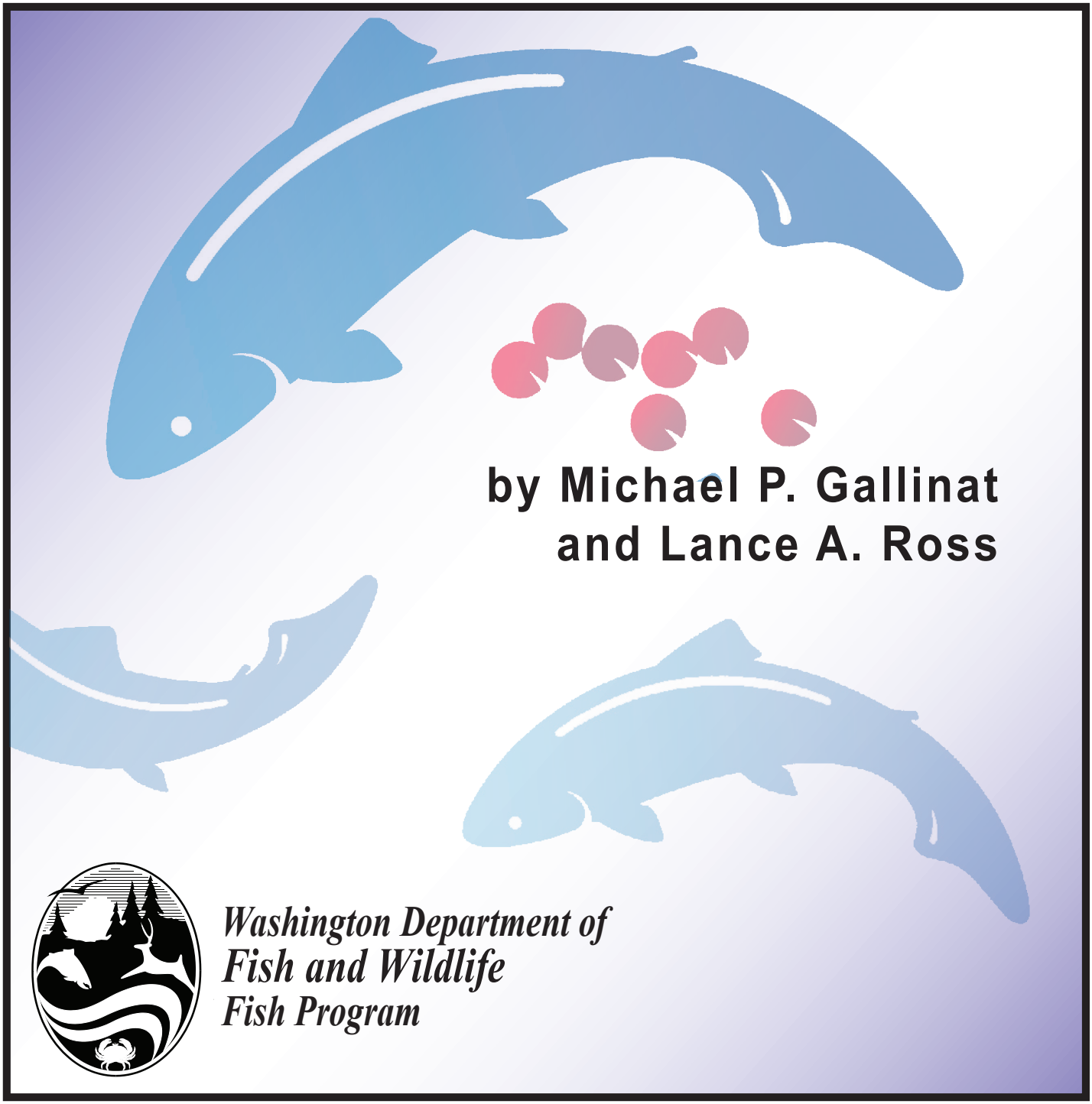
Tucannon River Spring Chinook Salmon Hatchery Evaluation Program 2016 Annual Report



by Michael P. Gallinat
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Washington Department of
Fish and Wildlife
Fish Program

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2016 Annual Report

by

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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 2016 to April 2017.

A total of 595 salmon were captured in the TFH trap in 2016 (116 natural adults, 11 natural jacks, 299 hatchery adults, and 169 hatchery jacks). Of these, 126 (55 natural, 71 hatchery) were collected and hauled to LFH for broodstock, 330 were held at LFH for adult outplanting, and the remaining fish were passed upstream. During 2016, three (2.4%) salmon collected for broodstock died prior to spawning.

Spawning of supplementation fish occurred once a week between 30 August and 20 September, with peak eggtake occurring on 6 September. A total of 245,174 eggs were collected from 31 natural and 41 hatchery-origin female Chinook. Egg mortality to eye-up was 4.5% (10,999 eggs) which left 234,175 live eggs. An additional 1.7% (4,069) loss of sac-fry left 230,106 BY 2016 fish for production.

Due to the relatively low run size in 2016 and the recent high pre-spawn mortality rates for Tucannon River spring Chinook, fish managers decided to hold a portion of the returning adults at LFH and then returning those fish to the upper stream reaches near the beginning of spawning. A total of 296 fish were returned to the river in small groups (~15 pairs/group) and released between Curl Lake (rkm 65.6) and Lady Bug Flat Campground (rkm 77.8) at nine different locations on 22 August and 23 August. Four pre-spawn mortalities of outplanted fish were recovered.

Evaluations personnel conducted pre-spawn mortality surveys in the Tucannon River between 23 June and 19 August during 2016, after which regular weekly spawning ground surveys commenced. These surveys covered from Camp Wooten (rkm 68) to Bridge 12 (rkm 47). Weekly spawning ground surveys were conducted from 26 August and were completed by 30 September 2016. A total of 154 redds and 113 carcasses (39 natural, 74 hatchery) were found. Based on redd counts, carcasses recovered, and broodstock collection, the estimated return to the

river for 2016 was 752 spring Chinook (215 natural adults, 8 natural jacks and 397 hatchery-origin adults, 132 hatchery jacks).

Volitional release of the 2015 BY smolts began on 4 April and continued until 21 April, 2017 when the remaining fish were forced out. An estimated 199,686 BY15 smolts were released.

Evaluation staff operated a downstream migrant trap to provide juvenile outmigration estimates. During the 2015/2016 emigration, we estimated that 6,604 (5,674-7,696 95% C.I.) natural spring Chinook (BY 2014) smolts emigrated from the Tucannon River.

Smolt-to-adult return rates (SAR) for natural origin salmon were almost eight 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.

Preliminary data does not show a significant benefit in either survival or homing back to the Tucannon River by rearing fish at TFH instead of LFH. Unless future data shows a different result, we will continue to use LFH for holding, spawning, and incubation and early life rearing of Tucannon River spring Chinook.

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Introduction

Program Objectives

Legislation under the Water Resources Act of 1976 authorized the establishment of the Lower Snake River Compensation Plan (LSRCP) to help mitigate for the losses of salmon and steelhead runs due to construction and operation of the Snake River dams and 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 (SAR) 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.

In an attempt to increase adult returns and come closer to achieving the 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 2016 through April 2017.

[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.

ESA Permits

The Tucannon River spring Chinook population was originally listed as "endangered" under the Endangered Species Act (ESA) on April 22, 1992 (FR 57 No. 78: 14653). The listing status was changed to "threatened" in 1995 (April 17, 1995; FR 60 No. 73: 19342). The listing was reviewed again in 1999 (FR 64 (57): 14517-14528) with the population remaining listed as "threatened" as part of the Snake River Spring/Summer Chinook Salmon evolutionary significant unit (ESU). The WDFW was originally issued a Section 10 Permit (#848 – broodstock collection and monitoring) which expired in March 1998. Permits #1126 and #1129 were issued in 1998 to allow continued 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, and was approved in 2016 (Permit #18024). This annual report summarizes all work performed by WDFW's LSRCP Tucannon Spring Chinook Salmon Evaluation Program during 2016. Numbers of direct and indirect takes of listed Snake River spring Chinook (Tucannon River stock) for the 2016 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/March, 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.

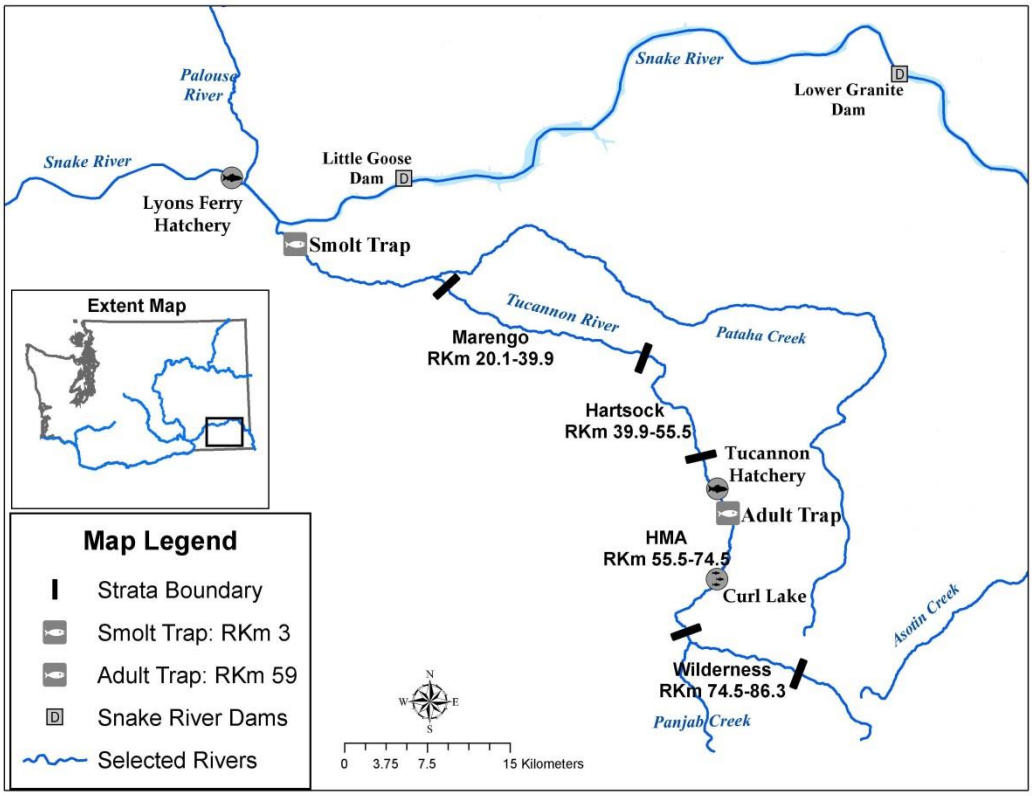

Figure 1. Location of the Tucannon River, and Lyons Ferry and Tucannon Hatcheries within the Snake River basin.

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 allowed collection goal for broodstock is 170 adult salmon, depending upon size and fecundity, collected from throughout the duration of the run to meet the smolt production/release goal of 225,000. The proportion of natural origin fish incorporated into the broodstock is based on the estimated run size and the Tucannon Spring Chinook Salmon Hatchery and Genetic Management Plan sliding scale. 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. All adipose clipped fish captured at the trap are killed outright as strays.

The TFH adult trap began operation in February (for steelhead) with the first spring Chinook captured on 10 May. State and Tribal Fisheries Managers decided to collect all Tucannon River returns that would not be used for broodstock and hold them at LFH for outplanting back into the river closer to the commencement of spawning (See Adult Outplanting Section). These measures were taken due to the high pre-spawn mortality rates observed in recent years. The majority of hatchery jacks were killed outright at the trap for fish management purposes. The trap was operated through September. A total of 595 fish entered the trap (116 natural adults, 11 natural jacks, 299 hatchery adults, and 169 hatchery jacks), and 55 natural (55 adults, 0 jacks) and 71 hatchery (71 adults, 0 jacks) spring Chinook were collected and hauled to LFH for broodstock (Table 2, Appendix B). Fish held for adult outplanting were given a right opercle punch and included 66 natural (57 adults, 9 jacks) and 264 hatchery origin fish (203 adults, 61 jacks). Fish not collected for transport to LFH were given a left opercle punch and passed upstream (25 total fish). Adults collected for broodstock were injected with tulathromycin (Draxxin[3]) at 2.5 mg/kg and oxytetracycline at 22 mg/kg, but fish held for adult outplants were not injected per WDFW Fish Health regulations. Broodstock and fish held for adult ouplanting were transported to LFH and received formalin drip treatments during holding at 167 ppm every other day at LFH to control fungus.

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

Table 2. Numbers of spring Chinook salmon captured at the TFH trap, trap mortalities, strays or jacks killed outright, fish collected for broodstock, and passed upstream or held for adult outplanting for natural spawning from 1986-2016.

	Captured at Trap		Trap Mortalities		Killed Outright[a]	Broodstock Collected		Passed Upstream		Held for Adult Outplanting	
Year	Natural	Hatchery	Natural	Hatchery	Hatchery	Natural	Hatchery	Natural	Hatchery	Natural	Hatchery
1986	247	0	0	0	0	116	0	131	0	0	0
1987	209	0	0	0	0	101	0	108	0	0	0
1988	267	9	0	0	0	116	9	151	0	0	0
1989	156	102	0	0	0	67	102	89	0	0	0
1990	252	216	0	1	0	60	75	192	140	0	0
1991	109	202	0	0	0	41	89	68	113	0	0
1992	242	305	8	3	0	47	50	187	252	0	0
1993	191	257	0	0	0	50	47	141	210	0	0
1994	36	34	0	0	0	36	34	0	0	0	0
1995	10	33	0	0	0	10	33	0	0	0	0
1996	76	59	1	4	0	35	45	40	10	0	0
1997	99	160	0	0	0	43	54	56	106	0	0
1998[b]	50	43	0	0	0	48	41	1	1	0	0
1999[c]	4	139	0	1	0	4	135	0	0	0	0
2000	25	180	0	0	17	12	69	13	94	0	0
2001	405	276	0	0	0	52	54	353	222	0	0
2002	168	610	0	0	0	42	65	126	545	0	0
2003	84	151	0	0	0	42	35	42	116	0	0
2004	311	155	0	0	0	51	41	260	114	0	0
2005	131	114	0	0	3	49	51	82	60	0	0
2006	61	78	0	1	2	36	53	25	22	0	0
2007	112	112	0	0	6	54	34	58	72	0	0
2008	114	386	0	0	1	42	92	72	293	0	0
2009	390	835	0	0	7	89	88	301	740	0	0
2010	774	796	0	0	9	86	87	688	700	0	0
2011	400	383	0	0	6	89	77	311	300	0	0
2012	240	301	0	0	6	93	77	147	218	0	0
2013	271	268	0	0	2	98	60	173	206	0	0
2014[d]	343	215	0	0	0	86	41	257	174	0	0
2015	285	594	0	0	32	101	30	126	348	58	184
2016	127	468	0	0	114	55	71	6	19	66	264

[a] Fish identified as strays at the adult trap are killed outright. Some hatchery jacks were killed outright in 2016.
[b] Two males (one natural, one hatchery) captured were transported back downstream to spawn in the river.
[c] Three hatchery males that were captured were transported back downstream to spawn in the river.
[d] Ninety-four natural origin fish were collected for broodstock , however eight natural origin females were returned to the river for natural spawning leaving a total of 86 natural origin fish collected for broodstock.

Broodstock Mortality

Three (2.4%) of the 126 salmon collected for broodstock died prior to spawning in 2016 (Table 3). One of the pre-spawn mortalities was a stray hatchery male (CWT 090719 – Umatilla River). Table 3 shows that pre-spawning mortality in 2016 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 (1992-2016).

	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
2013	2	3	0	5.1	0	2	0	3.3
2014	0	1	0	1.2	0	0	0	0.0
2015	0	1	0	1.0	0	1	0	3.3
2016	0	1	0	1.8	2	0	0	2.8

Broodstock Spawning

Spawning at LFH was conducted once a week from 30 August to 20 September, with peak eggtake occurring on 6 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). The priority order of crosses were Natural x Hatchery, Natural x Natural, and Hatchery x Hatchery, depending upon availability of fish. Two hatchery males and two hatchery females were identified as Umatilla Hatchery strays during spawning based on reading their CWT and their gametes were destroyed and not used for production.

A total of 245,174 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 were incubated in vertical tray 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 4.5% which left 234,175 live eggs. An additional 1.7% (4,069) loss of sac-fry left 230,106 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 2016. (Numbers in parentheses were live spawned).

				Natural Origin			
	Males		**Jacks**		**Females**		
Spawn Date	**Spawned**	**K.O.**	**Spawned**	**K.O.**	**Spawned**	**K.O.**	**Eggs Taken**
8/30	0 (9)				9		33,730
9/06	0 (19)				10		32,894
9/13	9 (14)				11		45,207
9/20	13[a]				1	1[b]	2,996
Totals	22	0	0	0	31	1	**114,827**
Egg Mortality							4,804
				Hatchery Origin			
	Males		**Jacks**		**Females**		
Spawn Date	**Spawned**	**K.O.**	**Spawned**	**K.O.**	**Spawned**	**K.O.**	**Eggs Taken**
8/30	8	1			8	1	27,678
9/06	9	1			19	1	61,710
9/13	7				14		40,959
Totals	24	2	0	0	41	2	**130,347**
Egg Mortality							6,195

[a] Eleven were previously live spawned and sampled at the completion of spawning.
[b] This female was green and killed outright.

Adult Outplanting

After discussions with the Tribal co-managers, it was decided to collect all returning fish not collected for broodstock or killed outright (strays, hatchery jacks) and hold them at LFH for adult outplanting back into the river during late August near the on-set of spawning. This decision was made due to the relatively low run size and the high pre-spawn mortality rate of adult spring Chinook salmon that has been documented in the Tucannon River in recent years (Gallinat and Ross 2014; Gallinat and Ross 2015; Snake River Lab 2015). Collected fish would be returned to the river between Beaver/Watson Bridge and Lady Bug Flat Campground (rkms 62-78).

A total of 330 fish (66 natural origin, 264 hatchery origin) were collected for adult outplanting. Held fish were treated with formalin to control fungus growth, but were not injected with antibiotics. Of the fish that were held, three natural origin and 26 hatchery origin fish died at LFH (8.8% pre-spawn mortalities). In addition, five hatchery origin fish were determined to be strays (AD clipped) and were killed outright. The remaining 296 fish were transported back to the river in small groups (~ 15 pairs/group) and released at or above Curl Lake (rkm 65.6) at nine different locations on 22 August and 23 August (Table 5). Fish captured in the adult trap after 21 August were given a left opercle punch (LOP) and released upstream. Stream surveys were conducted prior to and following adult outplanting and four pre-spawn mortalities of outplanted fish were recovered.

Table 5. The number of Tucannon River spring Chinook outplanted in the Tucannon River by release location during 2016.

Date	Release Location	Rkm	Females	Males	Jacks	Total
8/22/16	Lady Bug Flat Campground	77.8	15	8	6	29
8/22/16	Panjab Bridge	74.5	30	16	12	58
8/22/16	Private Lands Campsite	73.3	15	8	6	29
8/22/16	Campground above Cow Camp	73.1	15	8	6	29
8/22/16	Campground at Cow Camp Br.	72.9	15	10	2	27
8/23/16	Across from Camp Wooten	68.4	15	8	6	29
8/23/16	Camp Wooten Bridge	68.1	15	8	6	29
8/23/16	Curl Lake Intake	66.1	15	8	6	29
8/23/16	Behind Curl Lake	65.6	3	17	17	37
Totals			**138**	**91**	**67**	**296**

Only one outplanted hatchery jack (ROP) was recovered below the outplant area at rkm 59.4, suggesting that movement of outplanted fish from the release sites was negligible. Some redd superimposition was observed in the upper watershed suggesting available suitable spawning areas were saturated.

Natural Spawning

Pre-spawn mortality surveys were conducted from 23 June to 19 August during 2016, after which regular weekly spawning ground surveys commenced. Although fish were not passed above the trap prior to 21 August, pre-spawn mortality surveys were still conducted upstream of the trap in case fish were able to bypass the trap. The pre-spawning mortality surveys covered from Camp Wooten (rkm 68) to Bridge 12 (rkm 47). Only one unidentified origin female was recovered (rkm 58.6) during pre-spawn mortality surveys. Six other pre-spawn mortalities were recovered during regular spawning ground surveys. This included four fish (two hatchery origin, two natural origin) above the trap from the adult outplant group and two fish (hatchery origin) below the adult trap. Cause of death could not be determined for any of the recovered pre-spawn mortalities, but many had been partially to mostly consumed by predators/scavengers.

Weekly spawning ground surveys were conducted from 26 August and were completed by 30 September 2016. One hundred fifty-four redds were counted and a total of 39 natural and 74 hatchery origin carcasses were recovered (Table 6). Eighty-three redds (54% of total) and 76 carcasses (67% of total) were found above the adult trap. Adult outplanting during 2016 indicated that there was a low conversion rate of females to eventual redd (151 females outplanted or passed upstream and only 83 redds produced for a 55% conversion rate).

Table 6. Numbers and general locations of salmon redds and carcasses (includes pre-spawn mortalities) recovered on the Tucannon River spawning grounds, 2016 (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	14	9	9
	75-78	23	10	13
HMA	73-75	14	2	9
	68-73	15	0	12
	66-68	11	2	4
	62-66	0	1	1
	59-62	6	2	2
----------Tucannon Fish Hatchery Trap----------				
	56-59	33	12	22
Hartsock	52-56	8	0	0
	47-52	14	1	1
	43-47	3	0	0
	40-43	6	0	1
Marengo	34-40	3	0	0
	28-34	0	0	0
Below Marengo	0-28	4	0	0
Totals	**0-86**	**154**	**39**	**74**

[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, these two factors were a result of a greater emphasis on broodstock collection in an effort to reduce the risk of 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 7). Also, moving the release location from TFH (rkm 57.7) upstream to Curl Lake AP (rkm 65.6) 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 7).

