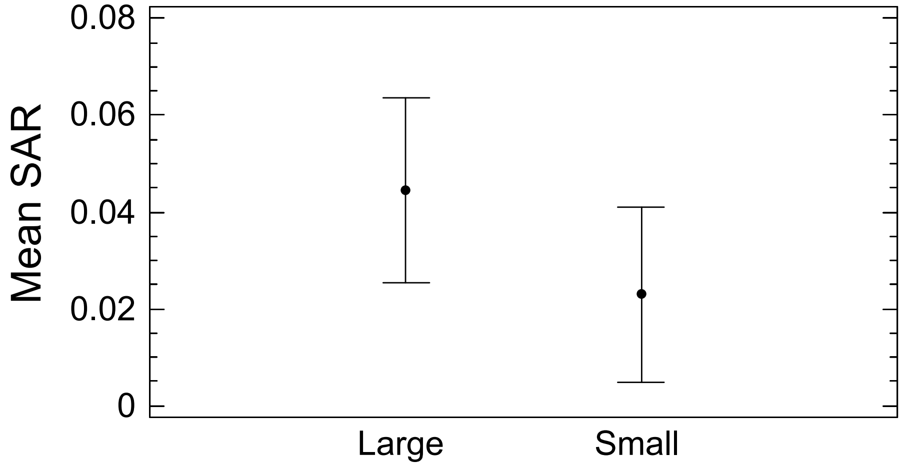

Figure 9. Mean smolt-to-adult return (SAR) survival rates (with 95% confidence interval) for age-3 returning fish from hatchery releases of large smolts (≥ 36 g) and small smolts (< 36 g) from the 1985-2003 brood years.

Mean SARs for ages 4 and 5 were nearly identical and there was not a statistically significant difference between the means at the 95% confidence interval (Figure 10). While examination of the historical data suggests there are no significant differences, the results from this analysis are confounded since there were no paired within-year releases of different size groups of fish.

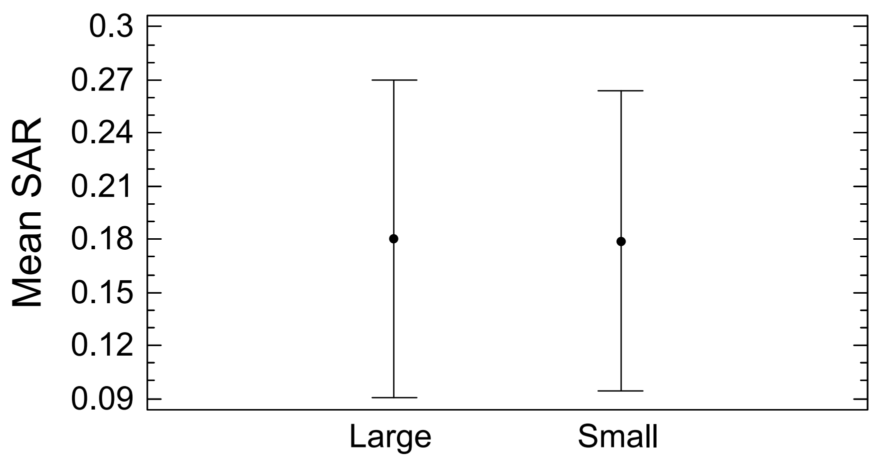

Figure 10. Mean smolt-to-adult return (SAR) survival rates (with 95% confidence interval) for age 4 and 5 returning fish from hatchery releases of large smolts (≥ 36 g) and small smolts (< 36 g) from the 1985-2003 brood years.

In order to fully examine the effects of size at release, we will compare the differences in survival and size and age at return between smolts reared to 30 g/fish and 50 g/fish from the 2006-2008 brood years. Conventional supplementation fish from each brood year will be ponded into the starter and intermediate vessels at Lyons Ferry Hatchery. Hatchery staff will manipulate feeding levels so that the growth cycles of the different egg takes produce fish similar in size. At marking in mid-September (~13 g), the fish will be separated into their respective study groups. Fish for the 30 g/fish group will be marked with a coded-wire tag (CWT) and a purple visible implant elastomer (VIE) tag behind the left eye. Fish that will be reared to 50 g/fish will be given a different CWT code and a blue VIE tag behind the left eye. Fish will be transferred to Tucannon Fish Hatchery in October, approximately 2-3 weeks after tagging. A total of 2,500 fish from each group will be PIT tagged and sampled (length, weight, tag retention) before placement in February in Curl Lake Acclimation Pond for volitional release. Fish will be sampled again (length, weight) at Curl Lake before final release in April.

The first jack returns from these experimental releases will occur during the 2009 run. We will use PIT tags to examine outmigration survival through the hydropower system, estimate smolt-to-adult survival rates, and compare age composition for the two groups. Results will be reported annually.

Survival Rates

Point estimates of population sizes have been calculated for various life stages (Tables 18 and 19) of natural and hatchery-origin spring Chinook from spawning ground and juvenile mid-summer population surveys, smolt trapping, and fecundity estimates. 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 20) because they have been protected in the hatchery. However, smolt-to-adult return rates (SAR) of natural salmon were five times higher than for hatchery-reared salmon (Tables 21 and 22). Hatchery SARs (mean = 0.21%; geometric mean = 0.14%) documented from the 1985-2003 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 (30 g/fish vs. 50 g/fish) to improve hatchery SARs.

