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Tucannon River Spring Chinook Salmon Hatchery Evaluation Program 2012 Annual Report

by Michael P. Gallinat and Lance A. Ross

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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 5,760 (1,152 above the project area and 4,608 below the project area for harvest) Tucannon River spring Chinook 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. 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 2012 to April 2013.

A total of 541 salmon were captured in the TFH trap in 2012 (220 natural adults, 20 natural jacks, 232 hatchery adults, and 69 hatchery jacks). Of these, 170 (93 natural, 77 hatchery) were collected and hauled to LFH for broodstock and the remaining fish were passed upstream. During 2012, three of the salmon that were collected for broodstock died prior to spawning.

Spawning of supplementation fish occurred between 28 August and 18 September, with peak eggtake occurring on 18 September. A total of 269,514 eggs were collected from 48 natural and 47 hatchery-origin female Chinook. Egg mortality to eye-up was 5.7% (15,262 eggs), with an additional loss of 8,219 (3.2%) sac-fry. Total fry ponded for 2012 BY production in the rearing ponds was 246,033.

WDFW staff conducted spawning ground surveys in the Tucannon River between 30 August and 4 October, 2012. Eighty-four redds and 43 carcasses were found above the adult trap and 85 redds and 79 carcasses were found below the trap. Based on redd counts, broodstock collection, and in-river pre-spawning mortalities, the estimated return to the river for 2012 was 1,239 spring Chinook (808 natural adults, 7 natural jacks and 416 hatchery-origin adults, 8 hatchery jacks).

Evaluation staff operated a downstream migrant trap to provide juvenile outmigration estimates. During the 2011/2012 emigration, we estimated that 35,080 (30,063-41,026 95% C.I.) natural spring Chinook (BY 2010) smolts emigrated from the Tucannon River.

Smolt-to-adult return rates (SAR) for natural origin salmon were over five times higher on average (based on geometric means) than hatchery origin salmon. However, hatchery salmon survive almost three times greater than natural salmon from parent to adult progeny. Based on density-dependent effects we have observed, the mitigation goal may be higher than the habitat can support under current habitat conditions.

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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 authorized 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 spring Chinook (2% of passage at McNary Dam) 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[1] lost adult Tucannon River origin spring Chinook needed to be compensated for above the project area, with the expectation that the other 1,248 (52%) would continue to come from natural production. An additional 4,608 needed to be compensated for to provide harvest below the project area for a total mitigation goal of 5,760 Tucannon River spring Chinook. The agencies also determined through other survival studies at the time that a smolt-to-adult survival rate to the project area of 0.87% was a reasonable expectation for spring and summer Chinook salmon. Based on an assumed 0.87% above project area SAR and the 1,152 above project area mitigation goal it was determined that 132,000 smolts needed to be released annually. In 1984, Washington Department of Fish and Wildlife[2] (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 initiated the Tucannon River Spring Chinook Captive Broodstock Program in 1997, which was 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 from 2003-2007 during peak production. Releases of captive broodstock progeny, in combination with the hatchery supplementation program smolts and natural production, were 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

[1] The project area escapement is 1,152. It was also assumed that four times that number (4,608 fish) would be harvested below the project area. Here "project area" is defined as above Ice Harbor Dam.

[2] Formerly Washington Department of Fisheries.

LSRCP mitigation goal, the co-managers agreed to increase the conventional supplementation program goal to 225,000 yearling smolts annually beginning with the 2006 brood year. Size at release was increased to 38 g fish (12 fpp) beginning with the 2011 brood year. This report summarizes work performed by the WDFW Tucannon Spring Chinook Evaluation Program from May 2012 through April 2013.

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) was originally submitted as the application for a new Section 4 (d) Permit for this program in 2005. An updated HGMP requesting ESA Section 10 permit coverage was submitted in 2011. This annual report summarizes all work performed by WDFW's LSRCP Tucannon Spring Chinook Salmon Evaluation Program during 2012. Numbers of direct and indirect takes of listed Snake River spring Chinook (Tucannon River stock) and fall Chinook salmon (Snake River stock) for the 2012 calendar year are presented in Appendix A (Tables 1-2).

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) located at rkm 66, 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.

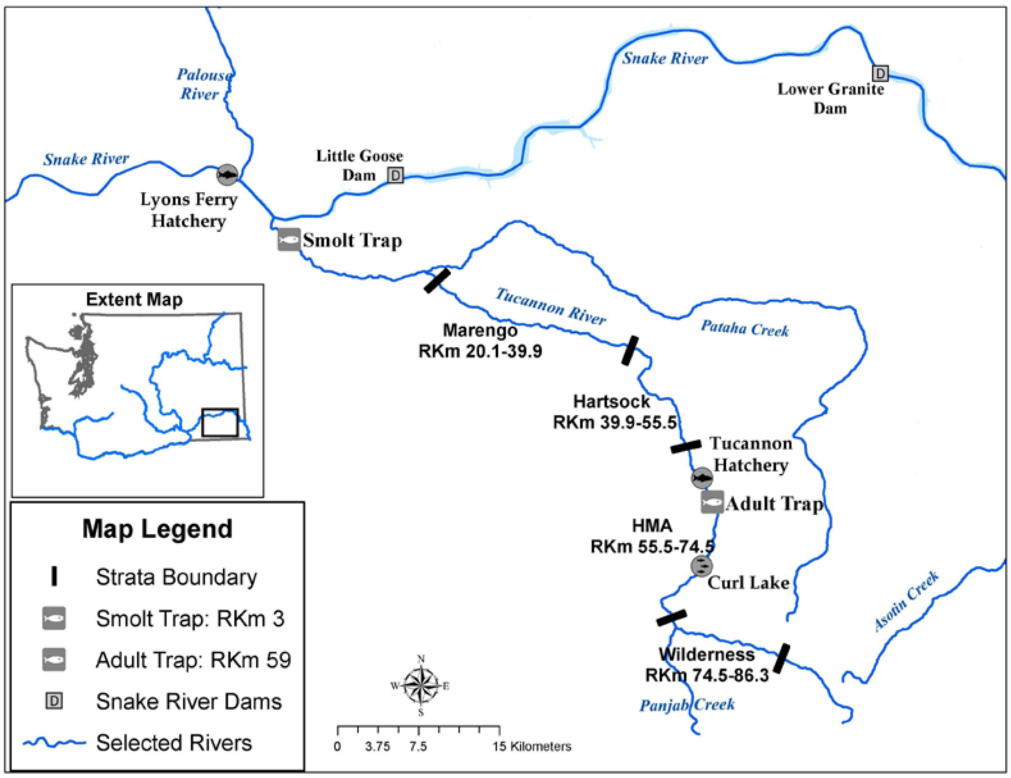

Figure 1. Location of the Tucannon River, and Lyons Ferry and Tucannon Hatcheries within the Snake River basin.

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.

Adult Salmon Evaluation

Broodstock Trapping

The collection goal for broodstock in 2012 was for up to 85 natural and 85 hatchery adults collected throughout the duration of the run to meet the smolt production/release goal of 225,000. Additional jack salmon may be collected up to their proportion of the run with an upper limit of 10% of the broodstock. 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.

The TFH adult trap began operation in February (for steelhead) with the first spring Chinook captured 22 May. The trap was operated through September. A total of 541 fish entered the trap (220 natural adults, 20 natural jacks, 232 hatchery adults, and 69 hatchery jacks), and 93 natural (93 adults, 0 jacks) and 77 hatchery (77 adults, 0 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. Broodstock were transported to LFH and 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 1986-2012.

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	192	140
1991	109	202	0	0	41	89	68	113
1992	242	305	8	3	47	50	187	252
1993	191	257	0	0	50	47	141	210
1994	36	34	0	0	36	34	0	0
1995	10	33	0	0	10	33	0	0
1996	76	59	1	4	35	45	40	10
1997	99	160	0	0	43	54	56	106
1998 [a]	50[a]	43[a]	0	0	48	41	1	1
1999 [b]	4	139[b]	0	1	4	135	0	0
2000 [c]	25	180	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
2009[h]	390	835	0	7	89	88	301	740
2010[i]	774	796	0	9	86	87	688	700
2011[j]	400	383	0	6	89	77	311	300
2012[k]	240	301	0	6	93	77	147	218

[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.
[h] Six AD/No Wire and one AD/CWT stray fish were killed at the trap.
[i] Nine AD/No Wire stray fish were killed at the trap.
[j] Four AD/CWT and two AD/No Wire stray fish were killed at the trap.
[k] Six AD/No Wire stray fish killed at trap.

Broodstock Mortality

Three of the 170 salmon collected for broodstock died prior to spawning in 2012 (Table 3). Table 3 shows that prespawning mortality in 2012 was 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), likely 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 (1992-2012).

	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
2009	0	0	0	0.0	0	2	0	2.3
2010	0	0	0	0.0	0	0	0	0.0
2011	0	0	0	0.0	0	0	0	0.0
2012	0	0	0	0.0	1	2	0	3.9

Broodstock Spawning

Spawning at LFH was conducted once a week from 28 August to 18 September, with peak eggtake occurring on 18 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 2012. One hatchery fish collected for broodstock was unaccounted for at the end of spawning.

A total of 269,514 eggs were collected (Table 4). Eggs were initially disinfected and water hardened for one hour in an iodophor (buffered iodine) solution (100 ppm). The eggs from 17 females from the last eggtake were incubated in moist air incubators with the remaining eggs incubated in vertical incubators. 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 5.7% with an additional 3.2% (8,219) loss of sac-fry, which left 246,033 fish for production.

Table 4. Number of fish spawned or killed outright (K.O.), estimated egg collection, and egg mortality of natural and hatchery origin Tucannon River spring Chinook salmon at LFH in 2012. (Numbers in parentheses were live spawned).

	Natural Origin						
	Males		Jacks		Females		
Spawn Date	**Spawned**	**K.O.**	**Spawned**	**K.O.**	**Spawned**	**K.O.**	**Eggs Taken**
8/28	0 (9)				8		26,948
9/04	0 (15)				13	1	43,936
9/11	1 (8)				15		43,131
9/18	43[a]				12		35,030
Totals	44	0	0	0	48	1	**149,045**
Egg Mortality							4,928
	Hatchery Origin						
	Males		**Jacks**		**Females**		
Spawn Date	**Spawned**	**K.O.**	**Spawned**	**K.O.**	**Spawned**	**K.O.**	**Eggs Taken**
8/28	0 (4)				5		13,760
9/04	8 (4)				15	1	37,511
9/11	13 (2)				8		17,813
9/18	4[b]				19		51,385
Totals	25	0	0	0	47	1	**120,469**
Egg Mortality							10,334

[a] Thirty-one were previously live spawned and sampled at the completion of spawning.
[b] Three were previously live spawned and sampled at the completion of spawning.

Natural Spawning

Pre-spawn mortality walks were conducted during July and August (dates: 7/26, 8/3, 8/17) from Cummings Creek Bridge (rkm 56) to Camp Wooten Bridge (rkm 68). Fish with fungus on the head were observed but no carcasses were recovered during those surveys. Weekly spawning ground surveys were conducted from 30 August and were completed by 4 October 2012. Additional walks were conducted prior to fall Chinook spawning to count spring/summer Chinook redds below Marengo and were concluded by 11 October. One hundred sixty-nine redds were counted and 85 natural and 37 hatchery origin spawned carcasses were recovered in the total surveyed area (Table 5). Eighty-four redds (49.7% of total) and 43 carcasses (35.2% of total) were found above the adult trap.

Table 5. Numbers and general locations of salmon redds and carcasses recovered on the Tucannon River spawning grounds, 2012 (the Tucannon Hatchery adult trap is located at rkm 59).

			Carcasses Recovered	
Stratum	**Rkm[a]**	**Number of redds**	**Natural**	**Hatchery**
Wilderness	84-86	0	0	0
	78-84	1	1	0
	75-78	10	6	0
HMA	73-75	19	0	0
	68-73	17	3	2
	66-68	6	3	0
	62-66	14	8	5
	59-62	17	8	7
-------------------------Tucannon Fish Hatchery Trap----------------------------------				
	56-59	59	52	21
Hartsock	52-56	10	2	1
	47-52	8	2	1
	43-47	2	0	0
	40-43	3	0	0
Marengo	34-40	0	0	0
	28-34	0	0	0
Below Marengo	0-28	3	0	0
Totals	**0-86**	**169**	**85**	**37**

[a] Rkm descriptions: 86-Rucherts Camp; 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. (Brines Rd.)

Historical Trends in Natural Spawning

Two general spawning trends were evident (Figure 2) from the program's inception in 1985 through 1999:

1) The proportion of the total number of redds occurring below the adult 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 2; 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).

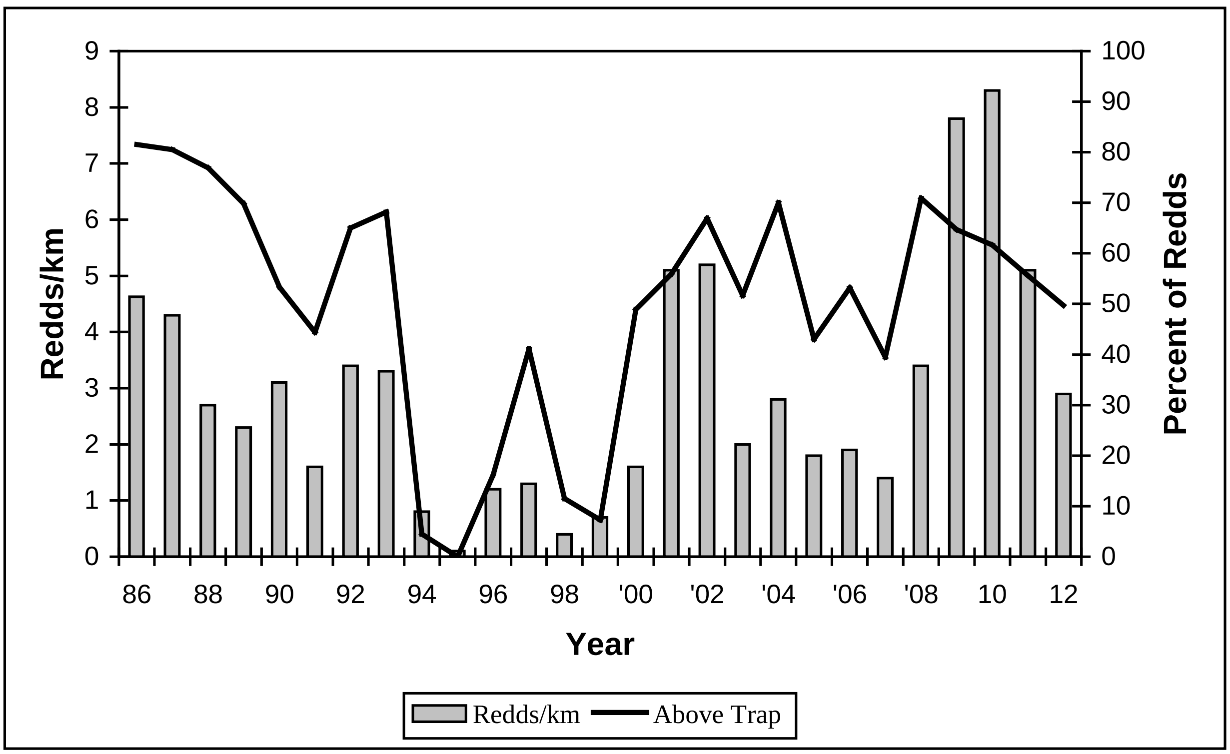

Figure 2. Number of redds/km and percentage of redds above the adult trap on the Tucannon River, 1986-2012.

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, 1985-2012.

	Strata[1]					TFH Adult Trap[2]			
Year	Wilderness	HMA	Hartsock	Marengo	Total Redds[2]	Above	%	Below	%
1985	84 (7.1)	105 (5.3)	–	–	189	–	–	–	–
1986	53 (4.5)	117 (6.2)	29 (1.9)	0 (0.0)	200	163	81.5	37	18.5
1987	15 (1.3)	140 (7.4)	30 (1.9)	–	185	149	80.5	36	19.5
1988	18 (1.5)	79 (4.2)	20 (1.3)	–	117	90	76.9	27	23.1
1989	29 (2.5)	54 (2.8)	23 (1.5)	–	106	74	69.8	32	30.2
1990	20 (1.7)	94 (4.9)	64 (4.1)	2 (0.3)	180	96	53.3	84	46.7
1991	3 (0.3)	67 (2.9)	18 (1.1)	2 (0.3)	90	40	44.4	50	55.6
1992	17 (1.4)	151 (7.9)	31 (2.0)	1 (0.2)	200	130	65.0	70	35.0
1993	34 (3.4)	123 (6.5)	34 (2.2)	1 (0.2)	192	131	68.2	61	31.8
1994	1 (0.1)	10 (0.5)	28 (1.8)	5 (0.9)	44	2	4.5	42	95.5
1995	0 (0.0)	2 (0.1)	3 (0.2)	0 (0.0)	5	0	0.0	5	100.0
1996	1 (0.1)	33 (1.7)	34 (2.2)	1 (0.2)	69	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	22 (2.0)	194 (10.2)	80 (5.0)	1 (0.1)	297	166	55.9	131	44.1
2002	29 (2.6)	214 (11.3)	45 (2.8)	11 (0.9)	299	200	66.9	99	33.1
2003	3 (0.3)	89 (4.7)	26 (1.6)	0 (0.0)	118	61	51.7	57	48.3
2004	24 (2.2)	119 (6.3)	17 (1.1)	0 (0.0)	160	112	70.0	48	30.0
2005	4 (0.4)	71 (3.7)	27 (1.7)	5 (0.4)	107	46	43.0	61	57.0
2006	2 (0.2)	81 (4.3)	17 (1.1)	1 (0.1)	109	58	53.2	51	46.8
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
2009	67 (6.1)	329 (17.3)	52 (3.3)	3 (0.3)	451	292	64.7	159	35.3
2010	83 (7.5)	289 (15.2)	106 (6.6)	3 (0.3)	481	297	61.7	184	38.3
2011	35 (3.2)	196 (10.3)	53 (3.3)	6 (0.5)	297	165	55.6	132	44.4
2012	11 (1.0)	132 (6.9)	23 (1.4)	0 (0.0)	169	84	49.7	85	50.3

Note: – indicates the river was not surveyed in that section during that year.
[1] Excludes redds found below the Marengo stratum.
[2] Includes all redds counted during redd surveys.

Genetic Sampling

During 2012, we collected 249 DNA samples (tissue samples) from adult salmon (143 natural origin, 103 conventional supplementation hatchery, and three 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 storage. Genotypes, allele frequencies, and tissue samples from previous sampling years are available from WDFW's Genetics Laboratory.

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 enables 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 and have fewer age-5 fish in the population (Figure 3). This difference is likely due to larger size-at-release that results in earlier maturation (hatchery origin smolts are generally 25-30 mm greater in length than natural smolts). The low proportion of age-3 fish that returned in 2012 in the Tucannon River (Figure 3), and elsewhere in the Columbia Basin, may be indicative of poor survival for that year class and a potential lower return of age-4 fish for 2013. The age composition by brood year for natural and hatchery origin fish is found in Appendix C.