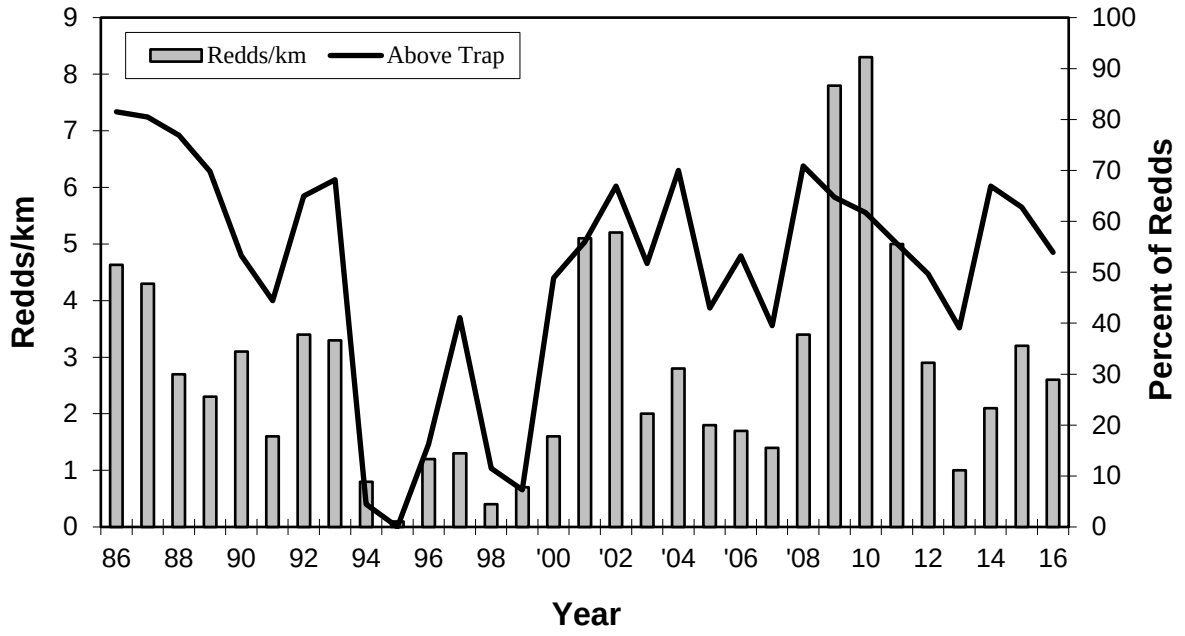

Figure 2. Number of redds/km and percentage of redds above the adult trap on the Tucannon River, 1986-2016.

Table 7. Number of spring Chinook salmon redds and redds/km (in parenthesis) by stratum and year, and the number and percent of redds above and below the TFH adult trap in the Tucannon River, 1985-2016.

	Strata[a]					TFH Adult Trap[b]			
Year	Wilderness	HMA	Hartsock	Marengo	Total Redds[b]	Above	%	Below	%
1985[c]	101 (9.2)	165 (8.7)	50 (3.1)	–	316	–	–	–	–
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
2013	3 (0.3)	42 (2.2)	15 (0.9)	0 (0.0)	64	25	39.1	39	60.9
2014	26 (2.4)	70 (3.7)	25 (1.6)	1 (0.1)	124	83	66.9	41	33.1
2015	56 (5.1)	91 (4.8)	33 (2.1)	4 (0.3)	191	120	62.8	71	37.2
2016	37 (3.4)	79 (4.2)	31 (1.9)	3 (0.3)	154	83	53.9	71	46.1

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

[a] Excludes redds found below the Marengo stratum.

[b] Includes all redds counted during redd surveys.

[c] The 1985 redd counts were revised to account for all redds during the spawning season (WDFW 2015).

Stream Nutrient Enrichment

The majority of hatchery broodstock carcasses have traditionally been buried on-site at LFH after spawning. However, declines in salmonid abundance during the last century have resulted in decreased deposition of marine-derived nutrients and pose a significant restraint in the recovery of threatened and endangered Pacific salmon (Nehlsen et al. 1991; Scheuerell et al. 2005). The importance of marine derived nutrients to salmon recovery efforts has prompted local volunteer groups and state, federal, and tribal agencies to add supplemental nutrients into freshwater habitats, especially in salmon depleted habitats (Kohler et al. 2012).

A total of 304 fall Chinook and 148 spring Chinook carcasses were available for stream nutrient enrichment in the Tucannon River during 2016. Virology testing did not show signs of disease so the "Protocols for the Nutrient Enrichment of the Tucannon River to Increase Production of Salmon and Steelhead" were followed and fall Chinook carcasses, due to their relative abundance, were used as a surrogate for spring Chinook carcasses. Department employees and volunteers from the Tri-State Steelheaders Regional Fisheries Enhancement Group distributed the carcasses between Panjab Bridge (rkm 74.5) and Bridge 11 (rkm 44.0) from 14-19 December, 2016 (Table 8). Carcasses were distributed based on 2016 redd locations and expected downstream movement of juveniles.

Table 8. Summary of Chinook salmon carcass distribution on the Tucannon River from 14-19 December, 2016.

Location Name	River kilometer	Number of Carcasses
Panjab Bridge	74.5	40
Private Lands Campground	73.3	40
Cow Camp Bridge	72.9	40
Across from Camp Wooten	68.4	30
Camp Wooten Bridge	68.1	40
Forest Service Guard Station	66.8	20
Beaver/Watson Bridge	61.9	20
Below Beaver/Watson	61.6	20
Hatchery Intake----------	--------59.2--------	----------
Hatchery Bridge	58.2	35
Cummings Creek Bridge	55.9	41
Bridge 14	51.5	40
Bridge 13	48.9	40
Bridge 12	47.1	37
Bridge 11	44.0	9
Totals		**452**

Genetic Sampling

During 2016, we collected 207 DNA samples (tissue samples) from hatchery broodstock and carcasses collected from the spawning grounds (85 natural origin, 109 hatchery supplementation, and 13 hatchery origin strays). 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. Due to the management decision in 2016 to kill hatchery jacks outright at the adult trap, the proportion of jacks sampled from the population were skewed higher than if samples were collected only from recovered carcasses. Therefore, we adjusted the proportion of hatchery jacks using a simple linear regression describing the relationship between the proportion of hatchery jacks trapped at the TFH adult trap and the expanded proportion of hatchery jacks based on the historical run size for the 2000-2015 run years (r^2 = 74%; P< 0.01):

Proportion of Hatchery Jacks (expanded) = -6.718 + 0.912(Proportion of Hatch. Jacks Trapped)

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 can lead to higher proportions of early maturating fish (hatchery origin smolts are generally 25-30 mm greater in length than natural smolts). The age composition for natural origin fish that returned in 2016 had more age-5 fish compared to the historical age composition (Figure 3). While there are more older age fish in the natural component of the population, we have not seen significant change in the mean age (weighted) of males and females over 27 brood years (Figure 4). The age composition by brood year for natural and hatchery origin fish is found in Appendix C.

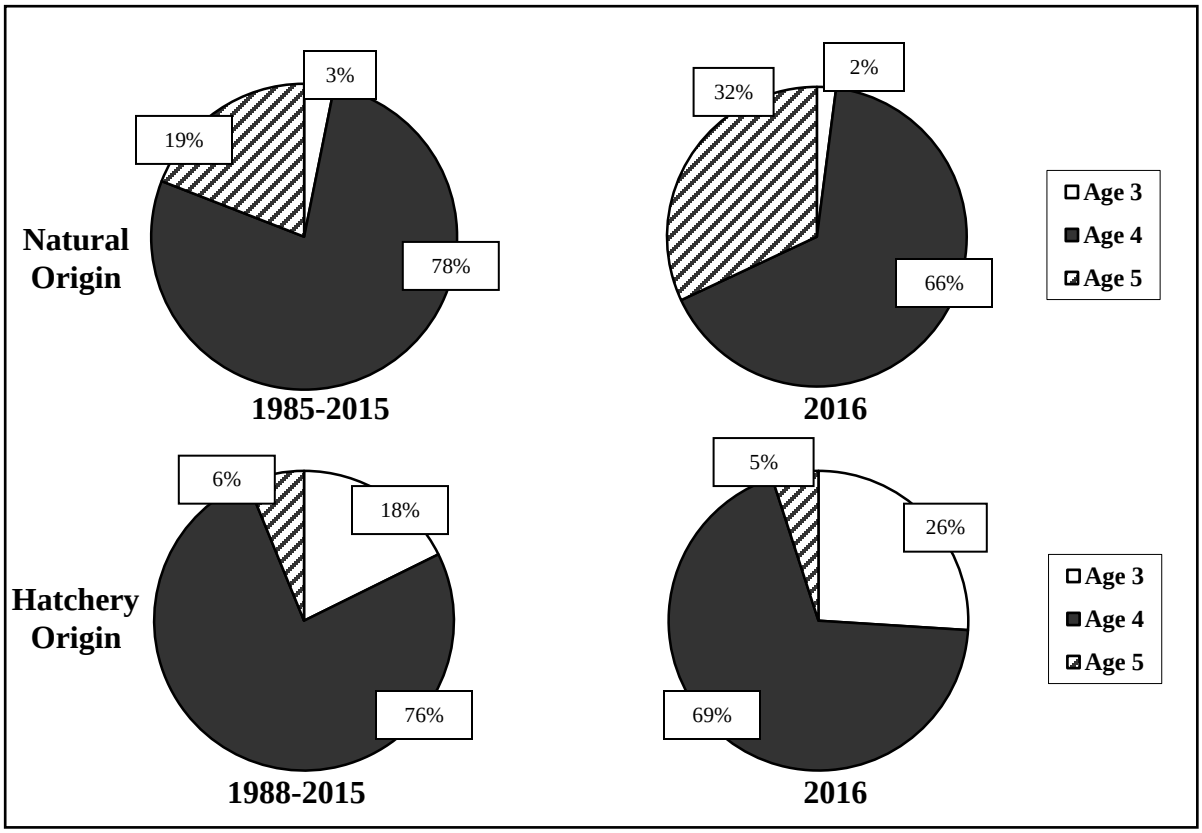

Figure 3. Historical (1985-2015), and 2016 age composition (run year) for spring Chinook in the Tucannon River.

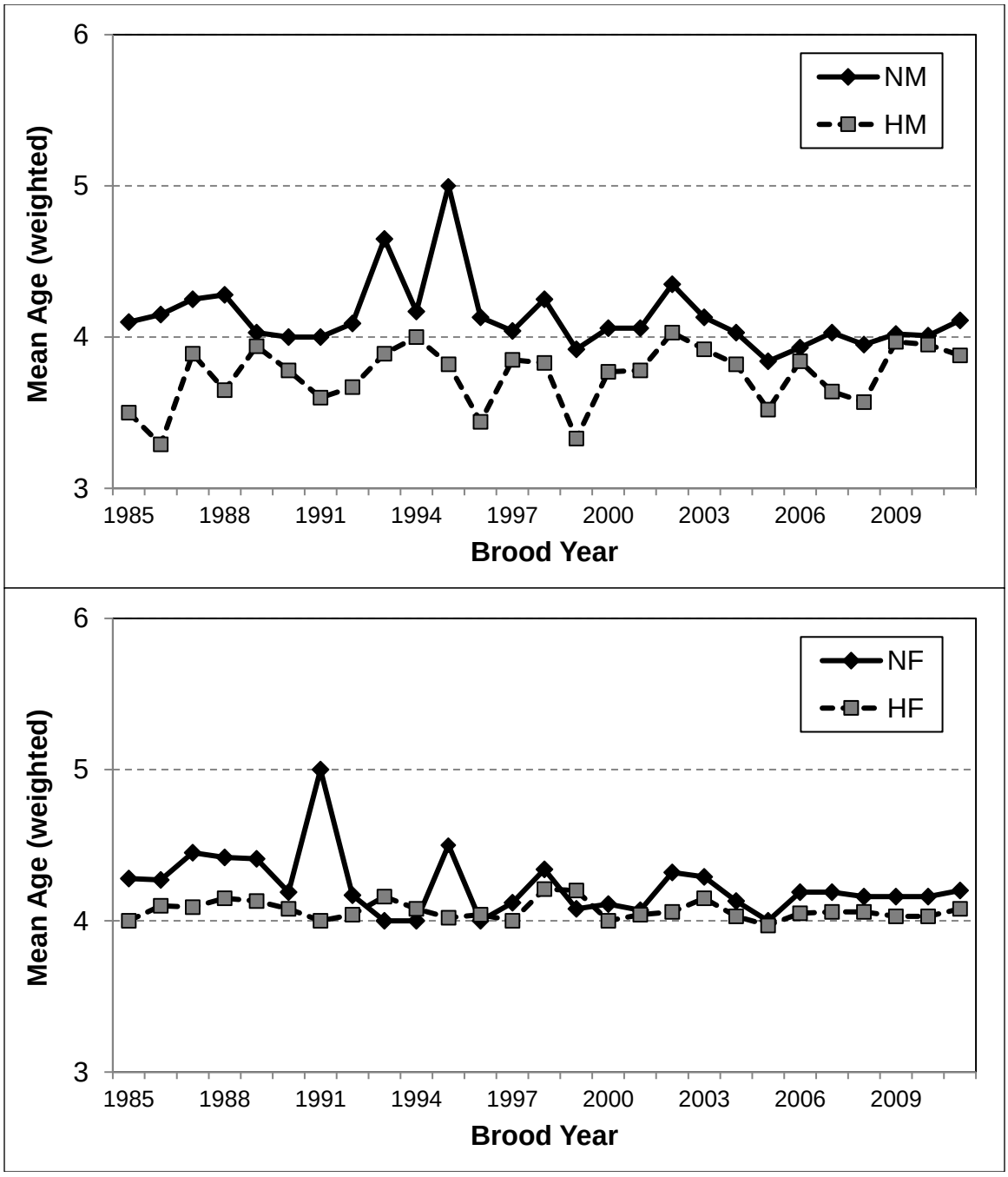

Figure 4. Weighted mean age of natural and hatchery origin males (NM, HM) and natural and hatchery origin females (NF, HF) for the 1985 to 2011 brood years for spring Chinook in the Tucannon River.

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) length. We examined size at age for returns using multiple comparison analysis from 1985-2016 and found a significant difference ($P < 0.05$) in mean POH length between age-4 natural and hatchery-origin female, and age-4 natural and hatchery-origin male spring Chinook salmon (Figure 5).

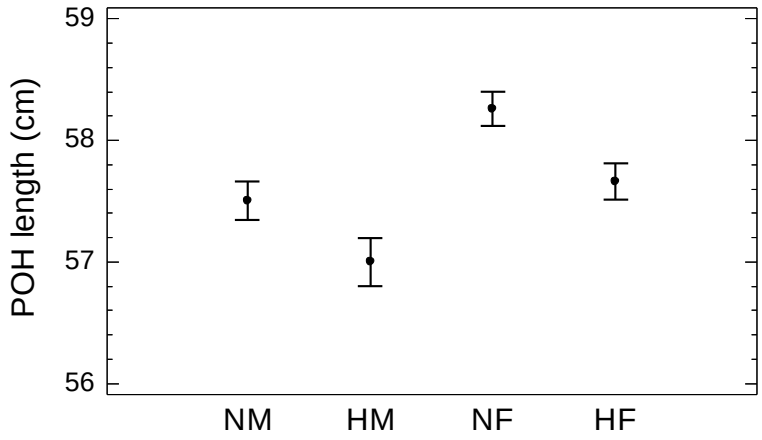

Figure 5. Mean post-orbital to hypural-plate (POH) length comparisons between age-4 natural and hatchery-origin males (NM and HM) and natural and hatchery-origin females (NF and HF) with 95% confidence intervals for the years 1985-2016.

To estimate fecundities (number of eggs/female) from the 2016 return year, dead eggs were counted for each female and a subsample of 100 live eyed-eggs was weighed. The total mass of live eggs was also weighed, and divided by the average weight per egg to yield total number of live eggs. This estimate was decreased by 4% to compensate for adherence of water on the eggs (WDFW Snake River Lab, unpublished data). Fecundities of natural and hatchery origin fish from the Tucannon River program have been documented since 1990 (Table 9). 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 ($P < 0.001$).

These data correspond with data collected by Gallinat and Chang (2013) that examined the effects of hatchery rearing on selected phenotypic traits of female Tucannon River spring Chinook salmon. They found that hatchery origin females had significantly lower fecundity than natural origin fish after correcting for body size. They also observed that the progeny of captive-

reared broodstock, released as smolts and recaptured as returning age-4 adults, had a size and fecundity distribution that was similar to the hatchery-origin adults, suggesting that the decrease in fecundity was related to hatchery rearing and not a genetically linked trait.

Table 9. Average number of eggs/female (n, SD) by age group of Tucannon River natural and hatchery origin broodstock, 1990-2016 (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)
2013	3,479 (34, 574.8)	3,145 (28, 592.9)	4,702 (12, 931.5)	3,746 (2, 185.3)
2014	3,622 (34, 501.3)	3,280 (26, 545.6)	4,575 (3, 807.3)	3,558 (1, 000.0)
2015	3,683 (47, 629.5)	3,468 (20, 671.8)	4,755 (8, 818.0)	No Fish
2016	3,456 (19, 676.1)	3,133 (36, 652.7)	4,096 (12, 891.2)	3,514 (5, 508.6)
Mean	**3,481**	**3,084**	**4,467**	**3,689**
SD	**637.2**	**652.9**	**860.2**	**725.2**

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 for natural origin fish was earlier than normal during 2016 but was within the historical range (Table 10). However, this earlier arrival may have been due to a smaller run size since the next highest number of natural origin fish at the adult trap was the same date (6 June) as the peak for hatchery origin fish (Table 10). Peak spawning date in the hatchery was close to the historical means and was 13 September for hatchery fish and 6 September for natural origin fish (Table 10). The duration of spawning in the hatchery was also within the historical mean. Spawning in the river peaked on 7 September. The duration of active spawning in the Tucannon River was within the range found from previous years.

Natural origin fish typically arrive earlier and at a slightly faster rate than hatchery origin fish (Figure 6). On average, about half of the total run of hatchery origin fish typically arrives at the adult trap by 12 June (Figure 6). After the end of June, the hatchery fish tend to arrive at the adult trap at a slightly faster rate than natural origin fish.

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, 1986-2016.

	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
2012	5/30	6/02	9/11	9/18	22	9/12	36
2013	6/06	6/06	9/10	9/10	29	9/11	42
2014	5/27	6/04	9/09	9/09	22[c]	9/11	35
2015	5/18	5/20	9/15	9/08	29	9/09	44
Mean	**6/01**	**6/05**	**9/12**	**9/10**	**26**	**9/13**	**35**
2016	5/19	6/06	9/13	9/06	22	9/07	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 in excess of eggtake goals were returned to the river for natural spawning which may have truncated duration of spawning in the hatchery.

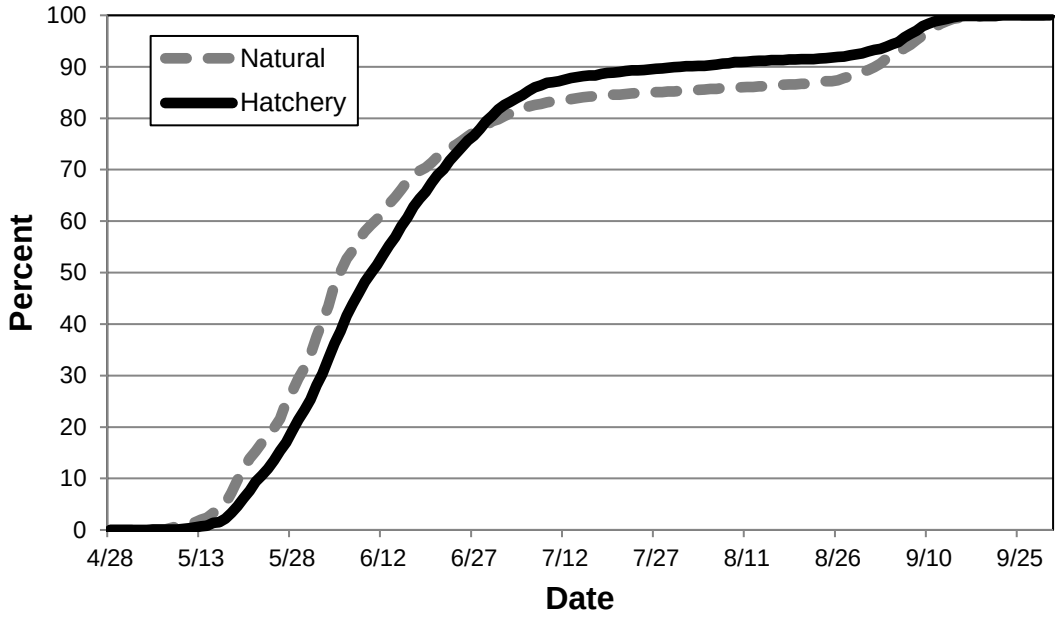

Figure 6. Cumulative run timing by date at the Tucannon Fish Hatchery adult trap on the Tucannon River for both natural and hatchery origin Tucannon River spring Chinook salmon, 1994-2016.

Total Run-Size

Not passing any fish above the adult trap until the end of August and the use of adult outplants (See Adult Outplanting Section) has confounded our calculations of fish below the adult trap. Hatchery staff passed six natural origin and 19 hatchery origin fish upstream of the trap (left opercle punch) for a total of 25 fish passed upstream. There were a total of 296 (63 natural origin, 233 hatchery origin) total adult outplants (right opercle punch). No fish without an opercle punch were recovered above the trap so we made the assumption that no fish were able to bypass the trap in 2016. No fish that passed over the trap or were outplanted upstream (left or right opercle punched carcasses) were recovered below the trap, so we assumed little to no fallback at the trap. We calculated the number of fish below the trap by using the fish/redd estimate (2.21 – from the spawning escapement calculation) and multiplied that by the number of redds below the trap (71) for a total of 157 fish below the trap.

The run-size estimate for 2016 was calculated by adding the estimated number of fish upstream of the TFH adult trap (321), the estimated fish below the weir (157), the number of pre-spawn mortalities and strays killed outright from fish held at LFH for adult outplanting (34), strays and hatchery jacks killed at the trap for management purposes (114), and the number of broodstock collected (126) (Table 11). Run-size for 2016 was estimated to be 752 fish (215 natural adults, 8

natural jacks, and 397 hatchery adults, 132 hatchery-origin jacks). Historical breakdowns are provided in Appendix D.

Table 11. Estimated spring Chinook salmon run to the Tucannon River and recovered pre-spawn mortalities (PSM), 1985-2016.

Year[a]	Total Redds	Fish/Redd Ratio[b]	Potential Spawners	Broodstock Collected	Trap/Holding Mortalities[c]	Total Run-Size	River PSM[d]	Percent Natural
1985[e]	316	2.60	822	22	0	844	0	100
1986	200	2.60	520	116	0	636	0	100
1987	185	2.60	481	101	0	582	0	100
1988	117	2.60	304	125	0	429	0	96
1989	106	2.60	276	169	0	445	0	76
1990	180	3.39	610	135	1	746	7	66
1991	90	4.33	390	130	0	520	8	50
1992	200	2.82	564	97	11	672	81	58
1993	192	2.27	436	97	0	533	56	57
1994	44	1.59	70	70	0	140	0	70
1995	5	2.20	11	43	0	54	0	39
1996	69	2.00	138	80	5	223	29	64
1997	73	2.00	146	97	0	243	108	50
1998	26	1.94	51	89	0	140	4	61
1999	41	2.60	107	136	1	244	1	1
2000	92	2.60	239	81	17	337	2	24
2001	297	3.00	891	106	0	997	12	71
2002	299	3.00	897	107	0	1,004	1	35
2003	118	3.10	366	77	0	443	1	56
2004	160	3.00	480	92	0	572	1	70
2005	107	3.10	332	100	3	435	0	69
2006	109	1.60	174	89	3	266	0	57
2007	81	3.10	250	88	6	344	0	58
2008	199	4.10	1,056	134	1	1,191	0	45
2009	451	3.70	1,676	177	7	1,860	2	40
2010	481	4.87	2,341	173	9	2,523	2	57
2011	297	3.79	1,128	166	6	1,300	0	58
2012	169	6.30	1,059	170	6	1,235	4	66
2013	64	14.96	955	158	2	1,115	2	67
2014	124	7.70	959	127	0	1,086	18	83
2015	191	6.10[f]	1,604	131	42	1,777	28	41
2016	154	3.87[f]	478	126	148	752	6	30

[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] This total includes stray fish that are killed at the trap and pre-spawn mortalities of fish held at LFH for adult outplanting. During 2016 jacks were killed outright at the adult trap and are included in this total.