Table 18. Estimates of *natural* Tucannon spring Chinook salmon abundance by life stage for 1985-2008 broods.

Brood Year	Females in River: Natural	Females in River: Hatchery	Mean Fecundity[a]: Natural	Mean Fecundity[a]: Hatchery	Number of Eggs	Number[b] of Parr	Number of Smolts	Progeny[c] (returning adults)
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	196
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	389
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	173
2004	117	43	3,444	2,601	514,791	30,809	21,057	360
2005	77	25	3,773	2,903	363,096	21,162	17,579	131
2006	65	36	2,887	2,654	283,199	---	30,228	
2007	49	32	3,847	2,869	280,311	---		
2008	95	104	3,732	3,020	668,620			

[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 19. Estimates of Tucannon spring Chinook salmon abundance (*spawned and reared in the hatchery*) by life stage for 1985-2008 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	327
1987	48	-	4,096	-	196,573	164,630	152,165	188
1988	49	-	3,882	-	182,438	150,677	146,200	445
1989	28	9	3,883	2,606	133,521	103,420	99,057	243
1990	21	23	3,993	2,697	126,334	89,519	85,500	28
1991	17	11	3,741	2,517	91,275	77,232	74,058	25
1992	28	18	3,854	3,295	156,359	151,727	87,752[c]	82
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	178
1996	18	19	3,516	2,843	117,287	80,325	76,219	267
1997	17	25	3,609	3,315	144,237	29,650	24,186	181
1998	30	14	4,023	3,035	161,019	136,027	127,939	796
1999	1	36	3,965	3,142	113,544	106,880	97,600	33
2000	3	35	3,969	3,345	128,980	123,313	102,099	157
2001	29	27	3,612	3,252	184,127	174,934	146,922	125
2002	22	25	3,981	3,368	169,364	151,531	123,586	120
2003	17	20	3,789	3,812	140,658	126,400	71,154	71
2004	28	18	3,444	2,601	140,459	128,877	67,542	116
2005	25	24	3,773	2,903	161,345	151,466	149,466	291
2006	18	27	2,887	2,654	123,629	112,350	106,530	
2007	27	9	3,847	2,869	124,543	117,182	114,681	
2008	17	43	3,732	3,020	193,324	183,925		

[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 20. 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	95.5	67.7	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	---	---	10.7	90.9	94.8	86.2	---	---	8.1
2007				94.1	97.9	92.1			
2008				95.1					
Mean	10.1	55.8	6.0	84.5	87.8	73.5	11.1	1.5	12.2
SD	4.7	16.2	2.6	15.8	13.9	17.1	11.2	0.4	4.8

Table 21. Adult returns and SARs of natural salmon to the Tucannon River for brood years 1985-2003.

		Number of Adult Returns, observed (obs) and expanded (exp)[a]						SAR (%)	
		Age 3		Age 4		Age 5			
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	161	16	33	0.39	0.38
1993	49,560	1	2	62	127	58	75	0.41	0.41
1994	7,000	0	0	8	10	1	2	0.17	0.17
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	91	259	43	121	7.06	6.90
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
2003	23,003	4	7	55	115	21	51	0.75	0.72
Mean								1.46[c]	1.43[c]
Geometric Mean								0.71[c]	0.69[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 22. Adult returns and SARs of hatchery salmon to the Tucannon River for brood years 1985-2003.

		Number of Adult Returns, known and expanded (exp.)							
		Age 3		Age 4		Age 5		SAR (%)	
Brood Year	Estimated Number of Smolts	Known	Exp.	Known	Exp.	Known	Exp.	w/ Jacks	No Jacks
1985	12,922	9	19	25	26	0	0	0.35	0.20
1986	152,725	79	83	99	226	8	18	0.21	0.16
1987	152,165	9	20	70	151	8	17	0.12	0.11
1988	145,146	46	99	140	293	26	53	0.31	0.24
1989	99,057	7	15	100	211	14	17	0.25	0.23
1990	85,737	3	6	16	20	2	2	0.03	0.03
1991	74,064	4	5	20	20	0	0	0.03	0.03
1992	87,752	11	11	50	67	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	62,144	13	16	117	158	2	4	0.29	0.26
1996	76,219	44	59	100	194	5	14	0.35	0.27
1997	24,186	7	13	59	168	0	0	0.75	0.69
1998	127,939	36	99	174	547	39	150	0.62	0.54
1999	97,600	3	11	5	19	1	3	0.03	0.02
2000	102,099	7	26	47	131	0	0	0.15	0.13
2001	146,922	7	19	51	105	1	1	0.09	0.07
2002	123,586	3	6	60	98	6	16	0.10	0.09
2003	71,154	1	2	23	65	2	4	0.10	0.10
Mean								0.21	0.18
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 20). With the exception of the 1988 and 1997-2000 brood years, naturally produced fish have been below the replacement level (Figure 11; Table 23). Based on adult returns from the 1985-2004 broods, naturally reared salmon produced only 0.6 adults for every spawner, while hatchery reared fish produced 1.6 adults.