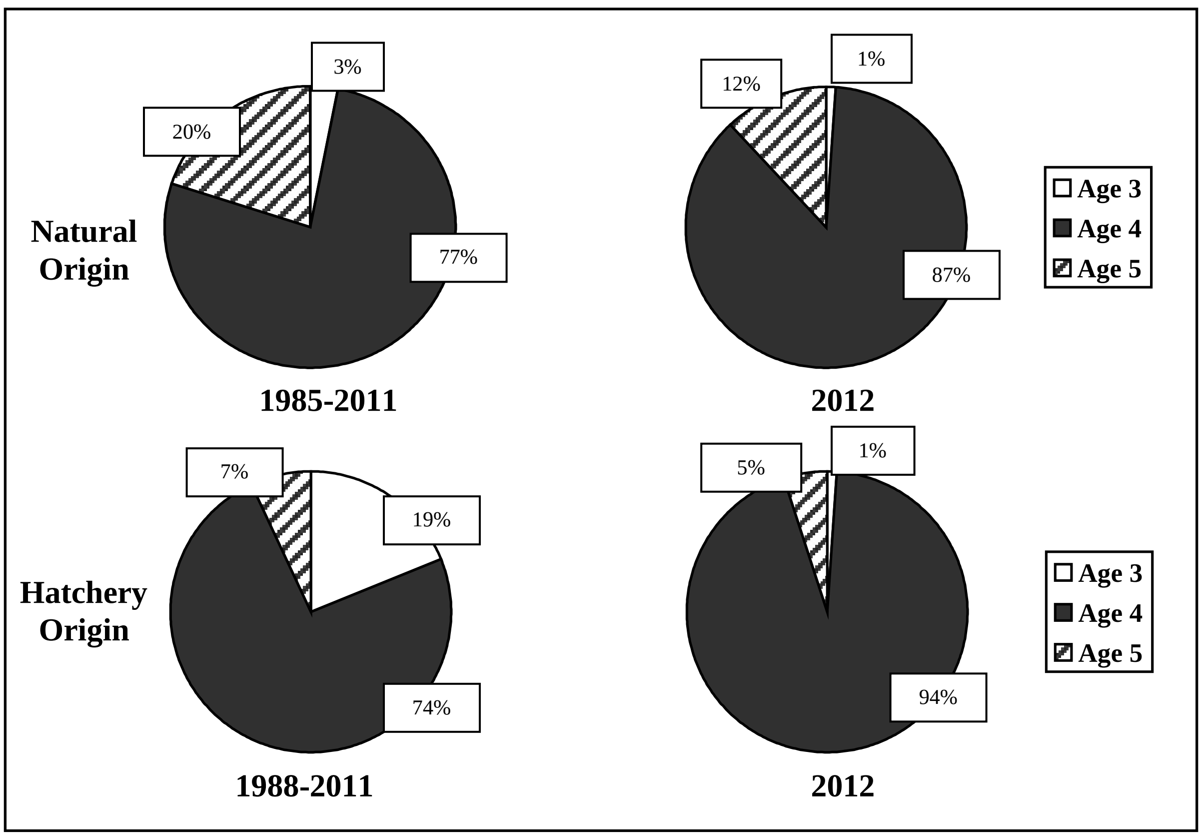

Figure 3. Historical (1985-2011), and 2012 age composition (run year) for spring Chinook in the Tucannon River.

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 multiple comparison analysis from 1985-2012 and found a significant difference ($P < 0.05$) in mean POH length between age-4 natural and hatchery-origin female fish but not males (Figure 4).

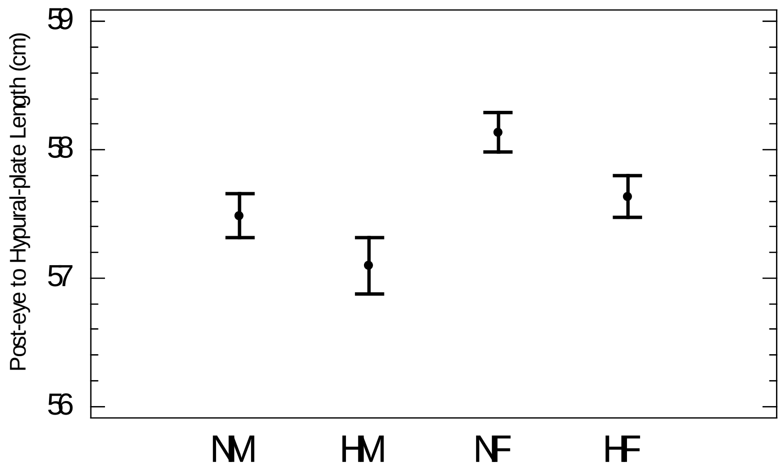

Figure 4. Mean POH length comparisons between age-4 natural and hatchery-origin males (NM and HM) and natural and hatchery-origin females (NF and HF) with 95% confidence intervals for the years 1985-2012.

A Jensorter[3] fish egg sorter and counter (Model JM4) was used to sort and count eggs. The number of live and dead eggs was summed to provide an estimated total fecundity for each fish. Fecundities (number of eggs/female) of natural and hatchery origin fish from the Tucannon River program have been documented since 1990 (Table 7). 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 ($P < 0.001$).

[3] The use of trade names does not imply endorsement by the Washington Department of Fish and Wildlife.

Table 7. Average number of eggs/female (n, SD) by age group of Tucannon River natural and hatchery origin broodstock, 1990-2012 (partial spawned females are excluded).

	Age 4				Age 5			
Year	Natural		Hatchery		Natural		Hatchery	
1990	3,691	(13, 577.3)	2,795	(18, 708.0)	4,383	(8, 772.4)	No Fish	
1991	3,140	(5, 363.3)	2,649	(9, 600.8)	4,252	(11, 776.0)	3,052	(1, 000.0)
1992	3,736	(16, 588.3)	3,286	(25, 645.1)	4,800	(2, 992.8)	3,545	(1, 000.0)
1993	3,267	(4, 457.9)	3,456	(5, 615.4)	4,470	(2, 831.6)	4,129	(1, 000.0)
1994	3,688	(13, 733.9)	3,280	(11, 630.3)	4,848	(8, 945.8)	3,352	(10, 705.9)
1995	No Fish		3,584	(14, 766.4)	5,284	(6, 1,361.2)	3,889	(1, 000.0)
1996	3,510	(17, 534.3)	2,853	(18, 502.3)	3,617	(1, 000.0)	No Fish	
1997	3,487	(15, 443.1)	3,290	(24, 923.2)	4,326	(3, 290.8)	No Fish	
1998	4,204	(1, 000.0)	2,779	(7, 405.5)	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, 1,571.2)	3,320	(34, 553.6)	3,618	(1, 000.0)	4,208	(1, 000.0)
2001	3,612	(27, 518.1)	3,225	(24, 705.4)	No Fish		3,585	(2, 1,191.5)
2002	3,584	(14, 740.7)	3,368	(24, 563.7)	4,774	(7, 429.1)	No Fish	
2003	3,342	(10, 778.0)	2,723	(2, 151.3)	4,428	(7, 966.3)	3,984	(17, 795.9)
2004	3,376	(26, 700.5)	2,628	(17, 397.8)	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)	3,018	(40, 501.3)	4,285	(1, 000.0)	4,430	(1, 000.0)
2009	3,469	(34, 628.9)	3,267	(52, 641.3)	4,601	(6, 753.6)	No Fish	
2010	3,579	(38, 594.8)	3,195	(44, 640.9)	No Fish		No Fish	
2011	3,513	(18, 613.0)	3,061	(30, 615.1)	4,709	(27, 755.2)	3,954	(11, 731.3)
2012	2,998	(40, 618.1)	2,539	(45, 462.5)	4,371	(5, 478.0)	3,105	(2, 356.4)
Mean	**3,442**		**3,054**		**4,461**		**3,705**	
SD	**649.4**		**655.6**		**854.5**		**759.4**	

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 2012, based on the estimated escapement of fish to the river, we sampled approximately 24% of the run (Table 9).

Table 8. Coded-wire tag codes of hatchery salmon sampled at LFH and the Tucannon River, 2012.

	Broodstock Collected[a]			Recovered in Tucannon River			
CWT Code	**Died in Pond**	**Killed Outright**	**Spawned**	**Dead in Trap**	**Pre-spawn Mortality**	**Spawned**	**Totals**
63-55-66						1	1
63-51-74	1		26		1	8	36
63-51-75	2		42			22	66
63-46-88			3		1	1	5
No Wire/LB[b]			2				2
-Strays-							
AD/No Wire[c]				6		3	9
Total	3	0	73	6	2	35	119

[a] One hatchery fish collected for broodstock was unaccounted for at the end of spawning.
[b] These were age-4 (08BY) Left Blue VIE fish which would make it tag code 63-51-75.
[c] Adipose clipped strays are killed outright at the trap.

Table 9. Spring Chinook salmon (natural and hatchery) sampled from the Tucannon River, 2012.

	2012		
	Natural	**Hatchery**	**Total**
Total escapement to river	815	424	1,239
Broodstock collected	93	76[a]	169[a]
Fish dead in adult trap	0	6	6
Total hatchery sample	93	82	175
Total fish left in river	722	342	1,064
In-river pre-spawn mortalities observed	2	2	4
Spawned carcasses recovered	83	35	118
Total river sample	85	37	122
Carcasses sampled	178	119	297

[a] One hatchery fish collected for broodstock was unaccounted for at the end of spawning.

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 adult trap during 2012 was within the range found in previous years for both natural and hatchery origin fish, with peak arrival a little earlier for natural origin fish (Table 10). Peak spawning date of natural origin females in the hatchery was within the range found from previous years; however hatchery females peaked a week later. It is typical for the two groups to be off a week and this is likely due to sample size, rather than an actual shift in spawn timing. The peak and duration of active spawning in the Tucannon River were very similar to the historical means.

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, 1986-2012.

	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
2008	6/16	6/20	9/09	9/16	21	9/11	34
2009	6/01	6/15	9/15	9/08	29	9/10	37
2010	6/04	6/03	9/14	9/08	14[c]	9/10	33
2011	6/08	6/23	9/6	9/06	22	9/16	33
Mean	**6/01**	**6/05**	**9/12**	**9/09**	**26**	**9/14**	**34**
2012	5/30	6/02	9/11	9/18	22	9/12	36

[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.
[c] Unspawned females determined to be excess of eggtake goals were returned to the river for natural spawning which truncated duration of spawning in the hatchery.

Half of the total run for both natural and hatchery-origin fish arrive at the adult trap by 12 June (Figure 5). After this date, the hatchery fish tend to arrive at the trap at a slightly faster rate than natural origin fish.

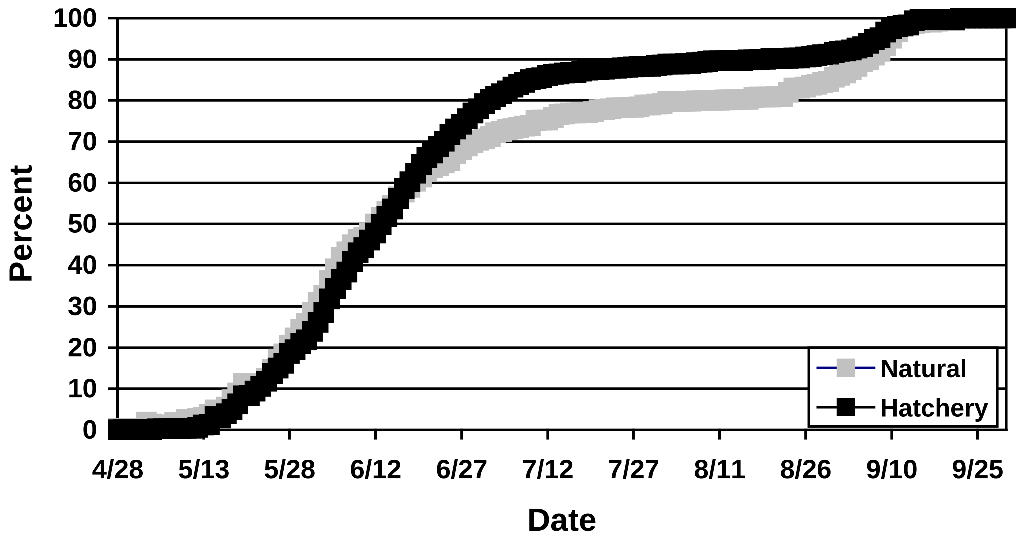

Figure 5. Mean percent of total run captured by date at the Tucannon Fish Hatchery adult trap on the Tucannon River for both natural and hatchery origin Tucannon River spring Chinook salmon, 1993-2012.

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). However, fish have been able to bypass the Tucannon River adult trap in past years (Gallinat and Ross 2009). In order to more accurately estimate escapement, a hanging plastic curtain was installed at the adult trap by hatchery staff during the winter of 2008 to inhibit salmon and steelhead from bypassing the adult trap during high flows. While the plastic curtain might have reduced the bypass problem, some fish are still able to travel upstream without going through the adult trap. We calculated separate bypass rates for both jacks and adults since their ability to bypass the trap was different. Using fish recovered during spawning ground surveys we calculated the number of jacks and adults that bypassed the adult trap by solving for the following equation:

$$\text{Number of fish}^{4}\text{ that bypassed adult trap} = \frac{\text{Number of carcasses without operculum punches x Fish passed above trap}}{\text{Number of carcasses with operculum punches}}$$

Based on 2012 spawning ground carcass operculum punch recoveries, 170 adult spring Chinook were able to bypass the adult trap. We added the calculated number of fish that bypassed the trap (0 jacks, 170 adults) to the number of fish that were passed upstream by hatchery staff (89 jacks, 276 adults) for a total of 535 fish above the trap. Eight fish (1 jack, 7 adults) fell back

[4] This formula was used to separately calculate for jacks and adults bypassing the adult trap. The word “fish” is used as a generic term referring to either adults or jacks.

below the adult trap and there were two pre-spawn mortalities leaving 525 fish above the trap. The number of fish above the trap divided by the number of redds above the trap (84) calculated out to 6.3 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 (85) to estimate the number of fish below the trap (536). There were two pre-spawn mortalities below the trap leaving 534 fish available for spawning.

The run-size estimate for 2012 was calculated by adding the estimated number of fish upstream of the TFH adult trap (525), the estimated fish below the weir (534), the number of observed pre-spawn mortalities above (2) and below the weir (2), the number of trap mortalities (0) and stray fish killed at the trap (6), and the number of broodstock collected (170) (Table 11). Run-size for 2012 was estimated to be 1,239 fish (808 natural adults, 7 natural jacks, and 416 hatchery adults, 8 hatchery-origin jacks). Historical breakdowns are provided in Appendix D.

Table 11. **Estimated spring Chinook salmon run to the Tucannon River, 1985-2012.**

Year[a]	Total Redds	Fish/Redd Ratio[b]	Potential Spawners	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
2009	451	3.70	1,676	177	9	1,862	40
2010	481	4.87	2,341	173	11	2,525	57
2011	297	3.79	1,128	166	6	1,300	58
2012	169	6.30	1,059	170	10	1,239	66

[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 or large runs. This total also includes stray fish that are killed at the trap.

Spawning Escapement

To calculate spawning escapement, we assume one redd per female (Murdoch et al. 2009) and multiply the number of redds by the sex ratio of the pre-spawning population that was collected at the adult trap (i.e., no carcass collection bias issues). This should provide a more accurate expansion method than simply applying a constant value based on assumptions, or data from other studies, since it incorporates the natural variability that occurs in most populations (Murdoch et al. 2010). Because spawner distribution of hatchery and natural origin fish may be different, we expanded redds by reach and estimate natural and hatchery fish by reach based on carcass recoveries. The total for all reaches equals the spawning escapement.

Sex ratio from the adult trap was only available from 2000 to present. For 1985 to 1999, we used corrected carcass data based on the methodology of Murdoch et al. (2010). For years when the corrected carcass data produced clear outliers, or produced spawning escapements greater than the run escapement we used data cited by Meekin (1967) that cited an average of 2.20 adults/redd and proportionately adjusted that figure up during years with high jack returns. The estimated spawning escapement for 1985 to 2012 is found in Table 12.

Table 12. Estimated spawning escapement and the calculation methodology used for the 1985 to 2012 run years.

Run Year	Number of Redds	Spawning Escapement	Natural:Hatchery Ratio	Fish/Redd	Methodology
1985	189	416	1.000:0.000	2.20	Meekin (1967)
1986	200	440	1.000:0.000	2.20	Meekin (1967)
1987	185	407	1.000:0.000	2.20	Meekin (1967)
1988	117	257	1.000:0.000	2.20	Meekin (1967)
1989	106	276	0.988:0.012	2.60	Meekin (1967)
1990	180	572	0.785:0.215	3.18	Corrected Carcasses
1991	90	291	0.677:0.323	3.23	Corrected Carcasses
1992	200	476	0.641:0.359	2.38	Corrected Carcasses
1993	192	397	0.617:0.383	2.07	Corrected Carcasses
1994	44	97	1.000:0.000	2.20	Meekin (1967)
1995	5	27	1.000:0.000	5.30	Corrected Carcasses
1996	69	152	0.767:0.233	2.20	Meekin (1967)
1997	73	105	0.644:0.356	1.44	Corrected Carcasses
1998	26	60	0.739:0.261	2.30	Meekin (1967)
1999	41	160	0.023:0.977	3.91	Corrected Carcasses
2000	92	201	0.307:0.693	2.18	Sex ratio at Adult Trap
2001	297	766	0.801:0.199	2.58	Sex ratio at Adult Trap
2002	299	568	0.395:0.605	1.90	Sex ratio at Adult Trap
2003	118	329	0.742:0.258	2.79	Sex ratio at Adult Trap
2004	160	346	0.826:0.174	2.16	Sex ratio at Adult Trap
2005	107	264	0.804:0.196	2.47	Sex ratio at Adult Trap
2006	109	202	0.759:0.241	1.85	Sex ratio at Adult Trap
2007	81	210	0.776:0.224	2.60	Sex ratio at Adult Trap
2008	199	796	0.610:0.390	4.00	Sex ratio at Adult Trap
2009	451	1190	0.507:0.493	2.64	Sex ratio at Adult Trap
2010	481	938	0.578:0.422	1.95	Sex ratio at Adult Trap
2011	297	849	0.703:0.297	2.86	Sex ratio at Adult Trap
2012	169	334	0.697:0.303	1.98	Sex ratio at Adult 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). Increased strays, particularly from the Umatilla River, was a concern since it exceeded the 5% stray proportion of hatchery fish deemed acceptable by NOAA Fisheries, and was 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 that 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, we are unable to differentiate between unmarked Tucannon fish and unmarked strays based on scale patterns 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 (adipose clipped). 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 of strays into the Tucannon River, similar to the Umatilla strays (Glen Mendel, WDFW, personal communication). WDFW will continue to monitor the Tucannon River and emphasize the need for external marks and CWTs for Walla Walla River releases.

Nine strays were recovered from the Tucannon River during 2012. All nine were AD only/no wire hatchery strays of unknown origin. Six of these strays were identified and killed at the adult trap. The remaining three strays were recovered below the adult trap. After expansions, strays accounted for an estimated 2.3% of the total 2012 run (Appendix E). Stray rates are potentially underestimated because of the lack of recovery of CWTs to allow for appropriate expansions of tags to account for adipose clipped only fish.

While no stray fish of known origin were recovered, the increased use of PIT tags by fish and wildlife agencies and the utilization of in-stream PIT tag arrays in the Tucannon River have permitted us to identify the origin of stray PIT tagged spring Chinook during 2012. A total of 16 fish originally PIT tagged at locations other than the Tucannon River had their last known detections in the Tucannon River (Table 13). These strays included six from Idaho, six from Oregon, and four natural origin fish of unknown origin that were tagged as adults at Lower Granite Dam and eventually returned back downstream and entered the Tucannon River (Table 13).

