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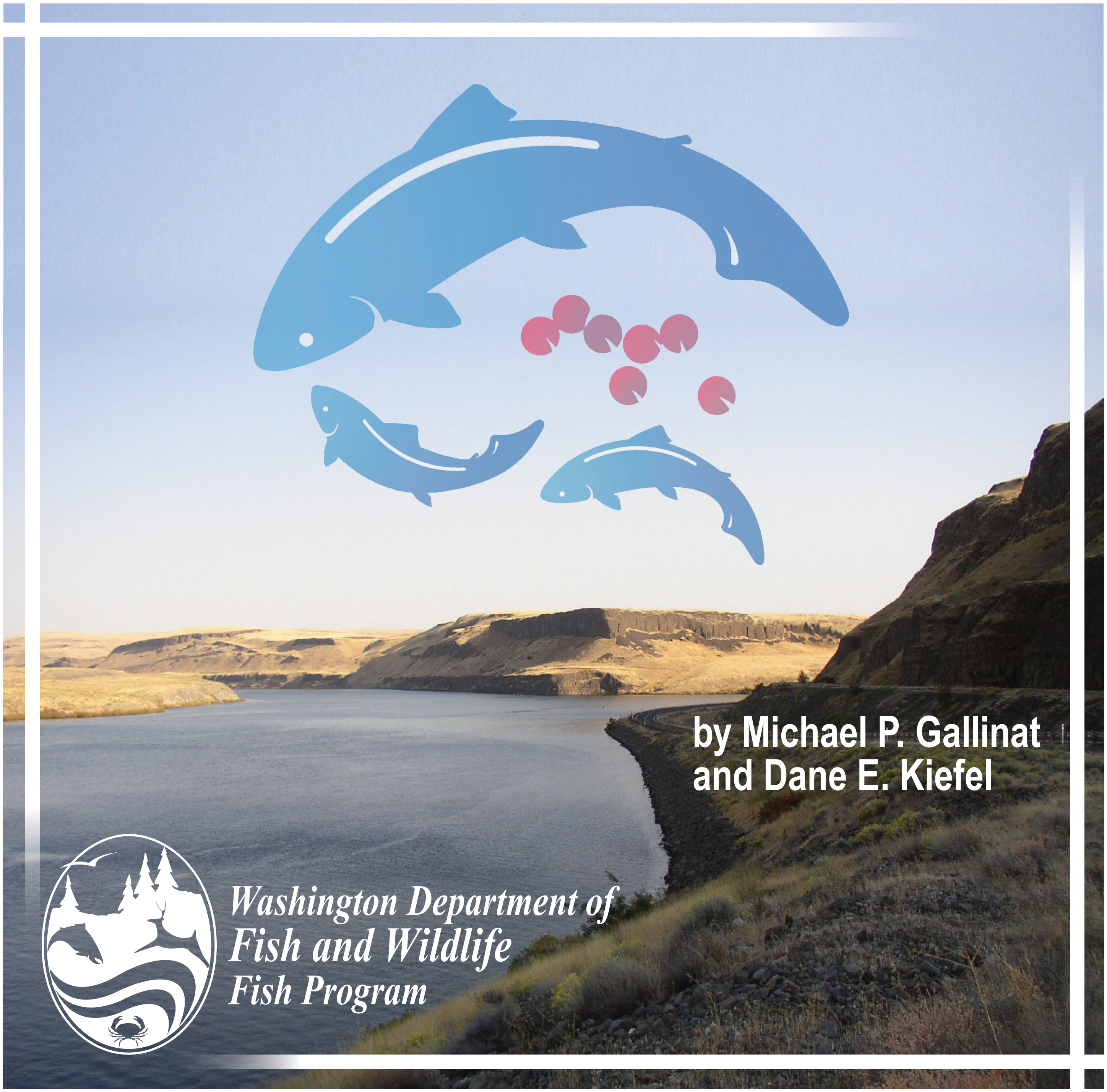
Tucannon River Spring Chinook Salmon Hatchery Evaluation Program 2019 Annual Report



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

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Tucannon River Spring Chinook Salmon Hatchery Evaluation Program

2019 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 1,152 Tucannon River spring Chinook caused by hydroelectric projects on the Snake River. 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 2019 to April 2020.

A total of 183 salmon were captured in the TFH trap in 2019 (37 natural adults, 2 natural jacks, 115 hatchery adults, and 29 hatchery jacks). Of these, 149 adults (36 natural, 113 hatchery) were collected for broodstock, one adipose clipped stray was killed outright, two males were passed upstream (1 natural, 1 hatchery), and 31 jacks (2 natural, 29 hatchery) were held at LFH for outplanting. During 2019, 64 (43.0%) salmon collected for broodstock died prior to spawning.

Spawning of supplementation fish occurred once a week between 3 September and 24 September, with peak eggtake occurring on 10 September. A total of 126,102 eggs were collected from 7 natural and 38 hatchery-origin female Chinook. Egg mortality to eye-up was 5.7% (7,213 eggs) which left 118,889 live eggs. An additional 0.6% (730) loss of sac-fry left 118,159 BY 2019 fish for production.

Weekly spawning ground surveys were conducted from 26 August and were completed by 9 October 2019. A total of 11 redds and 3 carcasses (1 natural, 2 hatchery) were found. Three redds (27% of the total) were counted above the adult trap. Based on redd counts, carcasses recovered, and broodstock collection, the estimated return to the river for 2019 was 203 spring Chinook (43 natural adults, 2 natural jacks and 129 hatchery-origin adults, 29 hatchery jacks).

The 2018 BY smolts were direct stream released on 23-24 March just below Beaver/Watson Bridge (rkm 61.9) as the road to the acclimation pond was washed out due to flooding. An estimated 192,521 BY18 smolts were released.

Evaluation staff operated a downstream migrant trap to provide juvenile outmigration estimates. During the 2018/2019 emigration, we estimated that 17,972 (13,302-25,871 95% C.I.) natural spring Chinook (BY 2017) smolts emigrated from the Tucannon River.

Smolt-to-adult return rates (SAR) for natural origin salmon are almost eight times higher on average (based on geometric means) than hatchery origin salmon. However, hatchery salmon survive three times greater than natural salmon from parent to adult progeny over the length of the project.