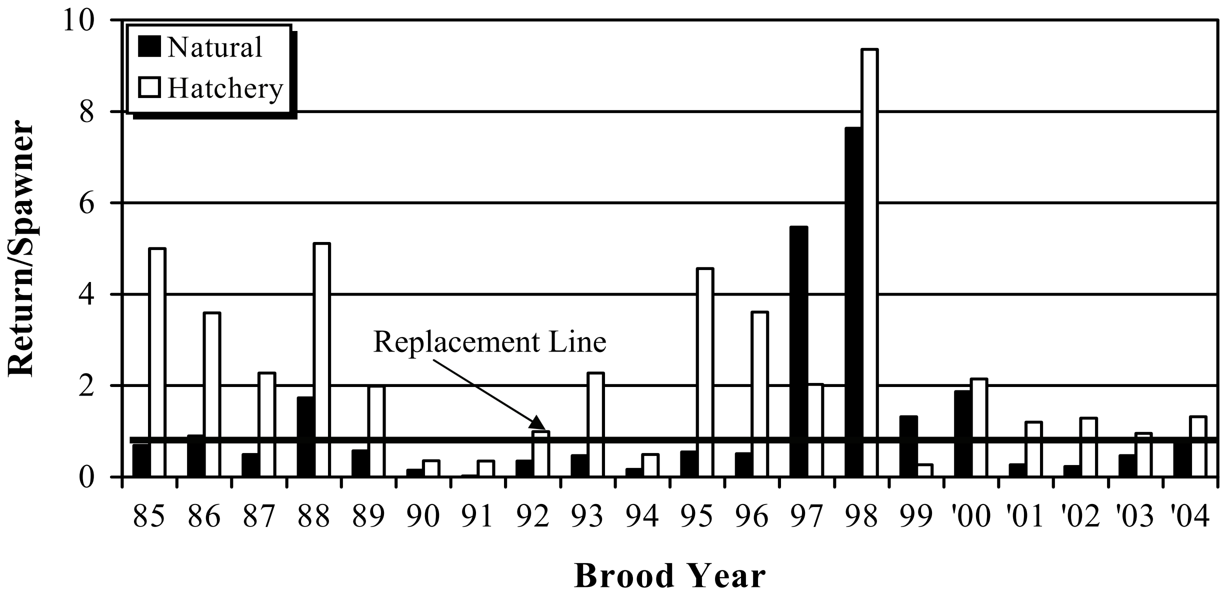

Figure 11. Return per spawner (with replacement line) for the 1985-2004 brood years (2004 incomplete brood year).

Table 23. Parent-to-progeny survival estimates of Tucannon River spring Chinook salmon from 1985 through 2004 brood years (2004 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	327	3.59	4.0
1987	481	238	0.49	83	188	2.27	4.6
1988	304	527	1.73	87	445	5.11	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	196	0.35	83	82	0.99	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	178	4.56	8.4
1996	136	69	0.51	74	267	3.61	7.1
1997	146	799	5.47	89	181	2.03	0.4
1998	51	389	7.63	85	796	9.36	1.2
1999	107	141	1.32	122	33	0.27	0.2
2000	239	446	1.87	73	157	2.15	1.2
2001	894	244	0.27	104	125	1.20	4.4
2002	897	202	0.23	93	120	1.29	5.7
2003	366	173	0.47	75	71	0.95	2.0
2004	480	360	0.75	88	116	1.32	1.8
Mean			**1.23**			**2.46**	**4.4**
Geometric Mean			**0.58**			**1.64**	**2.9**

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 G). The fishery managers will need to decide whether the hatchery supplementation program is worth the potential adverse genetic risk to the population or how to remove excess hatchery fish.

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 12). Based on 1985-2004 brood year CWT recoveries reported to the RMIS database (Appendix H), sport, commercial, and treaty ceremonial harvest combined accounted for an average of less than 6% of the adult hatchery fish recovered for the 1985-1996 brood years. Increased fishery impacts occurred for the 1997 through 1999 broods (fishery harvest comprised an average of 19% for recoveries). We subsequently stopped adipose clipping of hatchery production (Gallinat et al. 2001) to lessen fishery impacts. Conventional supplementation fish are now marked with a CWT and a VIE tag behind the left or right eye. Captive brood progeny were marked 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 generally been low (Appendix I), with an average of 2.3% of the adult hatchery fish straying to other river systems/hatcheries for brood years 1985-2004 (range 0-20%).