[d] 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.

[e] The 1985 redd counts were revised on the SASI database to account for all redds during the spawning season (WDFW 2016).

[f] The fish/redd ratio was not used to estimate the number of fish below the adult trap due to survival differences between outplanted fish and fish that were passed upstream.

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 the natural and hatchery fish by reach [Wilderness, HMA (above trap), HMA (below trap), Hartsock, Marengo, and below Marengo] 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 spawning escapement for 2016 was 340 fish (114 natural-origin, 226 hatchery-origin) based on 2.21 fish per redd. The estimated spawning escapement for 1985 to 2016 is found in Table 12.

Table 12. Estimated spawning escapement and the calculation methodology used for the 1985 to 2016 run years.

Run Year	Number of Redds	Spawning Escapement	Natural:Hatchery Ratio	Fish/Redd	Methodology
1985[a]	316	695	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	211	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	1191	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	335	0.698:0.302	1.98	Sex ratio at Adult Trap
2013	64	170	0.697:0.303	2.66	Sex ratio at Adult Trap
2014	124	294	0.726:0.274	2.37	Sex ratio at Adult Trap
2015	191	523	0.330:0.670	2.74	Sex ratio at Adult Trap
2016	154	340	0.336:0.664	2.21	Sex ratio at Adult Trap

[a] The 1985 redd counts were revised on the SASI database to account for all redds during the spawning season (WDFW 2015).

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 13). In 2016, based on the estimated escapement of fish to the river, we sampled approximately 52% of the run (Table 14).

Table 13. Coded-wire tag codes of hatchery salmon sampled at LFH and the Tucannon River, 2016.

	Broodstock Collected			Adult Outplants[a]	Recovered in Tucannon River			
CWT Code	Died in Pond	Killed Outright	Spawned	PSM's And KO's	Dead in Trap[b]	Pre-spawn Mortality	Spawned	Totals
63-68-84							1	1
63-67-42				2	78		4	84
63-67-43					14			14
63-65-85			54	18	2	3	51	128
63-65-86			3	1			2	6
63-64-41	1		6	1			2	10
Lost			2		1		1	4
-Strays-								
09-08-61							1	1
09-07-19	1	2		3		1	5	12
09-07-29					2			2
09-07-33							1	1
22-01-34							1	1
09-06-52		2						2
AD/No Wire[b]				6	17		1	24
Total	**2**	**4**	**65**	**31**	**114**	**4**	**70**	**290**

[a] These are pre-spawn mortalities that died during holding at LFH and strays that were killed outright from the adult outplant group.

[b] The majority of hatchery jacks were killed outright at the adult trap in 2016 for adult management. Adipose clipped strays are killed outright at the trap.

Table 14. Spring Chinook salmon (natural and hatchery) sampled from the Tucannon River, 2016.

	2016		
	Natural	**Hatchery**	**Total**
Total escapement to river	223	529	752
Broodstock collected	55	71	126
Fish dead in adult trap	0	114	114
Adult outplant pre-spawn mortalities	3	31	34
Total hatchery sample	58	216	274
Total fish left in river	165	313	478
In-river pre-spawn mortalities observed	2	4	6
Spawned carcasses recovered	39	70	109
Total river sample	41	74	115
Carcasses sampled	99	290	389

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 fish 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. Beginning with the 2000 BY, Umatilla River hatchery-origin spring Chinook were 100% marked (adipose clipped), however, the implementation of a "stepping stone" hatchery management protocol for the Umatilla Hatchery Program has resulted in a portion of Umatilla Hatchery releases being unclipped beginning with the 2009 BY. This hinders our ability to selectively remove stray hatchery fish during broodstock collection, or from fish passed upstream at the TFH adult trap. We will continue to monitor the Tucannon River and emphasize the need for external marks and CWTs for Umatilla River releases.

Forty-three strays (one Clearwater River, 18 Umatilla River, and 24 AD clip/no wire) were recovered during 2016 (Appendix E). Nineteen strays were killed outright at the trap (two CWT 090729 and 17 AD clip/no wire), ten were recovered during spawning ground surveys (one CWT 090861, one CWT 090733, six CWT 090719, one CWT 220134, and one AD clip/no wire), nine were killed outright from the adult outplant group (three CWT 090719 and six AD clip/no wire), and five were inadvertently collected for broodstock (three CWT 090719 and two CWT 090652)]. After expansions, strays accounted for an estimated 10.0% of the total 2016 run (Appendix E).

The increased use of passive integrated transponder (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 some spring Chinook PIT tagged from other locations during 2016. A total of thirty-five fish originally PIT tagged at locations other than the Tucannon River were detected in the Tucannon River (Table 15). The majority of these fish (30) were of unknown origin that were tagged as adults at Lower Granite Dam and eventually returned back downstream and entered the Tucannon River (Table 15). These fish could be Tucannon origin fish that overshot the river and returned back, however their actual origin is unknown. However, based on detection histories from three of the four strays detected in the Tucannon River that were also detected at Lower Granite Dam, these unknown origin fish could just as likely be stray spring Chinook from other basins. Two PIT tagged strays were detected at the Upper Tucannon River array (John Day and Walla Walla river origin), and three were detected at the Lower Tucannon River array (John Day, Selway, and Umatilla river origin) (Table 15).

Table 15. Tucannon River PIT tag array detections of spring Chinook originally tagged at locations other than the Tucannon River during 2016.

PIT Tag	Origin	Tag Date	Life Stage At Tagging	Tag Release Location	Detection Date	Tucannon Site[a]
384.3B23A964E5[b]	H	4/09/14	Juvenile	Umatilla River	6/19/16	LTR
384.3B23AE9D6E[c]	W	4/02/14	Juvenile	John Day River	5/22/16	LTR
3DD.0077471ACA[b]	W	12/05/14	Juvenile	John Day River	5/31/16	UTR
3D9.1C2DB792F3[b]	W	4/26/13	Juvenile	Walla Walla River	9/04/16	UTR
3DD.007776DC04	H	3/14/16	Juvenile	Selway River	7/08/16	LTR
3D9.1C2DDC302F	W	5/11/16	Adult	Lower Granite Dam	9/05/16	UTR
3D9.1C2DDC584C	W	6/03/16	Adult	Lower Granite Dam	6/23/16	UTR
3D9.1C2DDC7780	H	6/01/16	Adult	Lower Granite Dam	6/15/16	UTR
3D9.1C2DDC9287	W	5/20/16	Adult	Lower Granite Dam	6/08/16	UTR
3D9.1C2DDCBCAD	H	6/06/16	Adult	Lower Granite Dam	6/29/16	UTR
3D9.1C2DDCC352	W	5/13/16	Adult	Lower Granite Dam	6/01/16	UTR
3D9.1C2DDCDD35	H	5/16/16	Adult	Lower Granite Dam	6/09/16	UTR
3D9.1C2DDCE668	W	5/11/16	Adult	Lower Granite Dam	6/04/16	UTR
3D9.1C2DDCFCA6	W	6/17/16	Adult	Lower Granite Dam	7/14/16	MTR
3D9.1C2DDD178B	H	6/02/16	Adult	Lower Granite Dam	6/20/16	UTR
3D9.1C2DDD25E2	W	6/16/16	Adult	Lower Granite Dam	6/29/16	UTR
3D9.1C2DDD2EFA	W	5/27/16	Adult	Lower Granite Dam	6/16/16	UTR
3D9.1C2DDD37C2	W	5/26/16	Adult	Lower Granite Dam	6/20/16	UTR
3D9.1C2DDD3E66	W	5/20/16	Adult	Lower Granite Dam	6/02/16	UTR
3D9.1C2DDD4E5E	H	5/11/16	Adult	Lower Granite Dam	5/27/16	UTR
3D9.1C2DDD4ED1	W	6/10/16	Adult	Lower Granite Dam	6/18/16	LTR
3D9.1C2DDD58A1	W	6/13/16	Adult	Lower Granite Dam	7/08/16	UTR
3D9.1C2DE0F54B	H	5/20/16	Adult	Lower Granite Dam	5/29/16	LTR
3D9.1C2DE114BB	W	5/19/16	Adult	Lower Granite Dam	6/05/16	UTR
3D9.1C2DE12305	H	5/25/16	Adult	Lower Granite Dam	6/10/16	UTR
3D9.1C2DE12371	W	6/10/16	Adult	Lower Granite Dam	6/26/16	UTR
3D9.1C2DE13175	W	5/19/16	Adult	Lower Granite Dam	6/06/16	UTR
3D9.1C2DE1497E	W	5/13/16	Adult	Lower Granite Dam	5/29/16	UTR
3D9.1C2DE14A56	W	6/01/16	Adult	Lower Granite Dam	6/14/16	UTR
3D9.1C2DE15B98	W	6/14/16	Adult	Lower Granite Dam	7/15/16	UTR
3D9.1C2DE17543	W	5/10/16	Adult	Lower Granite Dam	5/29/16	UTR
3D9.1C2DE17E52	H	5/26/16	Adult	Lower Granite Dam	6/11/16	UTR
3D9.1C2DE185BD	W	5/20/16	Adult	Lower Granite Dam	6/05/16	UTR
3D9.1C2DE23E09	H	5/13/16	Adult	Lower Granite Dam	5/24/16	LTR
3D9.1C2DE258C8	H	5/26/16	Adult	Lower Granite Dam	6/07/16	UTR

[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).

[b] These fish were detected at Lower Granite Dam before falling back and entering the Tucannon River.

[c] This fish was detected in the Tucannon but left and was detected in the Imnaha River.

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 did not capture any adult spring Chinook at the Asotin Creek weir before the weir was removed on 3 June, 2016 due to declining flows and increasing stream temperatures (Ethan Crawford, WDFW, personal communication). One natural origin PIT tagged spring Chinook salmon was detected at a PIT tag array near the mouth of Asotin Creek during 2016. This fish was PIT tagged at Lower Granite Dam on 10 May 2016 and was detected on 15 May 2016. This fish was not detected at an upstream array so it may have returned back to the Snake River. Snake River Lab and Asotin Creek Field Office staff surveyed known spring Chinook spawning areas in Asotin Creek (rkm 14.6-41.3) on 21 and 22 September, 2016. Two redds and one live fish were observed during 2016, however the section from Lick Creek (rkm 28.6) to the Confluence Bridge (rkm 27.0) was not surveyed, so redds and/or fish may have been missed (Table 16). Historical redd numbers for Asotin Creek are found in Table 17.

Table 16. Numbers and general locations of spring Chinook salmon redds, live fish observed, and carcasses recovered from Asotin Creek, 2016.

			Carcasses Recovered				
			Natural		Hatchery		
Rkm[a]	Number of Redds	Live Fish Observed	Male	Female	Male	Female	Unknown
36.5-41.3	0	0	0	0	0	0	0
28.6-36.5	0	0	0	0	0	0	0
27.0-28.6[b]	---	---	---	---	---	---	---
22.0-27.0	2	1	0	0	0	0	0
14.6-22.0	0	0	0	0	0	0	0
Totals	**2**	**1**	**0**	**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.
[b] This section was not surveyed in 2016.

Table 17. Historical redd counts in Asotin Creek from 1972-73 and 1984-2016 (WDFW 2017).

Year	Number of Redds	Year	Number of Redds
1972	12	1999	0
1973	13	2000	1
“	“	2001	4
1984	8	2002	4
1985	1	2003	1
1986	1	2004	13
1987	3	2005	2
1988	1	2006	11
1989	0	2007	3
1990	2	2008	6
1991	0	2009	6
1992	0	2010	5
1993	2	2011	16
1994	0	2012	8
1995	0	2013	2
1996	0	2014	1
1997	1	2015	0
1998	0	2016	2

Adult PIT Tag Returns

Five hundred twenty-seven Tucannon River spring Chinook originally PIT tagged as juveniles have been detected returning to the Columbia River System (Table 18).

Table 18. Number of Tucannon River spring Chinook juvenile fish PIT tagged by origin and calendar 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	1,292	---	---	1 (0.08%)	---	---
1996	1,923	---	---	0	---	---
1997	1,984	---	---	2 (0.10%)	---	---
1998	1,999	---	---	0	---	---
1999	335	374	---	2 (0.60%)	5 (1.34%)	---
2000	---	---	---	---	---	---
2001	301	158	---	0	0	---
2002	318	321	---	1 (0.31%)	3 (0.93%)	---
2003	1,010	---	1,007	3 (0.30%)	---	0
2004	1,012	---	1,029	0	---	0
2005	993	93	993	0	1 (1.08%)	0
2006	1,001	70	1,002	1 (0.10%)	1 (1.43%)	0
2007	1,308	504	1,000	3 (0.23%)	11 (2.18%)	4 (0.40%)
2008	4,989	1,915	997	47 (0.94%)	48 (2.51%)	6 (0.60%)
2009	4,987	1,232	---	14 (0.28%)	17 (1.38%)	---
2010	15,000	2,800	---	88 (0.59%)	20 (0.71%)	---
2011	24,976	5,267	---	47 (0.19%)	26 (0.49%)	---
2012	22,982	3,889	---	29 (0.13%)	23 (0.59%)	---
2013	14,987	4,026	---	37 (0.25%)	41 (1.02%)	---
2014	14,969	660	---	35 (0.23%)	0	---
2015	14,962	368	---	11 (0.07%)	0	---
Totals	**131,328**	**21,677**	**6,028**	**321 (0.24%)**	**196 (0.90%)**	**10 (0.17%)**

From the detected returns, 115 (22%) of the returning PIT tagged spring Chinook were detected upstream of the Tucannon River (Table 19; Appendix F). Thirty-six of these fish (7%) had their last detections at or above Lower Granite Dam (Table 19; Appendix F). The overshoot 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, increases in tagging numbers/sample size, or greater detection capabilities in the Tucannon River (Table 19). This does not appear to be a hatchery effect as both natural and hatchery origin fish overshoot the Tucannon River (Table 19). 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 Tucannon River (LTR) at rkm 2.2 - 2005, Middle Tucannon River (MTR) at rkm 17.8 and Upper Tucannon River (UTR) at rkm 44.4 - 2011, and Tucannon Fish Hatchery (TFH) at rkm 59.2 – 2012] have enabled us to document that the majority of the Tucannon spring Chinook that overshoot are able to make it back (about 75%) to the Tucannon River (Table 19). Returning spring Chinook overshooting the Tucannon River continues to be a concern, especially if they are unable to return to the Tucannon River, or if they return in a more compromised state (i.e., injuries from additional dam crossings), and may partially explain why this population has been slow to respond to recovery and supplementation actions.

Table 19. Number and origin of PIT tagged Tucannon River spring Chinook returns that overshoot the Tucannon River (includes fish that were last detected returning back downstream towards the Tucannon River) and also detected at Lower Granite Dam (LGR) that stayed above LGR Dam. Years with installed in-stream PIT tag arrays (2005 – 2015) are included for comparison.

Tag Years	# Adult Detections Bonneville	Initial # Adults Above Tucannon R.	Initial Overshoot Rate	Percent Natural	Percent Hatchery	# Adults Above LGR	Percent Natural	Percent Hatchery	Overshoot Rate (%)
1995-1999	10	8	80.0	37.5	62.5	8	37.5	62.5	80.0
2000-2004	7	2	28.6	50.0	50.0	2	50.0	50.0	28.6
2005-2009	153	20	13.1	35.0	65.0	14	42.9	57.1	9.2
2010-2014	346	80	23.1	37.5	62.5	12	41.7	58.3	3.5
2015-	11	5	45.5	0.0	100.0	0	---	---	0.0
Totals	**527**	**115**	**21.8%**	**35.7%**	**64.3%**	**36**	**41.7%**	**58.3%**	**6.8%**
2005-2015	**510**	**105**	**20.6%**			**26**			**5.1%**

Juvenile Salmon Evaluation

Hatchery Rearing, Marking, and Release

Supplementation juveniles (249,357) were tagged with CWT (63/70/39) from 8 March to 16 March, 2016. Fish were transferred from LFH to TFH between 12 and 19 October, 2015. Fish were PIT tagged (target 15,000) for outmigration survival and adult return estimates on 26 January 2017. 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 and greater adult returns for larger fish from the size at release study.

Brood year 2015 fish were sampled twice by Evaluations staff during the rearing cycle (Table 20). During February, a total of 1,801 fish were sampled for precocity and mark quality and 261 were sampled for length and weight statistics. The 2015 BY fish were transferred to Curl Lake AP on 15-17 February 2017 for acclimation and volitional release. Length, weight, and precocity samples were repeated in April at Curl Lake AP prior to release (Table 20).

Table 20. Sample size (N), mean length (mm), coefficient of variation (CV), condition factor (K), mean weight (g), and precocity of 2015 BY juveniles sampled at TFH, and Curl Lake AP.

Date	Sample Location	N	Mean Length (mm)	CV	K	Mean Wt. (g)	% Precocity
2/07/17	TFH	261	136.6	14.9	1.24	33.5	1.05
4/03/17	Curl Lake	275	143.2	11.3	1.31	39.5	0.36

A new fence was constructed around Curl Lake AP during the spring of 2015 after reports from hatchery staff of increased numbers of predators (primarily river otters) consuming hatchery fish. A PIT tag array was installed at the outlet of Curl Lake AP in 2014 in order to obtain a more accurate release number due to the high predation and was used again for release estimates during the spring of 2017. Interference caused by two or more PIT tags passing by the detectors at one time, also known as PIT tag "collisions", is a problem at the array so estimated release numbers should be considered minimal estimates. The release number will be adjusted in the future after previously undetected tags are detected along the outmigration corridor and an updated final release number will be reported in the historical hatchery releases (Appendix G) in the next annual report. Volitional release began 4 April and continued until 21 April when the remaining fish were forced out. Estimated numbers and size of fish released are provided in Table 21.

Table 21. Preliminary spring Chinook salmon releases into the Tucannon River, 2017 release year.

Release Date	CWT Code	Total Released	Number CWT	VIE Mark	Size	
					Total (kg)	Mean (g)
4/04-4/21	63/70/39	199,686	187,601	None	7,883	40

Smolt Trapping

Evaluation staff operated a 1.5 m rotary screw trap at rkm 3 on the Tucannon River from 13 October 2015 through 8 July 2016 to estimate numbers of migrating juvenile natural and hatchery spring Chinook. Numbers of each fish species captured by month during the 2016 outmigration can be found in Appendix H. The main outmigration of natural origin spring Chinook for the 2015/2016 outmigration occurred during the spring, with a very limited outmigration during the fall and winter months (Figure 7). Prior years have shown more outmigration in the fall and winter (Gallinat and Ross 2014, Gallinat and Ross 2015), although even in those years, the majority of the outmigration occurred in the spring.

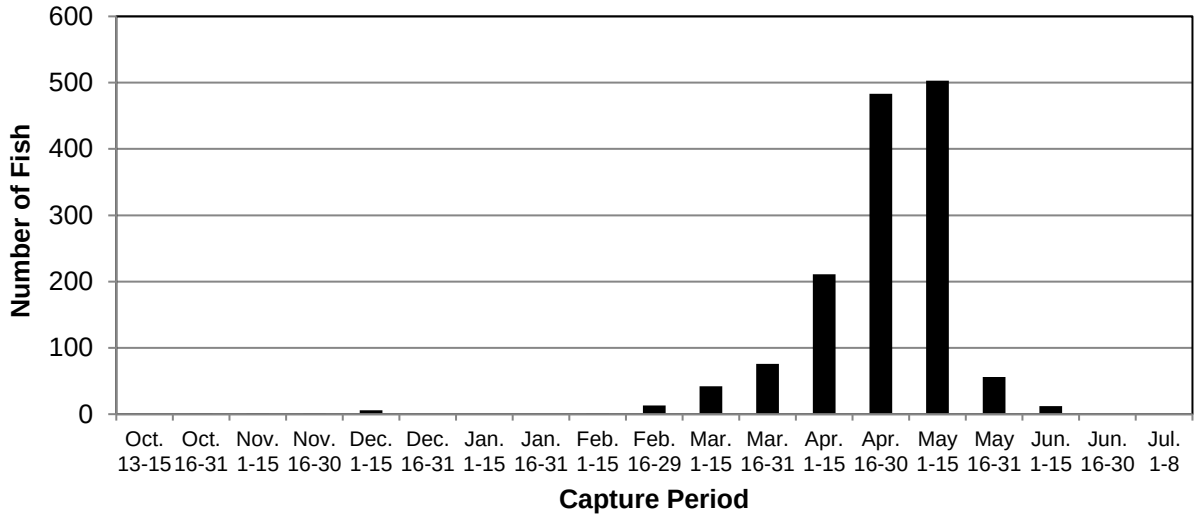

Figure 7. Emigration timing of natural spring Chinook salmon captured during smolt trap operations (rkm 3) on the Tucannon River for the 2015-16 migration year.

Natural spring Chinook emigrating from the Tucannon River (BY 2014) averaged 103 mm (Figure 8). This is in comparison to a mean length of 146 mm for hatchery-origin fish (BY 2014) released from Curl Lake Acclimation Pond (Gallinat and Ross 2015).