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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 original 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 were originally assumed to have been harvested in downriver fisheries or in the ocean, and was an additional objective of the plan. 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 fish/lb (fpp)] beginning with the 2011 brood year. In theory, both actions should have increased adult hatchery salmon returns back to the river, however, it does not appear that these actions will produce enough adult returns to reach the LSRCP adult mitigation goal (1,152).

Because of this, WDFW, along with the co-managers, have initiated an additional hatchery spring Chinook program in SE Washington. A program using Carson stock spring Chinook salmon has been implemented in the Touchet River, with eyed eggs shipped to LFH from the

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

[2] Formerly Washington Department of Fisheries.

2018 and 2019 brood years with the first smolt releases occurring in 2020. Moving forward, adult returns from the Tucannon and Touchet programs will be used to measure contribution towards the LSRCP spring Chinook mitigation goal (1,152) for Washington.

This report summarizes work performed by the WDFW Tucannon Spring Chinook Evaluation Program from May 2019 through April 2020.

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 2019. Numbers of direct and indirect takes of listed Snake River spring Chinook (Tucannon River stock) for the 2019 calendar year are presented in Appendix A (Tables 1-2), along with information required for the NEOR/SEWA Biological Opinion reporting.

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. Tucannon Fish Hatchery, located at rkm 59 on the Tucannon River, has an adult collection trap on site (Figure 1). Due to a leak in the pipeline at LFH, adults collected during 2019 were held at TFH until the pipe could be fixed. Juveniles from the 2018 BY were transferred to Dworshak National Fish Hatchery (NFH) in Idaho during May and reared in two 85 m^3 burrow ponds (3,000 ft^3) with an average flow of 3,331 lpm (880 gpm). The BY18 fish were transferred back to LFH in August and placed into one of the 18,222 m^3 (643,500 ft^3) lakes with a flow of 13,249-22,713 lpm (3,500-6,000 gpm) for final rearing before release. Curl Lake Acclimation Pond was not used during 2020 because a flood in early February 2020 washed away the road leading up to it.

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.

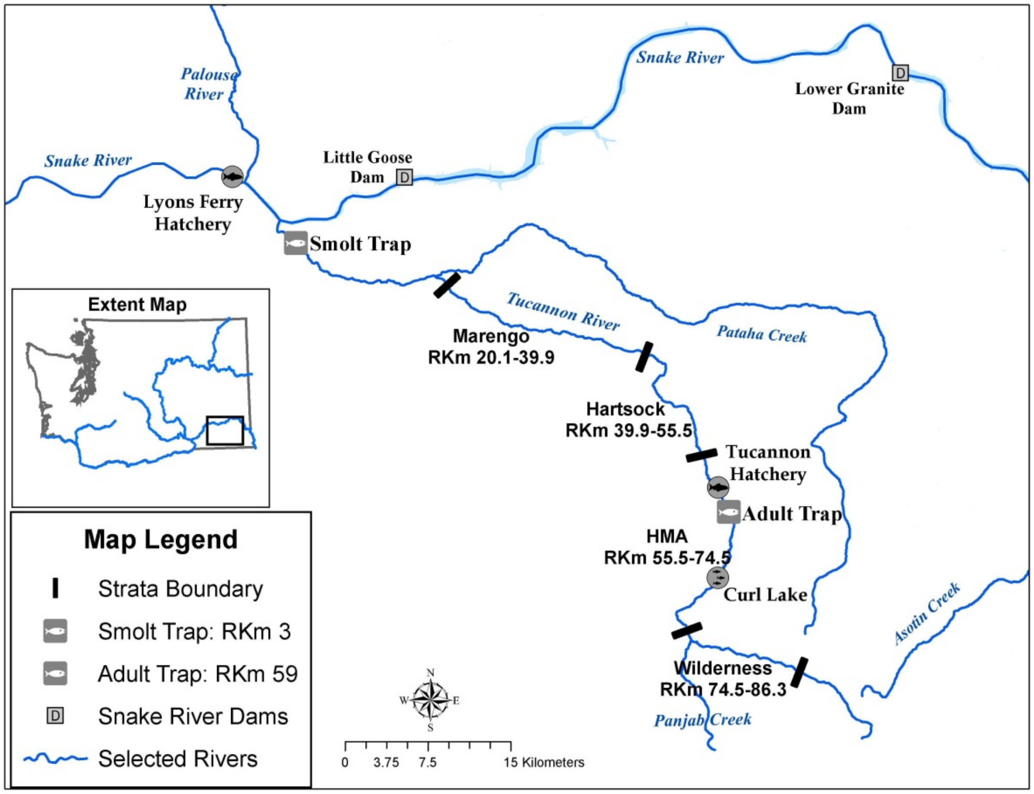

Figure 1. Location of the Tucannon River, and Lyons Ferry and Tucannon Hatcheries within the Snake River basin.

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 HGMP sliding scale. Additional jack salmon may be collected up to their proportion of the run with an upper limit of 10% used in broodstock, if needed. Returning Tucannon hatchery salmon were identified by coded-wire tag (CWT) in the snout, with no adipose fin clips. 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 24 May (Appendix B). State and Tribal Fisheries Managers decided to collect all Tucannon River returns that would not be used for broodstock and hold them for outplanting back into the river closer to the commencement of spawning. These measures were taken to reduce potential in-river pre-spawn mortality that has been observed in preceding years.

During 2019, initially all fish captured were held at TFH until work to fix the water pipeline at LFH was completed. Broodstock held at TFH were transferred to LFH in early August. Due to high pre-spawn mortality observed at both TFH and LFH during 2019, all adult fish captured and held were included in the broodstock.

The trap was operated through 30 September. A total of 183 fish entered the trap (37 natural adults, 2 natural jacks, 115 hatchery adults, and 29 hatchery jacks) and 149 adults (36 natural, 113 hatchery) were collected for broodstock (Table 2, Appendix B). One adipose clipped stray was killed outright, two males (1 natural, 1 hatchery) were passed upstream, and 31 jacks (2 natural, 29 hatchery) were held for outplanting (Table 2, Appendix B). Adults collected for broodstock were injected with tulathromycin (Draxxin[3]) at 2.5 mg/kg but fish held for adult outplants were not injected per WDFW Fish Health regulations. Antibiotic injections for broodstock were repeated 30 days prior to spawning. Broodstock and fish held for outplanting received formalin drip treatments during holding at 167 ppm every other day 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 1986-2019.