Table 13. Final Tucannon River PIT tag array detections of spring Chinook originally tagged at locations other than the Tucannon River (strays) during 2012.

PIT Tag	Origin	Detection Date	Tucannon Site[a]	Tag Release Location
3D9.1C2DBD74F7	H	5/15/12	LTR	Rapid River Hatchery (Idaho)
3D9.1C2D6E2043	H	7/26/12	LTR	Rapid River Hatchery (Idaho)
3D9.1C2DD4EAD5	H	7/06/12	LTR	Selway River (Idaho)
3D9.1C2DAA334D	H	7/24/12	LTR	Catherine Creek (Oregon)
3D9.1C2DF50914	H	7/25/12	LTR	Sawtooth Hatchery (Idaho)
3D9.1C2D18ADE2	H	8/18/12	LTR	Imnaha River (Oregon)
3D9.1C2DB30821	N	9/01/12	LTR	Returning adult tagged at LGR Dam
3D9.1C2C94EF89	N	5/30/12	LTR	Crooked Fork Creek – Lochsa River (Idaho)
3D9.1C2D4AB8D3	N	5/22/12	LTR	John Day River (Oregon)
3D9.1C2D4B05A4	N	6/03/12	LTR	John Day River (Oregon)
3D9.1C2DB1D895	N	6/09/12	MTR	Returning adult tagged at LGR Dam
3D9.1C2DAC58E1	N	6/20/12	MTR	Returning adult tagged at LGR Dam
3D9.1C2CA3B762	N	6/08/12	MTR	American River (Idaho)
3D9.1C2D4B055A	N	5/26/12	MTR	John Day River (Oregon)
3D9.1C2D4B3BED	N	6/01/12	UTR	John Day River (Oregon)
3D9.1C2DB32F6E	N	6/18/12	TFH	Returning adult tagged at LGR Dam

[a] PIT tag array locations are as follows: LTR – Lower Tucannon River (rkm 2.2), MTR – Middle Tucannon River (rkm 17.8), UTR – Upper Tucannon River (rkm 44.4), TFH – Tucannon Fish Hatchery (rkm 59.2).

Tucannon River Spring Chinook in Asotin Creek

The Major Population Group (MPG) for the lower Snake River includes only the Tucannon River and Asotin Creek populations; both must be viable for ESA recovery of this MPG (or the Tucannon population must be highly viable). The Asotin Creek population is considered to be functionally extirpated (SRSRB 2011). Based on genetic analysis of spring Chinook sampled from Asotin Creek (Blankenship and Mendel 2010), Tucannon River spring Chinook salmon are known to stray to Asotin Creek and contribute to population genetics. To assess the extent of this behavior, we conduct annual spring Chinook spawning ground surveys on Asotin Creek.

Asotin Creek Field Office staff captured six spring Chinook at the Asotin Creek weir before the weir was removed on 27 June 2012 (Ethan Crawford, WDFW, personal communication). Three known origin PIT tagged spring Chinook were detected at PIT tag arrays in Asotin Creek during 2012. Two of them were Tucannon spring Chinook (natural and hatchery origin) and the third spring Chinook was from the Rapid River Hatchery. Snake River Lab and Asotin Creek Field Office staff walked known spring Chinook spawning areas in Asotin Creek (rkm 14.6-41.3) on 10, 12, 24, 28 September and 1 October, 2012. Eight redds and three live fish were observed, but no carcasses were recovered (Table 14). Historical redd numbers are found in Table 15.

Table 14. Numbers and general locations of spring Chinook salmon redds, live fish observed, and carcasses recovered from Asotin Creek, 2012.

			Carcasses Recovered			
			Natural		Hatchery	
Rkm[a]	Number of Redds	Live Fish Observed	Male	Female	Male	Female
36.5-41.3	3	1	0	0	0	0
28.6-36.5	4	1	0	0	0	0
27.0-28.6	0	0	0	0	0	0
22.0-27.0	1	1	0	0	0	0
14.6-22.0	0	0	0	0	0	0
Totals	**8**	**3**	**0**	**0**	**0**	**0**

[a] River kilometers used here are from the mouth of Asotin Creek and continue up the north fork of Asotin Creek.

Table 15. Historical redd counts in Asotin Creek from 1972-73 and 1984-2012 (data from WDFW SASI website).

Year	Number of Redds	Year	Number of Redds
1972	12	1998	0
1973	13	1999	0
1984	8	2000	1
1985	1	2001	4
1986	1	2002	4
1987	3	2003	1
1988	1	2004	13
1989	0	2005	2
1990	2	2006	11
1991	0	2007	3
1992	0	2008	6
1993	2	2009	6
1994	0	2010	5
1995	0	2011	16
1996	0	2012	8
1997	1		

Adult PIT Tag Returns

Two hundred ninety-eight Tucannon River spring Chinook adults originally tagged as juveniles have been detected returning to the Columbia River System (Table 16).

Table 16. 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	---	---	1 (1.0%)	---	---
1996	1,923	---	---	0	---	---
1997	1,984	---	---	2 (0.10%)	---	---
1998	1,999	---	---	0	---	---
1999	336	374	---	2 (0.60%)	5 (1.34%)	---
2000	---	---	---	---	---	---
2001	301	158	---	0	0	---
2002	319	320	---	0	3 (0.94%)	---
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	1 (0.10%)	1 (1.43%)	0
2007	1,202	504	1,000	3 (0.25%)	11 (2.18%)	4 (0.40%)
2008	4,989	1,898	997	47 (0.94%)	48 (2.53%)	6 (0.60%)
2009	4,987	1,190	---	14 (0.28%)	17 (1.43%)	---
2010	15,000	2,565	---	87 (0.58%)	15 (0.58%)	---
2011	24,976	5,407	---	15 (0.06%)	12 (0.22%)	---
Totals	**62,132**	**12,579**	**6,028**	**175 (0.28%)**	**113 (0.90%)**	**10 (0.17%)**

From the detected returns, 41 (14%) of the returning PIT tagged adults were detected upstream of the Tucannon River (Table 17; Appendix F). Twenty-nine of these fish (9.7%) had their last detections at or above Lower Granite Dam (Table 17; Appendix F). The bypass rate has decreased over time and it is unknown whether this is related to changes in smolt release methods (from direct release to acclimation ponds with volitional release), changes in hydropower operations and river flows, changes in the proportion barged downstream, or increases in tagging numbers/sample size (Table 17). This does not appear to be a hatchery effect as both natural and hatchery origin fish bypass the Tucannon River (Table 17). Non-direct homing behavior has been documented for adult Chinook in the Columbia River System (Keefer et al. 2008), and similar percentages of natural origin spring Chinook from the John Day River have been documented bypassing that river (Jim Ruzycki, ODFW, personal communication). 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. The installation of PIT tag arrays in the Tucannon River during the past few years (Lower at rkm 2.2 - 2005, Middle at rkm 17.8 and Upper at rkm 44.4 - 2011, and Tucannon Fish Hatchery at rkm 59.2 - 2012) should enable us to document whether Tucannon spring Chinook are able to 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 partially explain why this population has been slow to respond to recovery and supplementation actions.

Table 17. Number and origin of PIT tagged Tucannon River spring Chinook adult returns that bypassed the Tucannon River (includes fish that were last detected returning back downstream towards the Tucannon River) and also adults detected at Lower Granite Dam (LGR) that stayed above LGR Dam.

Tag Years	# Adult Detections	# Adults Above Tucannon R.	Percent Natural	Percent Hatchery	# Adults Above LGR	Percent Natural	Percent Hatchery	Percent Bypass
1995-1999	10	8	37.5	62.5	8	37.5	62.5	80.0
2000-2004	6	1	100.0	0.0	1	100.0	0.0	16.7
2005-2009	153	20	35.0	65.0	14	42.9	57.1	9.2
2010-2011	129	12	8.3	91.7	6	16.7	83.3	4.7
Totals	**298**	**41**	**29.3%**	**70.7%**	**29**	**37.9%**	**62.1%**	**9.7%**

Juvenile Salmon Evaluation

Hatchery Rearing, Marking, and Release

The majority of conventional supplementation juveniles (2011 BY) were reared at Lyons Ferry Hatchery with a small test group (~30,000) reared at Tucannon Fish Hatchery to evaluate the potential for full time rearing at that facility. On 17 October, 2011, 30,044 eyed eggs were transferred from LFH to TFH for hatching and rearing. The Lyons Ferry Hatchery reared fish (232,097) were tagged with CWT (63/64/41) from 27 August to 30 August, 2012. The Tucannon Fish Hatchery reared fish (29,681) were tagged with CWT (63/64/42) on 11 October, 2012. Lyons Ferry Hatchery fish were transported to TFH during 11 October, 2012. The target release size was increased from 30 g fish (15 fpp) to 38 g fish (12 fpp) beginning with the 2011 BY based on higher survival estimates through the hydropower system for larger fish from the size at release study.

Brood year 2011 fish were sampled twice during the rearing cycle (Table 18). During January, fish were sampled for length, weight, precocity and mark quality, and were PIT tagged for outmigration and adult return comparisons (7,500 per group) before transfer to Curl Lake AP. The WDFW Fish Health Specialist diagnosed Bacterial Kidney Disease in the 2011 brood year fish on 24 January 2013. Due to the low water temperature and scheduled transfer to Curl Lake AP, the fish were not treated. Before transfer, chronic mortality (0.02%/day) was noted. The 2011 BY fish were transported to Curl Lake from 5-8 February 2013 for acclimation and volitional release. The fish were transferred without problem and mortality was low in Curl Lake AP. Length, weight, and precocity samples were repeated in April at Curl Lake AP prior to release.

Table 18. Sample size (N), mean length (mm), coefficient of variation (CV), condition factor (K), mean weight (g), and precocity of 2011 BY juveniles sampled at TFH, and Curl Lake AP.

Brood/ Date	Rearing Type	Sample Location	N	Mean Length (mm)	CV	K	Mean Wt. (g)	% Precocity
2011								
1/07/13	LFH	TFH	258	110.0	12.3	1.22	17.0	0.0
1/07/13	TFH	TFH	258	114.1	11.7	1.24	19.0	0.1
4/03/13	Combined	Curl Lake	265	136.7	17.9	1.19	33.4	0.0

Volitional release began 3 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 19. Historical hatchery releases are summarized in Appendix G.

Table 19. Spring Chinook salmon releases into the Tucannon River, 2013 release year.

Release Year	Release Date	CWT Code	Total Released	Number CWT	VIE Mark	Size Total (kg)	Size Mean (g)
2013	4/03-4/22	63/64/41	230,391	227,703	None	2,688	33
2013	4/03-4/22	63/64/42	29,573	27,748	None	1,825	33

Smolt Trapping

Evaluation staff operated a 1.5 m rotary screw trap at rkm 3 on the Tucannon River from 9 October 2011 through 30 July 2012 to estimate numbers of migrating juvenile natural and hatchery spring Chinook. Numbers of each fish species captured by month during the 2012 outmigration can be found in Appendix H. The main outmigration of natural origin spring Chinook occurred during the spring, but outmigration also occurred in the fall and winter (Figure 6).

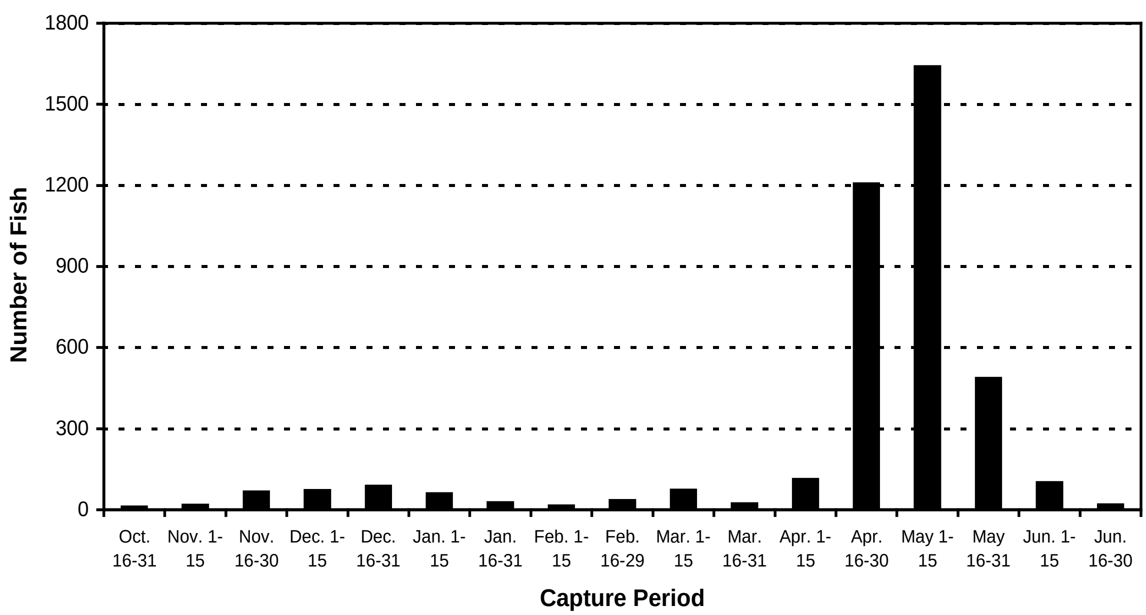

Figure 6. Emigration timing of natural spring Chinook salmon captured during smolt trap operations (rkm 3) on the Tucannon River for the 2011-12 migration year.

Natural spring Chinook emigrating from the Tucannon River (BY 2010) averaged 104 mm (Figure 7). This is in comparison to a mean length of 135 mm for the 30 g/fish target size group and 170 mm for the 50 g/fish target size group of hatchery-origin fish (BY 2010) released from Curl Lake Acclimation Pond (Gallinat and Ross 2012).

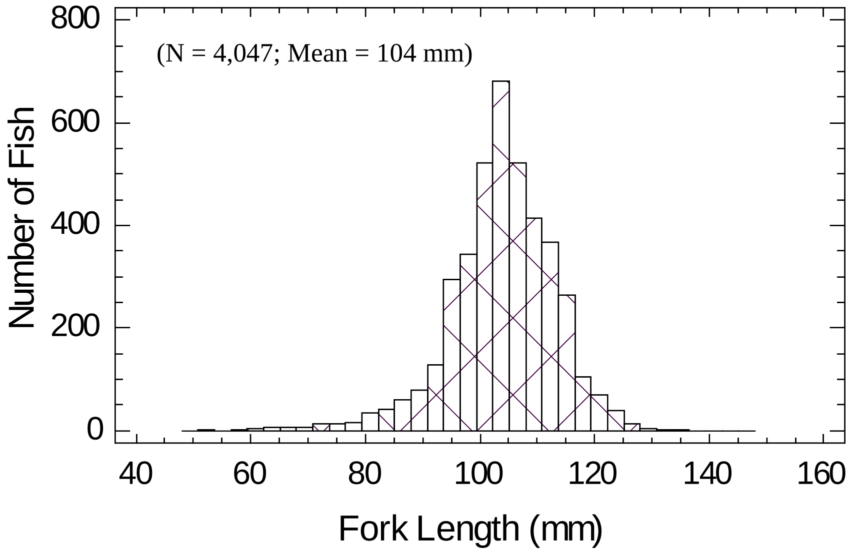

Figure 7. Length frequency distribution of sampled natural spring Chinook salmon captured in the Tucannon River smolt trap, 2011/2012 season.

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.

A number of assumptions are required to attain unbiased estimates of smolt production. How well the assumptions are met will determine the 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.

Accurate outmigration estimates are critical for describing survival trends and to measure population response to management actions such as hatchery supplementation and habitat restoration. It has been strongly suggested that researchers test the assumptions of population estimators being used (Peterson et al. 2004; Rosenberger and Dunham 2005). Other WDFW researchers have identified bias in smolt trap efficiency estimates that were conducted similarly to Tucannon River trap efficiency tests. While the evidence of estimator bias and error seem consistent in the literature, our methods differ from those, and must be tested to estimate the level of error, and confirm compliance of the methods with underlying assumptions. If bias in our methods has been consistent over the term of the data, data could be adjusted as appropriate once bias is measured.

In past years, we attempted to measure bias in our efficiency estimates through the use of PIT tags and the PIT tag array that has been deployed in the lower Tucannon River below the smolt trap. Representative groups of fish were fin clipped and PIT tagged to determine smolt trap efficiency based on either recaptures in the smolt trap or detections by the PIT tag array in the Tucannon River. However, the PIT tag array proved unreliable in its detection of juvenile salmonids. If PIT tag technology in the future allows for greater detections of juvenile salmonids, then we will attempt to measure trapping bias again. We estimate that 35,080 (S.E. 2,736; 95% C.I. 30,063-41,026) migrant natural-origin spring Chinook (2010 BY) passed the smolt trap during 2011-2012.

Juvenile Migration Studies

In 2012, we used passive integrated transponder (PIT) tags to study the emigration timing and relative success of our hatchery supplementation and natural origin smolts. A total of 22,981 hatchery supplementation fish were PIT tagged (11,488 of the 30 g fish and 11,493 of the 50 g fish target size release groups) during January before transferring them to Curl Lake AP for acclimation and volitional release (Table 20). We also tagged natural origin smolts at the smolt trap throughout the outmigration year (Oct.-June) but report only January through June detections when PIT tag arrays were operating within the outmigration corridor. Cumulative PIT tag detections at hydroelectric projects downstream of the Tucannon River were 24% for the 30 g/fish target size group, 35% for the 50 g/fish target size group, and 60% for the natural origin smolts (Table 20).

Table 20. Cumulative detection (one unique detection per tag code) and mean travel time in days (TD) of PIT tagged conventional hatchery supplementation (30g and 50g fish) smolts released[a] from Curl Lake AP (rkm 65.6) on the Tucannon River at downstream Snake and Columbia River dams and natural origin smolts tagged and released at the Tucannon River smolt trap (rkm 3) during 2012.

	Release Data				Recapture Data											
Hatch.		Mean		Mean	LMJ		ICH		MCJ		JDJ		BONN		Total[b]	
Origin	N	Length	S.D.	Length	N	TD	N	TD	N	TD	N	TD	N	TD	N	%
30 g	11,488	106.0	8.5	107.4	421	30.1	237	32.4	307	36.1	165	37.9	53	42.5	2,795	24.3
50 g	11,493	151.3	18.5	152.9	430	21.1	229	25.5	494	26.8	215	26.1	146	32.2	4,067	35.4
Natural	3,830	104.4	8.8	104.5	974	6.5	341	9.3	331	12.7	268	18.2	46	14.8	2,309	60.3

[a] Fish were volitionally released from 4/11/12 – 4/23/12.
[b] Includes fish detected at the lower Tucannon River PIT tag array (LTR) and trawl detections below Bonneville Dam (TWX).
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 4.19.7 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 0.21 (S.E. = 0.01) for 30 g fish and 0.28 (S.E. = 0.02) for 50 g fish. Estimated survival probabilities for natural origin fish tagged at the smolt trap to Lower Monumental Dam were 0.84 (S.E. = 0.02).