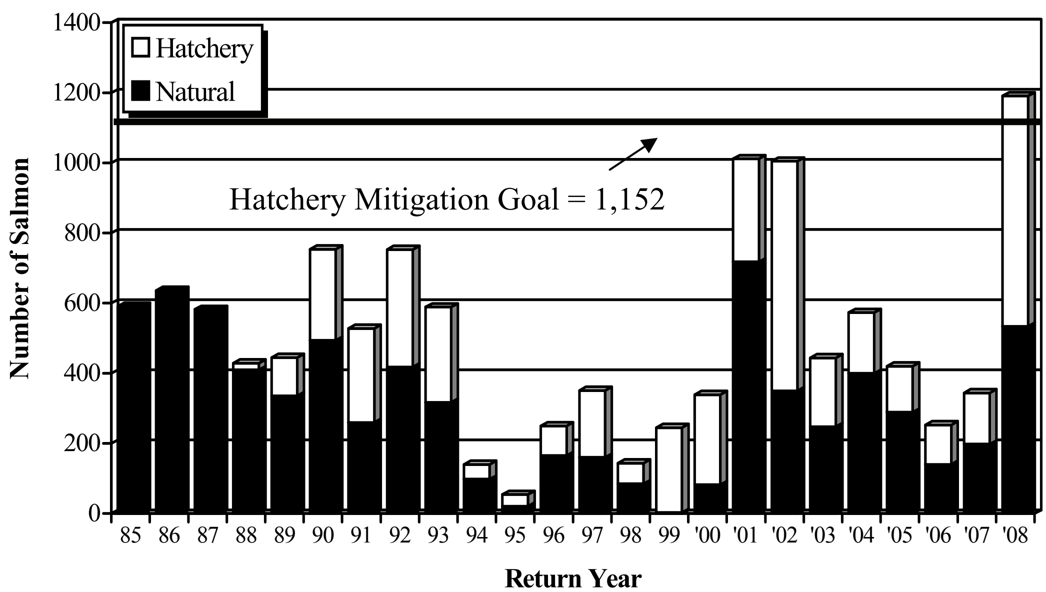

Figure 12. Total escapement for Tucannon River spring Chinook salmon for the 1985-2008 run years.

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 1985-2003 brood years were still well below the LSRCP survival goal of 0.87% (Table 24). 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 24. Hatchery SARs adjusted for recoveries from outside the Tucannon River subbasin as reported in the RMIS database. (Data downloaded from RMIS database on 2/19/09).

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	152,725	327	15	342	0.21	0.22
1987	152,165	188	2	190	0.12	0.12
1988	145,146	445	26	471	0.31	0.32
1989	99,057	243	12	255	0.25	0.26
1990	85,737	28	0	28	0.03	0.03
1991	74,064	25	6	31	0.03	0.04
1992	87,752	82	22	104	0.09	0.12
1993	138,848	207	11	218	0.15	0.16
1994	130,069	34	0	34	0.03	0.03
1995	62,144	178	2	180	0.29	0.29
1996	76,219	267	5	272	0.35	0.36
1997	24,186	181	41	222	0.75	0.92
1998	127,939	796	216	1,012	0.62	0.79
1999	97,600	33	3	36	0.03	0.04
2000	102,099	157	1	158	0.15	0.15
2001	146,922	125	1	126	0.09	0.09
2002	123,586	120	0	120	0.10	0.10
2003	71,154	71	0	71	0.10	0.10
Mean					**0.21**	**0.24**
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 remains 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 to succeed, and the natural run to persist over the short-term and the population 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.

   <u>Recommendation</u>: 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 is 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.

   <u>Recommendation</u>: 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 subsequent year's smolt production 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.

   Recommendation: Assist subbasin planning in determining carrying capacity and productivity of the Tucannon River so that hatchery stocking is appropriate, and hatchery and natural performance is measured against future basin capacity after habitat improvements. 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 and natural production to meet recovery 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: Continue 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 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 determine 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). If funding is available, conduct a radio telemetry study to examine behavior of Tucannon spring Chinook as they approach the vicinity of the mouth of the Tucannon. Develop and evaluate a plan to capture and return Tucannon spring Chinook from Lower Granite Dam to the Tucannon River.

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Appendix A: Annual Section 10 Permit Takes for 2008

Appendix A. Table 1. Summary of maximum annual (calendar year) takes allowed and 2008 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 (45)	4,000 (9)	(0)	
Capture, Handle and Release	6,500 (244)		10,500 (1,333)	32,500 (845)	(1,038)
Capture, Handle, Tag/Mark, and Release [b]	2,800 (6)	28 (0)	1,700 (1,894)	4,300 (727)	(726)
Lethal Take [c]	100 (0)		125 (0)	200 (0)	
Spawning, Dead, or Dying		400 (150)			
Other Take (specify)					
Indirect Mortality	50 (9)		50 (24)	100 (26)	(70)
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 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 2008 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 (40)	NA (2)	325 (76)	NA (16)		
Observe/Harass (Total of all fish trapped)	325 (90)	NA (24)	325 (118)	NA (268)		
Capture, Handle and Release [b]	325 (50)	NA (22)	325 (42)	NA (251)		
Capture, Handle, Tag/Mark, and Release						150,000 (106,530 06 BY; 115,842 07BY)
Lethal Take (Broodstock)	50 (38)	NA (2)	100 (76)	NA (14)		
Spawning, Dead, or Dying [c]	5 (0)	NA (0)	10 (0)	NA (1)		
Other Take (specify)						
Indirect Mortality [d]	10 (2)	NA (0)	10 (0)	NA (1)		
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 2008 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	78,176 (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 2008

Appendix B. Spring Chinook salmon captured, collected, or passed upstream at the Tucannon Hatchery trap in 2008. (Trapping began in February; last day of trapping was September 30).