	Captured at Trap		Trap Mortalities		Killed Outright[a]	Broodstock Collected		Passed Upstream		Held for 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
2017	26	237	0	0	15	18	93	0	0	8[e]	129[e]
2018	73	358	0	0	38	37	123	15	3	21	194
2019	39	144	0	0	1	36	113	1	1	2	29

[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.
[e] None of the fish held for adult outplanting in 2017 were outplanted. All of the fish held for adult outplanting were < 61 cm in fork length (jack size) and were either used to supplement broodstock (natural jacks) or were killed outright.

Adult Weir/Trap Evaluations

Radio telemetry studies conducted on Tucannon River spring Chinook showed that some spring Chinook were unwilling to enter the TFH fish ladder/trap, leading to high redd densities immediately below the adult trap (Bumgarner et al. 2000, Gallinat et al. 2001, Gallinat et al. 2002). During 2015, 2016, 2018, and 2019, evaluation staff monitored the movement, conversion, and migration delay of returning PIT tagged spring Chinook salmon at the TFH weir/trap (Bumgarner and Engle 2019). A series of temporary and permanent PIT tag antennas that were placed above and below the intake dam, in the fish ladder, and in the adult trap (2019 only) were used for this evaluation. Based on the data obtained over the four years, 96-100% of the PIT tagged spring Chinook salmon detected below the intake dam enter the fish ladder (Figure 2). In three of the four years, about 65% were eventually captured (Figure 2). Based on detections above the trap (fish intentionally passed upstream after capture or fish that jumped over the dam), it was estimated that 10-35% of the fish that were in the weir/trap area remained below the trap (Figure 2). With the installed adult trap antenna in 2019, it was estimated that 41% of the spring Chinook salmon that entered the adult trap were able to escape, with some eventually recaptured days or weeks later. Based on the 2019 results, and a similar escapement rate of bull trout, the trap fyke opening is being modified prior to the 2020 return. Evaluation staff will continue to monitor the return in 2020 to determine if the new trap fyke opening is effective in retaining salmonids.

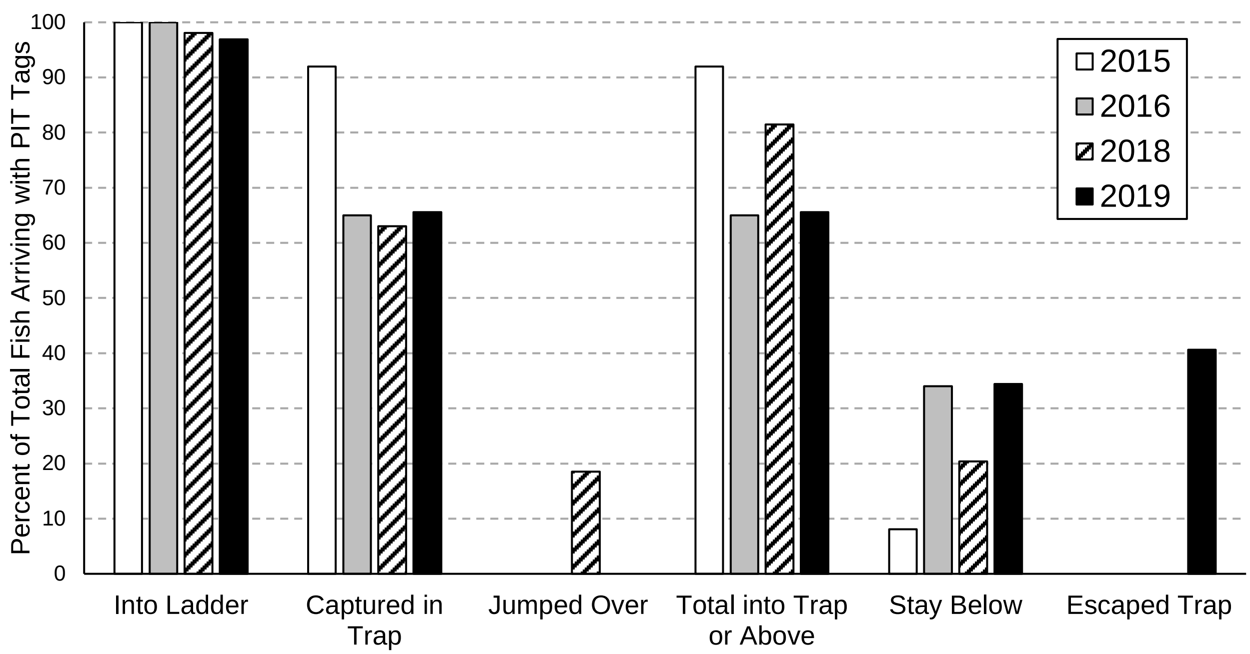

Figure 2. Tucannon River spring Chinook salmon passage (conversion) through the Tucannon adult weir/trap, 2015, 2016, 2018, and 2019 (From Bumgarner and Engle 2019).

Broodstock Mortality

Sixty-four (43.0%) of the 149 salmon collected for broodstock died prior to spawning in 2019 (Table 3). This rate was higher than recent years due to holding fish at TFH while LFH was undergoing water supply repairs. Mortalities during holding occurred at both TFH and LFH. Cause of death in some fish appeared to be from Bacterial Kidney Disease (see Broodstock BKD Screening and Virology Testing section below). High pre-spawn mortality was experienced when fish were held at TFH in the past (1986-1991), likely due to higher water temperatures (Table 3) and is suspected again as a factor during 2019.

Table 3. Numbers of pre-spawning mortalities and percent of fish collected for broodstock at TFH and held at TFH (1985-1991 and 2019) or LFH (1992-2018).