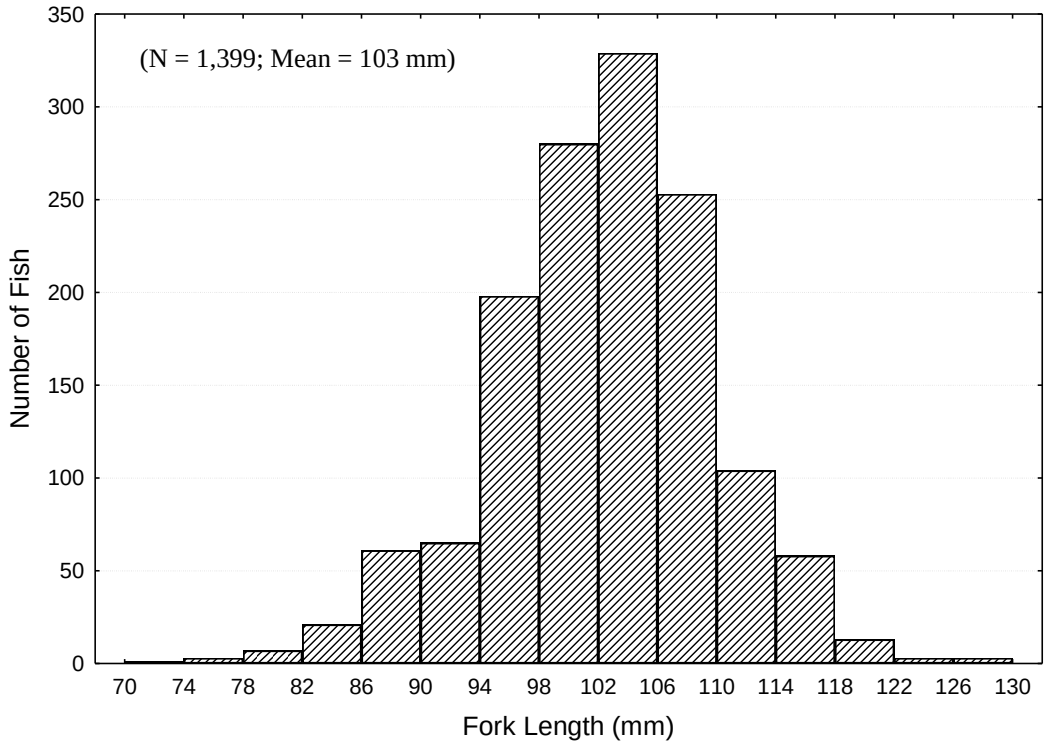

Figure 8. Length frequency distribution of sampled natural spring Chinook salmon captured in the Tucannon River smolt trap, 2015/2016 season.

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. 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.

To estimate potential juvenile migrants passing when the trap was not operated for short intervals ($\leq$ 5 days), 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.

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. The majority of the historical emigration estimates did not have confidence limits around the estimates, and if they did, they were calculated using a different method. To standardize estimates, when possible, we re-calculated emigration estimates from the historical database using the approach of Steinhorst et al. (2004). Revised historical emigration estimates for spring Chinook salmon are found in Appendix I.

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 6,604 (S.E.

517.0; 95% C.I. 5,674-7,696) migrant natural-origin spring Chinook (2014 BY) passed the smolt trap during 2015-2016.

Juvenile Migration Studies

In 2016, we used PIT tags to study the emigration timing and relative success of our hatchery supplementation smolts. A total of 14,983 hatchery supplementation fish were PIT tagged during January before transferring them to Curl Lake AP for acclimation and volitional release (Table 22). Cumulative PIT tag detections at hydroelectric projects downstream of the Tucannon River were 48% (Table 22).

Table 22. Cumulative detection (one unique detection per tag code) and mean travel time in days (TD) of PIT tagged conventional hatchery supplementation smolts released[a] from Curl Lake AP (rkm 65.6) on the Tucannon River at downstream Snake and Columbia River dams during 2016.

	Release Data				Recapture Data											
		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	%
Hatch.	14,983	133.2	18.1	133.5	2139	15.8	421	18.5	1255	21.2	693	21.1	125	24.5	7,187	48.0

[a] Fish were volitionally released from 4/01/16 – 4/15/16.

[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 Rates

Point estimates of population sizes have been calculated for various life stages (Tables 23 and 24) 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 25) because they have been protected in the hatchery. However, SARs to the Tucannon River of natural salmon were over seven times higher (based on geometric means) than for hatchery-reared salmon (Tables 26 and 27). With the exception of the 2006 brood year, hatchery SARs (mean 0.25%; geometric mean 0.16%) documented from the 1985-2011 broods have been 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. The target size at release was increased to 38 g fish (12 fpp) beginning with the 2011 brood year in an attempt to improve smolt-to-adult return survival rates.

Table 23. Estimates of *natural in-river produced* Tucannon spring Chinook salmon (both hatchery and natural origin parents) abundance by life stage for 1985-2016 broods.

Brood Year	Females in River		Mean Fecundity[a]		Number of Eggs	Number of Parr[b]	Number of Smolts	Progeny (returning adults)[c]
	Natural	Hatchery	Natural	Hatchery				
1985[d]	316	---	3,883	---	1,227,028	90,200	35,559	392
1986	200	---	3,916	---	783,200	102,600	51,004	467
1987	185	---	4,096	---	757,760	79,100	52,349	228
1988	117	---	3,882	---	454,194	69,100	35,925	502
1989	103	3	3,883	2,606	407,767	58,600	19,107	153
1990	128	52	3,993	2,697	651,348	86,259	32,969	94
1991	51	40	3,741	2,517	291,471	54,800	30,000[e]	7
1992	119	81	3,854	3,295	725,521	103,292	36,749	161
1993	112	80	3,701	3,237	673,472	86,755	34,623	177
1994	39	5	4,187	3,314	179,863	12,720	4,957	12
1995	5	0	5,224	0	26,120	0	75[e]	6
1996	53	16	3,516	2,843	231,836	2,845	2,906	69
1997	39	34	3,609	3,315	253,461	32,913	25,553	791
1998	19	7	4,023	3,035	97,682	8,453	4,849	388
1999	1	40	3,965	3,142	129,645	15,944	8,721	141
2000	26	66	3,969	3,345	323,964	44,618	29,442	448
2001	219	78	3,612	3,252	1,044,684	63,412	42,416	257
2002	104	195	3,981	3,368	1,070,784	72,197	64,036	212
2003	67	51	3,789	3,812	448,275	40,900	27,724	173
2004	117	43	3,444	2,601	514,791	30,809	21,057	399
2005	82	25	3,773	2,903	381,961	21,162	17,579	739
2006	73	36	2,887	2,654	306,295	---	30,228	1,720
2007	50	31	3,847	2,869	281,289	---	8,529	610
2008	95	104	3,732	3,020	668,620	---	14,778	884
2009	178	273	3,639	3,267	1,539,633	---	45,538	619
2010	278	203	3,579	3,195	1,643,547	---	35,080	938
2011	175	122	4,230	3,301	1,142,972	---	23,376	727
2012	115	54	3,151	2,563	500,767	---	12,886	213
2013	44	20	3,798	3,185	230,812	---	3,831	8
2014	105	19	3,699	3,290	450,905	---	6,604	
2015	64	127	3,839	3,468	686,132	---		
2016	53	101	3,704	3,179	517,391	---		

[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.

[d] The 1985 redd counts were revised on the SASI database to account for all redds during the spawning season (WDFW 2016).

[e] Smolt estimates could not be estimated with the GAUSS program for the 1991 and 1995 brood years. Numbers of smolts for those brood years were obtained from estimates in the annual reports.

Table 24. Estimates of Tucannon spring Chinook salmon abundance (*spawned and reared in the hatchery*) by life stage for 1985-2016 broods.

Brood Year	Females Spawned		Mean Fecundity[a]		Number of Eggs	Number of Parr	Number of Smolts	Progeny (returning Adults)[b]
	Natural	Hatchery	Natural	Hatchery				
1985	4	---	3,883	---	14,843	13,401	12,922	45
1986	57	---	3,916	---	187,958	177,277	152,725	319
1987	48	---	4,096	---	196,573	164,630	152,165	178
1988	49	---	3,882	---	182,438	150,677	145,146	385
1989	28	9	3,883	2,606	133,521	103,420	99,057	209
1990	21	23	3,993	2,697	126,334	89,519	85,737	28
1991	17	11	3,741	2,517	91,275	77,232	74,064	25
1992	28	18	3,854	3,295	156,359	151,727	87,752[c]	76
1993	21	28	3,701	3,237	168,366	145,303	138,848	138
1994	22	21	4,187	3,314	161,707	132,870	130,069	32
1995	6	15	5,224	0	85,772	63,935	62,144	177
1996	18	19	3,516	2,843	117,287	80,325	76,219	265
1997	17	25	3,609	3,315	144,237	29,650	24,186	176
1998	30	14	4,023	3,035	161,019	136,027	127,939	793
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	127
2002	22	25	3,981	3,368	169,364	151,531	123,586	121
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	690
2006	18	27	2,887	2,654	123,629	112,350	106,530	1,122
2007	27	9	3,847	2,869	124,543	117,182	114,681	261
2008	17	43	3,732	3,020	193,324	183,925	172,897	643
2009	42	54	3,639	3,267	323,341	292,291	231,437[d]	300
2010	39	44	3,579	3,195	279,969	237,861	201,585	194
2011	45	41	4,230	3,301	325,701	305,215	259,964	711
2012	48	47	3,151	2,563	269,514	246,033	203,510	503
2013	48	30	3,798	3,185	275,188	263,630	207,859	116
2014	39	27	3,699	3,290	231,026	226,300	221,099	
2015	55	20	3,839	3,468	280,519	266,134	199,686[e]	
2016	31	41	3,704	3,179	245,174	230,106		

[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.

[e] Temporary estimate based on PIT tag detections at the Curl lake PIT tag array. A final estimate will be provided in the 2017 annual report.

Table 25. 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	7.4	39.4	2.9	90.3	96.4	87.1	12.3	2.4	30.0
1986	13.1	49.7	6.5	94.3	86.2	81.3	7.2	1.7	12.5
1987	10.4	66.2	6.9	83.8	92.4	77.4	8.0	1.4	11.2
1988	15.2	52.0	7.9	82.6	96.3	79.6	5.4	1.9	10.1
1989	14.4	32.6	4.7	77.5	95.8	74.2	5.4	2.9	15.8
1990	13.2	38.2	5.1	70.9	95.8	67.9	5.4	2.5	13.4
1991	18.8	54.7	10.3	84.6	95.9	81.1	4.5	1.8	7.9
1992	14.2	35.6	5.1	97.0	57.8	56.1	6.8	1.6	11.1
1993	12.9	39.9	5.1	86.3	95.6	82.5	6.7	2.4	16.0
1994	7.1	39.0	2.8	82.2	97.9	80.4	11.6	2.5	29.2
1995	0.0	0.0	0.3	74.5	97.2	72.5	---	---	---
1996	1.2	102.1	1.3	68.5	94.9	65.0	55.8	0.9	51.8
1997	13.0	77.6	10.1	20.6	81.6	16.8	1.6	1.1	1.7
1998	8.7	57.4	5.0	84.5	94.1	79.5	9.8	1.6	16.0
1999	12.3	54.7	6.7	94.1	91.3	86.0	7.7	1.7	12.8
2000	13.8	66.0	9.1	95.6	82.8	79.2	6.9	1.3	8.7
2001	6.1	66.9	4.1	95.0	84.0	79.8	15.7	1.3	19.7
2002	6.7	88.7	6.0	89.5	81.6	73.0	13.3	0.9	12.2
2003	9.1	67.8	6.2	89.9	56.3	50.6	9.8	0.8	8.2
2004	6.0	68.3	4.1	91.8	52.4	48.1	15.3	0.8	11.8
2005	5.5	83.1	4.6	93.9	98.7	92.6	16.9	1.2	20.1
2006	---	---	9.9	90.9	94.8	86.2	---	---	8.7
2007	---	---	3.0	94.1	97.9	92.1	---	---	30.4
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	---	---	2.0	93.7	85.2	79.8	---	---	39.0
2012	---	---	2.6	91.3	82.7	75.5	---	---	29.3
2013	---	---	1.7	95.8	78.8	75.5	---	---	45.5
2014	---	---	1.5	98.0	97.7	95.7	---	---	65.3
2015[a]	---	---		94.9	75.0[a]	71.2[a]	---	---	
2016				93.9					
Mean	10.0	56.2	4.7	86.6	86.9	74.8	11.3	1.6	22.0
SD	4.8	22.7	2.8	14.2	12.5	15.5	11.2	0.6	15.2

[a] Smolt release numbers were estimated with a PIT tag array at the outlet of Curl Lake AP and will be finalized in the 2017 annual report.

Table 26. Adult returns and SARs of natural salmon to the Tucannon River for brood years 1985-2013. (2012 and 2013 are incomplete brood years included for comparison.)

Brood Year	Estimated Number of Smolts	Number of Adult Returns, observed (obs) and expanded (exp)[a]						SAR (%)	
		Age 3		Age 4		Age 5		With Jacks	No Jacks
		Obs	Exp	Obs	Exp	Obs	Exp		
1985	35,559	8	19	110	255	36	118	1.10	1.05
1986[b]	51,004	1	2	115	375	28	90	0.92	0.91
1987	52,349	0	0	52	167	29	61	0.44	0.44
1988	35,925	1	3	136	318	74	181	1.40	1.39
1989	19,107	5	12	47	115	23	26	0.80	0.74
1990	32,969	3	8	63	72	12	14	0.29	0.26
1991	30,000[c]	0	0	4	5	1	2	0.02	0.02
1992	36,749	2	2	84	138	16	21	0.44	0.43
1993	34,623	1	2	62	100	58	75	0.51	0.51
1994	4,957	0	0	8	10	1	2	0.24	0.24
1995	75[c]	0	0	1	1	2	5	8.00	8.00
1996	2,906	0	0	27	63	2	6	2.37	2.37
1997	25,553	6	14	234	695	29	82	3.10	3.04
1998	4,849	3	9	91	259	43	120	8.00	7.82
1999	8,721	3	9	44	124	3	8	1.62	1.51
2000	29,442	1	3	148	392	16	53	1.52	1.51
2001	42,416	0	0	73	246	5	11	0.61	0.61
2002	64,036	1	3	68	134	36	75	0.33	0.33
2003	27,724	4	7	55	115	21	51	0.62	0.60
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	1,389	73	215	5.69	5.31
2007	8,529	4	41	133	456	22	113	7.15	6.67
2008	14,778	10	85	150	693	23	106	5.98	5.41
2009	45,538	1	7	94	554	10	58	1.36	1.34
2010	35,080	3	91	136	799	17	48	2.67	2.41
2011	23,376	3	41	145	619	31	67	3.11	2.93
2012	12,886	4	65	64	148	---	---	1.65	1.15
2013	3,831	2	8	---	---	---	---	0.21	---
Mean								**2.38[d]**	**2.27[d]**
Geometric Mean								**1.26[d]**	**1.22[d]**

[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] Numbers of smolts obtained from estimates in the annual reports.

[d] The 2011 and 2012 SARs are not included in the mean.

Table 27. Adult returns and SARs of hatchery salmon to the Tucannon River for brood years 1985-2013. (2012 and 2013 are incomplete brood years included for comparison.)

Brood Year	Estimated Number of Smolts	Number of Adult Returns, observed (obs) and expanded (exp)[a]						SAR (%)	
		Age 3		Age 4		Age 5		With Jacks	No Jacks
		Obs	Exp	Obs	Exp	Obs	Exp		
1985	12,922	9	19	25	26	0	0	0.35	0.20
1986	152,725	79	83	99	220	8	16	0.21	0.15
1987	152,165	9	19	70	145	8	14	0.12	0.10
1988	145,146	46	99	140	244	26	42	0.27	0.20
1989	99,057	7	13	100	179	14	17	0.21	0.20
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	63	2	2	0.09	0.07
1993	138,848	11	15	93	107	15	16	0.10	0.09
1994	130,069	2	4	21	23	4	5	0.02	0.02
1995	62,144	13	16	117	157	2	4	0.28	0.26
1996	76,219	44	59	100	192	5	14	0.35	0.27
1997	24,186	7	13	59	163	0	0	0.73	0.67
1998	127,939	36	97	174	546	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	107	1	1	0.09	0.07
2002	123,586	3	6	60	99	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	399	0	0	0.46	0.27
2006	106,530	60	402	180	679	19	41	1.05	0.68
2007	114,681	7	74	76	171	5	16	0.23	0.16
2008	172,897	27	269	104	369	6	5	0.37	0.22
2009	231,437	1	8	62	291	1	1	0.13	0.13
2010	201,585	2	66	55	113	2	15	0.10	0.06
2011	259,964	8	62	113	633	10	16	0.27	0.25
2012	203,510	24	184	136	319	---	---	0.25	0.16
2013	207,859	100	116	---	---	---	---	0.06	---
Mean								**0.25[b]**	**0.19[b]**
Geometric Mean								**0.16[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] The 2011 and 2012 SARs 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 25). With the exception of eleven brood years (39%), naturally produced fish have been below the replacement level (Figure 9; Table 28). Based on adult returns from the 1985-2012 broods, naturally reared salmon produced only 0.76 adults for every spawner, while hatchery reared fish produced 2.02 adults (based on geometric means).

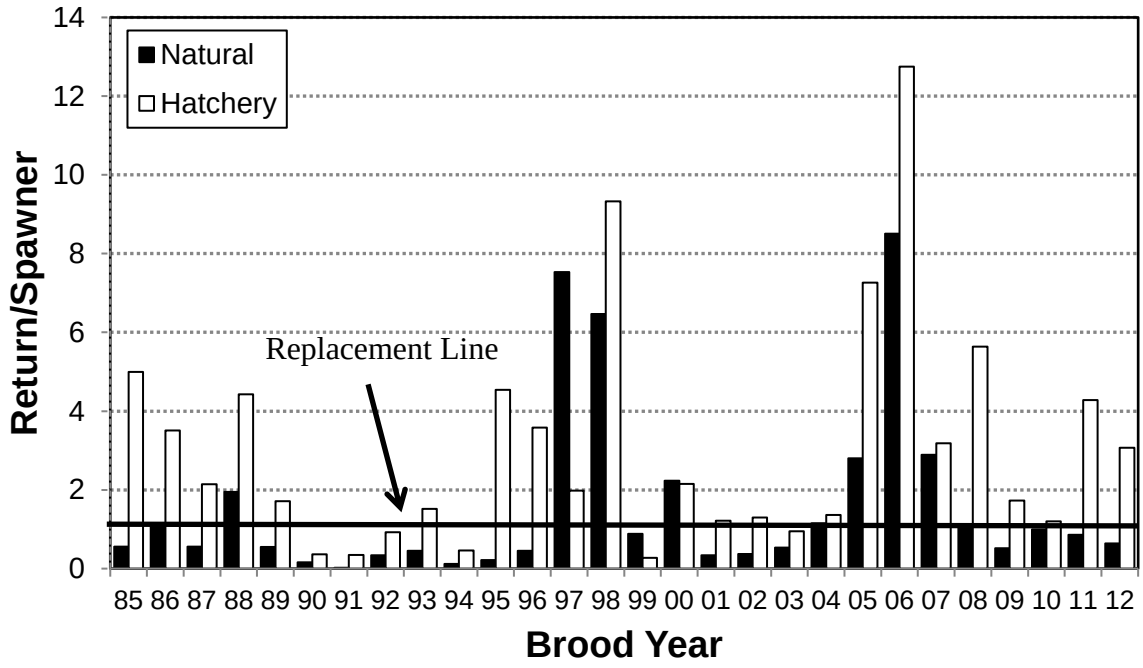

Figure 9. Return per spawner (with replacement line) for the 1985-2012 brood years (2012 incomplete brood year).

Table 28. Progeny-to-parent survival estimates of Tucannon River spring Chinook salmon from 1985 through 2012 brood years (2012 brood year incomplete).

	Natural Salmon			Hatchery Salmon			
Brood Year	Estimated Spawners	Number of Returns	Return/ Spawner	Number Spawned	Number of Returns	Return/ Spawner	Hatchery to Natural Advantage
1985	695	392	0.56	9	45	5.00	8.9
1986	440	467	1.06	91	319	3.51	3.3
1987	407	228	0.56	83	178	2.14	3.8
1988	257	502	1.95	87	385	4.43	2.3
1989	276	153	0.55	122	209	1.71	3.1
1990	572	94	0.16	78	28	0.36	2.2
1991	291	7	0.02	72	25	0.35	14.4
1992	476	161	0.34	83	76	0.92	2.7
1993	397	177	0.45	91	138	1.52	3.4
1994	97	12	0.12	69	32	0.46	3.7
1995	27	6	0.22	39	177	4.54	20.4
1996	152	69	0.45	74	265	3.58	7.9
1997	105	791	7.53	89	176	1.98	0.3
1998	60	388	6.47	85	793	9.33	1.4
1999	160	141	0.88	122	33	0.27	0.3
2000	201	448	2.23	73	157	2.15	1.0
2001	766	257	0.34	104	127	1.22	3.6
2002	568	212	0.37	93	121	1.30	3.5
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	690	7.26	2.6
2006	202	1,720	8.51	88	1,122	12.75	1.5
2007	211	610	2.89	82	261	3.18	1.1
2008	796	884	1.11	114	643	5.64	5.1
2009	1191	619	0.52	173	300	1.73	3.3
2010	938	938	1.00	161	194	1.20	1.2
2011	849	727	0.86	166	711	4.28	5.0
2012	335	213	0.64	164	503	3.07	4.8
Mean			**1.58**			**3.08**	**4.1**
Geometric Mean			**0.76**			**2.02**	**2.7**

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. Hatchery production changes that result in

increased survival/return numbers 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 J).

The long-term restoration goal for the State of Washington 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). Natural origin returns had been increasing in recent years (Figure 10), but decreased in 2016. However, we are still below the 10-year moving geometric mean of 750 natural origin fish.

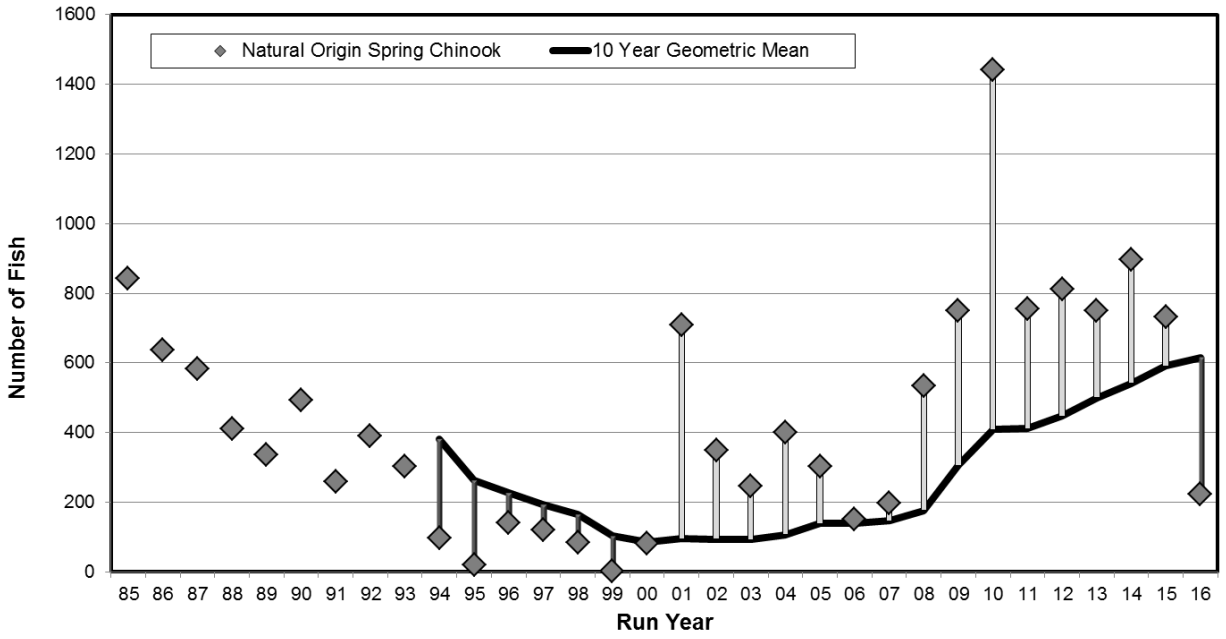

Figure 10. Tucannon River spring Chinook natural origin returns with the moving ten year geometric mean (black line) for the 1985-2016 run years.