	Captured in Trap		Collected for Broodstock		Passed Upstream		Killed Outright[a]		Trap Mortality	
Date	Natural	Hatchery	Natural	Hatchery	Natural	Hatchery	Natural	Hatchery	Natural	Hatchery
5/16	1				1					
6/3	1		1							
6/4	1		1							
6/5		1		1						
6/6	3				3					
6/9	6	2	4	2	2					
6/10	4	2	4	1		1				
6/12	4	13	4	9		4				
6/13	6	11		2	6	9				
6/14	2	1			2	1				
6/16	7	13	3	9	4	4				
6/17	3	21	2	13	1	8				
6/18	1	15	1	6		9				
6/19	3	22	2	8	1	14				
6/20	4	26	2	9	2	17				
6/21	2	19			2	19				
6/23	1	25		8	1	17				
6/24	4	14	1	3	3	11				
6/25	4	18	2	6	2	12				
6/26	3	18	1	1	2	17				
6/27	3	13		1	3	12				
6/28	3	10			3	10				
6/30	2	16	2	1		15				
7/1	3	14	1	4	2	10				
7/2	2	9	1	1	1	8				
7/3	3	7	2		1	7				
7/4		10				10				
7/5	1	1			1	1				
7/7	4	12			4	12				
7/8	1	6		1	1	5				
7/9		6				6				
7/13		2				2				
7/14	2	4	2	1		3				
7/15		2				2				
7/16		1				1				
7/18		3				3				
7/21		3				3				
7/25		1				1				
7/28	1	1			1	1				
7/29	1				1					
8/4	1		1							
8/6	1	1	1	1						
8/11		1				1				
8/12	1	1	1			1				
8/13		1				1				
8/15		1				1				
8/18		2		1				1		
8/21		2				2				
8/25		1				1				
8/26		2				2				
9/2	2	1	1	1	1					
9/3	1	1			1	1				
9/5	2	3			2	3				

Appendix B (continued). Spring Chinook salmon captured, collected, or passed upstream at the Tucannon Hatchery trap in 2008. (Trapping began in February; last day of trapping was September 30).

	Captured in Trap		Collected for Broodstock		Passed Upstream		Killed Outright[a]		Trap Mortality	
Date	**Natural**	**Hatchery**	**Natural**	**Hatchery**	**Natural**	**Hatchery**	**Natural**	**Hatchery**	**Natural**	**Hatchery**
9/7	1	9			1	9				
9/8	4	5	4			5				
9/9	2	2			2	2				
9/10	4	1			4	1				
9/11	6	3			6	3				
9/12	1	1			1	1				
9/13	1	2			1	2				
9/14	1				1					
9/16		1				1				
9/18	1				1					
9/19	1				1					
9/21		1				1				
Total	**116**	**384**	**44**	**90**	**72**	**293**	**0**	**1**	**0**	**0**
Final Total[b]	**114**	**386**	**42**	**92**	**72**	**293**	**0**	**1**	**0**	**0**

[a] Fin clipped strays are killed outright at the trap.

[b] Corrected numbers after spawning. Two collected natural males were actually hatchery-origin fish.

Appendix C: Total Estimated Run-Size of Tucannon River Spring Chinook Salmon (1985-2008)

Appendix C. Total estimated run-size of spring Chinook salmon to the Tucannon River, 1985-2008. (Includes breakdown of conventional hatchery supplementation, captive brood progeny and stray hatchery components).

Year	Natural Jacks	Natural Adults	Hatchery Jacks	Hatchery Adults	C.B. Jacks	C.B. Adults	Stray Jacks	Stray Adults	Total Natural	Total Hatchery	Total Run
1985	---	---	---	---	---	---	---	---	591	0	591
1986	---	---	---	---	---	---	---	---	636	0	636
1987	---	---	---	---	---	---	---	---	582	0	582
1988	19	391	19	---	---	---	---	---	410	19	429
1989	2	334	83	26	---	---	---	---	336	109	445
1990	0	494	20	226	---	---	0	14	494	260	754
1991	3	257	99	169	---	---	0	0	260	268	528
1992	12	406	15	310	---	---	0	10	418	335	753
1993	8	309	6	264	---	---	0	2	317	272	589
1994	0	98	5	37	---	---	0	0	98	42	140
1995	2	19	11	22	---	---	0	0	21	33	54
1996	2	163	15	67	---	---	0	3	165	85	250
1997	0	160	4	178	---	---	0	9	160	191	351
1998	0	85	16	43	---	---	0	0	85	59	144
1999	0	3	59	163	---	---	5	15	3	242	245
2000	14	68	13	198	---	---	5	41	82	257	339
2001	9	709	99	182	---	---	13	0	718	294	1,012
2002	9	341	11	547	---	---	0	97	350	655	1,005
2003	3	245	26	169	---	---	1	0	248	196	444
2004	0	400	19	134	3	0	0	17	400	173	573
2005	3	286	6	105	0	14	2	4	289	131	420
2006	7	133	2	99	2	2	0	8	140	113	253
2007	8	190	18	81	0	19	15	13	198	146	344
2008	131	403	291	102	158	82	23	1	534	657	1,191

Appendix D: Stray Hatchery-Origin Spring Chinook Salmon in the Tucannon River (1990-2008)

Appendix D. Summary of identified stray hatchery origin spring Chinook salmon that escaped into the Tucannon River (1990-2008).