	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
2017	0	2	0	12.5	4	8	0	12.6
2018	2	2	0	10.8	12	4	0	13.0
2019	3	9	0	33.3	14	38	0	46.0

Broodstock Spawning

Spawning at LFH was conducted once a week from 3 September to 24 September, with peak eggtake occurring on 10 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 was Natural x Hatchery, Natural x Natural, and Hatchery x Hatchery, depending upon availability and origin of ripe fish on a weekly basis.

A total of 126,102 eggs were collected from 45 spawned females (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 5.7%, which left 118,889 live eggs. An additional 0.6% (730) loss of eggs and sac-fry left 118,159 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 2019. (Numbers in parentheses were live spawned).

	Natural Origin						
	Males		**Jacks**		**Females**		
Spawn Date	**Spawned**	**K.O.**	**Spawned**	**K.O.**	**Spawned**	**K.O.**	**Eggs Taken**
9/03	0 (8)				2		6,681
9/10	0 (9)				4		14,904
9/17	0 (3)				1		2,354
9/24	17[a]				0		---
Totals	**17**				**7**		**23,939**
Egg Mortality							1,106
	Hatchery Origin						
	Males		**Jacks**		**Females**		
Spawn Date	**Spawned**	**K.O.**	**Spawned**	**K.O.**	**Spawned**	**K.O.**	**Eggs Taken**
9/03	2				10		27,196
9/10	14				17		44,337
9/17	7				9		23,492
9/24	0				2		7,138
Totals	**23**				**38**		**102,163**
Egg Mortality							6,107

[a] Only four of the 17 natural origin males were used for spawning on this date.

Broodstock BKD Screening and Virology Testing

Broodstock females were screened for Bacterial Kidney Disease (BKD), caused by the bacterium *Renibacterium salmoninarum*, using Enzyme Linked Immunosorbent Assay (ELISA). Eighteen percent of the spawned females had high values in 2019 (Table 5). This is higher than values from 2018, but lower than values from 2017, which were believed to be directly related to the decision to suspend antibiotic injections during that year (Figure 3). Eggs and progeny from high BKD ELISA broodstock were segregated for rearing from the rest of the broodstock. Six pre-spawn broodstock mortalities were sampled by the Fish Health Specialist and tissue samples for histopathology were examined at the Washington Animal Disease Diagnostic Lab in Pullman, WA. The results found that the biggest contributor to the high pre-spawn mortality during 2019 was BKD. The Fish Health Specialist will consider switching from tulathromycin injections back to erythromycin injections in 2020 since it seemed to be more effective against BKD.

Spawned females were also examined for viruses and sampling showed no evidence of virus in the samples tested.

Table 5. Enzyme Linked Immunosorbent Assay (ELISA) values for hatchery spawned Tucannon River spring Chinook females, 2019.

ELISA Value	ELISA O.D.	Number of Females	Percent (%)
Below Low	< 0.099	32	71.1
Low	0.099 – 0.198	2	4.4
Moderate	0.199 – 0.450	3	6.7
High	> 0.450	8	17.8
Total		**45**	**100.0**

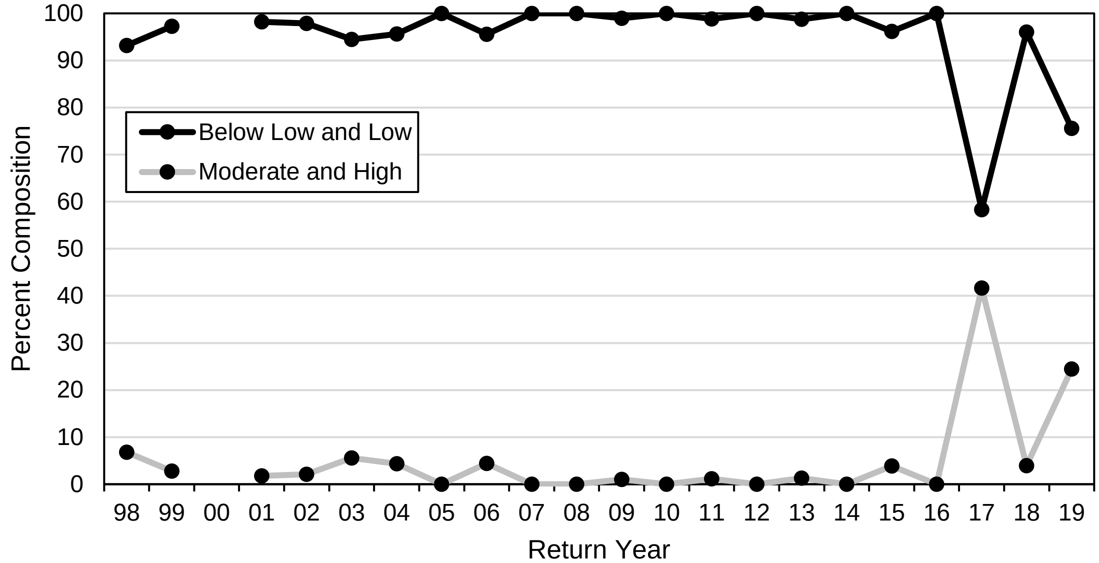

Figure 3. Historical Below Low and Low, and Moderate and High ELISA values for Tucannon River spring Chinook salmon female broodstock for the 1998 to 2019 return years.

Outplanting

After discussions with the Tribal co-managers, it was decided to collect all returning fish not collected for broodstock or killed outright (hatchery strays) and hold them at TFH while the pipeline repairs for LFH were completed. Adults were to be outplanted back into the river during late August near the on-set of spawning. This joint decision was made due to the expected 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).

Fish collected for adult outplanting were given a right opercle punch. These fish were treated with formalin to control fungus growth, but were not injected with antibiotics. However, due to the high pre-spawn mortality levels observed in 2019 at TFH and LFH, all adult fish that were initially held for outplanting were added to the collected broodstock. Of the remaining 31 jacks that were held for outplanting, 10 (32%) of the jacks (1 natural origin, 9 hatchery origin) were pre-spawn mortalities. Live adult fish were observed above the adult trap during pre-spawn mortality surveys. Therefore, the remaining 21 jacks (1 natural origin, 20 hatchery origin) were outplanted at three different sites on 3 September in order to ensure that males were available for any females that had bypassed the adult trap (Table 6).