Survival Rates

Point estimates of population sizes have been calculated for various life stages (Tables 21 and 22) 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 23) because they have been protected in the hatchery. However, smolt-to-adult return rates (SAR) to the Tucannon River of natural salmon were over five times higher (based on geometric means) than for hatchery-reared salmon (Tables 24 and 25). With the exception of the 2006 brood year, hatchery SARs (mean = 0.26%; geometric mean = 0.17%) documented from the 1985-2006 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. For the 2005 brood year, size at release was arbitrarily increased in an attempt to improve smolt-to-adult return survival rates. For the 2006-2010 brood years we experimented with size at release (30 g/fish vs. 50 g/fish) to improve hatchery SARs. Improvements in hatchery SARs were seen beginning with the 2005 BY (Table 25), however, more time will be needed to ascertain whether observed improvements in SARs were release size related or due to improved environmental conditions.

Table 21. Estimates of *natural in-river produced* Tucannon spring Chinook salmon (both hatchery and natural origin parents) abundance by life stage for 1985-2012 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	399
2005	77	25	3,773	2,903	363,096	21,162	17,579	739
2006	65	36	2,887	2,654	283,199	---	30,228	1,721
2007	49	32	3,847	2,869	280,311	---	8,529	612
2008	95	104	3,732	3,020	668,620	---	14,778	778
2009	179	272	3,639	3,267	1,540,005	---	45,538	7
2010	278	203	3,579	3,195	1,643,547	---	35,080	
2011	175	122	4,230	3,301	1,142,972	---		
2012	115	54	3,151	2,563	500,767			

[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 22. Estimates of Tucannon spring Chinook salmon abundance (*spawned and reared in the hatchery*) by life stage for 1985-2012 broods.

	Females Spawned		Mean Fecundity[a]					
Brood Year	Natural	Hatchery	Natural	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	120
2005	25	24	3,773	2,903	161,345	151,466	149,466	692
2006	18	27	2,887	2,654	123,629	112,350	106,530	1,123
2007	27	9	3,847	2,869	124,543	117,182	114,681	270
2008	17	43	3,732	3,020	193,324	183,925	172,897	660
2009	42	54	3,639	3,267	323,341	292,291	231,437[d]	8
2010	39	44	3,579	3,195	279,969	237,861	201,585	
2011	45	41	4,230	3,301	325,701	305,215	259,964	
2012	48	47	3,151	2,563	269,514	246,033		

[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.
[d] Parr determined to be in excess of program goals were released at Russell Springs and are not included in number of parr and smolts.
`

Table 23. 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	---	---	3.0	94.1	97.9	92.1	---	---	30.3
2008	---	---	2.2	95.1	94.0	89.4	---	---	40.5
2009	---	---	3.0	90.4	79.2	71.6	---	---	24.2
2010	---	---	2.1	85.0	84.7	72.0	---	---	33.7
2011				93.7	85.2	79.8			
2012				91.3					
Mean	10.1	55.8	5.5	85.3	87.5	74.2	11.1	1.5	15.6
SD	4.7	16.2	2.7	14.8	13.0	16.1	11.2	0.3	9.1

Table 24. Adult returns and SARs of natural salmon to the Tucannon River for brood years 1985-2009. (2008 and 2009 are incomplete brood years included for comparison.)

		Number of Adult Returns, observed (obs) and expanded (exp)[a]							
		Age 3		Age 4		Age 5		SAR (%)	
Brood Year	Estimated Number of Smolts	Obs	Exp	Obs	Exp	Obs	Exp	w/ Jacks	No Jacks
1985	42,000	8	19	110	255	36	118	0.93	0.89
1986[b]	58,200	1	2	115	376	28	90	0.80	0.80
1987	44,000	0	0	52	167	29	71	0.54	0.54
1988	37,500	1	3	136	335	74	189	1.41	1.40
1989	30,000	5	12	47	120	23	26	0.53	0.49
1990	49,500	3	8	63	72	12	14	0.19	0.17
1991	30,000	0	0	4	5	1	2	0.02	0.02
1992	50,800	2	2	84	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
2004	21,057	4	8	147	352	19	39	1.89	1.86
2005	17,579	23	131	260	595	2	13	4.20	3.46
2006	30,228	32	116	298	1,390	73	215	5.69	5.31
2007	8,529	4	41	133	456	22	115	7.18	6.69
2008	14,778	10	85	150	693	---	---	5.26	4.69
2009	45,538	1	7	---	---	---	---	0.02	---
Mean								2.05[c]	1.96[c]
Geometric Mean								0.99[c]	0.96[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, 2008, and 2009 SAR's are not included in the mean.

Table 25. Adult returns and SARs of hatchery salmon to the Tucannon River for brood years 1985-2009. (2008 and 2009 are incomplete brood years included for comparison.)

		Number of Adult Returns, known and expanded (exp.)[a]							
		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
2004	67,542	7	18	59	98	2	4	0.18	0.15
2005	149,466	50	291	180	401	0	0	0.46	0.27
2006	106,530	60	402	180	680	19	41	1.05	0.68
2007	114,681	7	74	76	171	6	25	0.24	0.17
2008	172,897	27	269	112	391	---	---	0.38	0.23
2009	231,437	1	8	---	---	---	---	0.00	---
Mean								0.26[b]	0.20[b]
Geometric Mean								0.17[b]	0.13[b]

[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] 2008 and 2009 brood years are not included in the mean.

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 23). With the exception of nine brood years, naturally produced fish have been below the replacement level (Figure 8; Table 26). Based on adult returns from the 1985-2007 broods, naturally reared salmon produced only 0.79 adults for every spawner, while hatchery reared fish produced 2.07 adults (based on geometric means). However, we may be underestimating survival rates if adult Tucannon River spring Chinook salmon are straying above Lower Granite Dam as suggested by adult PIT tag returns.

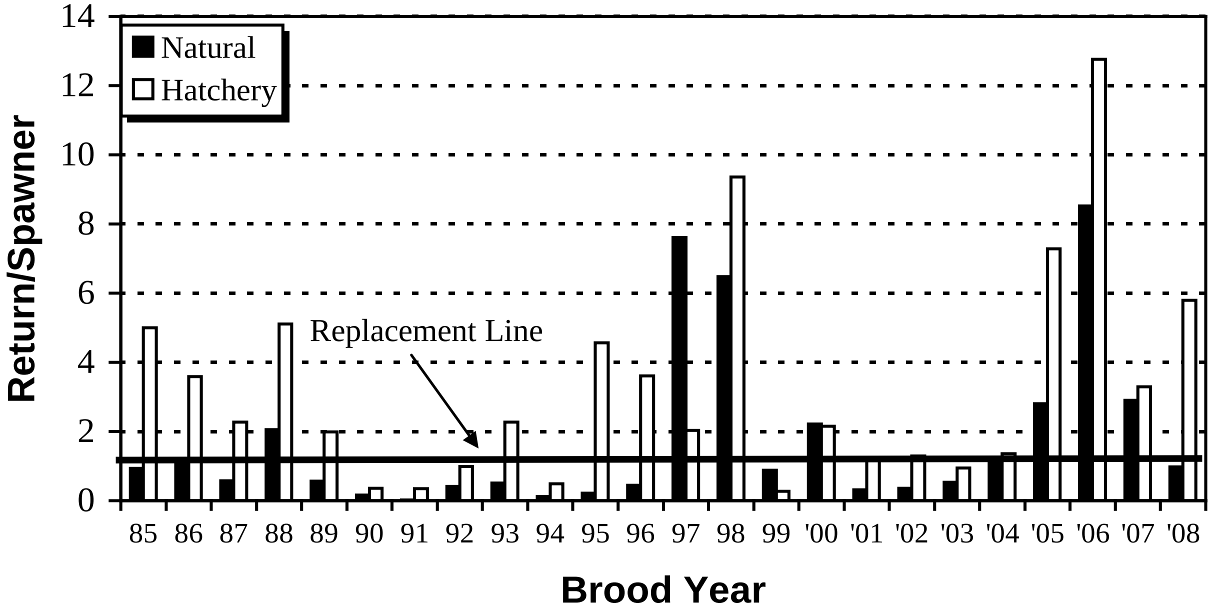

Figure 8. Return per spawner (with replacement line) for the 1985-2008 brood years (2008 incomplete brood year).

Table 26. Progeny-to-parent survival estimates of Tucannon River spring Chinook salmon from 1985 through 2008 brood years (2008 brood year incomplete).

	Natural Salmon			Hatchery Salmon			
Brood Year	**Potential Spawners**	**Number of Returns**	**Return/ Spawner**	**Number of Spawners**	**Number of Returns**	**Return/ Spawner**	**Hatchery to Natural Advantage**
1985	416	392	0.94	9	45	5.00	5.3
1986	440	468	1.06	91	327	3.59	3.4
1987	407	238	0.58	83	188	2.27	3.9
1988	257	527	2.05	87	445	5.11	2.5
1989	276	158	0.57	122	243	1.99	3.5
1990	572	94	0.16	78	28	0.36	2.2
1991	291	7	0.02	72	25	0.35	14.4
1992	476	196	0.41	83	82	0.99	2.4
1993	397	204	0.51	91	207	2.27	4.4
1994	97	12	0.12	69	34	0.49	4.0
1995	27	6	0.22	39	178	4.56	20.5
1996	152	69	0.45	74	267	3.61	7.9
1997	105	799	7.61	89	181	2.03	0.3
1998	60	389	6.48	85	796	9.36	1.4
1999	160	141	0.88	122	33	0.27	0.3
2000	201	446	2.22	73	157	2.15	1.0
2001	766	244	0.32	104	125	1.20	3.8
2002	568	202	0.36	93	120	1.29	3.6
2003	329	173	0.53	75	71	0.95	1.8
2004	346	399	1.15	88	120	1.36	1.2
2005	264	739	2.80	95	692	7.28	2.6
2006	202	1,721	8.52	88	1,123	12.76	1.5
2007	211	612	2.90	82	270	3.29	1.1
2008	796	778	0.98	114	660	5.79	5.9
Mean			**1.74**			**3.26**	**4.1**
Geometric Mean			**0.79**			**2.07**	**2.6**

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. As mentioned previously, 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 may result in a Proportionate Natural Influence (PNI) of less than 0.5. This level is generally not considered acceptable for supplementation programs. Historically the PNI for the Tucannon Spring Chinook Program has generally been above 0.5 (Appendix I).

Fishery Contribution and Out-of-Basin Straying

An original goal of the LSRCP supplementation program was to enhance returns of salmon to the Tucannon River by providing 1,152 adult hatchery origin fish (the number estimated to have been lost to the project area due to the construction and operation of the Lower Snake River hydropower system) to the river from hatchery-reared smolt releases. Such an increase would allow for limited harvest and increased spawning. However, hatchery adult returns have always been below the mitigation goal (Figure 9). Based on 1985-2008 brood year CWT recoveries reported to the RMIS database (Appendix J), 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 when the states implemented mark-selective fisheries in the lower Columbia River (fishery harvest comprised an average of 19% for recoveries). We subsequently stopped adipose fin clipping of hatchery production (Gallinat et al. 2001) to lessen non-tribal fishery impacts. Returning conventional supplementation adults are now marked with either a CWT and a VIE tag behind the left eye or just CWT. This has resulted in lower sport fishery impacts. Based on CWT recoveries for the 2000-2008 brood years, harvest (primarily commercial) has accounted for only 9% of the hatchery adult CWT recoveries (Appendix J).

Out-of-basin stray rates of Tucannon River spring Chinook have generally been low (Appendix J), with an average of 1.4% of the adult hatchery fish straying to other river systems/hatcheries for brood years 1985-2008 (range 0-20%).

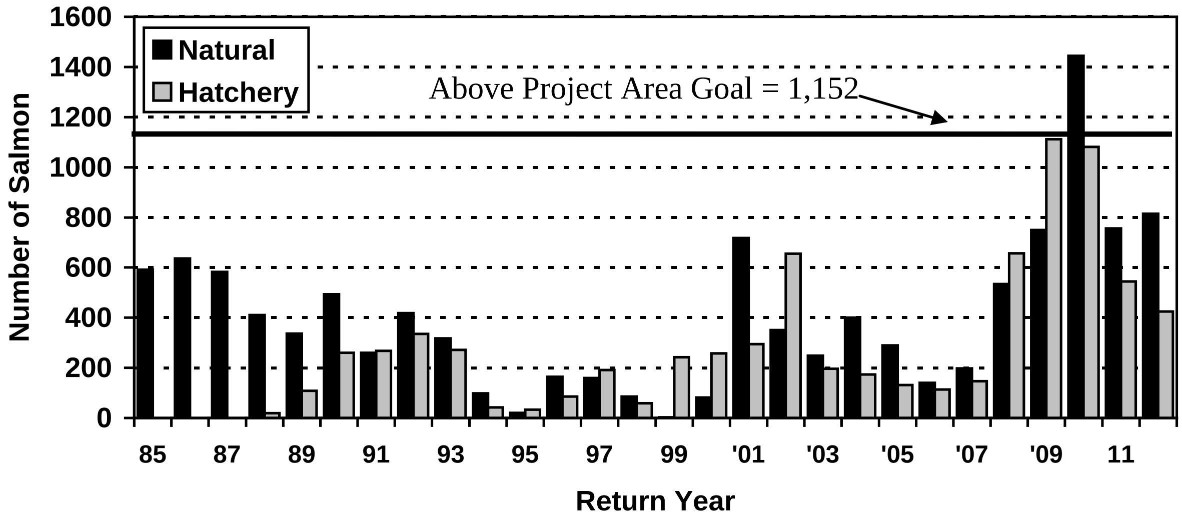

Figure 9. Total escapement for Tucannon River spring Chinook salmon for the 1985-2012 run years.

Adjusted Hatchery SAS

Using CWT recoveries from the RMIS database, we adjusted Tucannon River spring Chinook hatchery smolt-to-adult survival (SAS) to include all known recoveries both from within and outside the Tucannon River. With minor exceptions (1997 and 2006 brood years), even after adjustment, hatchery SAS were still well below the LSRCP survival goal of 0.87% (Table 27). Increased fishing mortality resulted in higher adjusted SAS for the 1997, 1998, and 2006 brood years.

Table 27. Hatchery SAS adjusted for recoveries from outside the Tucannon River subbasin as reported in the RMIS database, 1985-2007 brood years. (Data downloaded from RMIS database on 2/14/13).

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 SAS (%)
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	4	29	0.03	0.04
1992	87,752	82	17	99	0.09	0.11
1993	138,848	207	11	218	0.15	0.16
1994	130,069	34	0	34	0.03	0.03
1995	62,144	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	0	125	0.09	0.09
2002	123,586	120	0	120	0.10	0.10
2003	71,154	71	0	71	0.10	0.10
2004	67,542	120	1	121	0.18	0.18
2005	149,466	692	2	694	0.46	0.46
2006	106,530	1,123	44	1,167	1.05	1.10
2007	114,681	270	5	275	0.24	0.24
Mean					**0.26**	**0.28**
Geometric Mean					**0.17**	**0.18**

[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.).

Tucannon River Natural Productivity

The carrying capacity of spring Chinook in the Tucannon River has been of great interest for informed fisheries management. Carrying capacity is one of the main factors in determining whether hatchery supplementation is a viable technique of increasing natural production (Pearsons 2002). Large returns in 2009 and 2010 have been invaluable in determining current carrying capacity. We define carrying capacity as the minimum number of adults that produce the asymptotic number of progeny and not the maximum numbers of adults that the environment can support. To estimate the carrying capacity (K) of the Tucannon River for spring Chinook we used both Ricker and Beverton-Holt stock-recruit models (Ricker 1975). Both models assume density-dependent mortality at high abundances.

The Ricker model is defined as: $R = \alpha \cdot P \exp^{-\beta(P)}$ and the Beverton-Holt model is: $R = P/(\alpha P + \beta)$; where R = recruitment and P is parental stock size. The α coefficient for both models represents density independent recruitment (productivity coefficient) and represents the slope of the stock-recruitment curve at the origin (rate of recruitment in the absence of any environmental constraints). The β coefficient in both models represents density-dependent processes. At relatively high spawning stock levels various ecological processes (e.g., rate of predation, habitat or food limitations) will result in compensation in the survival of recruits, and recruitment rate will decline with an increase in spawner abundance (Maceina and Pereira 2007).

The Ricker model was developed to describe stocks in which recruitment declines as population size tends toward infinity. Proposed mechanisms of this density dependence include predation, cannibalism, redd superimposition, and disease (Maceina and Pereira 2007). The Beverton-Holt recruitment curve assumes that competition among early life stages for a limited resource (e.g., food or space) will cause recruits to increase initially, then to decline to an asymptotic value as spawner abundance increases (Maceina and Pereira 2007).

Variance in the numbers of males relative to females can confound true relationships between the number of spawners and progeny, therefore we used redd counts, with the assumption that only one female produces one redd, to reduce the potential variance between parents and progeny. Redd counts are conducted throughout the spawning area over the length of the spawning period during optimum river conditions in the fall (i.e., low water, high visibility) and are thought to be very reliable. Recruitment estimates are based on natural origin smolt estimates from juvenile trapping in the lower river (below the production area) for the 1985-2010 brood years (the 1991 and 1995 brood year data were excluded due to questionable estimates).

We used the computer software program FISHPARM (Prager et al. 1989) to fit the models. The output from the non-linear least squares fitting procedure provided by FISHPARM provided estimates of the model parameters as well as estimates of the model fits to the data. The parameter estimates were used in a spreadsheet to compute predicted recruitment based on the models and to graphically plot the model fits to the data. For the Ricker model, carrying capacity was assumed to be the asymptote, or the point on the curve where the slope of the model is zero. For the Beverton-Holt model, the asymptote was far outside the range of data observed, or even thought to have occurred, so points were selected that were within 95% and 99% of the asymptote. All modeled stock-recruit relationships represent average conditions.

Ricker Model

The parameter estimates calculated by FISHPARM for the Ricker model were α = $3.363E^{-1}$ and β = $2.614E^{-3}$ (R^2 = 0.616; adjusted R^2 = 0.579). Estimated carrying capacity K was 383 redds (females) and 47,300 emigrants (Figure 10).

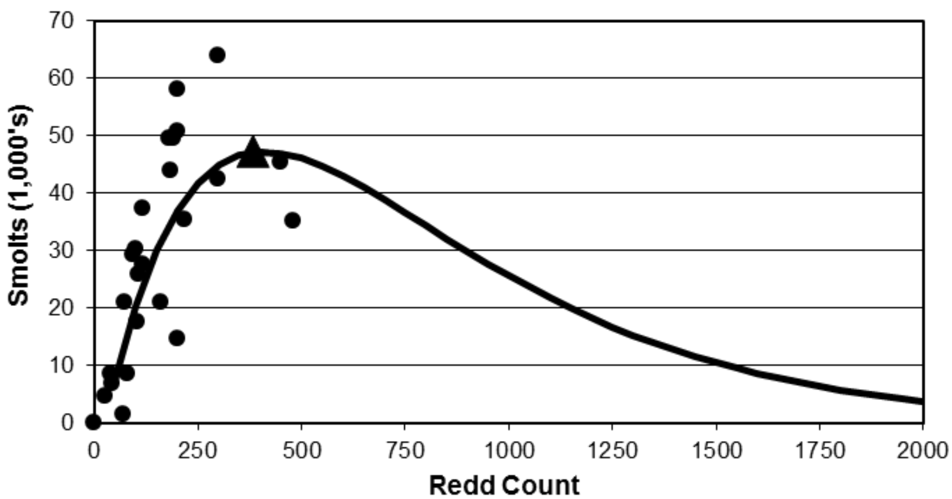

Figure 10. Ricker stock-recruitment curve relating Tucannon spring Chinook emigrants against number of redds for the 1985-2010 brood years. Maximum carrying capacity (black triangle) is estimated at 383 redds and 47,300 emigrants.