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 / Umatilla 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	**10**	**1.3**
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**	**1.7**
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 D (continued). Summary of identified stray hatchery origin spring Chinook salmon that escaped into the Tucannon River (1990-2008).

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[b]	Unknown	3/6	
				Total Strays	**6**	**1.4**
				Total Umatilla River[b]	**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[b]	Unknown	3/6	
				Total Strays	**8**	**3.2**
				Total Umatilla River[b]	**7**	**2.8**
2007	092043	ODFW	Rogue R. – Cole H.	Cole Rivers Hatchery/Rogue R.	1/1	
	Ad clip	Unknown	Unknown[b]	Unknown	9/27	
				Total Strays	**28**	**8.1**
				Total Umatilla River[b]	**27**	**7.8**
2008	092045	ODFW	Rogue R. – Cole H.	Cole Rivers Hatchery/Rogue R.	1/1	
	094358	ODFW	Grande Ronde R.	Lookingglass/Grande Ronde R.	1/11	
	094460	ODFW	Umatilla R.	Umatilla Hatch./Umatilla River	1/11	
	Ad clip	Unknown	Unknown[b]	Unknown	1/1	
				Total Strays	**24**	**2.0**
				Total Umatilla River[b]	**12**	**1.0**

[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 years, historical stray rates, and large number of releases, we believe these fish are probable Umatilla River or Walla Walla River origin strays.

Appendix E: Historical Hatchery Releases (1985-2007 Brood Years)

Appendix E. 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]	Kg	Mean Wt. (g)
1987	1985	H-Acc	4/6-10	34/42	12,922			986	76
Total					**12,922**				
1988	1986	H-Acc	3/7	33/25	12,328	512		628	45
		"	"	41/46	12,095	465		570	45
		"	"	41/48	13,097	503		617	45
		"	4/13	33/25	37,893	1,456		1,696	45
		"	"	41/46	34,389	1,321		1,621	45
		"	"	41/48	37,235	1,431		1,756	45
Total					**147,037**	**5,688**			
1989	1987	H-Acc	4/11-13	49/50	151,100	1,065		7,676	50
Total					**151,100**	**1,065**			
1990	1988	H-Acc	3/30-4/10	55/01	68,591	3,007		2,955	41
Total					**139,050**	**6,096**			
1991	1989	H-Acc	4/1-12	14/61	75,661	989		3,867	50
Total					**97,779**	**1,278**			
1992	1990	H-Acc	3/30-4/10	40/21	51,149		BWT, RC, WxW	2,111	41
		"	"	43/11	21,108		BWT, LC, HxH	873	41
		"	"	37/25	13,480		Mixed	556	41
Total					**85,737**				
1993	1991	H-Acc	4/6-12	46/25	55,716	796	VI, LR, WxW	1,686	30
		"	"	46/47	16,745	807	VI, RR, HxH	507	30
Total					**72,461**	**1,603**			
1993	1992	Direct	10/22-25	48/23	24,883	251	VI, LR, WxW	317	13
		"	"	48/24	24,685	300	VI, RR, HxH	315	13
		"	"	48/56	7,111	86	Mixed	91	13
Total					**56,679**	**637**			
1994	1992	H-Acc	4/11-18	48/10	35,405	871	VI, LY, WxW	1,176	32
		"	"	49/05	35,469	2,588	VI, RY, HxH	1,234	32
		"	"	48/55	8,277	799	Mixed	294	32
Total					**79,151**	**4,258**			
1995	1993	H-Acc	3/15-4/15	53/43	45,007	140	VI, RG, HxH	1,437	32
		"	"	53/44	42,936	2,212	VI, LG, WxW	1,437	32
		P-Acc	3/20-4/3	56/15	11,661	72	VI, RR, HxH	355	30
		"	"	56/17	10,704	290	VI, LR, WxW	333	30
		"	"	56/18	13,705	47	Mixed	416	30
		Direct	3/20-4/3	56/15	3,860	24	VI, RR, HxH	118	30
		"	"	56/17	3,542	96	VI, LR, WxW	110	30
		"	"	56/18	4,537	15	Mixed	138	30
Total					**135,952**	**2,896**			
1996	1994	H-Acc	3/16-4/22	56/29	89,437		VI, RR, Mixed	2,326	26
		P-Acc	3/27-4/19	57/29	35,334	35	VI, RG, Mixed	1,193	30
		Direct	3/27	43/23	5,263		VI, LG, Mixed	168	34
Total					**130,034**	**35**			