Fish that were passed upstream after 2 September were given a left opercle punch. A jack (likely outplanted) was observed paired with a female near Cow Camp Bridge (rkm 72.9), however none of the outplanted jacks were recovered during spawning ground surveys.

Table 6. The number of Tucannon River spring Chinook salmon outplanted in the Tucannon River by release location during 2019.

Date	Release Location	Rkm	Jacks
9/03/19	Cow Camp Bridge	72.9	7
9/03/19	Camp Wooten Bridge	68.1	7
9/03/19	Curl Lake Intake	66.1	7
Totals			**21**

Natural Spawning

Pre-spawn mortality surveys were conducted from 26 June to 23 August during 2019, after which regular weekly spawning ground surveys commenced. Although fish were not passed above the adult trap prior to 3 September, pre-spawn mortality surveys were still conducted upstream of the trap as we know some fish are able to bypass the trap each year. The pre-spawn mortality surveys covered from Panjab Bridge (rkm 74.5) to Bridge 10 (rkm 43.3) and totaled 168 river kilometers. No carcasses were recovered during pre-spawn mortality walks.

Weekly spawning ground surveys were conducted from 26 August to 9 October 2019 and a total of 234 river kilometers were surveyed. Eleven redds were counted and one natural and two hatchery origin carcasses were recovered (Table 7). Three redds (27% of total) were found above the adult trap, however, no carcasses were recovered. Three carcasses (two hatchery-origin, one natural-origin) were recovered below the adult trap (Table 7).

Table 7. Numbers and general locations of salmon redds and carcasses (includes pre-spawn mortalities) recovered on the Tucannon River spawning grounds, 2019 (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	0	0	0
	75-78	0	0	0
HMA	73-75	1	0	0
	68-73	1	0	0
	66-68	0	0	0
	62-66	0	0	0
	59-62	1	0	0
--------------------------Tucannon Fish Hatchery Trap----------------------------------				
	56-59	6	1	2
Hartsock	52-56	1	0	0
	47-52	0	0	0
	43-47	0	0	0
	40-43	0	0	0
Marengo	34-40	0	0	0
	28-34	0	0	0
Below Marengo	0-28	1	0	0
Totals	**0-86**	**11**	**1**	**2**

[a] Rkm descriptions: 86-Rucherts Camp; 84-Sheep Cr.; 78-Lady Bug Flat CG; 75-Panjab Br.; 73-Cow Camp Bridge; 68-Camp Wooten Br.; 66-Curl Lake; 62-Beaver/Watson Lakes Br.; 59-Tucannon Hatchery Intake/Adult Trap; 56-Cummings Creek Br.; 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

Examining historical traits in natural spawning (1985-present), redd density has varied greatly with run size over the years with a high of 8.3 redds/km in 2010 to a low of 0.1 redds/km during 1995 (Figure 4; Table 8). Since the program's inception in 1985, the proportion of the total number of redds occurring below the adult trap has increased (1994-1999 data was removed from the graph due to management actions at the trap, and after 2014 since adult outplants began in 2015.) (Figure 5; Table 8). This is likely the result of a combination of fish that are unwilling to enter the TFH fish ladder/trap (see Adult Weir/Trap Evaluations section) and an emphasis on broodstock collection in an effort to reduce the risk of extinction.

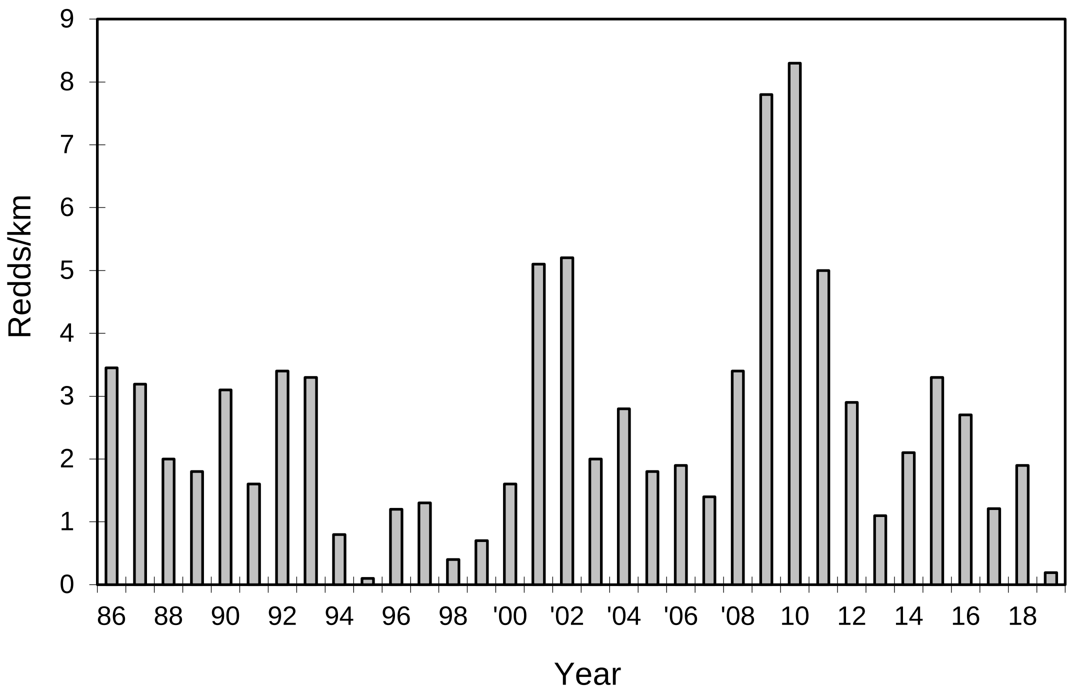

Figure 4. Spring Chinook redd density (redds/km) in the Tucannon River, 1986-2019.