Beverton-Holt Model

The parameter estimates calculated by FISHPARM for the Beverton-Holt model were α = $1.368E^{-2}$ and β = 2.559 (R^2 = 0.562; Adjusted R^2 = 0.521). The Beverton-Holt model provided an estimate of 649 redds (females) that produced approximately 56,700 smolts at 95% of capacity (K) (Figure 11). The model also predicted that 1,684 redds (females) would produce approximately 65,800 smolts at 99% of capacity (K) (Figure 11).

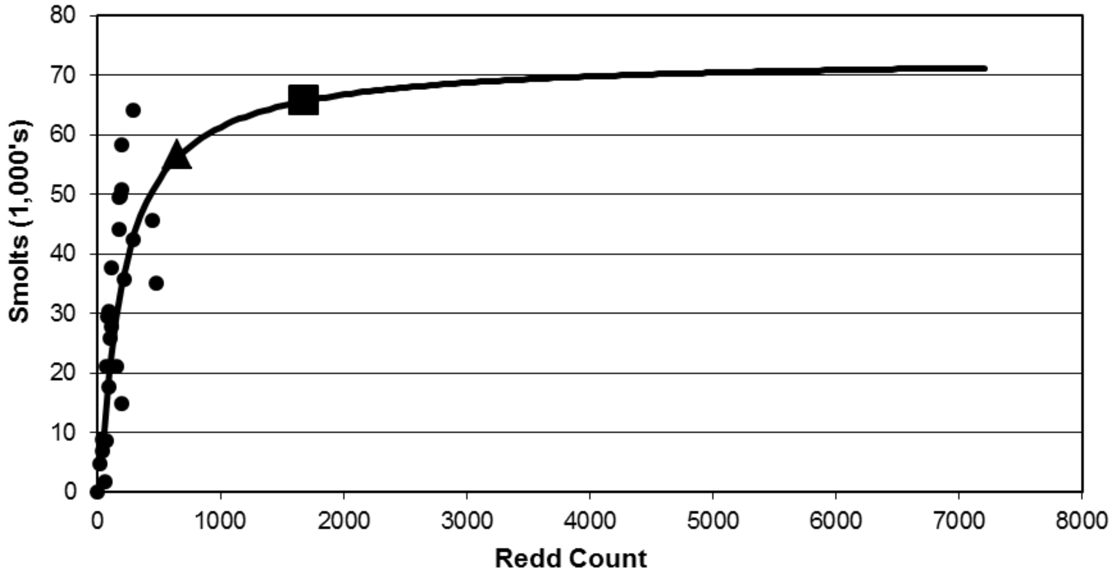

Figure 11. Beverton-Holt stock-recruitment curve relating Tucannon spring Chinook emigrants against number of redds for the 1985-2010 brood years. The black triangle represents carrying capacity at 95% of the asymptote (649 redds; 56,700 smolts) and the black square represents carrying capacity at 99% of the asymptote (1,684 redds; 65,800 smolts).

Progeny-per-Parent Ratios

Another metric we used to examine natural productivity of spring Chinook in the Tucannon River was progeny-per-parent ratios (adults). Chilcote et al. (2011) found a negative relationship between the reproductive performance of natural, anadromous salmonid populations and the proportion of hatchery fish in the spawning population. However, when we plotted progeny-per-parent ratios against the proportion of hatchery fish on the spawning grounds we found a slightly increasing trend in natural productivity rather than a decrease (Figure 12). This graph seems to corroborate findings from the genetic analysis of the Tucannon spring Chinook population that the diversity of the population has not significantly changed as a result of the hatchery supplementation or captive brood programs (Kassler and Dean 2010).

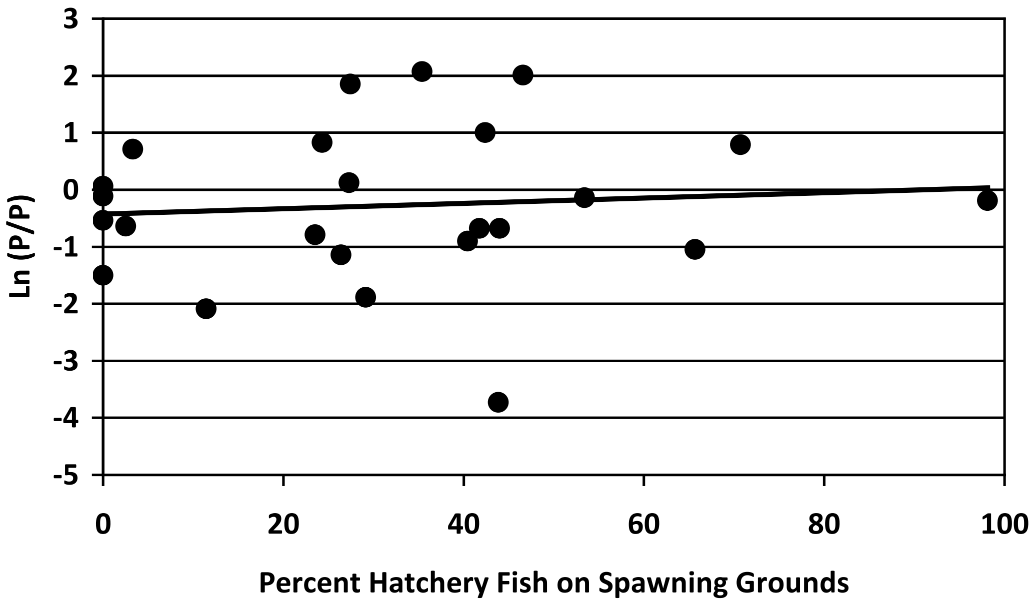

Figure 12. Graph of Tucannon River spring Chinook in-river natural-log transformed progeny-per-parent ratio (adult) against percent hatchery fish on the spawning grounds.

A large amount of effort/focus has been spent in recent years examining the effects (either adverse or beneficial) of hatchery origin fish on natural populations. Although this evaluation is important, it may not be focused on the primary limitations for expanding ESA-listed populations to meet ESA/recovery goals. This hatchery evaluation process has provided many years of detailed evaluations of both the hatchery and natural components of the population and helped identify other limiting factors that may be depressing population abundance and productivity.

Our data shows that years with large escapement back to the Tucannon River did not produce large returns suggesting density-dependent effects were affecting productivity. Comparing mean lengths of outmigrating spring Chinook at the Tucannon smolt trap with year class strength showed a significant relationship ($P < 0.01$), with smaller year class strength producing larger smolts on average (Figure 13). These larger smolts survived at a greater rate and tended to be the brood years that were above replacement (Figure 14). Sampling conducted by Howell et al. (1985) before the Tucannon Hatchery Program was in place noted that pre-smolts collected in the Tucannon River averaged 78 mm and this was generally smaller than juveniles of the same age collected from other spring Chinook populations. Could this small size help explain why the Tucannon spring Chinook population has struggled to recover? Will the higher survival of larger smolts result in an evolutionary shift to a Tucannon population with greater size of smolts at outmigration? Or will habitat improvements in the Tucannon River Basin lead to increases in carrying capacity, smolt length/size, and higher survival? These are questions that should be examined as part of this hatchery evaluation in the future.

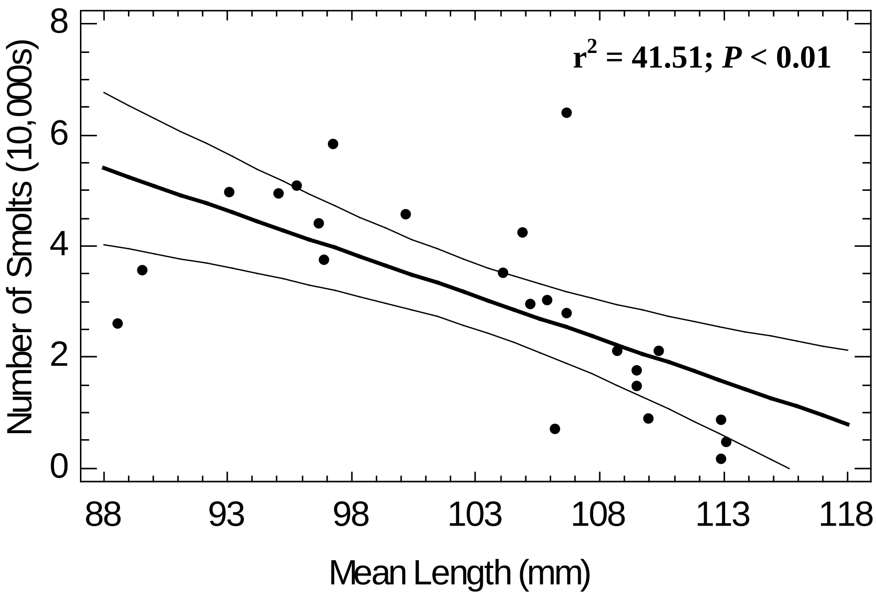

Figure 13. Linear regression of mean length (mm) of outmigrating Tucannon River spring Chinook smolts versus year class strength with 95% confidence limit.

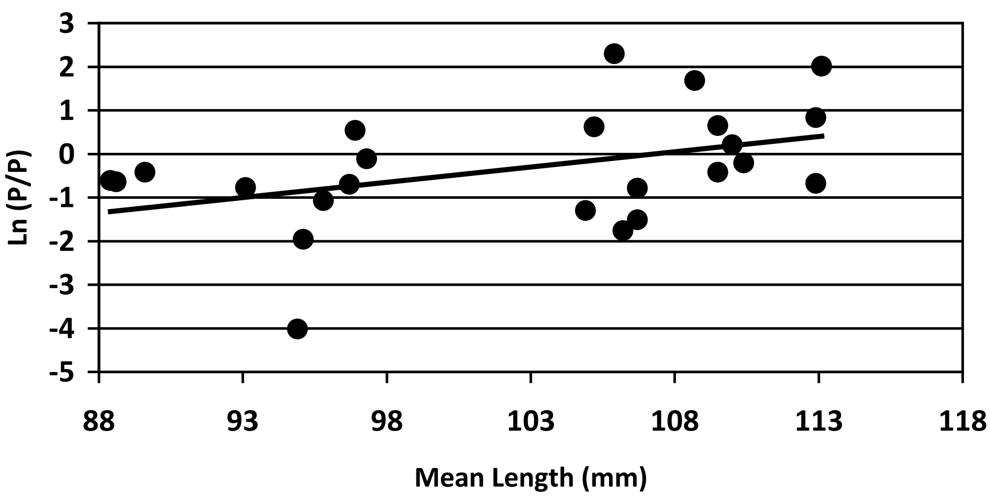

Figure 14. Graph of Tucannon River spring Chinook in-river natural-log transformed progeny-per-parent ratio (adult) against mean length (mm) of natural-origin emigrating smolts.

The long-term mitigation goal is to provide a total annual return of between 2,400-3,400 hatchery and natural origin fish back to the Tucannon River (SRSRB 2006) that should include at least 750 natural origin fish over a 10-year geometric mean (population viability threshold) (ICTRT 2008). Based on the density-dependent effects we have observed, this goal may be higher than the habitat can support under current conditions. Natural origin returns have been increasing in recent years (Figure 15). However, we are still well below the 10-year moving geometric mean of 750 natural origin fish.

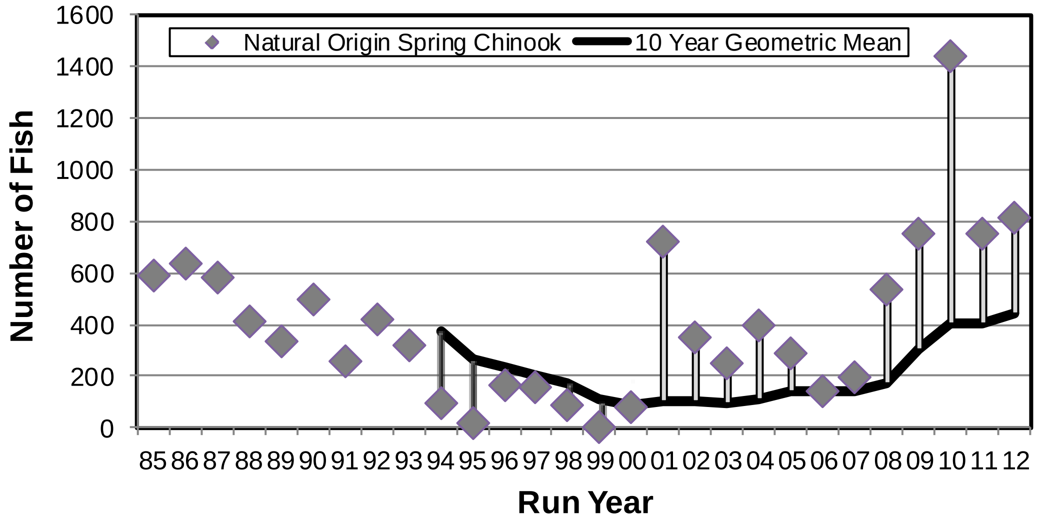

Figure 15. Tucannon River spring Chinook natural origin returns with the moving ten year geometric mean (black line) for the 1985-2012 run years.

Size at Release Evaluation

In order to release Tucannon River spring Chinook at 30 g/fish hatchery staff must retard fish growth in the hatchery. While a target goal of 30 g/fish more closely mimics the migrating size of natural origin spring Chinook smolts (approximately 18 g/fish), the hatchery fish are not surviving as well as the natural fish based on smolt to adult returns (Gallinat and Ross 2009). Hatchery fish, due to their protection in the hatchery environment may lack the necessary survival skills learned by natural origin fish living in the wild. Hatchery fish may also have difficulty adjusting to and locating food 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 number of precocious males and possibly change the age structure of the returning adult population. Although precocious maturation of males is associated with spring Chinook populations in headwater tributaries, many precocious males mature outside the normal spawning time of sea-run fish (Groot and Margolis 1991). If this occurs, then contribution by precocial males to the next generation may be small overall. Therefore, the amount of production from hatchery 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 larger fish.

In order to fully examine the effects of size at release, we initiated a plan to compare the differences in survival and size and age at return between smolts reared to 30 g/fish and 50 g/fish from the 2006-2010 brood years. Methods were previously described in Gallinat and Ross (2010).

Estimated survival probabilities from Curl Lake to Lower Monumental Dam were similar for the first two years of the study (Table 28). However, there was a large overlap in size between the two groups at release (Gallinat and Ross 2010). Beginning with the 2008 brood year we PIT tagged fish based on length to better separate the two groups of fish. With that change in protocol we were able to detect significantly greater outmigration survival of the larger fish for the 2008 and 2009 brood years (Table 28). However, the survival advantage of the larger hatchery smolts through the outmigration corridor still does not equal survival of the natural origin fish, 0.28 and 0.84, respectively (pg. 32). Although the hatchery fish were tagged before planting into Curl Lake AP and the natural origin fish were tagged at the smolt trap which may explain the differences in survival rates.

We are now gathering adult return data (Table 29). However, with only two complete brood year returns, it is still too early in the study to come to any definite conclusions. We will continue to examine smolt-to-adult survival rates and compare age composition for the two groups. Results will be reported annually.

Table 28. Summary of SURPH juvenile survival estimates from Curl Lake to Lower Monumental Dam and survival based on CWT recoveries obtained from the RMIS website for the Tucannon River spring Chinook size at release experiment.

Brood Year	CWT	VIE	Target Size (g)	Release Size (g)	Tagging Target	SURPH Surv. Est.	S.E.	RMIS CWT Survival
2006	63/40/94	L. Purple	30	39	2,500	0.26	0.02	1.08
2006	63/40/93	L. Blue	50	54	2,500	0.30	0.02	0.97
2007	63/46/87	L. Purple	30	37	2,500	0.28	0.03	0.13
2007	63/46/88	L. Blue	50	57	2,500	0.33	0.04	0.23
2008	63/51/74	L. Purple	30	40	7,500	0.48	0.07	0.09
2008	63/51/75	L. Blue	50	66	7,500	0.75	0.36	0.10
2009	63/55/65	L. Purple	30	35	12,500	0.52	0.02	---
2009	63/55/66	L. Blue	50	51	12,500	0.74	0.03	---
2010	63/60/75	L. Purple	30	32	11,500	0.21	0.01	---
2010	63/60/76	L. Blue	50	66	11,500	0.28	0.02	---

Table 29. Adult returns and smolt-to-adult return (SAR) rates from the Tucannon River spring Chinook size at release experiment.

50g Target Smolt Size

Brood Year	Estimated Number Of Smolts	Age 3	Age 4	Age 5	SAR (%)
2006	52,735	207	313	21	1.03
2007	55,480	35	108	17	0.29
2008	86,203	141	233	---	0.43
2009	113,049	8	---	---	0.01
2010	97,259	---	---	---	---

30 g Target Smolt Size

Brood Year	Estimated Number Of Smolts	Age 3	Age 4	Age 5	SAR (%)
2006	53,795	195	367	20	1.08
2007	59,201	39	63	0	0.17
2008	86,694	128	136	---	0.30
2009	118,388	0	---	---	0.00
2010	104,326	---	---	---	---

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 been consistently 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. However, because of the advantage in survival during early life history stages for fish in the hatchery, the progeny-to-parent ratio for hatchery produced fish has generally been above replacement and therefore may have sustained the population during years when the population was at critically low levels. We have seen a significant rebound of natural origin fish in recent years and we came close to reaching the LSRCP within river hatchery goal of 1,152 fish in 2009 and 2010. System survivals (in-river, migration corridor, and ocean) must increase in the near future for the hatchery program to succeed, the natural run to persist over the short-term, and the natural population to increase to a level where it can be sustainable over the long-term.

Until that time, the evaluation program will continue to document and study life history survivals, straying, carrying capacity, 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 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 has detected little change in the natural population that may have resulted from hatchery actions.

   Recommendation: Continue to collect as many carcasses as possible for the most accurate age composition data. Collect biological data (length, run timing, spawn timing, fecundity estimates, 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. Based on annual redd densities and historical spring Chinook radio tag data, the Tucannon Fish Hatchery weir/trap has been an impediment to upstream passage of spring Chinook to the better spawning and rearing habitat upstream of the trap.

   Recommendation: Seek funding and engineering expertise to modify the design and/or operation of the weir/trap structure.

3. Subbasin and recovery planning for ESA listed species in the Tucannon River have identified factors limiting the spring Chinook population and strategies to recover the population.

Recommendation: Assist population conservation efforts by updating recent carrying capacity/density and straying effects, and productivity estimates 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). Compare the Tucannon population with unsupplemented control populations in the Columbia Basin to examine if hatchery supplementation is benefiting the natural population in the Tucannon River.

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 for 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 mean hatchery SARs this would still not produce enough adult returns to consistently reach the LSRCP mitigation goal.

   Recommendation: Continue to evaluate survival rates from other reference watersheds to see if the LSRCP goal of 0.87% is a realistic goal under existing conditions. PIT tag natural origin fish in the river to ascertain where or at what life stage mortality is occurring. Encourage fish and wildlife enforcement patrols and additional public education efforts during periods when spring Chinook adults are most vulnerable (pre-spawn and spawning).