Appendix E (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]	Kg	Mean Wt. (g)
1997	1995	H-Acc	3/07-4/18	59/36	42,160	40	VI, RR, Mixed	1,095	26
		P-Acc	3/24-3/25	61/41	10,045	50	VI, RB, Mixed	244	24
		Direct	3/24	61/40	9,811	38	VI, LB, Mixed	269	27
Total					**62,016**	**128**			
1998	1996	H-Acc	3/11-4/17	03/60	14,308	27	Mixed	410	29
		C-Acc	3/11-4/18	61/25	23,065	62	"	680	29
		"	"	61/24	24,554	50	"	707	29
		Direct	4/03	03/59	14,101	52	"	392	28
Total					**76,028**	**191**			
1999	1997	C-Acc	3/11-4/20	61/32	23,664	522	Mixed	704	29
Total					**23,664**	**522**			
2000	1998	C-Acc	3/20-4/26	12/11	125,192	2,747	Mixed	4,647	36
Total					**125,192**	**2,747**			
2001	1999	C-Acc	3/19-4/25	02/75	96,736	864	Mixed	4,180	43
Total					**96,736**	**864**			
2002	2000	C-Acc	3/15-4/23	08/87	99,566	2,533[e]	VI, RR, Mixed	2,990	29
Total					**99,566**	**2,533[e]**			
2002	2000CB	C-Acc	3/15/4/23	63	3,031	24[f]	CB, Mixed	156	51
Total					**3,031**	**24[f]**			
2002	2001	Direct	5/06	14/29	19,948	1,095	Mixed	77	4
Total					**19,948**	**1,095**			
2002	2001CB	Direct	5/06	14/30	20,435	157	CB, Mixed	57	3
Total					**20,435**	**157**			
2003	2001	C-Acc	4/01-4/21	06/81	144,013	2,909[e]	VI, RR, Mixed	5,171	35
Total					**144,013**	**2,909[e]**			
2003	2001CB	C-Acc	4/01-4/21	63	134,401	5,995[f]	CB, Mixed	4,585	33
Total					**134,401**	**5,995[f]**			
2004	2002	C-Acc	4/01-4/20	17/91	121,774	1,812[e]	VI, RR, Mixed	4,796	39
Total					**121,774**	**1,812[e]**			
2004	2002CB	C-Acc	4/01-4/20	63	42,875	1,909[f]	CB, Mixed	1,540	34
Total					**42,875**	**1,909[f]**			
2005	2003	C-Acc	3/28-4/15	24/82	69,831	1,323[e]	VI, RR, Mixed	2,544	36
Total					**69,831**	**1,323[e]**			
2005	2003CB	C-Acc	3/28-4/15	27/78	125,304	4,760[f]	CB, Mixed	4,407	34
Total					**125,304**	**4,760[f]**			
2006	2004	C-Acc	4/03-4/26	28/87	67,272	270[e]	VI, RR, Mixed	2,288	34
Total					**67,272**	**270[e]**			
2006	2004CB	C-Acc	4/03-4/26	28/65	127,162	5,150[f]	CB, Mixed	3,926	30
Total					**127,162**	**5,150[f]**			
2007	2005	C-Acc	4/02-4/23	35/99	144,833	4,633[e]	VI, RR, Mixed	8,482	57
Total					**144,833**	**4,633[e]**			
2007	2005CB	C-Acc	4/02-4/23	34/77	88,885	1,171[f]	CB, Mixed	5,525	61
Total					**88,885**	**1,171[f]**			

Appendix E (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]	Kg	Mean Wt. (g)
2008	2006	C-Acc	4/08-4/22	40/93	50,309	2,426[e]	VI, LB, Mixed	2,850	54
2008	2006	C-Acc	4/08-4/22	40/94	51,858	1,937[e]	VI, LP, Mixed	2,106	39
Total					**102,167**	**4,363[e]**			
2008	2006CB	C-Acc	4/08-4/22	41/94	75,283	2,893[f]	CB, Mixed	4,493	57
Total					**75,283**	**2,893[f]**			
2009	2007	C-Acc	4/13-4/22	46/88	55,266	214	VI, LB, Mixed	3,162	57
2009	2007	C-Acc	4/13-4/22	46/87	58,044	1,157	VI, LP, Mixed	2,190	37
Total					**113,310**	**1,371**			

[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 F: Numbers of Fish Species Captured by Month in the Tucannon River Smolt Trap During the 2008 Outmigration

Appendix F. Numbers of fish species captured by month in the Tucannon River smolt trap during the 2008 outmigration sampling period (October 8, 2007 – June 30, 2008).

Species	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Total
Wild spring Chinook	75	268	389	115	64	416	1,298	331	5	2,961
Hatchery spring Chinook – Blue VIE							320	442	13	775
Hatchery spring Chinook – Purple VIE							330	466	27	823
Captive brood hatchery spring Chinook					3		749	1,043	39	1,834
Fall Chinook					1		99	76	83	259
Coho salmon					1	8	31	14	7	61
Bull trout		6	16	4						26
Steelhead - smolts	356	430	412	124	92	58	801	333	14	2,620
Steelhead – parr							1		57	58
Hatchery endemic steelhead – CWT only				1			565	231	16	813
Hatchery endemic steelhead – L.G. VIE				1			1	1		3
Pacific lamprey - ammocoetes	1	12	63	9	95	110	76	26	4	396
Pacific lamprey - macropthalmia	2	7	18	7	50	32	34			150
Pacific lamprey - adults										0
Grass pickerel							1			1
Smallmouth bass	7	3	1	1	2	5	9	9	4	41
Bluegill	12			2			3	1		18
Pumpkinseed sunfish	3	9	5	6	2	4	19	17	3	68
Peamouth							1			1
Chiselmouth	232	211	71	57	19	16	59	7	15	687
Longnose dace	6						4	1		11
Northern pikeminnow	30	18	44	13	4	2	8	2	1	122
Bridgelip sucker	27	2	22	9	52	13	55	16	3	199
Brown bullhead	7	3	3		12		2			27
American shad			2	6	3					11