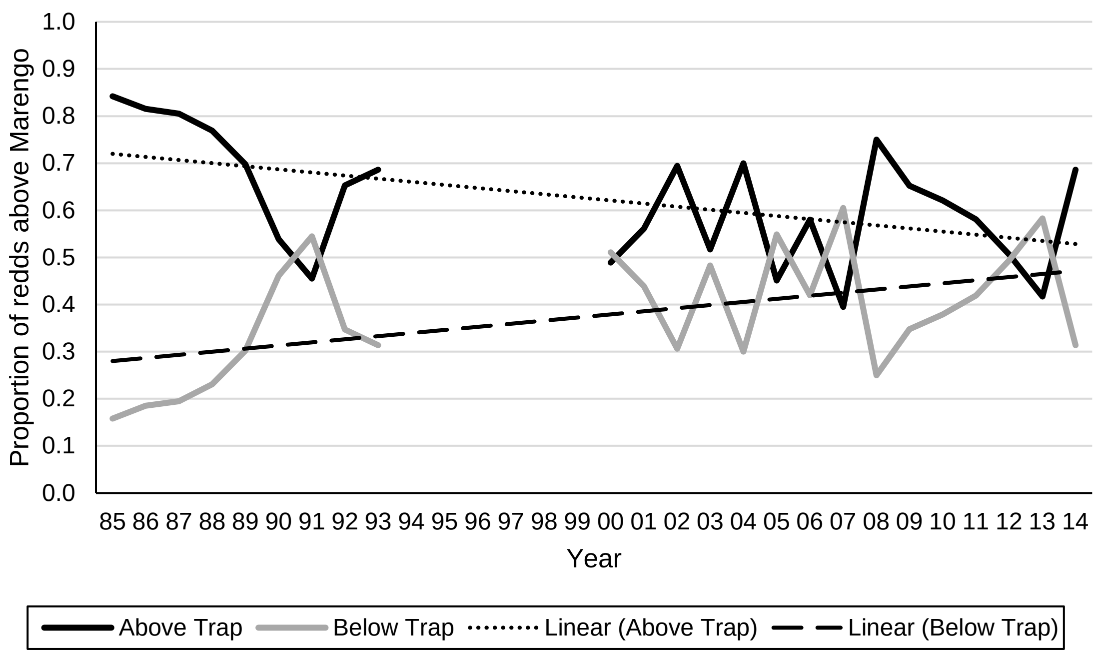

Figure 5. The proportion of redds above Marengo that were either above the adult trap/weir or below the adult trap/weir with trend lines, 1985-1993 and 2000-2014.

Table 8. 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, 1985-2019.

	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
2017	8 (0.7)	47 (2.5)	15 (0.9)	0 (0.0)	70	29	41.4	41	58.6
2018	31 (2.8)	64 (3.4)	13 (0.8)	0 (0.0)	109	77	70.6	32	29.4
2019	0 (0.0)	9 (0.5)	1 (0.1)	0 (0.0)	11	3	27.3	8	72.7

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 2017).

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). Stream nutrient enrichment efforts in the Tucannon River had been sporadic during the history of the hatchery program. Stream nutrient enrichment has been occurring on an annual basis since 2016, however, the large freezer broke down in the summer of 2019. As such, no spring or fall Chinook carcasses from spawning could be kept/frozen which prevented stream nutrient enrichment during 2019. It is hoped that stream nutrient enrichment will begin again in 2020 if funding is available to repair the freezer.

Genetic Sampling

During 2019, we collected 147 DNA samples (tissue samples) from hatchery broodstock and carcasses collected from the spawning grounds (34 natural origin and 113 hatchery origin). These samples were sent to the WDFW genetics lab in Olympia, Washington for storage. Genetic samples from the broodstock were also collected and sent to the Idaho Department of Fish and Game for parentage-based tagging analysis. 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 collected for broodstock and from carcasses collected during spawning ground surveys. This enables us to compare ages of natural and hatchery-reared fish, and to examine trends and variability in age structure. The recovery of jack salmon from the river is low and jacks are typically not collected for broodstock, so their representation is biased low compared to observations from the adult trap.

Overall, hatchery origin fish return at a younger age than natural origin fish and have fewer age-5 fish in the population (Figure 6). 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 40-50 mm greater in length than natural smolts). The age composition for both hatchery and natural origin fish that returned in 2019 had fewer age-3 and 5 fish compared to the historical age composition (Figure 6). This is likely the result of poor ocean conditions during the past few years. There has been a slight decrease in the mean age (weighted) of males and females for both hatchery and natural origin fish (Figure 7) during recent brood years, which may also be related to poor ocean conditions (Peterson et al. 2014, Kintisch 2015). We will continue to monitor this trend. The age composition by brood year for natural and hatchery origin fish is found in Appendix C.