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 11). Based on CWT recoveries reported to the Regional Mark Information System (RMIS) database (Appendix K), 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 hatchery adults are now just tagged with CWTs, but do not have external marks to identify them as hatchery origin fish. This has resulted in lower sport fishery impacts. Based on CWT recoveries for the 2000-2012 brood years, harvest (primarily commercial) has accounted for only 6% of the hatchery adult CWT recoveries (Appendix K).

Out-of-basin stray rates of Tucannon River spring Chinook have generally been low (Appendix K), with an average of 1.2% of the adult hatchery fish straying to other river systems/hatcheries for brood years 1985-2013 (range 0-20%).

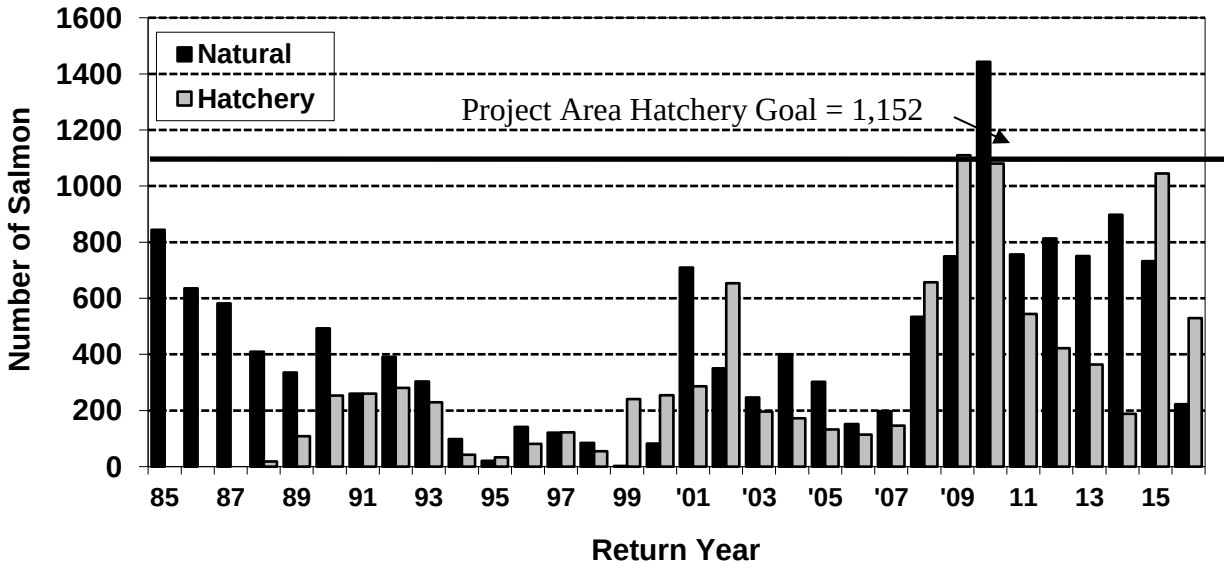

Figure 11. Total escapement for Tucannon River spring Chinook salmon for the 1985-2016 run years.

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. Increased fishing mortality resulted in higher adjusted SAS for the 1997, 1998, and 2006 brood years. 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 29).

Table 29. Hatchery SAS adjusted for recoveries from outside the Tucannon River subbasin as reported in the RMIS database, 1985-2011 brood years. (Data downloaded from RMIS database on 3/13/17).

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	319	15	334	0.21	0.22
1987	152,165	178	2	180	0.12	0.12
1988	145,146	385	26	411	0.27	0.28
1989	99,057	209	12	221	0.21	0.22
1990	85,737	28	0	28	0.03	0.03
1991	74,064	25	4	29	0.03	0.04
1992	87,752	76	17	93	0.09	0.11
1993	138,848	138	11	149	0.10	0.11
1994	130,069	32	0	32	0.02	0.02
1995	62,144	177	2	179	0.28	0.29
1996	76,219	265	5	270	0.35	0.35
1997	24,186	176	41	217	0.73	0.90
1998	127,939	793	216	1,009	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	127	5	132	0.09	0.09
2002	123,586	121	0	121	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	690	2	692	0.46	0.46
2006	106,530	1,122	36	1,158	1.05	1.09
2007	114,681	261	5	266	0.23	0.23
2008	172,897	643	4	647	0.37	0.37
2009	231,437	300	8	308	0.13	0.13
2010	201,585	194	1	195	0.10	0.10
2011	259,964	711	24	735	0.27	0.28
Mean					**0.25**	**0.27**
Geometric Mean					**0.16**	**0.17**

[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.).

LFH vs. TFH Reared Comparison

As mentioned earlier in this report, Tucannon River spring Chinook salmon that are collected for broodstock at the TFH adult trap are transported to LFH for holding and spawning, and incubation and early life rearing. This is primarily due to the availability of colder, pathogen free water and rearing space at LFH. However, during the review of the Tucannon River Spring Chinook Hatchery and Genetic Management Plan, the Hatchery Scientific Review Group recommended developing long-term rearing capabilities within the Tucannon River Subbasin as one of their recommendations for the hatchery program (HSRG 2009). This recommendation was based on questions that were raised as to whether rearing the hatchery fish for the majority of their early life at LFH affected their survival and ability to home back to the Tucannon River. To answer these questions, approximately 30,000 eggs were transferred to TFH for incubation and rearing for three brood years (BY11-13) for comparison to LFH reared fish (Appendix L). To avoid potential bias in recovery rates between the two release groups (Zhou 2002, Murdoch et al. 2010), we used PIT tag detections of migrating smolts and returning adults to compare performance and relative survival between the LFH reared and TFH reared groups of spring Chinook. Fish with PIT tags are detected through a network of interrogation systems currently in place in juvenile bypass systems and adult fishways at hydroelectric dams (Burke and Jepson 2006). In addition, small instream arrays have been developed to remotely detect PIT tagged fish (Zydlewski et al. 2006; Bond et al. 2007), and these units have been installed in the Tucannon River. Each group was tagged with a unique CWT and a subset (Target – 7,500) of each group was PIT tagged (Table 30).

Juvenile Survival

Survival probabilities were estimated by the Cormack-Jolly-Seber methodology using the Survival Under Proportional Hazards (SURPH) 3.0 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. To determine significant differences in survival probabilities between groups, we used the Likelihood Ratio Test statistic. Estimated survival probabilities from Curl Lake to Lower Monumental Dam were not significantly different ($P > 0.05$) between the two groups (Table 30).

Adult Returns

Returning PIT tagged detected fish were assumed to be mature the year they entered freshwater after being in the marine environment. We calculated the smolt-to-adult survival (SAS) as the total number of fish that were detected within the Columbia and Snake River watersheds (Table

31). Smolt-to-adult return (SAR) was calculated as the number of fish that were detected in the Tucannon River (Table 31). Returns for the 2012 and 2013 brood years are incomplete, but preliminary data does not show a significant benefit in either survival or homing back to the Tucannon River by rearing fish at TFH (Table 31). Unless future data shows a different result, we will continue to use LFH for holding and spawning, and incubation and early life rearing.

Table 30. Release number, size at release (g), and number of Tucannon River hatchery spring Chinook PIT tagged by brood year (BY) for each rearing location and SURPH survival probabilities from Curl Lake Acclimation Pond to Lower Monumental Dam for the 2011 to 2013 brood years.

Rearing Location	BY11	BY12	BY13
LFH Group			
Number released	230,391	180,493	184,425
Size at release	33 g	32 g	37 g
CWT	63/64/41	63/65/85	63/67/42
Number PIT tagged (Target 7,500)	7,493	7,478	7,479
TFH Group			
Number released	29,573	23,017	23,434
Size at release	33 g	32 g	37 g
CWT	63/64/42	63/65/86	63/67/43
Number PIT tagged (Target 7,500)	7,494	7,471	7,482
SURPH Survival Probabilities			
LFH reared group (S.E.)	0.56 (0.03)	0.63 (0.02)	0.49 (0.06)
TFH reared group (S.E.)	0.56 (0.03)	0.65 (0.02)	0.55 (0.06)
Likelihood Ratio Test Statistic	0.0594	0.4089	0.5022
Degrees of freedom	1	1	1
P-value	0.808	0.523	0.479

Table 31. Returning PIT tagged spring Chinook detected by age in the Columbia and Snake river mainstem corridor for smolt-to-adult survival (SAS) and detected in the Tucannon River for smolt-to-adult return (SAR) for the LFH and TFH reared groups (2011-2013 brood years) of Tucannon River spring Chinook through December 2016 (2012 and 2013 BYs are incomplete returns).

	Age 2	Age 3	Age 4	Age 5	Total Detections	SAS	Tucannon Detections	SAR
LFH BY11	6	5	16	1	28	0.37%	21	0.28%
TFH BY11	7	2	8	0	17	0.23%	9	0.12%
LFH BY12	21	8	9	---	38	0.51%	11	0.15%
TFH BY12	18	12	6	---	36	0.48%	15	0.20%
LFH BY13	22	2	---	---	24	0.32%	2	0.03%
TFH BY13	23	6	---	---	29	0.39%	4	0.05%

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 what was originally assumed under the LSRCP program development, even though hatchery returns (recruits/spawner) have generally been at 2-4 times the replacement level. 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 within river hatchery (LSRCP) 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 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. Numerous options to improve attraction into the ladder/trap have been discussed with some recently implemented.

   Recommendation: Monitor changes made to the ladder/trap to see if they improve passage for all fish species. If improvements are not seen, 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.

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 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. Utilize fish carcasses from hatchery operations for stream nutrient enrichment. 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. Over the last few years, we have documented higher in-river pre-spawn mortality than what was observed historically. The mechanism for this higher loss is still unclear. However, the high loss has prompted drastic action within the program, whereby all, or the majority of the returns to the TFH trap between 2015 to 2017 have been collected and held at LFH for adult outplanting. Results from the first year (2015) of adult outplants appeared successful, with > 90% of the fish spawning, contrasted to 30% survival of fish left in the river. In 2016, it appeared that only about 55% of outplanted fish successfully spawned.

   Recommendation: Continue to monitor high in-river pre-spawn mortality that has occurred in recent years. Continue intensive monitoring of adult outplants to determine spawning success. Weigh all pertinent information (pre-spawn mortality rates, outplant success, predicted run sizes, risk of holding all fish at one facility, etc.) and inform co-managers and NMFS on future adult outplants. An agreed upon threshold is needed to make the decision whether to pass fish at the adult trap or hold fish at LFH for outplanting.

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Appendix A: Annual Takes for 2016

Appendix A. Table 1. Summary of permissible direct take and actual take (in parenthesis) of Snake River spring/summer Chinook salmon for RM&E activities associated with the Tucannon River spring Chinook salmon program not directly related to fish culture for the 2016 calendar year. NMFS must be notified within two days if the number handled, tagged, or killed are exceeded.

Origin and lifestage	Take activity	Capture method And location	Total number handled annually (0.5% handling mortalities)	Number of those handled that are marked/tagged annually (1% handling mortalities	Total number killed or removed annually
Natural-origin juveniles	Capture, handle, tag, tissue sample, and release live animal.	Trapping operations that include a screw trap, beach seines, cast nets, dip nets, and use of backpack electroshock equipment throughout the Tucannon River.	18,000 (1,461)	7,000 (1,429)	Up to 160 (5)
Hatchery-origin juveniles	Capture, handle, tag, tissue sample, and release live animal.	Trapping operations that include a screw trap, beach seines, cast nets, dip nets, and use of backpack electroshock equipment throughout the Tucannon River.	35,000 (11,550)	7,000 (2,066)	Up to 245 (22)
Natural-origin adults & jacks	Capture, handle, tag, tissue sample, and release live animal.	Adult and jack fall back at screw traps.	5 (0)	5 (0) (genetic fin-clip or operculum punch – release live.)	Up to 2[a] (0)
Hatchery-origin adults & jacks	Capture, handle, tag, tissue sample, and release live animal.	Adult and jack fall back at screw traps.	10 (0)	10 (0)	Up to 2[a] (0)

[a] In cases where total number killed is not likely to exceed one (1) mortality, NMFS rounds the total mortality up to two (2), so that operations are not halted completely at the first mortality.

Appendix A. Table 2. Summary of permissible direct take and actual take (in parenthesis) of listed Snake River spring/summer Chinook salmon for fish culture purposes for the Tucannon River Spring Chinook salmon program for the 2016 calendar year. NMFS must be notified within two days if the number handled, tagged, or killed are exceeded.

Origin and lifestage	Take activity	Capture method and location	Total number handled annually	Number of those handled that are marked/tagged annually (1% trap mortalities	Total number killed or removed annually
Natural-origin adults	Capture, handle, tag, tissue sample, remove for transport, holding, and outplanting in the Tucannon River, remove for use for broodstock, or release live animal (pass above weir).	Tucannon River adult weir and Lyons Ferry Hatchery ladder[a]	2,000 (116)	Up to 1,824[b] (passed live with fin-clip or operculum punch, PIT and/or radio tagged) (4 passed upstream) (54 outplanted upstream)	Up to 232[b] broodstock and fish used for outplants (55 broodstock) (3 A.O. PSM's) Plus up to 19 adult trap mortalities (0)
Natural-origin jacks	Capture, handle, tag, tissue sample, remove for transport, holding, and outplanting in the Tucannon River, remove for use for broodstock, or release live animal (pass above weir).	Tucannon River adult weir and Lyons Ferry Hatchery ladder[a]	200 (11)	Up to 200 (passed live with fin-clip or operculum punch, PIT and/or radio tagged) (2 passed upstream) (9 outplanted upstream)	Up to 9 broodstock. (0) Plus up to 2 trap mortalities.
Hatchery-origin adults	Capture, handle, tag, tissue sample, remove for transport, holding, and outplanting in the Tucannon River, remove for use for broodstock, or release live animal (pass above weir).	Tucannon River adult weir and Lyons Ferry Hatchery ladder[a]	1,400[b] (up to 132 removed for broodstock based on sliding scale) (299)	Up to 1,400[b] (passed live with fin-clip or operculum punch, PIT and/or radio tagged) (13 passed upstream) (175 outplanted upstream)	Up to 232[b] broodstock and fish held for later outplanting. (71 broodstock) (28 A.O. PSM & KO) Up to 100% of total handled may be removed, killed, or transported as described in the HGMP (12 killed outright)
Hatchery-origin jacks	Capture, handle, tag, tissue sample, remove for transport, holding, and outplanting in the Tucannon River, use for broodstock, remove for adult management or release live animal (pass above weir).	Tucannon River adult weir and Lyons Ferry Hatchery ladder[a]	500 (169)	Up to 135 (more may be passed to mimic natural-origin jack proportions, with NMFS concurrence) (passed live with fin-clip or operculum punch) (6 passed upstream) (58 outplanted)	Up to 9 broodstock. (0) Up to 100% of remainder may be removed, transported, or killed for jack management as described in the HGMP (102 killed outright) (3 A.O. PSM & KO)
Hatchery-origin egg & juveniles	Capture, handle, tag, tissue sample, and release live animal (within hatchery sampling, and research use).	Tucannon Hatchery or Lyons Ferry Hatchery total	280,125 (245,174 - BY16) (Maximum eggs/juveniles on hand annually prior to any juvenile rearing loss)	280,125 (14,983 BY14 PIT tagged)	Up to 55,125 total rearing mortality (3,118 BY15) (15,949 BY16)
Hatchery-origin juveniles	Capture, sample, kill (fish health examinations)	Tucannon Hatchery or Lyons Ferry Hatchery total	170 (50)	170 (0)	170 (50)

[a] In years when returns to Tucannon Hatchery are low, adult Chinook arriving at Lyons Ferry Hatchery ladder that are identifiable as Tucannon River hatchery adults may be taken for broodstock.

[b] The actual number taken annually will be subject to the sliding scale in the HGMP, in addition to fish that are collected, held, and used for adult outplants in the Tucannon, but may die while holding, or be used as part of the broodstock, and shall not exceed the totals of each origin identified there.

Appendix B: Spring Chinook Captured, Transported to Lyons Ferry Hatchery, or Passed Upstream at the Tucannon Hatchery Trap in 2016

Appendix B. Spring Chinook salmon captured, transported to Lyons Ferry Hatchery, or passed upstream at the Tucannon Hatchery trap in 2016. (Trapping began in February; last day of trapping was September 30).

	Captured in Trap		Collected for Broodstock		Passed Upstream		Held at LFH[a]		Killed Outright[b]	
Date	Natural	Hatchery	Natural	Hatchery	Natural	Hatchery	Natural	Hatchery	Natural	Hatchery
5/10	1	1					1	1		
5/13		2						2		
5/19	13	9	5	3			8	5		1
5/20	5	7	5	7						
5/23	3	12					3	12		
5/25	3	11	3	9						2
5/26	1	15					1	13		2
5/27	1	3	1	3						
5/29	9	22					9	21		1
5/30	3	13	3	13						
5/31	9	13					9	13		
6/01	5	23	3	9			2	12		2
6/02	7	15	7	15						
6/03	2	27	2	7				20		
6/05	11	14					11	14		
6/06	12	34	8	3			4	31		
6/07	5	28					5	26		2
6/08	9	27	5	2			4	20		5
6/09		28						15		13
6/10	2	18	2					7		11
6/13		8						4		4
6/14	4	7	4							7
6/15		5						3		2
6/17		8						3		5
6/20	1	11					1	3		8
6/21		9						4		5
6/22		6						4		2
6/23		5						3		2
6/24		9						3		6
6/27		7						4		3
6/28	3	2	3							2
6/29	1	8					1	8		
7/01		8						6		2
7/05	1	6					1	2		4
7/07		3						1		2
7/08		3								3
7/11	1	2					1			2
7/13		1						1		
7/14		1								1
7/15	1	2					1			2
7/18	1	5					1	1		4
7/21	1	1					1			1
7/22		4								4
7/26		2								2
7/29		1						1		
8/05	1	1					1			1
8/08	1	2					1	1		1
8/19	2		2							
8/22		2				2				
8/29	1	1			1	1				
8/31		2				2				
9/04	1	2			1	2				

[a] These fish were held at Lyons Ferry Hatchery for outplanting back into the river closer to the commencement of spawning.
[b] Fin clipped strays and hatchery jacks that were killed outright at the trap.

Appendix B (continued). Spring Chinook salmon captured, collected, or passed upstream at the Tucannon Hatchery trap in 2016. (Trapping began in February; last day of trapping was September 30).

	Captured in Trap		Collected for Broodstock		Passed Upstream		Held at LFH[a]		Killed Outright[b]	
Date	**Natural**	**Hatchery**	**Natural**	**Hatchery**	**Natural**	**Hatchery**	**Natural**	**Hatchery**	**Natural**	**Hatchery**
9/06	1	1	1			1				
9/08	4	4			4	4				
9/09	1	4	1			4				
9/10		3				3				
Totals	**127**	**468**	**55**	**71**	**6**	**19**	**66**	**264**	**0**	**114**

[a] These fish were held at Lyons Ferry Hatchery for outplanting back into the river closer to the commencement of spawning.
[b] Fin clipped strays and hatchery jacks that were killed outright at the trap.

Appendix C: Age Composition by Brood Year for Tucannon River Spring Chinook Salmon (1985-2011 BYs)

Appendix C. Age composition by brood year for natural and hatchery origin Tucannon River spring Chinook salmon (1985-2011 BYs). (Number at age is found in Tables 26 and 27).

Brood	Natural origin			Hatchery origin		
Year	% Age 3	% Age 4	% Age 5	% Age 3	% Age 4	% Age 5
1985	5.19	71.43	23.38	26.47	73.53	0.00
1986	0.69	79.86	19.44	42.47	53.23	4.30
1987	0.00	64.20	35.80	10.34	80.46	9.20
1988	0.47	64.45	35.07	21.70	66.04	12.26
1989	6.67	62.67	30.67	5.79	82.64	11.57
1990	3.85	80.77	15.38	14.29	76.19	9.52
1991	0.00	80.00	20.00	16.67	83.33	0.00
1992	1.96	82.35	15.69	17.46	79.37	3.17
1993	0.83	51.24	47.93	9.24	78.15	12.61
1994	0.00	88.89	11.11	7.41	77.78	14.81
1995	0.00	33.33	66.67	9.85	88.64	1.52
1996	0.00	93.10	6.90	29.53	67.11	3.36
1997	2.23	86.99	10.78	10.61	89.39	0.00
1998	2.19	66.42	31.39	14.46	69.88	15.66
1999	6.00	88.00	6.00	33.33	55.56	11.11
2000	0.61	89.70	9.70	12.96	87.04	0.00
2001	0.00	93.59	6.41	11.86	86.44	1.69
2002	0.95	64.76	34.29	4.35	86.96	8.70
2003	5.00	68.75	26.25	3.85	88.46	7.69
2004	2.35	86.47	11.18	10.29	86.76	2.94
2005	8.07	91.23	0.70	21.74	78.26	0.00
2006	7.94	73.95	18.11	23.17	69.50	7.34
2007	2.52	83.65	13.84	7.95	86.36	5.68
2008	5.46	81.97	12.57	19.71	75.91	4.38
2009	0.95	89.52	9.52	1.56	96.88	1.56
2010	1.92	87.18	10.90	3.39	93.22	3.39
2011	1.68	81.00	17.32	6.02	84.96	9.02
Means	**3.37**	**78.76**	**17.87**	**16.90**	**76.47**	**6.63**

Appendix D: Total Estimated Run-Size of Tucannon River Spring Chinook Salmon (1985-2016)

Appendix D. Total estimated run-size of spring Chinook salmon to the Tucannon River, 1985-2016. (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	---	---	---	---	---	---	---	---	844	0	844
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	493	19	220	---	---	0	14	493	253	746
1991	3	257	99	161	---	---	0	0	260	260	520
1992	12	379	13	258	---	---	0	10	391	281	672
1993	8	296	6	221	---	---	0	2	304	229	533
1994	0	98	5	37	---	---	0	0	98	42	140
1995	2	19	11	22	---	---	0	0	21	33	54
1996	2	140	15	63	---	---	0	3	142	81	223
1997	0	121	4	109	---	---	0	9	121	122	243
1998	0	85	16	39	---	---	0	0	85	55	140
1999	0	3	59	162	---	---	5	15	3	241	244
2000	14	68	13	196	---	---	5	41	82	255	337
2001	9	701	97	177	---	---	13	0	710	287	997
2002	9	341	11	546	---	---	0	97	350	654	1,004
2003	3	244	26	169	---	---	1	0	247	196	443
2004	0	400	19	134	3	0	0	16	400	172	572
2005	3	299	6	107	0	14	2	4	302	133	435
2006	7	145	2	100	2	2	0	8	152	114	266
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	403	92	196	13	4	750	1,110	1,860
2010	41	1,402	74	679	0	306	4	17	1,443	1,080	2,523
2011	85	671	269	212	0	27	12	24	756	544	1,300
2012	7	806	8	385	---	---	0	29	813	422	1,235
2013	91	660	66	296	---	---	2	0	751	364	1,115
2014	41	857	62	114	---	---	0	12	898	188	1,086
2015	65	667	184	648	---	---	6	207	732	1,045	1,777
2016	8	215	120	335	---	---	12	62	223	529	752

Appendix E: Stray Hatchery-Origin Spring Chinook Salmon in the Tucannon River (1990-2016)

Appendix E. Summary of identified stray hatchery origin spring Chinook salmon that escaped into the Tucannon River (1990-2016).