5. Adult Tucannon River spring Chinook appear to be “overshooting” or bypassing the Tucannon River based on PIT tag returns. This is occurring for both hatchery and natural origin fish, and thus does not appear to be a hatchery effect; although genetic analysis of fish that bypass may be informative regarding hatchery effects and relatedness.

   Recommendation: Utilize detectors at the dams and on the Tucannon and Asotin Creek 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). Support the operation and maintenance of PIT tag arrays on the Tucannon River. Seek funding for a collaborative radio telemetry project to examine migratory behavior of Tucannon River spring Chinook. The magnitude of this bypass behavior, and its causes, must be understood and addressed in order to meet Tucannon spring Chinook population conservation needs and mitigation goals.

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Appendix A: Annual Takes for 2012

Appendix A. Table 1. Summary of maximum annual (calendar year) takes allowed and 2012 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
Collect for Transport				
Observe/Harass [a]		300 (0)	4,000 (0)	4,000 (0)
Capture, Handle and Release	26,850 (669)		25,000 (377)	100,000 (4,196)
Capture, Handle, Tag/Mark, and Release [b]	2,800 (1,360)	30 (0)	5,000 (2,300)	20,000 (3,154)
Lethal Take [c]	250 (0)		125 (0)	200 (0)
Spawning, Dead, or Dying		1,500 (85)		
Other Take (specify)[d]			10,000 (3,943)	50,000 (23,000)
Indirect Mortality	50 (10)		375 (28)	1,500 (8)
Incidental Take [e]			0	
Incidental Mortality [e]			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 PIT tagged at the hatchery or smolt trap.
[e] 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 2012 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]	300 (93)	NA (0)	300 (77)	NA (0)		
Observe/Harass (Total of all fish trapped)	2,500 (220)	NA (20)	2,500 (232)	NA (69)		
Capture, Handle and Release [b]	2,500 (127)	NA (20)	2,500 (149)	NA (69)		
Capture, Handle, Tag/Mark, and Release						247,500 (201,585 BY10; 39,460 BY11)
Lethal Take (Broodstock)[c]	300 (93)	NA (0)	300 (77)	NA (0)		
Spawning, Dead, or Dying[d]	25 (0)	NA (0)	25 (6)	NA (0)		
Other Take (specify)						
Indirect Mortality[e]	10 (0)	NA (0)	10 (6)	NA (0)		
Incidental Take						
Incidental Mortality						

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

Appendix B: Spring Chinook Captured, Collected, or Passed Upstream at the Tucannon Hatchery Trap in 2012

Appendix B. Spring Chinook salmon captured, collected, or passed upstream at the Tucannon Hatchery trap in 2012. (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
5/22	2	2			2	2				
5/23	1				1					
5/26	1	2			1	2				
5/27	2				2					
5/28	1	2			1	1		1		
5/29	14	8	12	3	2	4		1		
5/30	21	12			21	12				
5/31	9	3	8	2	1	1				
6/01	5	4	2	3	3	1				
6/02	14	20			14	20				
6/03	6	13			6	13				
6/04	15	13	8	7	7	6				
6/05	9	13	2	11	7	2				
6/06	2	12	2	6		6				
6/07	4	5			4	4		1		
6/08	1	3			1	3				
6/09	1	5			1	5				
6/11	4	13	4	5		8				
6/12	6	9	6	1		8				
6/13	8	8	5	2	3	6				
6/14	3	3			3	3				
6/15	1	4	1	2		2				
6/16		3				3				
6/17	7	10			7	10				
6/18	5	13	2	6	3	7				
6/19	3	2	2	2	1					
6/20		2				2				
6/21	2	4			2	4				
6/22	2	2	1	1	1	1				
6/23	1	6			1	6				
6/24		4				4				
6/25	3	3	2	1	1	2				
6/26	1	3	1	3						
6/27	2	2	1	2	1					
6/29	3	4	1	3	2	1				
6/30	2	1			2	1				
7/01		1				1				
7/02		2		1		1				
7/03	4	1	3	1	1					
7/05	2	3	2	3						
7/06		2				2				
7/07	1	2			1	2				
7/08		1				1				
7/09	5	3	5	2		1				
7/10	4		3		1					
7/11		1				1				
7/12		1				1				
7/13	3		3							
7/14	4				4					
7/15	1	1			1	1				
7/17	1		1							
7/18		2		2						
7/19		1				1				
7/20		2		2						
7/23	1	1	1	1						

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

Appendix B (continued). Spring Chinook salmon captured, collected, or passed upstream at the Tucannon Hatchery trap in 2012. (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**
7/27	1	1			1	1				
7/31	1	1	1	1						
8/07	3	4	3			4				
8/09	3	3	1		2	3				
8/10		1				1				
8/13	1	1	1			1				
8/20		2				2				
8/21	1				1					
8/23	1		1							
8/27		2		2						
8/28	1		1							
8/29	2	2	2	1		1				
8/30	7	3	1	3	6					
8/31	6	4	1	1	5	3				
9/01	1	1			1	1				
9/03	3				3					
9/04	2	4	1	2	1	2				
9/05	2	5		2	2	3				
9/06	5	11	2	2	3	6		3		
9/07	1	4			1	4				
9/08	3	1			3	1				
9/09	4	4			4	4				
9/10		7				7				
9/11	1				1					
9/13	2	1			2	1				
9/14		1				1				
9/15	1	1			1	1				
9/16	1				1					
Total	**240**	**301**	**93**	**77**	**147**	**218**	**0**	**6**	**0**	**0**

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

Appendix C: Age Composition by Brood Year for Tucannon River Spring Chinook Salmon (1985-2007 BYs)

Appendix C. Age composition by brood year for natural and hatchery origin Tucannon River spring Chinook salmon (1985-2007 BYs). (Number at age are found in Tables 22 and 23).

Brood	Natural origin			Hatchery origin		
Year	% Age 3	% Age 4	% Age 5	% Age 3	% Age 4	% Age 5
1985	4.85	65.05	30.10	42.22	57.78	0.00
1986	0.43	80.34	19.23	25.38	69.11	5.50
1987	0.00	70.17	29.83	10.64	80.32	9.04
1988	0.57	63.57	35.86	22.25	65.84	11.91
1989	7.59	75.95	16.46	6.17	86.83	7.00
1990	8.51	76.60	14.89	21.43	71.43	7.14
1991	0.00	71.43	28.57	20.00	80.00	0.00
1992	1.02	82.14	16.84	13.41	81.71	4.88
1993	0.98	62.25	36.76	7.25	84.06	8.70
1994	0.00	83.33	16.67	11.76	73.53	14.71
1995	0.00	16.67	83.33	8.99	88.76	2.25
1996	0.00	91.30	8.70	22.10	72.66	5.24
1997	1.75	87.98	10.26	7.18	92.82	0.00
1998	2.31	66.58	31.11	12.44	68.72	18.84
1999	6.38	87.94	5.67	33.33	57.58	9.09
2000	0.67	87.89	11.43	16.56	83.44	0.00
2001	0.00	96.31	3.69	15.20	84.00	0.80
2002	1.49	61.39	37.13	5.00	81.67	13.33
2003	4.05	66.47	29.48	2.82	91.55	5.63
2004	2.01	88.22	9.77	15.00	81.67	3.33
2005	17.73	80.51	1.76	42.05	57.95	0.00
2006	6.74	80.77	12.49	35.80	60.55	3.65
2007	6.70	74.51	18.79	27.41	63.33	9.26
Means	**4.72**	**78.16**	**17.12**	**22.81**	**70.31**	**6.88**

Appendix D: Total Estimated Run-Size of Tucannon River Spring Chinook Salmon (1985-2012)

Appendix D. Total estimated run-size of spring Chinook salmon to the Tucannon River, 1985-2012. (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
2009	116	634	402	405	92	196	13	4	750	1,112	1,862
2010	41	1,403	74	680	0	306	4	17	1,444	1,081	2,525
2011	85	671	269	212	0	27	12	24	756	544	1,300
2012	7	808	8	387	---	---	0	29	815	424	1,239

Appendix E: Stray Hatchery-Origin Spring Chinook Salmon in the Tucannon River (1990-2012)

Appendix E. Summary of identified stray hatchery origin spring Chinook salmon that escaped into the Tucannon River (1990-2012).

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**
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**
1993	075110	ODFW	Lookingglass Cr.	Meacham Cr./Umatilla River	1 / 2	
				Total Strays	**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**
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**
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**
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**
2001	076040	ODFW	Umatilla R.	Umatilla Hatch./Umatilla River	1/7	
	092828	ODFW	Imnaha R. & Tribs.	Lookingglass/Imnaha River	1/3	
	092829	ODFW	Imnaha R. & Tribs.	Lookingglass/Imnaha River	1/3	
				Total Strays	**13**	**1.3**

[a] The expansion is based on subsample rates of the proportion of stray carcasses to Tucannon River origin carcasses from the river. Actual counts are not expanded.

Appendix E (continued). **Summary of identified stray hatchery origin spring Chinook salmon that escaped into the Tucannon River (1990-2012).**

Year	CWT Code or Fin clip	Agency	Origin (stock)	Release Location / Release River	Number Observed/ Expanded [a]	% of Tuc. Run
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**
2003	100472	IDFG	Salmon R.	Sawtooth Hatch./Nature's Rear.	1/1	
				Total Strays	**1**	**0.2**
2004	Ad clip	Unknown	Unknown	Unknown	6/17	
				Total Strays	**17**	**3.0**
2005	Ad clip	Unknown	Unknown	Unknown	3/6	
				Total Strays	**6**	**1.4**
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	Unknown	3/6	
				Total Strays	**8**	**3.2**
2007	092043	ODFW	Rogue R. – Cole H.	Cole Rivers Hatchery/Rogue R.	1/1	
	Ad clip	Unknown	Unknown	Unknown	9/27	
				Total Strays	**28**	**8.1**
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	Unknown	1/1	
				Total Strays	**24**	**2.0**
2009	092043	ODFW	Rogue R.	Cole Rivers Hatch./Rogue R.	1/3	
	094532	ODFW	Imnaha R.	Lookingglass Hatch./Imnaha R.	1/3	
	094538	ODFW	Lostine R.	Lookingglass/Lostine R.	2/4	
	100181	IDFG	Salmon R. Sum. Ck.	Knox Bridge/S. Fork Salmon	1/1	
	Ad clip	Unknown	Unknown	Unknown	6/6	
				Total Strays	**17**	**0.9**
2010	092737	ODFW	Umatilla R.	Umatilla Hatch./Umatilla River	1/6	
	094351	ODFW	Lostine R.	Lookingglass/Lostine R.	1/6	
	Ad clip	Unknown	Unknown	Unknown	9/9	
				Total Strays	**21**	**0.8**
2011	054685	USFWS	Dworshak	Dworshak Hatchery	1/1	
	094591	ODFW	Catherine Ck.	Lookingglass Hatchery	2/2	
	094593	ODFW	Lookingglass Ck.	Lookingglass Hatchery	1/1	
	094665	ODFW	Lostine R.	Lookingglass Hatchery	1/6	
	101381	IDFG	Clear Ck.	Clearwater Hatchery/Powell	1/6	
	102380	IDFG	S.F. Clearwater	Clearwater Hatchery	1/6	
	105081	IDFG	Selway R.	Clearwater Hatchery/Powell	1/6	
	Ad clip	Unknown	Unknown	Unknown	3/8	
				Total Strays	**36**	**2.8**

[a] The expansion is based on subsample rates of the proportion of stray carcasses to Tucannon River origin carcasses from the river. Actual counts are not expanded.

Appendix E (continued). Summary of identified stray hatchery origin spring Chinook salmon that escaped into the Tucannon River (1990-2012).

Year	CWT Code or Fin clip	Agency	Origin (stock)	Release Location / Release River	Number Observed/ Expanded[a]	% of Tuc. Run
2012	Ad clip	Unknown	Unknown	Unknown	9/29	
				Total Strays	**29**	**2.3**

[a] The expansion is based on subsample rates of the proportion of stray carcasses to Tucannon River origin carcasses from the river. Actual counts are not expanded.

Appendix F: Final PIT Tag Detections of Returning Tucannon River Spring Chinook

Appendix F. Final PIT tag detections of returning Tucannon River spring Chinook 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
1F4E71071B	H	169	3/20/95	LGR	8/03/95	136.0	2
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
3D9.257C5B558A	H	125	4/26/06	ICH	6/16/08	782.2	4
3D9.257C5A0975	W	113	11/20/06	MCN	5/29/09	920.7	5
3D9.1BF26E119D	H	170	4/12/07	LTR	5/22/08	405.8	3
3D9.257C6C4BAD	CB	142	4/12/07	ICH	5/15/08	398.9	3
3D9.257C6C1B20	CB	148	4/12/07	LTR	5/31/08	414.7	3
3D9.257C6C57DF	CB	125	4/12/07	ICH	5/31/08	415.3	3
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
3D9.1BF26DB184	W	106	4/24/07	BON	5/02/09	738.9	4
3D9.1BF26DB741	W	118	4/24/07	ICH	5/10/09	747.3	4
3D9.1BF26DA2CB	W	103	4/23/07	ICH	5/10/09	748.4	4
3D9.1BF26D340D	W	102	4/16/07	ICH	5/06/09	751.3	4
3D9.1BF26D39F9	W	110	4/24/07	ICH	5/15/09	752.1	4
3D9.1BF26D693A	H	144	4/12/07	ICH	5/08/09	757.0	4
3D9.1BF26DFD75	H	112	4/12/07	MCN	5/11/09	760.0	4
3D9/257C6C514A	CB	125	4/12/07	ICH	5/17/09	766.2	4
3D9.1BF26DF8E5	W	118	4/02/07	ICH	5/09/09	768.3	4
3D9.1BF26DEE22	W	115	4/15/07	MCN	5/24/09	769.3	4
3D9.257C59FC64	W	116	3/22/07	ICH	5/17/09	786.9	4

Abbreviations are as follows: BON – Bonneville Dam, MCN – McNary Dam, ICH – Ice Harbor Dam, LTR – Lower Tucannon River, MTR – Middle Tucannon River, UTR – Upper Tucannon River, LGO – Little Goose Dam, LGR – Lower Granite Dam, AFC – Asotin Creek.

[a] PIT tag adult detection systems were in operation beginning in 1988 for LGR, 1998 for BON, 2002 for MCN, 2005 for both ICH and LTR, 2011 for MTR and UTR, and 2012 for TFH.

Appendix F (continued). Final PIT tag detections of returning Tucannon River spring Chinook 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
3D9.257C5BF3CB	W	95	1/16/07	BON	4/11/09	816.0	4
3D9.1BF27DF007	H	---	4/15/08	LTR[b]	7/08/08	84.2	2
3D9.1BF27E6923	H	---	4/15/08	MCN	5/11/09	390.7	3
3D9.1BF27E6615	H	---	4/15/08	ICH	5/12/09	392.0	3
3D9.1BF27E396B	H	144	4/15/08	ICH	5/14/09	394.0	3
3D9.1BF27E5152	H	---	4/15/08	MCN	5/14/09	394.0	3
3D9.1BF27DFA43	H	136	4/15/08	ICH	5/14/09	394.2	3
3D9.1BF27E45D5	H	---	4/15/08	BON	5/14/09	394.3	3
3D9.1BF27E5420	H	---	4/15/08	ICH	5/15/09	395.2	3
3D9.1BF27DC33A	H	---	4/15/08	MCN	5/16/09	395.3	3
3D9.1C2C4A2C09	CB	---	4/15/08	ICH	5/16/09	396.2	3
3D9.1BF27E0BF9	H	174	4/15/08	ICH	5/20/09	400.0	3
3D9.1BF27E4A9A	H	---	4/15/08	BON	5/21/09	401.0	3
3D9.1BF27DDDE3	H	125	4/15/08	ICH	5/21/09	401.1	3
3D9.1BF27E5F9D	H	---	4/15/08	MCN	5/23/09	403.0	3
3D9.1C2C4A17EF	CB	---	4/15/08	ICH	5/29/09	409.0	3
3D9.1C2C4AC01A	CB	---	4/15/08	ICH	5/13/09	393.1	3
3D9.1BF27E6750	H	---	4/15/08	LGR	6/07/09	417.8	3
3D9.1BF27E0B48	H	---	4/15/08	LGR	6/19/09	429.8	3
3D9.1BF27E335D	H	112	4/15/08	LGR	6/21/09	431.9	3
3D9.1BF27DEBAF	H	---	4/15/08	ICH	5/30/09	409.8	3
3D9.1BF27DE680	H	209	4/15/08	ICH	5/13/09	393.3	3
3D9.1BF27C49AC	W	120	4/02/08	ICH	6/10/09	434.0	3
3D9.1BF27C15D9	W	103	4/07/08	BON	4/29/10	751.5	4
3D9.1BF27C3C06	W	112	3/31/08	MCN	4/26/10	755.8	4
3D9.1BF27C3C7F	W	108	4/11/08	ICH	5/13/10	762.2	4
3D9.1BF27C4002	W	121	3/31/08	ICH	6/15/10	806.2	4
3D9.1BF27C43BD	W	104	3/31/08	LTR	5/06/10	766.0	4
3D9.1BF27C47C9	W	120	4/30/08	LTR	4/11/10	711.6	4
3D9.1BF27C4C13	W	113	4/08/08	LTR	4/27/10	746.8	4
3D9.1BF27C5838	W	120	4/04/08	ICH	5/06/10	762.2	4
3D9.1BF27C6137	W	105	4/20/08	LTR	5/01/10	740.7	4
3D9.1BF27C67B1	W	105	4/26/08	ICH	5/12/10	746.1	4
3D9.1BF27C681F	W	105	3/31/08	ICH	4/30/10	760.1	4
3D9.1BF27CEC4F	W	106	4/14/08	LGR	5/14/10	760.0	4
3D9.1BF27CF786	W	109	4/26/08	ICH	5/22/10	756.0	4

Abbreviations are as follows: BON – Bonneville Dam, MCN – McNary Dam, ICH – Ice Harbor Dam, LTR – Lower Tucannon River, MTR – Middle Tucannon River, UTR – Upper Tucannon River, LGO – Little Goose Dam, LGR – Lower Granite Dam, AFC – Asotin Creek.

[a] PIT tag adult detection systems were in operation beginning in 1988 for LGR, 1998 for BON, 2002 for MCN, 2005 for both ICH and LTR, 2011 for MTR and UTR, and 2012 for TFH.

[b] This fish was detected bypassing the Tucannon River (LGO or LGR detection) before heading back downstream.