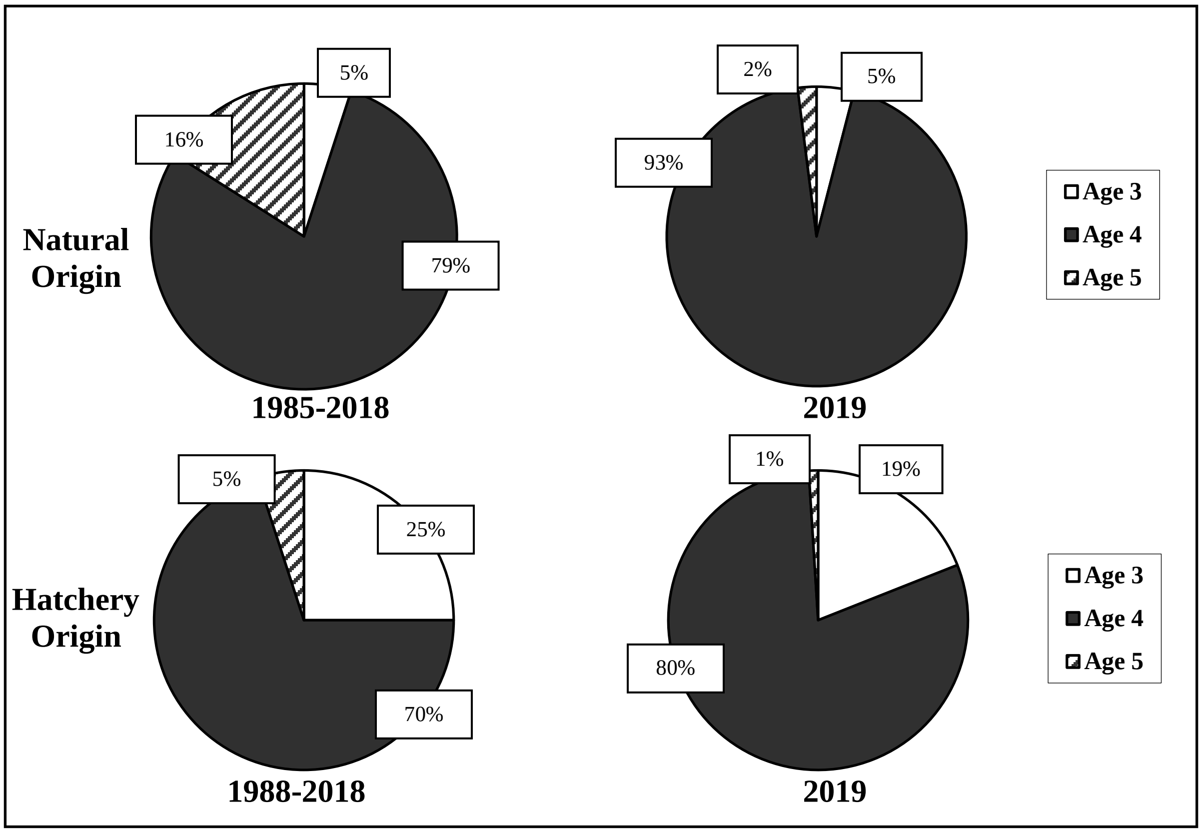

Figure 6. Historical (1985-2018), and 2019 age composition (run year) for spring Chinook in the Tucannon River.

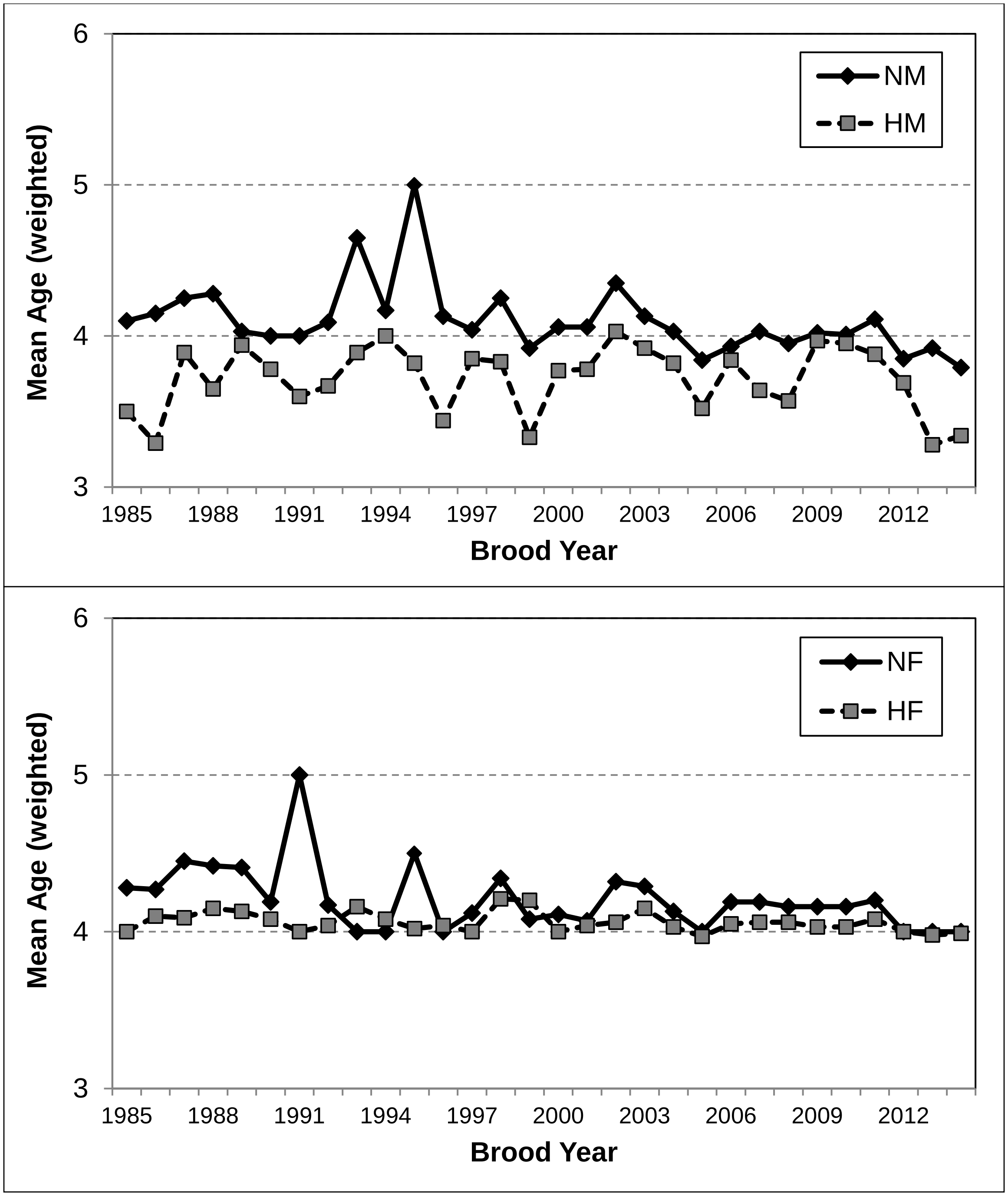

Figure 7. Weighted mean age of natural and hatchery origin males (NM, HM) and natural and hatchery origin females (NF, HF) for the 1985 to 2014 brood years for spring Chinook in the Tucannon River.

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 age-4 adult returns using multiple comparison analysis from 1985-2019 and found a significant difference ($P < 0.001$) in mean POH length between age-4 natural and hatchery-origin female, and age-4 natural and hatchery-origin male spring Chinook salmon (Figure 8).