Appendix G: Proportionate Natural Influence (PNI) for the Tucannon Spring Chinook Population (1985-2008)

Appendix G. Proportionate Natural Influence (PNI)[a] for the Tucannon River spring Chinook population (1985-2008). 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	
2008	114	35.09	1,056	53.41	0.40	*

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

Appendix H: Recoveries of Coded-Wire Tagged Salmon Released Into the Tucannon River for the 1985-2004 Brood Years

Appendix H. 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 1985-2004 brood years. (Data downloaded from RMIS database on 2/19/09.)

Brood Year	1985		1986		1987	
Smolts Released	12,922		147,037		151,100	
Fish Size (g)	76		45		50	
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 H (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 1985-2004 brood years. (Data downloaded from RMIS database on 2/19/09.)

Brood Year	1988		1989		1990	
Smolts Released	139,050		97,779		85,737	
Fish Size (g)	41		50		41	
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 H (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 1985-2004 brood years. (Data downloaded from RMIS database on 2/19/09.)

Brood Year	1991		1992		1992	
Smolts Released	72,461		56,679		79,151	
Fish Size (g)	30		13		32	
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	47
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	100
Tucannon (%)	80.0		40.0		81.0	
Out-of-Basin (%)	10.0		20.0		16.0	
Commercial Harvest (%)	0.0		40.0		0.0	
Sport Harvest (%)	0.0		0.0		2.0	
Treaty Ceremonial (%)	10.0		0.0		1.0	
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 H (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 1985-2004 brood years. (Data downloaded from RMIS database on 2/19/09.)

Brood Year	1993		1994		1995	
Smolts Released	135,952		130,034		62,016	
Fish Size (g)	30-32		25-35		24-27	
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	66	21	21	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	215	24	29	132	187
Tucannon (%)	94.9		100.0		98.9	
Out-of-Basin (%)	2.3		0.0		1.1	
Commercial Harvest (%)	0.0		0.0		0.0	
Sport Harvest (%)	1.4		0.0		0.0	
Treaty Ceremonial (%)	1.4		0.0		0.0	
Survival	0.16		0.02		0.30	

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

Appendix H (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 1985-2004 brood years. (Data downloaded from RMIS database on 2/19/09.)

Brood Year	1996		1997		1998	
Smolts Released	76,028		23,509		124,093	
Fish Size (g)	28		28		35	
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.	1	1				
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	144	243	74	172	300	979
Tucannon (%)	97.9		76.2		77.9	
Out-of-Basin (%)	2.1		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 H (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 1985-2004 brood years. (Data downloaded from RMIS database on 2/19/09.)

Brood Year	1999		2000		2001	
Smolts Released	96,736		99,566		144,013	
Fish Size (g)	43		29		35	
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 H (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 1985-2004 brood years. (Data downloaded from RMIS database on 2/19/09.)

Brood Year	2001		2002		2003	
Smolts Released	19,948		121,774		69,831	
Fish Size (g)	4		39		36	
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	4	17
Kalama R., Wind R.						
Fish Trap - F.W.						
Treaty Troll						
Lyons Ferry Hatch.[b]			58	58	20	20
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	69	105	24	37
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	0.01		0.09		0.05	

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

Appendix H (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 1985-2004 brood years. (Data downloaded from RMIS database on 2/19/09.)

Brood Year	2003		2004[c]		2004[c]	
Smolts Released	125,304		67,272		127,162	
Fish Size (g)	34		34		30	
CWT Codes[a]	27/78 CB		28/87		28/65 CB	
Release Year	2005		2006		2006	
Agency (fishery/location)	Observed Number	Estimated Number	Observed Number	Estimated Number	Observed Number	Estimated Number
WDFW						
Tucannon River	5	21	1	4		
Kalama R., Wind R.						
Fish Trap - F.W.						
Treaty Troll						
Lyons Ferry Hatch.[b]	3	3	6	6		
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					1	4
CDFO						
Non-treaty Ocean Troll						
Mixed Net & Seine						
Ocean Sport						
USFWS						
Warm Springs Hatchery						
Dworshak NFH						
IDFG						
Hatchery						
Total Returns	8	24	7	10	1	4
Tucannon (%)	100.0		100.0		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		100.0	
Treaty Ceremonial (%)	0.0		0.0		0.0	
Survival	0.02		0.01		0.00	

[a] WDFW agency code prefix is 63.
[b] Fish trapped at TFH and held at LFH for spawning.
[c] Data for the 2004 brood year is incomplete.

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