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 (1990-2016).

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 (1990-2016).

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**
2013	Ad clip	Unknown	Unknown	Unknown	2/2	
				Total Strays	**2**	**0.2**
2014	090471	ODFW	Umatilla R.	Umatilla Hatch./Umatilla River	1/1	
	090485	ODFW	Umatilla R.	Umatilla Hatch./Umatilla River	1/1	
	090282	ODFW	Lostine R.	Lookingglass/Lostine R.	1/11	
				Total Strays	**13**	**1.2**
2015	090552	ODFW	Imnaha R.	Lookingglass/Imnaha R.	1/14	
	090643	ODFW	Umatilla R.	Umatilla Hatch./Umatilla River	6/19	
	090652	ODFW	Umatilla R.	Umatilla Hatch./Umatilla River	15/123	
	090729	ODFW	Umatilla R.	Umatilla Hatch./Umatilla River	3/3	
	Ad clip	Unknown	Unknown	Unknown	28/54	
				Total Strays	**213**	**12.0**
2016	090861	ODFW	Umatilla R.	Umatilla Hatch./Umatilla River	1/4	
	090719	ODFW	Umatilla R.	Umatilla Hatch./Umatilla River	12/31	
	090729	ODFW	Umatilla R.	Umatilla Hatch./Umatilla River	2/2	
	090733	ODFW	Umatilla R.	Umatilla Hatch./Umatilla River	1/4	
	220134	NPT	Clearwater Mix	NPT Hatchery	1/4	
	090652	ODFW	Umatilla R.	Umatilla Hatch./Umatilla River	2/2	
	Ad clip	Unknown	Unknown	Unknown	24/27	
				Total Strays	**74**	**9.8**

[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 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	2
5042423B61	H	139	3/25/97	LGR	5/29/99	795	4
50470F3608	H	142	3/25/97	LGR	6/17/99	814	4
517D1E0552	W	112	4/22/99	BON	4/17/01	726	4
5202622F42	W	110	4/22/99	BON	4/19/01	728	4
517D1A197C	W	118	4/22/99	LGR	4/21/01	730	4
5176172874	W	108	4/29/99	LGR	4/29/01	731	4
5200712827	W	103	4/29/99	LGR	5/12/02	1109	5
5177201601	H	151	5/6/99	LGR	5/31/01	756	4
517D22216B	H	137	5/12/99	LGR	5/15/01	734	4
3D9.1BF1693290	H	130	5/07/02	LGR	5/23/04	747	4
3D9.1BF1677795	W	117	4/29/02	LGR	5/19/04	751	4
3D9.1BF16876C6	W	105	4/30/02	ICH	5/04/05	1100	5
3D9.1BF167698F	W	96	5/02/02	ICH	5/03/05	1097	5
3D9.1BF12F6891	H	136	4/21/03	ICH	5/09/04	392	3
3D9.1BF12F7182	H	115	4/21/03	ICH	5/19/04	396	3
3D9.1BF149E5EA	H	126	4/21/03	MCN	5/05/05	751	4
3D9.1BF1A2EF4B	W	104	12/07/05	LGR	6/16/08	922	5
3D9.257C5B558A	H	125	4/26/06	ICH	6/16/08	782	4
3D9.257C5A0975	W	113	11/20/06	MCN	5/29/09	921	5
3D9.1BF26E119D	H	170	4/12/07	LTR	5/22/08	406	3
3D9.257C6C4BAD	CB	142	4/12/07	ICH	5/15/08	399	3
3D9.257C6C1B20	CB	148	4/12/07	LTR	5/31/08	415	3
3D9.257C6C57DF	CB	125	4/12/07	ICH	5/31/08	415	3
3D9.1BF26D36B8	W	114	4/24/07	LTR	5/09/08	382	3
3D9.1BF26D389C	W	114	4/24/07	LTR	5/27/08	400	3
3D9.1BF26DB184	W	106	4/24/07	BON	5/02/09	739	4
3D9.1BF26DB741	W	118	4/24/07	ICH	5/10/09	747	4
3D9.1BF26DA2CB	W	103	4/23/07	ICH	5/10/09	748	4
3D9.1BF26D340D	W	102	4/16/07	ICH	5/06/09	751	4
3D9.1BF26D39F9	W	110	4/24/07	ICH	5/15/09	752	4
3D9.1BF26D693A	H	144	4/12/07	ICH	5/08/09	757	4
3D9.1BF26DFD75	H	112	4/12/07	MCN	5/11/09	760	4
3D9/257C6C514A	CB	125	4/12/07	ICH	5/17/09	766	4
3D9.1BF26DF8E5	W	118	4/02/07	ICH	5/09/09	768	4
3D9.1BF26DEE22	W	115	4/15/07	MCN	5/24/09	769	4

Abbreviations are as follows: BON – Bonneville Dam, TDA – The Dalles 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
3D9.257C59FC64	W	116	3/22/07	ICH	5/17/09	787	4
3D9.257C5BF3CB	W	95	1/16/07	BON	4/11/09	816	4
3D9.1BF27DF007	H	---	4/15/08	LTR[b]	7/08/08	84	2
3D9.1BF27E6923	H	---	4/15/08	MCN	5/11/09	391	3
3D9.1BF27E6615	H	---	4/15/08	ICH	5/12/09	392	3
3D9.1BF27E396B	H	144	4/15/08	ICH	5/14/09	394	3
3D9.1BF27E5152	H	---	4/15/08	MCN	5/14/09	394	3
3D9.1BF27DFA43	H	136	4/15/08	ICH	5/14/09	394	3
3D9.1BF27E45D5	H	---	4/15/08	BON	5/14/09	394	3
3D9.1BF27E5420	H	---	4/15/08	ICH	5/15/09	395	3
3D9.1BF27DC33A	H	---	4/15/08	MCN	5/16/09	395	3
3D9.1C2C4A2C09	CB	---	4/15/08	ICH	5/16/09	396	3
3D9.1BF27E0BF9	H	174	4/15/08	ICH	5/20/09	400	3
3D9.1BF27E4A9A	H	---	4/15/08	BON	5/21/09	401	3
3D9.1BF27DDDE3	H	125	4/15/08	ICH	5/21/09	401	3
3D9.1BF27E5F9D	H	---	4/15/08	MCN	5/23/09	403	3
3D9.1C2C4A17EF	CB	---	4/15/08	ICH	5/29/09	409	3
3D9.1C2C4AC01A	CB	---	4/15/08	ICH	5/13/09	393	3
3D9.1BF27E6750	H	---	4/15/08	LGR	6/07/09	418	3
3D9.1BF27E0B48	H	---	4/15/08	LGR	6/19/09	430	3
3D9.1BF27E335D	H	112	4/15/08	LGR	6/21/09	432	3
3D9.1BF27DEBAF	H	---	4/15/08	ICH	5/30/09	410	3
3D9.1BF27DE680	H	209	4/15/08	ICH	5/13/09	393	3
3D9.1BF27C49AC	W	120	4/02/08	ICH	6/10/09	434	3
3D9.1BF27C15D9	W	103	4/07/08	BON	4/29/10	752	4
3D9.1BF27C3C06	W	112	3/31/08	MCN	4/26/10	756	4
3D9.1BF27C3C7F	W	108	4/11/08	ICH	5/13/10	762	4
3D9.1BF27C4002	W	121	3/31/08	ICH	6/15/10	806	4
3D9.1BF27C43BD	W	104	3/31/08	LTR	5/06/10	766	4
3D9.1BF27C47C9	W	120	4/30/08	LTR	4/11/10	712	4
3D9.1BF27C4C13	W	113	4/08/08	LTR	4/27/10	747	4
3D9.1BF27C5838	W	120	4/04/08	ICH	5/06/10	762	4
3D9.1BF27C6137	W	105	4/20/08	LTR	5/01/10	741	4
3D9.1BF27C67B1	W	105	4/26/08	ICH	5/12/10	746	4
3D9.1BF27C681F	W	105	3/31/08	ICH	4/30/10	760	4
3D9.1BF27CEC4F	W	106	4/14/08	LGR	5/14/10	760	4

Abbreviations are as follows: BON – Bonneville Dam, TDA – The Dalles 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
3D9.1BF27CF786	W	109	4/26/08	ICH	5/22/10	756	4
3D9.1BF27DD7AC	W	101	5/04/08	ICH	5/23/10	736	4
3D9.1BF27DE7AE	W	121	5/28/08	LTR	5/02/10	705	4
3D9.1BF27E114D	W	98	4/30/08	ICH	5/07/10	737	4
3D9.1BF27E3670	W	120	5/12/08	ICH	5/05/10	723	4
3D9.1BF27E3A3B	W	105	5/01/08	BON	4/30/10	729	4
3D9.1BF27E4969	W	111	5/02/08	ICH	5/18/10	746	4
3D9.1BF27E5ADF	W	108	4/30/08	ICH	5/15/10	745	4
3D9.1BF27E6A2A	W	103	5/15/08	LTR	5/09/10	725	4
3D9.1BF27E806F	W	119	5/27/08	ICH	5/07/10	710	4
3D9.1BF27EA280	W	102	5/04/08	LTR	5/06/10	732	4
3D9.1BF27EC355	W	111	5/03/08	ICH	5/16/10	744	4
3D9.1C2C87304F	W	96	4/20/08	BON	4/28/10	738	4
3D9.1C2C875C89	W	115	4/18/08	MCN	5/08/10	750	4
3D9.1C2C87D02B	W	110	4/18/08	ICH	5/09/10	746	4
3D9.1C2C87D789	W	99	4/20/08	MCN	5/01/10	742	4
3D9.1C2C9CA1D0	W	115	4/22/08	BON	4/25/10	734	4
3D9.1C2CA9921E	W	109	4/22/08	LGR	5/23/10	761	4
3D9.1C2CA9B076	W	118	4/21/08	BON	4/25/10	734	4
3D9.1BF27DBF36	H	---	4/15/08	LTR	5/09/10	754	4
3D9.1BF27DE0CD	H	---	4/15/08	BON	4/29/10	744	4
3D9.1BF27E0336	H	---	4/15/08	ICH	5/15/10	760	4
3D9.1BF27E196E	H	---	4/15/08	ICH	5/01/10	746	4
3D9.1BF27E3B75	H	---	4/15/08	ICH	4/22/10	737	4
3D9.1BF27E55A0	H	135	4/15/08	ICH	5/24/10	769	4
3D9.1BF27E8ADF	H	---	4/15/08	BON	4/25/10	740	4
3D9.1BF27EBB28	H	113	4/15/08	LTR	5/26/10	771	4
3D9.1BF27ECB41	H	124	4/15/08	ICH	5/14/10	759	4
3D9.1BF27ED02D	H	---	4/15/08	BON	5/09/10	754	4
3D9.1BF27E53AA	H	123	4/15/08	LTR	6/05/10	781	4
3D9.1BF27E5A15	H	---	4/15/08	ICH	5/19/10	764	4
3D9.1BF27E9E98	H	---	4/15/08	MCN	4/23/10	738	4
3D9.1BF27EAC50	H	---	4/15/08	LTR	5/05/10	750	4
3D9.1BF27EAD0A	H	153	4/15/08	ICH	5/10/10	755	4
3D9.1BF27E4C02	H	---	4/15/08	ICH	5/12/10	757	4
3D9.1BF27E172D	H	---	4/15/08	BON	4/21/10	736	4

Abbreviations are as follows: BON – Bonneville Dam, TDA – The Dalles 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
3D9.1BF27E066A	H	---	4/15/08	LGR	5/24/10	768	4
3D9.1BF27E0720	H	131	4/15/08	LGR	5/17/10	744	4
3D9.1BF27E0425	H	---	4/15/08	BON	4/28/10	743	4
3D9.1BF27E050F	H	---	4/15/08	MCN	4/26/10	741	4
3D9.1BF27DF85C	H	---	4/15/08	LTR	6/07/10	783	4
3D9.1BF27DEFC8	H	124	4/15/08	BON	4/23/10	738	4
3D9.1BF27CF491	H	---	4/15/08	LGR	5/19/10	764	4
3D9.1BF27DB43A	H	131	4/15/08	ICH	5/05/10	750	4
3D9.1BF27DC0B5	H	138	4/15/08	LTR	4/30/10	745	4
3D9.1BF27DC33F	H	---	4/15/08	LTR[b]	5/08/10	753	4
3D9.1BF27DEB6D	H	---	4/15/08	LTR	5/26/10	771	4
3D9.1C2C455F7C	CB	---	4/15/08	MCN	5/15/10	760	4
3D9.1C2C48AA85	CB	---	4/15/08	ICH	5/08/10	753	4
3D9.1C2C4AF06C	CB	---	4/15/08	LTR	5/05/10	750	4
3D9.1BF27C301A	W	98	4/24/08	LTR[b]	5/17/11	1118	5
3D9.1BF27C38CD	W	106	4/25/08	LTR	5/14/11	1114	5
3D9.1BF27C3DD3	W	103	4/17/08	LTR	5/11/11	1119	5
3D9.1BF27C524B	W	110	4/29/08	BON	4/26/11	1092	5
3D9.1BF27C65EB	W	103	4/27/08	ICH	6/16/11	1145	5
3D9.1BF27CDCC9	W	103	4/26/08	ICH	5/07/11	1106	5
3D9.1BF27CF043	W	98	4/01/08	LTR	5/12/11	1136	5
3D9.1BF27E02B6	W	101	5/03/08	BON	4/30/11	1092	5
3D9.1C2C97ECE2	W	103	4/23/08	MCN	5/09/11	1112	5
3D9.1BF27E0E0D	W	112	11/17/08	ICH	5/15/11	909	5
3D9.1BF27E4192	W	113	12/31/08	ICH	5/08/11	858	5
3D9.1BF27E502E	W	102	12/29/08	AFC	6/20/11	903	5
3D9.1BF27E54F2	W	111	11/26/08	MCN	6/30/11	946	5
3D9.1BF27E8A96	W	125	12/31/08	MCN	6/24/11	905	5
3D9.1BF27EB33D	W	111	12/11/08	ICH	5/24/11	893	5
3D9.1BF27EC294	H	130	4/15/08	MCN	5/07/11	1116	5
3D9.1BF27C382A	W	110	4/17/08	LTR	3/27/12	1440	6
3D9.1C2CFD0260	H	---	4/17/09	LTR	6/20/10	429	3
3D9.1C2D044E4D	H	---	4/17/09	LTR[b]	5/30/10	408	3
3D9.1C2D03EA21	H	---	4/17/09	ICH	5/18/10	396	3
3D9.1C2CFCCEAF	H	---	4/17/09	LTR	6/29/10	438	3
3D9.1C2CF467AE	H	---	4/17/09	ICH	5/12/10	390	3

Abbreviations are as follows: BON – Bonneville Dam, TDA – The Dalles 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
3D9.1C2CFBAFCC	H	---	4/17/09	LTR[b]	5/24/11	767	4
3D9.1C2CFCD300	H	---	4/17/09	BON	5/17/11	760	4
3D9.1C2CFD176B	H	---	4/17/09	LGR	6/06/11	773	4
3D9.1C2D02834D	H	---	4/17/09	LTR	5/20/11	763	4
3D9.1C2D02ACF7	H	158	4/17/09	LGO[b]	5/17/11	760	4
3D9.1C2D034513	H	---	4/17/09	LTR	5/16/11	759	4
3D9.1C2D0357E4	H	194	4/17/09	LGR	6/21/11	781	4
3D9.1C2D040E6F	H	---	4/17/09	ICH	6/02/11	771	4
3D9.1BF27C2A80	W	110	5/02/09	ICH	5/11/11	739	4
3D9.1BF27C32F1	W	116	4/30/09	ICH	6/06/11	767	4
3D9.1BF27C34E2	W	131	5/01/09	ICH	5/17/11	746	4
3D9.1BF27C3AEE	W	114	4/27/09	LTR	5/10/11	743	4
3D9.1BF27C3EE4	W	117	5/10/09	ICH	5/20/11	740	4
3D9.1BF27C51C3	W	117	5/03/09	MCN	5/13/11	740	4
3D9.1BF27C610A	W	125	4/27/09	ICH	5/06/11	739	4
3D9.1BF27C652F	W	122	4/28/09	LTR	5/14/11	746	4
3D9.1BF27C6784	W	105	5/09/09	LTR	5/18/11	739	4
3D9.1BF27CE9F8	W	105	4/29/09	LTR	5/19/11	750	4
3D9.1BF27DB642	W	109	1/20/09	AFC	9/09/11	928	4
3D9.1BF27E20BB	W	99	1/27/09	MCN	5/15/11	838	4
3D9.1BF27E2615	W	128	4/19/09	ICH	6/22/11	794	4
3D9.1BF27EBF86	W	113	1/26/09	BON	5/14/11	838	4
3D9.1C2D031FC6	W	105	11/16/09	LGR	6/21/11	582	4
3D9.1C2CF44596	H	---	4/17/09	MTR	4/02/12	1081	5
3D9.1C2CF45F43	W	116	5/19/09	BON	4/24/12	1071	5
3D9.1C2CFCEF10	W	93	12/15/09	MTR	5/28/12	895	5
3D9.1C2CB17349	H	---	4/07/10	LTR	5/10/11	398	3
3D9.1C2CFBE7D3	H	---	4/07/10	ICH	5/16/11	404	3
3D9.1C2CFCA747	H	---	4/07/10	ICH	5/23/11	411	3
3D9.1C2CFCB6E1	H	---	4/07/10	ICH	5/24/11	412	3
3D9.1C2D0A57A9	H	---	4/07/10	LGR	5/11/11	399	3
3D9.1C2D0C6B10	H	---	4/07/10	ICH	5/20/11	408	3
3D9.1C2D0C6EC3	H	---	4/07/10	ICH	6/02/11	421	3
3D9.1C2D10D73B	H	---	4/07/10	LTR	7/04/11	453	3
3D9.1C2D116974	H	---	4/07/10	MCN	5/18/11	406	3
3D9.1C2D11BDED	H	---	4/07/10	ICH	5/22/11	410	3

Abbreviations are as follows: BON – Bonneville Dam, TDA – The Dalles 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
3D9.1C2D1227AC	H	---	4/07/10	ICH	5/21/11	409	3
3D9.1C2D74B711	H	---	4/07/10	MCN	6/05/11	424	3
3D9.1C2D750B0B	H	---	4/07/10	LTR[b]	7/05/11	455	3
3D9.1C2D752277	H	---	4/07/10	ICH	6/06/11	425	3
3D9.1C2D754D65	H	---	4/07/10	LTR	6/04/11	423	3
3D9.1C2D755233	H	---	4/07/10	LGR	6/17/11	436	3
3D9.1C2D7555EA	H	---	4/07/10	ICH	5/30/11	418	3
3D9.1C2D755E10	H	---	4/07/10	ICH	6/07/11	426	3
3D9.1C2D756572	H	---	4/07/10	LTR	6/07/11	426	3
3D9.1C2D7565B1	H	---	4/07/10	LTR	6/15/11	434	3
3D9.1C2D756D09	H	---	4/07/10	ICH	6/06/11	425	3
3D9.1C2D75B9F9	H	---	4/07/10	ICH	6/04/11	423	3
3D9.1C2D75BAC1	H	---	4/07/10	BON	5/23/11	411	3
3D9.1C2D75C3CB	H	---	4/07/10	LGO[b]	7/02/11	451	3
3D9.1C2D75CA67	H	---	4/07/10	LTR	6/05/11	425	3
3D9.1C2D7A9C66	H	---	4/07/10	MCN	6/08/11	427	3
3D9.1C2D7AB0CD	H	---	4/07/10	ICH	6/06/11	425	3
3D9.1C2D7AB2FB	H	---	4/07/10	MCN	5/14/11	402	3
3D9.1C2D7ABE87	H	---	4/07/10	LTR	5/11/11	399	3
3D9.1C2D7ABEE8	H	---	4/07/10	LTR	5/20/11	408	3
3D9.1C2D7ABF15	H	---	4/07/10	BON	5/20/11	408	3
3D9.1C2D7AD6C0	H	---	4/07/10	ICH	6/16/11	435	3
3D9.1C2D7AF0D6	H	---	4/07/10	ICH	5/31/11	419	3
3D9.1C2D7AF13B	H	---	4/07/10	BON	5/16/11	404	3
3D9.1C2D7B4C96	H	---	4/07/10	BON	5/09/11	397	3
3D9.1C2D7B723E	H	---	4/07/10	ICH	5/29/11	417	3
3D9.1C2D7C5759	H	---	4/07/10	ICH	5/29/11	417	3
3D9.1C2D80F436	H	---	4/07/10	MCN	5/27/11	415	3
3D9.1C2D80FE10	H	---	4/07/10	BON	5/19/11	406	3
3D9.1C2D8102EE	H	---	4/07/10	BON	5/16/11	404	3
3D9.1C2D8142B7	H	---	4/07/10	MCN	6/05/11	424	3
3D9.1C2D8158FB	H	---	4/07/10	BON	5/23/11	411	3
3D9.1C2D824F31	H	---	4/07/10	LTR	5/18/11	406	3
3D9.1C2CF45F7D	W	116	4/11/10	LTR	4/02/11	356	3
3D9.1C2CF468D0	W	123	4/17/10	LTR	6/09/11	418	3
3D9.1C2CFC3BD4	W	109	5/07/10	LTR	4/01/11	330	3