Appendix F (continued). Final PIT tag detections of returning Tucannon River spring Chinook 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
3D9.1BF27DD7AC	W	101	5/04/08	ICH	5/23/10	736.4	4
3D9.1BF27DE7AE	W	121	5/28/08	LTR	5/02/10	704.8	4
3D9.1BF27E114D	W	98	4/30/08	ICH	5/07/10	736.7	4
3D9.1BF27E3670	W	120	5/12/08	ICH	5/05/10	723.1	4
3D9.1BF27E3A3B	W	105	5/01/08	BON	4/30/10	728.9	4
3D9.1BF27E4969	W	111	5/02/08	ICH	5/18/10	745.7	4
3D9.1BF27E5ADF	W	108	4/30/08	ICH	5/15/10	745.2	4
3D9.1BF27E6A2A	W	103	5/15/08	LTR	5/09/10	724.6	4
3D9.1BF27E806F	W	119	5/27/08	ICH	5/07/10	710.4	4
3D9.1BF27EA280	W	102	5/04/08	LTR	5/06/10	732.1	4
3D9.1BF27EC355	W	111	5/03/08	ICH	5/16/10	743.6	4
3D9.1C2C87304F	W	96	4/20/08	BON	4/28/10	738.2	4
3D9.1C2C875C89	W	115	4/18/08	MCN	5/08/10	750.2	4
3D9.1C2C87D02B	W	110	4/18/08	ICH	5/09/10	746.2	4
3D9.1C2C87D789	W	99	4/20/08	MCN	5/01/10	741.6	4
3D9.1C2C9CA1D0	W	115	4/22/08	BON	4/25/10	733.8	4
3D9.1C2CA9921E	W	109	4/22/08	LGR	5/23/10	760.8	4
3D9.1C2CA9B076	W	118	4/21/08	BON	4/25/10	734.3	4
3D9.1BF27DBF36	H	---	4/15/08	LTR	5/09/10	754.0	4
3D9.1BF27DE0CD	H	---	4/15/08	BON	4/29/10	744.2	4
3D9.1BF27E0336	H	---	4/15/08	ICH	5/15/10	760.3	4
3D9.1BF27E196E	H	---	4/15/08	ICH	5/01/10	746.0	4
3D9.1BF27E3B75	H	---	4/15/08	ICH	4/22/10	737.2	4
3D9.1BF27E55A0	H	135	4/15/08	ICH	5/24/10	769.2	4
3D9.1BF27E8ADF	H	---	4/15/08	BON	4/25/10	739.8	4
3D9.1BF27EBB28	H	113	4/15/08	LTR	5/26/10	770.6	4
3D9.1BF27ECB41	H	124	4/15/08	ICH	5/14/10	759.2	4
3D9.1BF27ED02D	H	---	4/15/08	BON	5/09/10	754.2	4
3D9.1BF27E53AA	H	123	4/15/08	LTR	6/05/10	781.1	4
3D9.1BF27E5A15	H	---	4/15/08	ICH	5/19/10	764.1	4
3D9.1BF27E9E98	H	---	4/15/08	MCN	4/23/10	737.8	4
3D9.1BF27EAC50	H	---	4/15/08	LTR	5/05/10	749.8	4
3D9.1BF27EAD0A	H	153	4/15/08	ICH	5/10/10	755.3	4
3D9.1BF27E4C02	H	---	4/15/08	ICH	5/12/10	757.1	4
3D9.1BF27E172D	H	---	4/15/08	BON	4/21/10	736.3	4
3D9.1BF27E066A	H	---	4/15/08	LGR	5/24/10	768.3	4

Abbreviations are as follows: BON – Bonneville Dam, MCN – McNary Dam, ICH – Ice Harbor Dam, LTR – Lower Tucannon River, MTR – Middle Tucannon River, UTR – Upper Tucannon River, LGO – Little Goose Dam, LGR – Lower Granite Dam, AFC – Asotin Creek.

[a] PIT tag adult detection systems were in operation beginning in 1988 for LGR, 1998 for BON, 2002 for MCN, 2005 for both ICH and LTR, 2011 for MTR and UTR, and 2012 for TFH.

Appendix F (continued). Final PIT tag detections of returning Tucannon River spring Chinook 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
3D9.1BF27E0720	H	131	4/15/08	LGR	5/17/10	744.0	4
3D9.1BF27E0425	H	---	4/15/08	BON	4/28/10	743.3	4
3D9.1BF27E050F	H	---	4/15/08	MCN	4/26/10	740.9	4
3D9.1BF27DF85C	H	---	4/15/08	LTR	6/07/10	783.1	4
3D9.1BF27DEFC8	H	124	4/15/08	BON	4/23/10	738.1	4
3D9.1BF27CF491	H	---	4/15/08	LGR	5/19/10	764.1	4
3D9.1BF27DB43A	H	131	4/15/08	ICH	5/05/10	749.8	4
3D9.1BF27DC0B5	H	138	4/15/08	LTR	4/30/10	745.3	4
3D9.1BF27DC33F	H	---	4/15/08	LTR[b]	5/08/10	752.8	4
3D9.1BF27DEB6D	H	---	4/15/08	LTR	5/26/10	770.5	4
3D9.1C2C455F7C	CB	---	4/15/08	MCN	5/15/10	759.9	4
3D9.1C2C48AA85	CB	---	4/15/08	ICH	5/08/10	752.9	4
3D9.1C2C4AF06C	CB	---	4/15/08	LTR	5/05/10	750.3	4
3D9.1BF27C301A	W	98	4/24/08	LTR[b]	5/17/11	1118.4	5
3D9.1BF27C38CD	W	106	4/25/08	LTR	5/14/11	1113.9	5
3D9.1BF27C3DD3	W	103	4/17/08	LTR	5/11/11	1119.0	5
3D9.1BF27C524B	W	110	4/29/08	BON	4/26/11	1092.3	5
3D9.1BF27C65EB	W	103	4/27/08	ICH	6/16/11	1145.1	5
3D9.1BF27CDCC9	W	103	4/26/08	ICH	5/07/11	1105.8	5
3D9.1BF27CF043	W	98	4/01/08	LTR	5/12/11	1135.8	5
3D9.1BF27E02B6	W	101	5/03/08	BON	4/30/11	1091.7	5
3D9.1C2C97ECE2	W	103	4/23/08	MCN	5/09/11	1111.7	5
3D9.1BF27E0E0D	W	112	11/17/08	ICH	5/15/11	909.1	5
3D9.1BF27E4192	W	113	12/31/08	ICH	5/08/11	858.1	5
3D9.1BF27E502E	W	102	12/29/08	AFC	6/20/11	903.3	5
3D9.1BF27E54F2	W	111	11/26/08	MCN	6/30/11	946.1	5
3D9.1BF27E8A96	W	125	12/31/08	MCN	6/24/11	905.1	5
3D9.1BF27EB33D	W	111	12/11/08	ICH	5/24/11	893.2	5
3D9.1BF27EC294	H	130	4/15/08	MCN	5/07/11	1116.2	5
3D9.1BF27C382A	W	110	4/17/08	LTR	3/27/12	1440.0	6
3D9.1C2CFD0260	H	---	4/17/09	LTR	6/20/10	429.4	3
3D9.1C2D044E4D	H	---	4/17/09	LTR[b]	5/30/10	408.5	3
3D9.1C2D03EA21	H	---	4/17/09	ICH	5/18/10	396.1	3
3D9.1C2CFCCEAF	H	---	4/17/09	LTR	6/29/10	438.3	3
3D9.1C2CF467AE	H	---	4/17/09	ICH	5/12/10	390.1	3
3D9.1C2CFBAFCC	H	---	4/17/09	LTR[b]	5/24/11	767.4	4

Abbreviations are as follows: BON – Bonneville Dam, MCN – McNary Dam, ICH – Ice Harbor Dam, LTR – Lower Tucannon River, MTR – Middle Tucannon River, UTR – Upper Tucannon River, LGO – Little Goose Dam, LGR – Lower Granite Dam, AFC – Asotin Creek.

[a] PIT tag adult detection systems were in operation beginning in 1988 for LGR, 1998 for BON, 2002 for MCN, 2005 for both ICH and LTR, 2011 for MTR and UTR, and 2012 for TFH.

[b] This fish was detected bypassing the Tucannon River (LGO or LGR detection) before heading back downstream.

Appendix F (continued). Final PIT tag detections of returning Tucannon River spring Chinook 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
3D9.1C2CFCD300	H	---	4/17/09	BON	5/17/11	760.1	4
3D9.1C2CFD176B	H	---	4/17/09	LGR	6/06/11	773.2	4
3D9.1C2D02834D	H	---	4/17/09	LTR	5/20/11	762.9	4
3D9.1C2D02ACF7	H	158	4/17/09	LGO[b]	5/17/11	759.5	4
3D9.1C2D034513	H	---	4/17/09	LTR	5/16/11	759.0	4
3D9.1C2D0357E4	H	194	4/17/09	LGR	6/21/11	780.8	4
3D9.1C2D040E6F	H	---	4/17/09	ICH	6/02/11	771.2	4
3D9.1BF27C2A80	W	110	5/02/09	ICH	5/11/11	739.1	4
3D9.1BF27C32F1	W	116	4/30/09	ICH	6/06/11	767.4	4
3D9.1BF27C34E2	W	131	5/01/09	ICH	5/17/11	746.1	4
3D9.1BF27C3AEE	W	114	4/27/09	LTR	5/10/11	743.0	4
3D9.1BF27C3EE4	W	117	5/10/09	ICH	5/20/11	740.4	4
3D9.1BF27C51C3	W	117	5/03/09	MCN	5/13/11	739.5	4
3D9.1BF27C610A	W	125	4/27/09	ICH	5/06/11	739.3	4
3D9.1BF27C652F	W	122	4/28/09	LTR	5/14/11	746.1	4
3D9.1BF27C6784	W	105	5/09/09	LTR	5/18/11	739.0	4
3D9.1BF27CE9F8	W	105	4/29/09	LTR	5/19/11	749.9	4
3D9.1BF27DB642	W	109	1/20/09	AFC	9/09/11	927.6	4
3D9.1BF27E20BB	W	99	1/27/09	MCN	5/15/11	837.9	4
3D9.1BF27E2615	W	128	4/19/09	ICH	6/22/11	793.5	4
3D9.1BF27EBF86	W	113	1/26/09	BON	5/14/11	838.1	4
3D9.1C2D031FC6	W	105	11/16/09	LGR	6/21/11	581.8	4
3D9.1C2CF44596	H	---	4/17/09	MTR	4/02/12	1080.7	5
3D9.1C2CF45F43	W	116	5/19/09	BON	4/24/12	1071.4	5
3D9.1C2CFCEF10	W	93	12/15/09	MTR	5/28/12	895.4	5
3D9.1C2CB17349	H	---	4/07/10	LTR	5/10/11	398.4	3
3D9.1C2CFBE7D3	H	---	4/07/10	ICH	5/16/11	403.9	3
3D9.1C2CFCA747	H	---	4/07/10	ICH	5/23/11	411.2	3
3D9.1C2CFCB6E1	H	---	4/07/10	ICH	5/24/11	412.1	3
3D9.1C2D0A57A9	H	---	4/07/10	LGR	5/11/11	399.1	3
3D9.1C2D0C6B10	H	---	4/07/10	ICH	5/20/11	407.9	3
3D9.1C2D0C6EC3	H	---	4/07/10	ICH	6/02/11	421.0	3
3D9.1C2D10D73B	H	---	4/07/10	LTR	7/04/11	452.6	3
3D9.1C2D116974	H	---	4/07/10	MCN	5/18/11	405.9	3
3D9.1C2D11BDED	H	---	4/07/10	ICH	5/22/11	410.2	3
3D9.1C2D1227AC	H	---	4/07/10	ICH	5/21/11	408.9	3

Abbreviations are as follows: BON – Bonneville Dam, MCN – McNary Dam, ICH – Ice Harbor Dam, LTR – Lower Tucannon River, MTR – Middle Tucannon River, UTR – Upper Tucannon River, LGO – Little Goose Dam, LGR – Lower Granite Dam, AFC – Asotin Creek.

[a] PIT tag adult detection systems were in operation beginning in 1988 for LGR, 1998 for BON, 2002 for MCN, 2005 for both ICH and LTR, 2011 for MTR and UTR, and 2012 for TFH.

[b] This fish was detected bypassing the Tucannon River (LGO or LGR detection) before heading back downstream.

Appendix F (continued). Final PIT tag detections of returning Tucannon River spring Chinook 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
3D9.1C2D74B711	H	---	4/07/10	MCN	6/05/11	423.9	3
3D9.1C2D750B0B	H	---	4/07/10	LTR[b]	7/05/11	454.5	3
3D9.1C2D752277	H	---	4/07/10	ICH	6/06/11	425.0	3
3D9.1C2D754D65	H	---	4/07/10	LTR	6/04/11	422.8	3
3D9.1C2D755233	H	---	4/07/10	LGR	6/17/11	436.1	3
3D9.1C2D7555EA	H	---	4/07/10	ICH	5/30/11	417.9	3
3D9.1C2D755E10	H	---	4/07/10	ICH	6/07/11	426.2	3
3D9.1C2D756572	H	---	4/07/10	LTR	6/07/11	425.6	3
3D9.1C2D7565B1	H	---	4/07/10	LTR	6/15/11	433.7	3
3D9.1C2D756D09	H	---	4/07/10	ICH	6/06/11	424.8	3
3D9.1C2D75B9F9	H	---	4/07/10	ICH	6/04/11	423.0	3
3D9.1C2D75BAC1	H	---	4/07/10	BON	5/23/11	411.3	3
3D9.1C2D75C3CB	H	---	4/07/10	LGO[b]	7/02/11	450.6	3
3D9.1C2D75CA67	H	---	4/07/10	LTR	6/05/11	424.5	3
3D9.1C2D7A9C66	H	---	4/07/10	MCN	6/08/11	427.1	3
3D9.1C2D7AB0CD	H	---	4/07/10	ICH	6/06/11	425.2	3
3D9.1C2D7AB2FB	H	---	4/07/10	MCN	5/14/11	402.0	3
3D9.1C2D7ABE87	H	---	4/07/10	LTR	5/11/11	398.9	3
3D9.1C2D7ABEE8	H	---	4/07/10	LTR	5/20/11	408.0	3
3D9.1C2D7ABF15	H	---	4/07/10	BON	5/20/11	408.2	3
3D9.1C2D7AD6C0	H	---	4/07/10	ICH	6/16/11	435.1	3
3D9.1C2D7AF0D6	H	---	4/07/10	ICH	5/31/11	419.2	3
3D9.1C2D7AF13B	H	---	4/07/10	BON	5/16/11	404.1	3
3D9.1C2D7B4C96	H	---	4/07/10	BON	5/09/11	397.3	3
3D9.1C2D7B723E	H	---	4/07/10	ICH	5/29/11	417.0	3
3D9.1C2D7C5759	H	---	4/07/10	ICH	5/29/11	417.0	3
3D9.1C2D80F436	H	---	4/07/10	MCN	5/27/11	414.9	3
3D9.1C2D80FE10	H	---	4/07/10	BON	5/19/11	406.3	3
3D9.1C2D8102EE	H	---	4/07/10	BON	5/16/11	404.0	3
3D9.1C2D8142B7	H	---	4/07/10	MCN	6/05/11	423.7	3
3D9.1C2D8158FB	H	---	4/07/10	BON	5/23/11	411.1	3
3D9.1C2D824F31	H	---	4/07/10	LTR	5/18/11	405.9	3
3D9.1C2CF45F7D	W	116	4/11/10	LTR	4/02/11	355.7	3
3D9.1C2CF468D0	W	123	4/17/10	LTR	6/09/11	418.1	3
3D9.1C2CFC3BD4	W	109	5/07/10	LTR	4/01/11	329.6	3

Abbreviations are as follows: BON – Bonneville Dam, MCN – McNary Dam, ICH – Ice Harbor Dam, LTR – Lower Tucannon River, MTR – Middle Tucannon River, UTR – Upper Tucannon River, LGO – Little Goose Dam, LGR – Lower Granite Dam, AFC – Asotin Creek.

[a] PIT tag adult detection systems were in operation beginning in 1988 for LGR, 1998 for BON, 2002 for MCN, 2005 for both ICH and LTR, 2011 for MTR and UTR, and 2012 for TFH.

[b] This fish was detected bypassing the Tucannon River (LGO or LGR detection) before heading back downstream.

Appendix F (continued). Final PIT tag detections of returning Tucannon River spring Chinook 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
3D9.1C2D030778	W	120	4/15/10	LTR	1/17/11	276.8	3
3D9.1C2D030B45	W	130	4/26/10	MCN	6/07/11	407.1	3
3D9.1C2D03E72B	W	97	4/19/10	LTR	5/30/11	406.4	3
3D9.1C2D03EF5F	W	116	2/01/10	LTR	5/31/11	483.6	3
3D9.1C2CB10281	H	---	4/07/10	MTR	6/28/12	813.0	4
3D9.1C2CFB857B	H	---	4/07/10	TFH	9/07/12	884.3	4
3D9.1C2D07E9D1	H	---	4/07/10	MTR[b]	6/02/12	786.8	4
3D9.1C2D0C2DA7	H	---	4/07/10	MTR	5/24/12	777.8	4
3D9.1C2D0C5BED	H	---	4/07/10	MTR	5/19/12	773.4	4
3D9.1C2D0D1C3C	H	---	4/07/10	UTR	5/26/12	778.3	4
3D9.1C2D0D4DF0	H	---	4/07/10	MTR	5/22/12	776.2	4
3D9.1C2D10D771	H	---	4/07/10	UTR	6/13/12	797.7	4
3D9.1C2D10D97F	H	---	4/07/10	MTR[b]	6/3/12	788.2	4
3D9.1C2D1187CD	H	---	4/07/10	MTR	5/22/12	776.0	4
3D9.1C2D74B7DA	H	---	4/07/10	LGR	5/15/12	768.8	4
3D9.1C2D74B82A	H	---	4/07/10	UTR	5/26/12	780.1	4
3D9.1C2D74BF68	H	---	4/07/10	UTR	5/28/12	782.4	4
3D9.1C2D74C77F	H	---	4/07/10	MTR	5/24/12	778.0	4
3D9.1C2D754D26	H	---	4/07/10	BON	4/24/12	748.0	4
3D9.1C2D759A04	H	---	4/07/10	UTR	5/24/12	778.3	4
3D9.1C2D7A9292	H	---	4/07/10	MTR	5/19/12	773.0	4
3D9.1C2D7A941E	H	---	4/07/10	UTR[b]	6/14/12	799.2	4
3D9.1C2D7AB43F	H	---	4/07/10	MTR	4/3/12	726.6	4
3D9.1C2D7AB4B3	H	---	4/07/10	BON	5/9/12	763.0	4
3D9.1C2D7AB60D	H	---	4/07/10	LTR	5/9/12	762.8	4
3D9.1C2D7ACCC9	H	---	4/07/10	BON	4/22/12	745.8	4
3D9.1C2D7AE415	H	---	4/07/10	MTR	5/20/12	774.1	4
3D9.1C2D7AE70C	H	---	4/07/10	LTR	4/24/12	747.3	4
3D9.1C2D7AFC8E	H	---	4/07/10	MTR	3/31/12	724.0	4
3D9.1C2D7B0029	H	---	4/07/10	TFH	8/29/12	875.0	4
3D9.1C2D7B39BD	H	---	4/07/10	TFH	4/26/12	750.0	4
3D9.1C2D7B4B24	H	---	4/07/10	BON	5/08/12	761.9	4
3D9.1C2D7B5A59	H	---	4/07/10	BON	5/15/12	769.1	4

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[a] PIT tag adult detection systems were in operation beginning in 1988 for LGR, 1998 for BON, 2002 for MCN, 2005 for both ICH and LTR, 2011 for MTR and UTR, and 2012 for TFH.

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Appendix F (continued). Final PIT tag detections of returning Tucannon River spring Chinook 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
3D9.1C2D7B86D6	H	---	4/07/10	MTR	5/21/12	775.3	4
3D9.1C2D7BB359	H	---	4/07/10	AFC	7/01/12	815.8	4
3D9.1C2D7C0465	H	---	4/07/10	LTR	5/12/12	765.7	4
3D9.1C2D7C4237	H	---	4/07/10	MTR	6/14/12	799.1	4
3D9.1C2D7C4BBC	H	---	4/07/10	MTR	3/31/12	723.5	4
3D9.1C2D80D818	H	---	4/07/10	MTR	5/29/12	782.7	4
3D9.1C2D812B48	H	---	4/07/10	UTR	5/26/12	780.1	4
3D9.1C2D815183	H	---	4/07/10	MTR	5/21/12	775.4	4
3D9.1C2D8243D7	H	---	4/07/10	MTR	5/19/12	772.9	4
3D9.1C2D825C9D	H	---	4/07/10	MTR	5/26/12	780.2	4
3D9.1C2D826D4F	H	---	4/07/10	MTR	5/19/12	773.3	4
3D9.1C2D826F4D	H	---	4/07/10	LTR	5/21/12	774.8	4
3D9.1C2D828612	H	---	4/07/10	MTR	5/19/12	772.8	4
3D9.1C2D829474	H	---	4/07/10	LTR	5/24/12	778.3	4
3D9.1C2D829B73	H	---	4/07/10	LGR	5/23/12	777.0	4
3D9.1C2CFB5F1B	W	105	5/02/10	LTR	4/07/12	705.6	4
3D9.1C2CFD12B3	W	120	4/29/10	MTR	5/21/12	752.9	4
3D9.1C2CFF248D	W	116	5/10/10	BON	5/02/12	767.5	4
3D9.1C2D02D770	W	119	5/06/10	MTR	6/11/12	767.5	4
3D9.1C2D02EB49	W	104	5/07/10	AFC	9/27/12	874.0	4
3D9.1C2D03599C	W	101	4/05/10	LTR	4/18/12	742.6	4
3D9.1C2D03A283	W	112	5/13/10	LTR	6/14/12	762.8	4
3D9.1C2CF44450	W	93	12/20/10	LTR	4/25/12	491.8	4
3D9.1C2D9FAD7C	H	110	4/16/11	MTR	3/28/12	347.4	3
3D9.1C2D9FAFB1	H	107	4/16/11	LTR	4/22/12	372.5	3
3D9.1C2DA0DB23	H	105	4/16/11	LTR	3/26/12	344.5	3
3D9.1C2DA2D949	H	98	4/16/11	TFH	4/24/12	374.4	3
3D9.1C2DC02030	H	121	4/16/11	UTR	4/01/12	351.0	3
3D9.1C2DC03995	H	147	4/16/11	MTR	4/01/12	351.2	3
3D9.1C2DC172E2	H	164	4/16/11	LTR	4/02/12	351.0	3
3D9.1C2DC19AEF	H	155	4/16/11	UTR	7/02/12	443.3	3
3D9.1C2DC19B8B	H	142	4/16/11	UTR	6/02/12	413.1	3
3D9.1C2DC31A5A	H	154	4/16/11	LTR	5/22/12	402.4	3
3D9.1C2DC34F18	H	128	4/16/11	MTR	12/03/12	596.7	3

Abbreviations are as follows: BON – Bonneville Dam, MCN – McNary Dam, ICH – Ice Harbor Dam, LTR – Lower Tucannon River, MTR – Middle Tucannon River, UTR – Upper Tucannon River, LGO – Little Goose Dam, LGR – Lower Granite Dam, AFC – Asotin Creek.

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Appendix F (continued). Final PIT tag detections of returning Tucannon River spring Chinook 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
3D9.1C2DC3FB56	H	124	4/16/11	MTR	6/07/12	418.4	3
3D9.1C2DC4BAA0	H	122	4/16/11	MTR	3/18/12	337.1	3
3D9.1C2DC4C76D	H	149	4/16/11	BON	5/08/12	388.1	3
3D9.1C2DCA0C73	H	148	4/16/11	UTR[b]	7/02/12	443.3	3
3D9.1C2D751A48	W	114	4/05/11	BON	5/22/12	412.5	3
3D9.1C2D752AEA	W	86	2/02/11	LTR	4/25/12	448.5	3
3D9.1C2D80E283	W	101	5/15/11	LTR	4/01/12	321.9	3
3D9.1C2D810EC1	W	110	5/13/11	LTR	4/21/12	343.7	3
3D9.1C2DCA49A5	W	126	4/17/11	BON	9/26/12	528.0	3
3D9.1C2DCA78FE	W	110	4/21/11	LTR	4/01/12	345.8	3
3D9.1C2DCAD4E4	W	104	4/24/11	LTR	4/26/12	367.6	3
3D9.1C2DCB037F	W	106	4/15/11	UTR	6/18/12	429.7	3
3D9.1C2DCB1BF3	W	104	4/29/11	LTR	3/31/12	336.4	3
3D9.1C2DCB9A41	W	98	5/08/11	LTR	4/26/12	351.8	3
3D9.1C2DCC07AE	W	95	4/29/11	LTR	5/03/12	370.2	3
3D9.1C2DCC4647	W	112	4/24/11	LTR	4/23/12	363.4	3

Abbreviations are as follows: BON – Bonneville Dam, MCN – McNary Dam, ICH – Ice Harbor Dam, LTR – Lower Tucannon River, MTR – Middle Tucannon River, UTR – Upper Tucannon River, LGO – Little Goose Dam, LGR – Lower Granite Dam, AFC – Asotin Creek.

[a] PIT tag adult detection systems were in operation beginning in 1988 for LGR, 1998 for BON, 2002 for MCN, 2005 for both ICH and LTR, 2011 for MTR and UTR, and 2012 for TFH.

[b] This fish was detected bypassing the Tucannon River (LGO or LGR detection) before heading back downstream.

Appendix G: Historical Hatchery Releases (1987-2013 Release Years)

Appendix G. Historical hatchery spring Chinook releases from the Tucannon River, 1987-2013 release 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 G (continued). Historical hatchery spring Chinook releases from the Tucannon River, 1987-2013 release 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 G (continued). Historical hatchery spring Chinook releases from the Tucannon River, 1987-2013 release 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[e]	VI, LB, Mixed	3,188	57
2009	2007	C-Acc	4/13-4/22	46/87	58,044	1,157[e]	VI, LP, Mixed	2,203	37
Total					**113,310**	**1,371[e]**			
2010	2008	C-Acc	4/2-4/12	51/75	84,738	1,465[e]	VI, LB, Mixed	5,672	66
2010	2008	C-Acc	4/2-4/12	51/74	84,613	2,081[e]	VI, LP, Mixed	3,423	40
Total					**169,351**	**3,546[e]**			
2010	2009	Direct	4/22-4/23	None	0	52,253[f]	Oxytet., Mixed	342	7
Total					**0**	**52,253[f]**			
2011	2009	C-Acc	4/7-4/25	55/66	113,049	0[e]	VI, LB, Mixed	5,767	51
2011	2009	C-Acc	4/7-4/25	55/65	117,824	564[e]	VI, LP, Mixed	4,135	35
Total					**230,873**	**564[e]**			
2012	2010	C-Acc	4/11-4/23	60/76	96,984	275[e]	VI, LB, Mixed	6,400	66
2012	2010	C-Acc	4/11-4/23	60/75	102,169	2,157[e]	VI, LP, Mixed	3,312	32
Total					**199,153**	**2,432[e]**			
2012	2011	Direct	5/01	None	0	39,460[f]	Oxytet., Mixed	285	7
Total					**0**	**39,460[f]**			
2013	2011	C-Acc	4/3-4/22	64/42	27,748	1,825[f]	TFH reared, Mixed	987	33
2013	2011	C-Acc	4/3-4/22	64/41	227,703	2,688[f]	LFH reared, Mixed	7,691	33
Total					**255,451**	**4,513[f]**			

[a] Release types are: Tucannon Hatchery Acclimation Pond (H-Acc); Portable Acclimation Pond (P-Acc); Curl Lake Acclimation Pond (C-Acc); and Direct Stream Release (Direct).
[b] All tag codes start with agency code 63.
[c] Codes listed in column are as follows: BWT - Blank Wire Tag; CB - Captive Brood; VI-Visual Implant (elastomer); LR - Left Red, RR - Right Red, LG-Left Green, RG - Right Green, LY - Left Yellow, RY - Right Yellow, LB - Left Blue, RB - Right Blue, LP – Left Purple; Oxytet. – Oxytetracycline Mark; 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 H: Numbers of Fish Species Captured by Month in the Tucannon River Smolt Trap During the 2012 Outmigration

Appendix H. Numbers of fish species captured by month in the Tucannon River smolt trap during the 2012 outmigration sampling period (9 October, 2011 – 30 July, 2012).

Species	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Total
Nat. spring Chinook	12	83	159	85	49	96	1319	2125	119	5	4,052
Hatchery spring Chinook – Blue VIE							224	2871	14		3,109
Hatchery spring Chinook – Purple VIE							129	3296	28		3,453
Hatchery spring Chinook – VIE absent							22	756	18		796
Hatchery Spring - AD								3	901	87	991
Fall Chinook					74	11	14	643	1275	22	2,039
Coho salmon			1	3	4	4	18	134	196	21	381
Bull trout		2						1		1	4
Steelhead < 80 mm			1						53	16	70
Steelhead 80-124 mm	4	46	46	32	4	1	4	1			138
Steelhead ≥ 125 mm	12	77	75	50	20	27	550	1332	100		2,243
Hatch. endemic Steelhead							87	605	148		840
Mountain whitefish		1				1		1	2	1	6
Pacific lamprey - ammocoetes	18	24	44	247	233	29	56	12	50	24	737
Pacific lamprey - macropthalmia	3	13	46	89	10						161
Smallmouth bass	24	3	3	4	1		2	2	1	2	42
Bluegill								1		2	3
Pumpkinseed sunfish	2								1		3
Chiselmouth	115	43	148	105	7	3	16	31	489	2619	3,576
Peamouth								1		1	2
Banded killifish	5		6	10	14	15		1			51
Longnose dace	27	14	30	31	8	12		5	157	135	419
Speckled dace	1							9			10
Redside shiner	2		1	6	2		2	12	10	16	51
Bridgelip sucker	8	23	48	98	25	8	11	46	105	44	416
Northern pikeminnow	10	5	14	21	4	1	2	18	53	12	140
Brown bullhead		2						1			3
Sculpin sp.	1				1		2	4	7	1	16

Appendix I: Proportionate Natural Influence (PNI) for the Tucannon Spring Chinook Population (1985-2012)

Appendix I. Proportionate Natural Influence (PNI)[a] for the Tucannon River spring Chinook population (1985-2012). 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	416	0.00	1.00	
1986	91	100.00	440	0.00	1.00	
1987	83	100.00	407	0.00	1.00	
1988	90	100.00	257	0.00	1.00	
1989	122	45.08	276	1.45	0.97	
1990	62	48.39	572	21.50	0.69	
1991	71	56.34	291	32.30	0.64	
1992	82	45.12	476	35.92	0.56	
1993	87	51.72	397	38.29	0.57	
1994	69	50.72	97	0.00	1.00	
1995	39	23.08	27	0.00	1.00	
1996	75	44.00	152	23.68	0.65	
1997	89	42.70	105	35.24	0.55	
1998	86	52.33	60	26.67	0.66	
1999	122	0.82	161	97.52	0.01	*
2000	73	10.96	201	69.15	0.14	*
2001	104	50.00	766	19.84	0.72	
2002	93	45.16	568	60.56	0.43	*
2003	75	54.67	329	25.84	0.68	
2004	88	54.55	346	17.34	0.76	
2005	95	49.47	264	19.70	0.72	
2006	88	40.91	202	24.26	0.63	
2007	82	62.20	210	22.38	0.74	
2008	114	35.09	796	39.07	0.47	*
2009	173	50.87	1,190	49.24	0.51	
2010	161	50.31	938	42.22	0.54	
2011	166	53.61	849	29.68	0.64	
2012	164	56.10	334	30.24	0.65	

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

Appendix J: Recoveries of Coded-Wire Tagged Salmon Released Into the Tucannon River for the 1985-2008 Brood Years

Appendix J. 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 1985-2008 brood years. (Data downloaded from RMIS database on 2/14/13.)

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	
Other (%)	0.0		0.0		0.0	
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 J (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 1985-2008 brood years. (Data downloaded from RMIS database on 2/14/13.)

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	
Other (%)	0.0		0.0		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 J (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 1985-2008 brood years. (Data downloaded from RMIS database on 2/14/13.)

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	1			2	2
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	28	4	5	69	98
Tucannon (%)	85.7		40.0		82.7	
Out-of-Basin (%)	3.6		20.0		14.3	
Commercial Harvest (%)	0.0		40.0		0.0	
Sport Harvest (%)	0.0		0.0		2.0	
Treaty Ceremonial (%)	10.7		0.0		1.0	
Other (%)	0.0		0.0		0.0	
Survival	0.04		0.01		0.12	

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

Appendix J (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 1985-2008 brood years. (Data downloaded from RMIS database on 2/14/13.)

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	94
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	188
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	
Other (%)	0.0		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 J (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 1985-2008 brood years. (Data downloaded from RMIS database on 2/14/13.)

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	
Other (%)	0.0		0.0		0.0	
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 J (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 1985-2008 brood years. (Data downloaded from RMIS database on 2/14/13.)

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	
Other (%)	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 J (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 1985-2008 brood years. (Data downloaded from RMIS database on 2/14/13.)

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	5	21
Kalama R., Wind R.						
Fish Trap - F.W.						
Treaty Troll						
Lyons Ferry Hatch.[b]			58	58	21	21
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	26	42
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	
Other (%)	0.0		0.0		0.0	
Survival	0.01		0.09		0.06	

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

Appendix J (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 1985-2008 brood years. (Data downloaded from RMIS database on 2/14/13.)

Brood Year	2003		2004		2004	
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	24	102	17	73
Kalama R., Wind R.						
Fish Trap - F.W.						
Treaty Troll						
Lyons Ferry Hatch.[b]	3	3	44	44	36	36
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					3	14
Columbia R. Sport					1	4
CDFO						
Non-treaty Ocean Troll			1	1		
Mixed Net & Seine						
Ocean Sport						
USFWS						
Warm Springs Hatchery						
Dworshak NFH						
IDFG						
Hatchery						
Total Returns	8	24	69	147	57	127
Tucannon (%)	100.0		99.3		85.8	
Out-of-Basin (%)	0.0		0.0		0.0	
Commercial Harvest (%)	0.0		0.7		11.0	
Sport Harvest (%)	0.0		0.0		3.2	
Treaty Ceremonial (%)	0.0		0.0		0.0	
Other (%)	0.0		0.0		0.0	
Survival	0.02		0.22		0.10	

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

Appendix J (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 1985-2008 brood years. (Data downloaded from RMIS database on 2/14/13.)

Brood Year	2005		2005		2006	
Smolts Released	88,885		144,833		75,283	
Fish Size (g)	61		57		57	
CWT Codes[a]	34/77 CB		35/99		41/94 CB	
Release Year	2007		2007		2008	
Agency (fishery/location)	Observed Number	Estimated Number	Observed Number	Estimated Number	Observed Number	Estimated Number
WDFW						
Tucannon River	78	298	130	494	68	384
Kalama R., Wind R.						
Fish Trap - F.W.						
Treaty Troll						
Lyons Ferry Hatch.[b]	3	3	96	97	4	5
F.W. Sport						
Non-treaty Ocean Troll						
ODFW						
Test Net, Zone 4			2	2		
Treaty Ceremonial						
Three Mile, Umatilla R.						
Spawning Ground						
Fish Trap - F.W.						
F.W. Sport						
Hatchery						
Columbia R. Gillnet					8	33
Columbia R. Sport						
Juv. Marine Seine	1	1			3	3
CDFO						
Non-treaty Ocean Troll						
Mixed Net & Seine						
Ocean Sport						
USFWS						
Warm Springs Hatchery						
Dworshak NFH						
IDFG						
Hatchery						
Total Returns	82	302	228	593	83	425
Tucannon (%)	99.7		99.7		91.5	
Out-of-Basin (%)	0.0		0.0		0.0	
Commercial Harvest (%)	0.0		0.3		7.8	
Sport Harvest (%)	0.0		0.0		0.0	
Treaty Ceremonial (%)	0.0		0.0		0.0	
Other (%)	0.3		0.0		0.7	
Survival	0.34		0.41		0.56	

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

Appendix J (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 1985-2008 brood years. (Data downloaded from RMIS database on 2/14/13.)

Brood Year	2006		2006		2007	
Smolts Released	50,309		51,858		58,044	
Fish Size (g)	54		39		37	
CWT Codes[a]	40/93		40/94		46/87	
Release Year	2008		2008		2009	
Agency (fishery/location)	Observed Number	Estimated Number	Observed Number	Estimated Number	Observed Number	Estimated Number
WDFW						
Tucannon River	75	385	85	457	7	42
Kalama R., Wind R.						
Fish Trap - F.W.						
Treaty Troll						
Lyons Ferry Hatch.[b]	42	75	48	87	31	31
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	5	26	2	12	1	5
Columbia R. Sport						
Juv. Marine Seine	3	3	2	2		
CDFO						
Non-treaty Ocean Troll						
Mixed Net & Seine						
Ocean Sport						
USFWS						
Warm Springs Hatchery						
Dworshak NFH						
IDFG						
Hatchery			1	1		
Total Returns	125	489	138	559	39	78
Tucannon (%)	94.1		97.3		93.6	
Out-of-Basin (%)	0.0		0.2		0.0	
Commercial Harvest (%)	5.3		2.1		6.4	
Sport Harvest (%)	0.0		0.0		0.0	
Treaty Ceremonial (%)	0.0		0.0		0.0	
Other (%)	0.6		0.4		0.0	
Survival	0.97		1.08		0.13	

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

Appendix J (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 1985-2008 brood years. (Data downloaded from RMIS database on 2/14/13.)

Brood Year	2007		2008[c]		2008[c]	
Smolts Released	55,266		84,613		84,738	
Fish Size (g)	57		40		66	
CWT Codes[a]	46/88		51/74		51/75	
Release Year	2009		2010		2010	
Agency (fishery/location)	Observed Number	Estimated Number	Observed Number	Estimated Number	Observed Number	Estimated Number
WDFW						
Tucannon River	16	96	12	72	13	78
Kalama R., Wind R.						
Fish Trap - F.W.						
Treaty Troll						
Lyons Ferry Hatch.[b]	29	29	1	1		
F.W. Sport						
Non-treaty Ocean Troll						
ODFW						
Test Net, Zone 4						
Treaty Ceremonial						
Three Mile, Umatilla R.						
Spawning Ground						
Fish Trap - F.W.						
F.W. Sport						
Hatchery						
Columbia R. Gillnet			1	4		
Columbia R. Sport						
Juv. Marine Seine						
CDFO						
Non-treaty Ocean Troll						
Mixed Net & Seine						
Ocean Sport						
USFWS						
Warm Springs Hatchery						
Dworshak NFH						
IDFG						
Hatchery						
ADFG						
Ocean Troll					1	4
Total Returns	45	125	14	77	14	82
Tucannon (%)	100.0		94.8		95.1	
Out-of-Basin (%)	0.0		0.0		0.0	
Commercial Harvest (%)	0.0		5.2		4.9	
Sport Harvest (%)	0.0		0.0		0.0	
Treaty Ceremonial (%)	0.0		0.0		0.0	
Other (%)	0.0		0.0		0.0	
Survival	0.23		0.09		0.10	

[a] WDFW agency code prefix is 63.
[b] Fish trapped at TFH and held at LFH for spawning.
[c] Data for the 2008 brood year is incomplete.