Abbreviations are as follows: BON – Bonneville Dam, TDA – The Dalles 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	277	3
3D9.1C2D030B45	W	130	4/26/10	MCN	6/07/11	407	3
3D9.1C2D03E72B	W	97	4/19/10	LTR	5/30/11	406	3
3D9.1C2D03EF5F	W	116	2/01/10	LTR	5/31/11	484	3
3D9.1C2CB10281	H	---	4/07/10	MTR	6/28/12	813	4
3D9.1C2CFB857B	H	---	4/07/10	TFH	9/07/12	884	4
3D9.1C2D07E9D1	H	---	4/07/10	MTR[b]	6/02/12	787	4
3D9.1C2D0C2DA7	H	---	4/07/10	MTR	5/24/12	778	4
3D9.1C2D0C5BED	H	---	4/07/10	MTR	5/19/12	773	4
3D9.1C2D0D1C3C	H	---	4/07/10	UTR	5/26/12	778	4
3D9.1C2D0D4DF0	H	---	4/07/10	MTR	5/22/12	776	4
3D9.1C2D10D771	H	---	4/07/10	UTR	6/13/12	798	4
3D9.1C2D10D97F	H	---	4/07/10	MTR[b]	6/3/12	788	4
3D9.1C2D1187CD	H	---	4/07/10	MTR	5/22/12	776	4
3D9.1C2D74B7DA	H	---	4/07/10	LGR	5/15/12	769	4
3D9.1C2D74B82A	H	---	4/07/10	UTR	5/26/12	780	4
3D9.1C2D74BF68	H	---	4/07/10	UTR	5/28/12	782	4
3D9.1C2D74C77F	H	---	4/07/10	MTR	5/24/12	778	4
3D9.1C2D754D26	H	---	4/07/10	BON	4/24/12	748	4
3D9.1C2D759A04	H	---	4/07/10	UTR	5/24/12	778	4
3D9.1C2D7A9292	H	---	4/07/10	MTR	5/19/12	773	4
3D9.1C2D7A941E	H	---	4/07/10	UTR[b]	6/14/12	799	4
3D9.1C2D7AB43F	H	---	4/07/10	MTR	4/3/12	727	4
3D9.1C2D7AB4B3	H	---	4/07/10	BON	5/9/12	763	4
3D9.1C2D7AB60D	H	---	4/07/10	LTR	5/9/12	763	4
3D9.1C2D7ACCC9	H	---	4/07/10	BON	4/22/12	746	4
3D9.1C2D7AE415	H	---	4/07/10	MTR	5/20/12	774	4
3D9.1C2D7AE70C	H	---	4/07/10	LTR	4/24/12	747	4
3D9.1C2D7AFC8E	H	---	4/07/10	MTR	3/31/12	724	4
3D9.1C2D7B0029	H	---	4/07/10	TFH	8/29/12	875	4
3D9.1C2D7B39BD	H	---	4/07/10	TFH	4/26/12	750	4
3D9.1C2D7B4B24	H	---	4/07/10	BON	5/08/12	762	4
3D9.1C2D7B5A59	H	---	4/07/10	BON	5/15/12	769	4
3D9.1C2D7B86D6	H	---	4/07/10	MTR	5/21/12	775	4
3D9.1C2D7BB359	H	---	4/07/10	AFC	7/01/12	816	4
3D9.1C2D7C0465	H	---	4/07/10	LTR	5/12/12	766	4

Abbreviations are as follows: BON – Bonneville Dam, TDA – The Dalles 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
3D9.1C2D7C4237	H	---	4/07/10	MTR	6/14/12	799	4
3D9.1C2D7C4BBC	H	---	4/07/10	MTR	3/31/12	724	4
3D9.1C2D80D818	H	---	4/07/10	MTR	5/29/12	783	4
3D9.1C2D812B48	H	---	4/07/10	UTR	5/26/12	780	4
3D9.1C2D815183	H	---	4/07/10	MTR	5/21/12	775	4
3D9.1C2D8243D7	H	---	4/07/10	MTR	5/19/12	773	4
3D9.1C2D825C9D	H	---	4/07/10	MTR	5/26/12	780	4
3D9.1C2D826D4F	H	---	4/07/10	MTR	5/19/12	773	4
3D9.1C2D826F4D	H	---	4/07/10	LTR	5/21/12	775	4
3D9.1C2D828612	H	---	4/07/10	MTR	5/19/12	773	4
3D9.1C2D829474	H	---	4/07/10	LTR	5/24/12	778	4
3D9.1C2D829B73	H	---	4/07/10	LGR	5/23/12	777	4
3D9.1C2D0C6405	H	---	4/07/10	UTR	5/12/13	1131	5
3D9.1C2CFB5F1B	W	105	5/02/10	LTR	4/07/12	706	4
3D9.1C2CFD12B3	W	120	4/29/10	MTR	5/21/12	753	4
3D9.1C2CFF248D	W	116	5/10/10	BON	5/02/12	768	4
3D9.1C2D02D770	W	119	5/06/10	MTR	6/11/12	768	4
3D9.1C2D02EB49	W	104	5/07/10	AFC	9/27/12	874	4
3D9.1C2D03599C	W	101	4/05/10	LTR	4/18/12	743	4
3D9.1C2D03A283	W	112	5/13/10	LTR	6/14/12	763	4
3D9.1C2CF44450	W	93	12/20/10	LTR	4/25/12	492	4
3D9.1C2D03EECD	W	125	3/26/10	TFH	6/17/13	1179	5
3D9.1C2D031A03	W	97	4/29/10	TFH	6/15/13	1143	5
3D9.1C2CFC3DD5	W	115	5/14/10	TDA	5/05/13	1087	5
3D9.1C2CF52775	W	83	11/15/10	UTR	5/18/13	915	5
3D9.1C2CF52CD5	W	80	12/09/10	AFC	9/20/13	915	5
3D9.1C2D9FAD7C	H	110	4/16/11	MTR	3/28/12	347	3
3D9.1C2D9FAFB1	H	107	4/16/11	LTR	4/22/12	373	3
3D9.1C2DA0DB23	H	105	4/16/11	LTR	3/26/12	345	3
3D9.1C2DA2D949	H	98	4/16/11	TFH	4/24/12	374	3
3D9.1C2DC02030	H	121	4/16/11	UTR	4/01/12	351	3
3D9.1C2DC03995	H	147	4/16/11	MTR	4/01/12	351	3
3D9.1C2DC172E2	H	164	4/16/11	LTR	4/02/12	351	3
3D9.1C2DC19AEF	H	155	4/16/11	UTR	7/02/12	443	3
3D9.1C2DC19B8B	H	142	4/16/11	UTR	6/02/12	413	3
3D9.1C2DC31A5A	H	154	4/16/11	LTR	5/22/12	402	3

Abbreviations are as follows: BON – Bonneville Dam, TDA – The Dalles 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
3D9.1C2DC34F18	H	128	4/16/11	MTR	12/03/12	597	3
3D9.1C2DC3FB56	H	124	4/16/11	MTR	6/07/12	418	3
3D9.1C2DC4BAA0	H	122	4/16/11	MTR	3/18/12	337	3
3D9.1C2DC4C76D	H	149	4/16/11	BON	5/08/12	388	3
3D9.1C2DCA0C73	H	148	4/16/11	UTR[b]	7/02/12	443	3
3D9.1C2D817ABD	H	119	4/16/11	TFH	6/09/13	780	4
3D9.1C2D81924A	H	115	4/16/11	UTR	5/29/13	765	4
3D9.1C2D8444A7	H	105	4/16/11	TFH	6/08/13	784	4
3D9.1C2D846942	H	108	4/16/11	BON	5/03/13	748	4
3D9.1C2D9FC789	H	110	4/16/11	UTR	5/24/13	769	4
3D9.1C2DA03139	H	107	4/16/11	TFH	6/07/13	773	4
3D9.1C2DA04F21	H	117	4/16/11	UTR	5/18/13	763	4
3D9.1C2DA2F58B	H	---	4/16/11	TFH	6/23/13	799	4
3D9.1C2DBF6BA9	H	141	4/16/11	TFH	6/11/13	773	4
3D9.1C2DBF6BBC	H	157	4/16/11	TFH	6/10/13	786	4
3D9.1C2DC00CEF	H	169	4/16/11	TFH	6/07/13	783	4
3D9.1C2DC0450F	H	152	4/16/11	TFH	5/30/13	775	4
3D9.1C2DC070AB	H	157	4/16/11	UTR	6/21/13	771	4
3D9.1C2DC182B7	H	176	4/16/11	TDA	4/29/13	744	4
3D9.1C2DC19B5C	H	156	4/16/11	BON	5/05/13	750	4
3D9.1C2DC19E38	H	170	4/16/11	TDA	5/21/13	766	4
3D9.1C2DC1A8B3	H	148	4/16/11	TFH	5/27/13	767	4
3D9.1C2DC29D7D	H	148	4/16/11	TFH	5/22/13	767	4
3D9.1C2DC361C7	H	134	4/16/11	UTR[b]	5/28/13	773	4
3D9.1C2DC3D35F	H	127	4/16/11	UTR	5/22/13	767	4
3D9.1C2DC43449	H	164	4/16/11	TFH	6/25/13	772	4
3D9.1C2DC45465	H	130	4/16/11	TFH	7/07/13	772	4
3D9.1C2DC4673F	H	158	4/16/11	TFH	6/30/13	806	4
3D9.1C2DC4ADF3	H	165	4/16/11	TFH	6/04/13	780	4
3D9.1C2DC5085D	H	142	4/16/11	MTR	5/06/13	751	4
3D9.1C2DC52B1C	H	143	4/16/11	TFH	6/08/13	773	4
3D9.1C2DC91C7A	H	121	4/16/11	TFH	6/30/13	806	4
3D9.1C2DC9248E	H	131	4/16/11	UTR	5/30/13	762	4
3D9.1C2DC9A9FC	H	150	4/16/11	TFH	6/12/13	769	4
3D9.1C2DC9B125	H	134	4/16/11	UTR	6/04/13	761	4
3D9.1C2DC9EA81	H	173	4/16/11	TFH	6/08/13	784	4

Abbreviations are as follows: BON – Bonneville Dam, TDA – The Dalles 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
3D9.1C2DA06E4C	H	109	4/16/11	MTR	3/07/14	1056	5
3D9.1C2D751A48	W	114	4/05/11	BON	5/22/12	413	3
3D9.1C2D752AEA	W	86	2/02/11	LTR	4/25/12	449	3
3D9.1C2D80E283	W	101	5/15/11	LTR	4/01/12	322	3
3D9.1C2D810EC1	W	110	5/13/11	LTR	4/21/12	344	3
3D9.1C2DCA49A5	W	126	4/17/11	BON	9/26/12	528	3
3D9.1C2DCA78FE	W	110	4/21/11	LTR	4/01/12	346	3
3D9.1C2DCAD4E4	W	104	4/24/11	LTR	4/26/12	368	3
3D9.1C2DCB037F	W	106	4/15/11	UTR	6/18/12	430	3
3D9.1C2DCB1BF3	W	104	4/29/11	LTR	3/31/12	336	3
3D9.1C2DCB9A41	W	98	5/08/11	LTR	4/26/12	352	3
3D9.1C2DCC07AE	W	95	4/29/11	LTR	5/03/12	370	3
3D9.1C2DCC4647	W	112	4/24/11	LTR	4/23/12	363	3
3D9.1C2D74F991	W	91	3/15/11	TFH	6/04/13	812	4
3D9.1C2DCAB790	W	110	4/17/11	TFH	6/17/13	787	4
3D9.1C2DCA9CB6	W	115	4/18/11	UTR	5/10/13	753	4
3D9.1C2DCADF0D	W	107	4/21/11	TFH	6/20/13	791	4
3D9.1C2D6F5121	W	108	4/25/11	LTR	5/21/13	757	4
3D9.1C2DCAEA83	W	115	4/26/11	TFH	5/28/13	757	4
3D9.1C2DCBB53A	W	104	4/27/11	UTR[b]	6/11/13	776	4
3D9.1C2DCBEA6D	W	106	4/27/11	UTR[b]	5/13/13	747	4
3D9.1C2D7B5F96	W	105	5/02/11	UTR	5/20/13	749	4
3D9.1C2D7A9160	W	101	5/14/11	TFH	6/07/13	755	4
3D9.1C2DCA977B	W	85	4/17/11	UTR	5/10/14	1119	5
3D9.1C2DCBF689	W	112	4/23/11	BON	5/16/14	1119	5
3D9.1C2D6F9B00	W	105	4/26/11	UTR	6/07/14	1138	5
3D9.1C2D7B9F0A	W	106	4/30/11	TFH	7/06/14	1132	5
3D9.1C2DC809DB	H	154	4/16/12	TFH	7/15/13	415	3
3D9.1C2DC852D4	H	111	4/16/12	UTR	6/26/13	436	3
3D9.1C2DC853A6	H	134	4/16/12	UTR[b]	6/17/13	427	3
3D9.1C2DCB165D	H	116	4/16/12	UTR	5/29/13	408	3
3D9.1C2DCE4C77	H	---	4/16/12	UTR[b]	6/15/13	425	3
3D9.1C2DCE4C9F	H	115	4/16/12	LTR	5/17/13	396	3
3D9.1C2DCF2BC0	H	168	4/16/12	MTR[b]	5/31/13	410	3
3D9.1C2DCF3297	H	129	4/16/12	TFH[b]	7/12/13	427	3
3D9.1C2DCF6319	H	138	4/16/12	UTR[b]	6/10/13	420	3

Abbreviations are as follows: BON – Bonneville Dam, TDA – The Dalles 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
3D9.1C2DCF6E41	H	178	4/16/12	TFH	6/07/13	417	3
3D9.1C2DCF99B4	H	159	4/16/12	UTR	7/01/13	441	3
3D9.1C2DCFA2AE	H	151	4/16/12	UTR	5/31/13	410	3
3D9.1C2DCF9410	H	165	4/16/12	UTR	3/09/14	692	4
3D9.1C2DCF2D72	H	179	4/16/12	UTR	3/10/14	693	4
3D9.1C2DCF8FC4	H	130	4/16/12	UTR	3/12/14	695	4
3D9.1C2DC87009	H	99	4/16/12	BON	4/23/14	737	4
3D9.1C2DC860F9	H	141	4/16/12	TDA	4/30/14	744	4
3D9.1C2DC8639B	H	158	4/16/12	UTR	5/15/14	759	4
3D9.1C2DD3F125	H	128	4/16/12	UTR	5/17/14	761	4
3D9.1C2DC856B2	H	127	4/16/12	UTR	5/19/14	763	4
3D9.1C2DC83952	H	165	4/16/12	UTR	5/20/14	764	4
3D9.1C2DCF6493	H	148	4/16/12	UTR	5/21/14	765	4
3D9.1C2DD01532	H	110	4/16/12	UTR	5/24/14	768	4
3D9.1C2DC838D7	H	133	4/16/12	UTR	6/07/14	782	4
3D9.1C2DCB0989	H	103	4/16/12	TFH	7/01/14	806	4
3D9.1C2DD00959	H	108	4/16/12	TFH	7/03/14	808	4
3D9.1C2DC8546B	H	172	4/16/12	TFH	6/10/14	785	4
3D9.1C2DCFB566	H	115	4/16/12	UTR[b]	5/16/15	1125	5
3D9.1C2DCE41D6	H	118	4/16/12	TFH	6/02/15	1131	5
3D9.1C2CF46D35	W	117	5/02/12	UTR	5/20/14	748	4
3D9.1C2CF4979F	W	104	5/03/12	UTR[b]	6/01/14	759	4
3D9.1C2CF51B24	W	101	4/22/12	UTR	6/18/14	787	4
3D9.1C2CF51F21	W	111	5/02/12	TFH	6/28/14	787	4
3D9.1C2CF68759	W	111	4/22/12	AFC	7/08/14	807	4
3D9.1C2CFC73E8	W	115	4/17/12	TFH[b]	8/28/14	778	4
3D9.1C2D0007AA	W	105	4/17/12	ICH	5/13/14	756	4
3D9.1C2D02AAF1	W	110	4/20/12	TFH	8/27/14	859	4
3D9.1C2D03180C	W	101	5/09/12	WL1	7/16/14	798	4
3D9.1C2D031EBC	W	107	5/05/12	TFH[b]	6/08/14	764	4
3D9.1C2D039F3E	W	124	4/19/12	UTR	6/25/14	778	4
3D9.1C2D03EA08	W	101	4/20/12	LTR	7/19/14	686	4
3D9.1C2D74C67B	W	99	3/03/12	UTR[b]	5/23/14	811	4
3D9.1C2D74FEBA	W	108	3/06/12	UTR	5/27/14	812	4
3D9.1C2D780CFE	W	96	5/17/12	BON	4/25/14	708	4
3D9.1C2D80D5FB	W	117	5/13/12	LTR	1/28/14	887	4

Abbreviations are as follows: BON – Bonneville Dam, TDA – The Dalles 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, WL1 – Wilson Creek, Entiat River..

[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
3D9.1C2D813C48	W	93	5/17/12	TFH[b]	6/04/14	745	4
3D9.1C2DF588B4	W	105	12/10/12	LGR	9/27/14	656	4
3D9.1C2CFD4F61	W	112	4/20/12	TFH[b]	5/22/15	1127	5
3D9.1C2D05017C	W	105	4/19/12	TFH	5/10/15	1116	5
3D9.1C2CFC993C	W	100	4/20/12	TFH[b]	5/22/15	1127	5
3D9.1C2D8A9CB1	W	109	12/10/12	MTR	6/25/15	927	5
3D9.1C2DF58C64	W	92	12/13/12	UTR	5/21/15	889	5
3D9.1C2DE837AF	H	117	4/12/13	LTR	3/07/14	329	3
3D9.1C2DE83BA5	H	91	4/12/13	MTR	3/13/14	335	3
3D9.1C2E02E2D8	H	146	4/12/13	UTR[b]	6/17/14	431	3
3D9.1C2E0A1490	H	118	4/12/13	MTR	5/27/14	410	3
3DD.003B9D167B	H	117	4/12/13	UTR[b]	6/03/14	417	3
3DD.003B9D1BBC	H	102	4/12/13	UTR	3/11/14	333	3
3DD.003B9D1EC2	H	108	4/12/13	UTR	3/10/14	332	3
3DD.003B9D214A	H	129	4/12/13	UTR	3/10/14	332	3
3DD.003B9D29FE	H	113	4/12/13	UTR	5/27/14	410	3
3DD.003B9D2C34	H	116	4/12/13	UTR[b]	6/04/14	418	3
3DD.003B9D2FCD	H	108	4/12/13	UTR	6/02/14	416	3
3DD.003B9D31F3	H	111	4/12/13	UTR	5/27/14	410	3
3D9.1C2DE8C3E2	H	120	4/12/13	MTR	5/10/15	758	4
3D9.1C2DE925DA	H	125	4/12/13	UTR[b]	5/12/15	760	4
3D9.1C2DE9368F	H	110	4/12/13	TFH	5/20/15	768	4
3D9.1C2DE959B0	H	103	4/12/13	TDA	5/29/15	777	4
3D9.1C2DE99306	H	140	4/12/13	TFH	5/23/15	771	4
3D9.1C2DE9ABF3	H	118	4/12/13	UTR	5/23/15	771	4
3D9.1C2DE9B0BA	H	115	4/12/13	UTR[b]	5/18/15	766	4
3D9.1C2E033E98	H	106	4/12/13	TFH	5/29/15	777	4
3DD.003B9D1935	H	104	4/12/13	UTR[b]	5/23/15	771	4
3DD.003B9D1AC0	H	132	4/12/13	UTR[b]	6/10/15	789	4
3DD.003B9D1B26	H	103	4/12/13	UTR[b]	5/22/15	770	4
3DD.003B9D1D63	H	107	4/12/13	UTR	5/16/15	764	4
3DD.003B9D2095	H	124	4/12/13	BON	5/16/15	764	4
3DD.003B9D244F	H	106	4/12/13	UTR	5/18/15	766	4
3DD.003B9D25E2	H	155	4/12/13	UTR[b]	6/01/15	780	4
3DD.003B9D2627	H	106	4/12/13	UTR	5/11/15	759	4
3DD.003B9D2727	H	99	4/12/13	TFH[b]	5/22/15	770	4

Abbreviations are as follows: BON – Bonneville Dam, TDA – The Dalles 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
3DD.003B9D281C	H	110	4/12/13	UTR[b]	5/27/15	775	4
3DD.003B9D2838	H	128	4/12/13	UTR	5/27/15	775	4
3DD.003B9D29EC	H	116	4/12/13	MTR[b]	5/15/15	763	4
3DD.003B9D2AEA	H	109	4/12/13	UTR	5/09/15	757	4
3DD.003B9D2DDC	H	125	4/12/13	UTR[b]	5/11/15	759	4
3DD.003B9D2ED0	H	116	4/12/13	UTR	5/24/15	772	4
3DD.003B9D321E	H	123	4/12/13	TFH[b]	5/22/15	770	4
3DD.003B9D31A8	H	111	4/12/13	UTR[b]	5/23/16	1137	5
3D9.1C2DF74B96	W	111	4/18/13	LTR	3/05/14	320	3
3D9.1C2DF60D13	W	117	4/04/13	LTR	3/04/14	334	3
3D9.1C2DF7025E	W	120	4/15/13	TDA	6/04/14	415	3
3D9.1C2DF5DE4B	W	103	4/16/13	LGR	10/02/14	534	3
3D9.1C2D8A76AF	W	98	3/05/13	TFH	5/24/15	810	4
3D9.1C2DF5F7BA	W	125	3/19/13	MCN	7/09/15	842	4
3D9.1C2DF60BD1	W	99	3/19/13	TFH[b]	5/23/15	795	4
3D9.1C2DF58C89	W	101	3/25/13	TFH	5/24/15	790	4
3D9.1C2DF5C27F	W	103	3/25/13	UTR[b]	6/03/15	800	4
3D9.1C2DF5CF8F	W	122	4/02/13	BON	4/30/15	758	4
3D9.1C2DF61573	W	118	4/08/13	UTR[b]	5/16/15	768	4
3D9.1C2DF72A0B	W	126	4/09/13	UTR	5/08/15	759	4
3D9.1C2DF58547	W	110	4/10/13	UTR[b]	6/06/15	787	4
3D9.1C2DF5EC24	W	116	4/10/13	TFH[b]	6/05/15	786	4
3D9.1C2DF5FF40	W	116	4/11/13	TFH[b]	5/23/15	772	4
3D9.1C2DF6C4D5	W	125	4/11/13	UTR[b]	5/29/15	778	4
3D9.1C2DF59B0B	W	110	4/14/13	UTR[b]	5/23/15	769	4
3D9.1C2DF5C991	W	119	4/16/13	TDA	5/30/15	774	4
3D9.1C2DF6D206	W	115	4/15/13	UTR[b]	6/09/15	785	4
3D9.1C2DF60BC1	W	110	4/16/13	TFH	5/16/15	760	4
3D9.1C2DF75306	W	102	4/17/13	TFH[b]	6/12/15	786	4
3D9.1C2DF60D90	W	106	4/17/13	TFH[b]	5/22/15	765	4
3D9.1C2DF58555	W	109	4/20/13	TFH	5/19/15	759	4
3D9.1C2DF601C4	W	124	4/23/13	TFH	5/27/15	764	4
384.3B23A32AAE	W	121	4/28/13	TFH	6/24/15	787	4
384.3B23A1F5CC	W	110	4/28/13	TFH	5/19/15	751	4
384.3B23A2D320	W	100	5/01/13	TFH	5/18/15	747	4
384.3B23A2DA29	W	117	5/03/13	TFH[b]	5/23/15	750	4

Abbreviations are as follows: BON – Bonneville Dam, TDA – The Dalles 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
384.3B23A21153	W	124	5/04/13	TFH[b]	5/19/15	743	4
384.3B23A34FB8	W	120	5/04/13	UTR[b]	6/02/15	759	4
384.3B23A2D2F9	W	100	5/07/13	TFH	5/29/15	752	4
384.3B23A1E082	W	115	5/11/13	TFH[b]	5/23/15	742	4
3D9.1C2DF5DD43	W	111	3/21/13	LTR	5/14/16	1150	5
3D9.1C2DF5C4D0	W	127	4/07/13	UTR	5/25/16	1144	5
3D9.1C2DF61011	W	107	4/07/13	TDA	5/09/16	1128	5
3D9.1C2DF5BC0D	W	114	4/13/13	UTR	5/22/16	1135	5
384.3B23A36516	W	99	4/22/13	UTR	5/15/16	1119	5
384.3B23A31042	W	111	5/02/13	ICH	5/15/16	1109	5
384.3B23A3C231	W	104	5/08/13	UTR	5/17/16	1105	5
384.3B23A24E07	W	116	5/10/13	UTR[b]	5/26/16	1112	5
384.3B23A3A635	W	113	5/10/13	BON	5/23/16	1109	5
384.3B23A48C3E	H	140	4/17/14	TFH[b]	6/15/15	424	3
384.3B23B1952B	H	154	4/17/14	TDA	6/01/15	410	3
384.3B23B1ADEC	H	118	4/17/14	TFH[b]	6/22/15	431	3
384.3B23B1DB32	H	140	4/17/14	TFH	6/08/15	417	3
384.3B23B1DF51	H	123	4/17/14	MTR	6/22/15	431	3
384.3B23B23BDC	H	107	4/17/14	TFH[b]	6/24/15	433	3
384.3B23B23C7F	H	159	4/17/14	TFH[b]	5/31/15	409	3
384.3B23B24F47	H	134	4/17/14	LGR	6/07/15	416	3
384.3B23A74AE0	H	151	4/17/14	UTR	6/16/15	425	3
384.3B23A7EDC3	H	163	4/17/14	TFH[b]	6/14/15	423	3
384.3B23A88231	H	166	4/17/14	UTR[b]	5/28/15	406	3
384.3B23A935F2	H	120	4/17/14	TFH[b]	5/24/15	402	3
384.3B23A94E4D	H	114	4/17/14	MTR[b]	6/13/15	422	3
384.3B23A95BAA	H	155	4/17/14	LGR	6/03/15	412	3
384.3B23A98410	H	115	4/17/14	TFH[b]	8/02/15	439	3
384.3B23AA49B7	H	124	4/17/14	TFH[b]	6/17/15	425	3
3D9.1C2DB6EEA0	H	140	4/17/14	UTR[b]	6/01/15	410	3
3D9.1C2DB7680C	H	162	4/17/14	UTR[b]	6/22/15	431	3
3D9.1C2DC064C9	H	126	4/17/14	MCN	6/06/15	415	3
3D9.1C2DCA985B	H	127	4/17/14	UTR	6/18/15	427	3
384.3B23A48FDF	H	114	4/17/14	UTR	5/15/16	759	4
384.3B23A49E45	H	148	4/17/14	UTR	5/17/16	761	4
384.3B23A91470	H	117	4/17/14	UTR	5/17/16	761	4

Abbreviations are as follows: BON – Bonneville Dam, TDA – The Dalles 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
384.3B23A91605	H	127	4/17/14	BON	5/17/16	761	4
384.3B23A98810	H	116	4/17/14	BON	4/27/16	741	4
384.3B23A991EB	H	134	4/17/14	UTR	5/29/16	773	4
384.3B23AA0FA0	H	170	4/17/14	UTR[b]	5/31/16	775	4
384.3B23B1E526	H	147	4/17/14	MTR[b]	5/20/16	764	4
384.3B23B20602	H	95	4/17/14	UTR[b]	6/09/16	784	4
384.3B23B214F5	H	147	4/17/14	TDA	5/09/16	753	4
384.3B23B2475C	H	139	4/17/14	TDA	5/04/16	748	4
384.3B23B2547B	H	107	4/17/14	TDA	4/25/16	739	4
384.3B23B2571A	H	158	4/17/14	UTR	6/07/16	782	4
384.3B23B258F8	H	126	4/17/14	BON	4/23/16	737	4
3D9.1C2DCA9B06	H	125	4/17/14	MTR	5/14/16	758	4
3DD.0077484E81	H	133	4/06/15	UTR[b]	6/04/16	425	3
3DD.0077487AD0	H	162	4/06/15	UTR	5/30/16	420	3
3DD.007748AE73	H	147	4/06/15	UTR	7/20/16	471	3
3DD.007749A8C2	H	136	4/06/15	UTR	9/21/16	444	3
3DD.007749DDBD	H	148	4/06/15	UTR[b]	6/23/16	444	3
3DD.007749EDDD	H	127	4/06/15	UTR[b]	7/02/16	453	3
3DD.00774A59CE	H	163	4/06/15	UTR	6/13/16	434	3
3DD.00774A73B1	H	138	4/06/15	MTR	5/31/16	421	3
3DD.00774A95A2	H	129	4/06/15	UTR[b]	6/19/16	440	3
3DD.00774AC987	H	130	4/06/15	UTR[b]	6/07/16	428	3
3DD.00774ACDFA	H	158	4/06/15	LTR	3/24/16	353	3

Abbreviations are as follows: BON – Bonneville Dam, TDA – The Dalles 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 (1987-2017 Release Years)

Appendix G. Historical hatchery spring Chinook releases from the Tucannon River, 1987-2017 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
		"	"	01/42	70,459	3,089		3,035	41
Total					**139,050**	**6,096**			
1991	1989	H-Acc	4/1-12	14/61	75,661	989		3,867	50
		"	"	01/31	22,118	289		1,130	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, 1987-2017 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, 1987-2017 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]**			
2014	2012	C-Acc	4/11-4/23	65/86	21,101	1,916[f]	TFH reared, Mixed	746	32
2014	2012	C-Acc	4/11-4/23	65/85	179,400	1,093[f]	LFH reared, Mixed	5,853	32
Total					**200,501**	**3,009[f]**			
2015	2013	C-Acc	3/27-4/16	67/43	20,373	3,061[f]	TFH reared, Mixed	872	37
2015	2013	C-Acc	3/27-4/16	67/42	179,494	4,931[f]	LFH reared, Mixed	6,863	37
Total					**199,867**	**7,992[f]**			
2016	2014	C-Acc	4/01-4/15	68/84	216,295	4,804[f]	Mixed	8,883	40
Total					**216,295**	**4,804[f]**			
2017	2015	C-Acc	4/04-4/21	70/39	187,601	12,085	Mixed	7,883	40
Total[g]					**187,601**	**12,085[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.

[g] Smolt release numbers were estimated with a PIT tag array at the outlet of Curl Lake AP and will be finalized in the 2017 annual report.

Appendix H: Numbers of Fish Species Captured by Month in the Tucannon River Smolt Trap during the 2016 Outmigration

Appendix H. Numbers of fish species captured by month in the Tucannon River smolt trap during the 2016 outmigration sampling period (13 October, 2015 – 8 July, 2016).

Species	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Total
Nat. spring Chinook	1	2	6		14	118	694	559	12		1,406
Hatch. spring Chinook						118	9,139	2,292	1		11,550
Fall Chinook				5	8	141	234	3,527	2,141	2	6,058
Coho salmon						4	70	137	8		219
Bull trout											0
Steelhead < 80 mm							3	91	142		236
Steelhead 80-124 mm		16	27	2	30	17	3	1			96
Steelhead ≥ 125 mm	1	63	44	13	74	104	929	2,230	5		3,463
Hat. endemic steelhead					1		271	1,103	11		1,386
Pacific lamprey - Ammocoetes		2	37	4	317	30	8	2			400
Pacific lamprey - Macropthalmia			57	18	167	2					244
Pacific lamprey - Adults			1					7			8
Smallmouth bass						4	37	95	30		166
Pumpkinseed sunfish			1		2	2	3	7	3		18
Bluegill							1				1
Chiselmouth	1		1			9	9	3	8	1	32
Banded killifish								1			1
Longnose dace		1	1			2	2	4	4		14
Speckled dace		1					3	5	1		10
Redside shiner		2				4	9	12	10		37
American shad				223	24	1					248
Bridgelip sucker		1	3	2	7	8	20	6	5		52
Northern pikeminnow			1			25	5	20	11		62
Brown bullhead		1	1		1		3	15	4	2	27

Appendix I: Updated Historical Number of Natural Origin Spring Chinook Smolts that Emigrated from the Tucannon River for the 1985-2014 Brood Years

Appendix I. Updated historical number of natural origin spring Chinook smolts (with 95% confidence interval and standard error) that emigrated from the Tucannon River for the 1985 to 2014 brood years.

Brood Year	Emigration Period	Smolt Emigration Estimate	Lower 95% C.I.	Upper 95% C.I.	S.E.
1985[a]	1986/1987	35,559	33,074	38,044	---
1986	1987/1988	51,004	46,610	55,782	2,355.9
1987	1988/1989	52,349	38,303	79,229	11,130.5
1988	1989/1990	35,925	29,338	45,652	4,055.2
1989	1990/1991	19,107	14,047	25,827	3,088.3
1990	1991/1992	32,969	26,335	41,735	4,124.7
1991[b]	1992/1993	---	---	---	---
1992	1993/1994	36,749	30,704	47,100	4,049.4
1993	1994/1995	34,623	30,747	39,791	2,319.9
1994	1995/1996	4,957	3,212	7,915	1,194.0
1995[c]	1996/1997	---	---	---	---
1996	1997/1998	2,906	2,122	4,276	565.7
1997	1998/1999	25,553	19,932	33,164	3,471.0
1998	1999/2000	4,849	3,456	7,838	1,104.6
1999	2000/2001	8,721	6,301	13,380	1,837.4
2000	2001/2002	29,442	15,836	48,359	8,639.8
2001	2002/2003	42,416	36,074	52,304	4,221.2
2002	2003/2004	64,036	46,704	98,183	12,352.2
2003	2004/2005	27,724	23,324	35,295	3,004.4
2004	2005/2006	21,057	17,779	25,627	2,094.8
2005	2006/2007	17,579	14,951	20,935	1,544.5
2006	2007/2008	30,228	21,534	46,614	6,849.5
2007	2008/2009	8,529	7,059	10,592	907.3
2008	2009/2010	14,778	12,767	17,978	1,363.0
2009	2010/2011	45,538	41,083	51,349	2,750.5
2010	2011/2012	35,080	30,063	41,026	2,735.6
2011	2012/2013	23,376	20,848	27,056	1,524.5
2012	2013/2014	12,886	9,151	19,261	2,748.1
2013	2014/2015	3,831	2,722	5,667	726.6
2014	2015/2016	6,604	5,674	7,696	517.0

[a] This estimate is from Seidel et al. 1988.
[b] Due to the lack of an ESA Section 10 Permit, the smolt trap had to be pulled.
[c] Estimates were not available due to too few recaptures during trap efficiency trials.

Appendix J: Proportionate Natural Influence (PNI) for the Tucannon Spring Chinook Population (1985-2016)

Appendix J. Proportionate Natural Influence (PNI)[a] for the Tucannon River spring Chinook population (1985-2016). 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	695	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	1.09	0.98	
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	23.03	0.66	
1997	89	42.70	105	35.24	0.55	
1998	86	52.33	60	26.67	0.66	
1999	122	0.82	160	97.50	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	211	22.27	0.74	
2008	114	35.09	796	38.94	0.47	*
2009	173	50.87	1,191	49.29	0.51	
2010	161	50.31	938	42.22	0.54	
2011	166	53.61	849	29.68	0.64	
2012	164	56.10	335	30.15	0.65	
2013	149	62.42	170	30.59	0.67	
2014	126	67.46	294	27.55	0.71	
2015	126	79.37	523	66.92	0.54	
2016	118	44.92	340	66.47	0.40	*

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

Appendix K: Recoveries of Coded-Wire Tagged Salmon Released Into the Tucannon River for the 1985-2013 Brood Years

Appendix K. 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 1985-2013 brood years. (Data downloaded from RMIS database on 3/13/17.)

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 K (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 1985-2013 brood years. (Data downloaded from RMIS database on 3/13/17.)

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 K (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 1985-2013 brood years. (Data downloaded from RMIS database on 3/13/17.)

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 K (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 1985-2013 brood years. (Data downloaded from RMIS database on 3/13/17.)

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 K (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 1985-2013 brood years. (Data downloaded from RMIS database on 3/13/17.)

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 K (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 1985-2013 brood years. (Data downloaded from RMIS database on 3/13/17.)

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					1	5
Mixed Net & Seine						
Ocean Sport						
USFWS						
Warm Springs Hatchery						
Dworshak NFH						
IDFG						
Hatchery						
Total Returns	9	21	53	77	58	82
Tucannon (%)	86.0		98.7		93.9	
Out-of-Basin (%)	0.0		0.0		0.0	
Commercial Harvest (%)	14.0		1.3		6.1	
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		0.06	

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

Appendix K (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 1985-2013 brood years. (Data downloaded from RMIS database on 3/13/17.)

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 K (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 1985-2013 brood years. (Data downloaded from RMIS database on 3/13/17.)

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 K (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 1985-2013 brood years. (Data downloaded from RMIS database on 3/13/17.)

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	26
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	418
Tucannon (%)	99.7		99.7		93.1	
Out-of-Basin (%)	0.0		0.0		0.0	
Commercial Harvest (%)	0.0		0.3		6.2	
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 K (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 1985-2013 brood years. (Data downloaded from RMIS database on 3/13/17.)

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	21	2	9	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	484	138	556	39	78
Tucannon (%)	95.1		97.8		93.6	
Out-of-Basin (%)	0.0		0.2		0.0	
Commercial Harvest (%)	4.3		1.6		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	0.96		1.07		0.13	

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

Appendix K (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 1985-2013 brood years. (Data downloaded from RMIS database on 3/13/17.)

Brood Year	2007		2008		2008	
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	18	113	22	179	35	270
Kalama R., Wind R.						
Fish Trap - F.W.						
Treaty Troll						
Lyons Ferry Hatch.[b]	32	32	28	28	49	49
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						
Total Returns	50	145	51	211	84	319
Tucannon (%)	100.0		98.1		100.0	
Out-of-Basin (%)	0.0		0.0		0.0	
Commercial Harvest (%)	0.0		1.9		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	0.26		0.25		0.38	

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

Appendix K (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 1985-2013 brood years. (Data downloaded from RMIS database on 3/13/17.)

Brood Year	2009		2009		2010	
Smolts Released	117,824		113,049		102,169	
Fish Size (g)	35		51		32	
CWT Codes[a]	55/65		55/66		60/75	
Release Year	2011		2011		2012	
Agency (fishery/location)	Observed Number	Estimated Number	Observed Number	Estimated Number	Observed Number	Estimated Number
WDFW						
Tucannon River	3	87	5	125	10	115
Kalama R., Wind R.						
Fish Trap - F.W.	1	1	1	1		
Treaty Troll						
Lyons Ferry Hatch.[b]	16	16	40	40	17	17
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	2		
Columbia R. Sport						
Juv. Marine Seine						
CDFO						
Non-treaty Ocean Troll						
Mixed Net & Seine						
Ocean Sport	1	4				
USFWS						
Warm Springs Hatchery						
Dworshak NFH						
NMFS						
Juvenile Trawl Sample					1	1
Total Returns	21	108	47	168	28	133
Tucannon (%)	95.4		98.2		99.2	
Out-of-Basin (%)	0.9		0.6		0.0	
Commercial Harvest (%)	0.0		1.2		0.0	
Sport Harvest (%)	3.7		0.0		0.0	
Treaty Ceremonial (%)	0.0		0.0		0.0	
Other (%)	0.0		0.0		0.8	
Survival	0.09		0.15		0.13	

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

Appendix K (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 1985-2013 brood years. (Data downloaded from RMIS database on 3/13/17.)

Brood Year	2010		2011		2011	
Smolts Released	96,984		227,703		27,748	
Fish Size (g)	66		33		33	
CWT Codes[a]	60/76		64/41		64/42	
Release Year	2012		2013		2013	
Agency (fishery/location)	Observed Number	Estimated Number	Observed Number	Estimated Number	Observed Number	Estimated Number
WDFW						
Tucannon River	10	122	89	664	5	36
Kalama R., Wind R.						
Fish Trap - F.W.			1	1		
Treaty Troll						
Lyons Ferry Hatch.[b]	22	22	20	21	2	2
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			4	19		
Columbia R. Sport						
Juv. Marine Seine						
Non-treaty Ocean Troll			1	4		
CDFO						
Non-treaty Ocean Troll						
Mixed Net & Seine						
Ocean Sport						
USFWS						
Warm Springs Hatchery						
Dworshak NFH						
IDFG						
Hatchery						
Total Returns	32	144	115	709	7	38
Tucannon (%)	100.0		96.6		100.0	
Out-of-Basin (%)	0.0		0.1		0.0	
Commercial Harvest (%)	0.0		3.3		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	0.15		0.31		0.14	

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

Appendix K (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 1985-2013 brood years. (Data downloaded from RMIS database on 3/13/17.)

Brood Year	2012[c]		2012[c]		2013[c]	
Smolts Released	179,400		21,101		179,494	
Fish Size (g)	32		32		37	
CWT Codes[a]	65/85		65/86		67/42	
Release Year	2014		2014		2015	
Agency (fishery/location)	Observed Number	Estimated Number	Observed Number	Estimated Number	Observed Number	Estimated Number
WDFW						
Tucannon River	21	151	3	22		
Kalama R., Wind R.						
Fish Trap - F.W.						
Treaty Troll						
Lyons Ferry Hatch.[b]						
F.W. Sport						
Non-treaty Ocean Troll	1	1				
ODFW						
Test Net, Zone 4						
Treaty Ceremonial						
Three Mile, Umatilla R.						
Spawning Ground						
Fish Trap - F.W.						
F.W. Sport						
Hatchery	1	1				
Columbia R. Gillnet						
Columbia R. Sport						
Juv. Marine Seine						
Non-treaty Ocean Troll						
CDFO						
Non-treaty Ocean Troll						
Mixed Net & Seine						
Ocean Sport						
USFWS						
Warm Springs Hatchery						
Dworshak NFH						
NMFS						
Juvenile Trawl Sample	1	1			1	1
Total Returns	24	154	3	22	1	1
Tucannon (%)	98.2		100.0		0.0	
Out-of-Basin (%)	0.6		0.0		0.0	
Commercial Harvest (%)	0.6		0.0		0.0	
Sport Harvest (%)	0.0		0.0		0.0	
Treaty Ceremonial (%)	0.0		0.0		0.0	
Other (%)	0.6		0.0		100.0	
Survival	0.09		0.10		0.00	

[a] WDFW agency code prefix is 63.
[b] Fish trapped at TFH and held at LFH for spawning.
[c] Data for the 2012 and 2013 brood years is incomplete.

Appendix K (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 1985-2013 brood years. (Data downloaded from RMIS database on 3/13/17.)

Brood Year	2013[c]					
Smolts Released	20,373					
Fish Size (g)	37					
CWT Codes[a]	67/43					
Release Year	2015					
Agency (fishery/location)	Observed Number	Estimated Number	Observed Number	Estimated Number	Observed Number	Estimated Number
WDFW						
Tucannon River						
Kalama R., Wind R.						
Fish Trap - F.W.						
Treaty Troll						
Lyons Ferry Hatch.[b]						
F.W. Sport						
Non-treaty Ocean Troll						
ODFW						
Test Net, Zone 4						
Treaty Ceremonial						
Three Mile, Umatilla R.						
Spawning Ground						
Fish Trap - F.W.						
F.W. Sport						
Hatchery						
Columbia R. Gillnet	1	5				
Columbia R. Sport						
Juv. Marine Seine						
Non-treaty Ocean Troll						
CDFO						
Non-treaty Ocean Troll						
Mixed Net & Seine						
Ocean Sport						
USFWS						
Warm Springs Hatchery						
Dworshak NFH						
NMFS						
Juvenile Trawl Sample						
Total Returns	1	5				
Tucannon (%)	0.0					
Out-of-Basin (%)	0.0					
Commercial Harvest (%)	100.0					
Sport Harvest (%)	0.0					
Treaty Ceremonial (%)	0.0					
Other (%)	0.0					
Survival	0.02					

[a] WDFW agency code prefix is 63.
[b] Fish trapped at TFH and held at LFH for spawning.
[c] Data for the 2013 brood year is incomplete.

Appendix L: Summary of egg distribution, egg loss, ponding numbers, and mean size for the LFH and TFH reared groups (2011-2013 brood years)

Appendix L. Summary of egg distribution, egg loss, ponding numbers, and mean size for the LFH and TFH reared groups (2011-2013 brood years) of Tucannon River spring Chinook.

	BY11	BY12	BY13
Number of eggs collected	325,701	269,514	275,188
Mortality to eye-up	14,551	15,262	8,357
Mortality to eye-up (%)	4.47	5.66	3.04
Live eggs left in trays	311,150	254,252	266,831
LFH:			
Live eggs reared at LFH	281,106	224,240	236,831
Additional egg loss	5,935	8,219	2,772
Additional egg loss (%)	2.11	3.67	1.17
Initial ponding numbers	275,171	216,021	234,059
TFH:			
Transfer from LFH to TFH	30,044	30,012	30,000
Additional egg loss	137	563	429
Additional egg loss (%)	0.46	1.88	1.43
Initial ponding numbers	29,907	29,449	29,571
January Sampling			
LFH – mean length (c.v.)	110.0 mm (12.3)	122.8 mm (13.0)	132.6 mm (17.3)
TFH – mean length (c.v.)	114.1 mm (11.7)	117.5 mm (8.5)	129.1 mm (17.8)
April Sampling – LFH & TFH			
Mean length (c.v.)	136.7 mm (17.9)	136.4 mm (15.2)	142.8 mm (15.4)

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