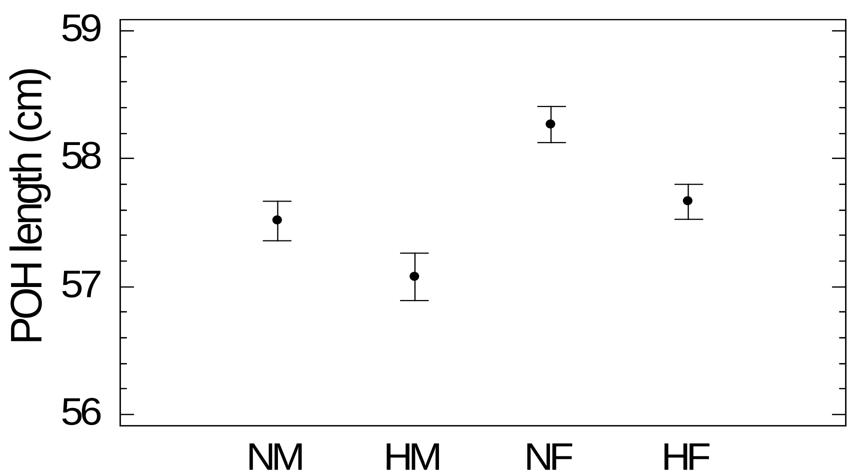

Figure 8. Mean post-orbital to hypural-plate (POH) length comparisons between age-4 natural and hatchery-origin males (NM and HM) and natural and hatchery-origin females (NF and HF) with 95% confidence intervals for the years 1985-2019.

To estimate fecundities (number of eggs/female) from the 2019 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.

Table 9. Average number of eggs/female (n, SD) by age group of Tucannon River natural and hatchery origin broodstock, 1990-2019 (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)
2017	3,393	(8, 453.9)	3,034	(50, 586.0)	No Fish		No Fish	
2018	2,977	(9, 573.1)	2,860	(64, 522.2)	No Fish		No Fish	
2019	3,420	(7, 672.9)	2,841	(35, 587.0)	No Fish		No Fish	
Mean	**3,470**		**3,052**		**4,467**		**3,689**	
SD	**636.2**		**640.0**		**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 TFH adult trap for both natural and hatchery origin fish during 2019 was identical to the historical average (Table 10). Peak spawning date in the hatchery was 10 September for both hatchery and natural origin fish and was similar to the historical mean (Table 10). The duration of spawning in the hatchery (22 days) was also close to the historical mean. Spawning in the river peaked on 11 September. The duration of active spawning in the Tucannon River (38 days) was also within the range found from previous years.

Natural origin fish typically arrive earlier and at a slightly faster rate than hatchery origin fish (Figure 9). On average, about half of the total run of hatchery origin fish typically arrives at the adult trap by 12 June (Figure 9). 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, 1986-2019.

	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	9/08	---[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	9/06	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
2016	5/19	6/06	9/13	9/06	22	9/07	36
2017	6/06	6/18	9/12	9/12	29	9/11	26
2018	5/29	6/15	9/11	9/11	22	9/12	42
Mean	**5/31**	**6/04**	**9/12**	**9/10**	**26**	**9/13**	**35**
2019	5/31	6/04	9/10	9/10	22	9/11	38

[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.

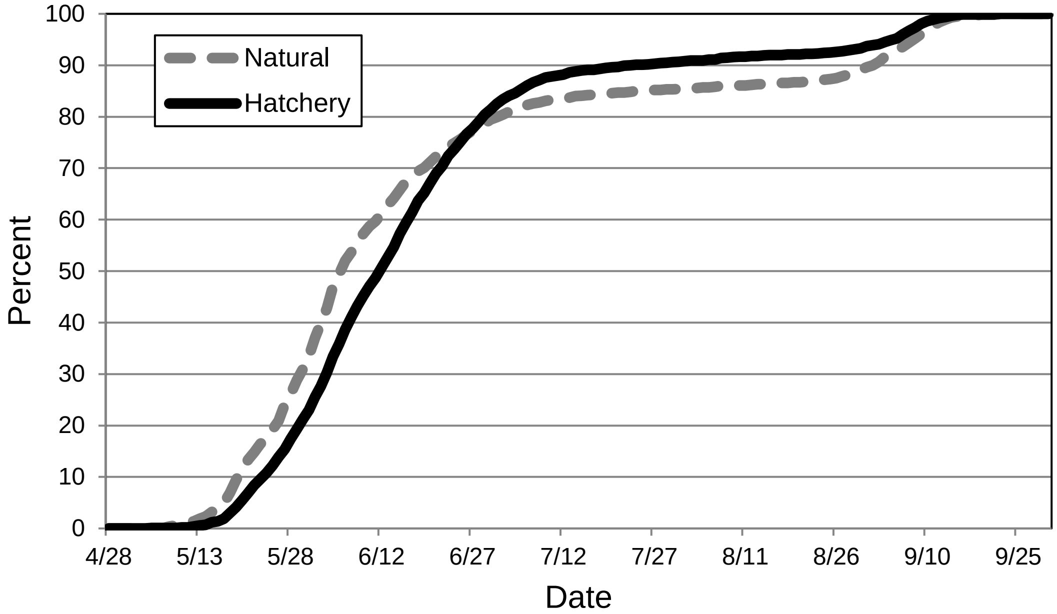

Figure 9. Cumulative run timing by date at the Tucannon Fish Hatchery adult trap on the Tucannon River for both natural and hatchery origin Tucannon River spring Chinook salmon, 1994-2019.

Total Run-Size

During 2019, two males (one natural and one hatchery) were the only fish passed above the trap. However, some adults were able to bypass the TFH trap/intake dam and we counted three redds above the trap. No carcasses were recovered above the trap so we could not estimate a bypass rate. We calculated the number of fish above the trap by using the fish/redd estimate (1.97 – from the spawning escapement calculation in the next section) for an estimate of six. We also multiplied the fish/redd estimate by the number of redds below the trap (8) for a total of 16 fish below the trap.

The run-size estimate for 2019 was calculated by adding the estimated number of fish upstream of the TFH adult trap (6), the estimated fish below the weir (16), adipose clipped strays killed at the trap (1), pre-spawn mortality of fish held for outplanting (10), the number of broodstock collected (149), and jacks (21) held for outplanting (Table 11). Run-size for 2019 was estimated to be 203 fish (43 natural adults, 2 natural jacks, and 129 hatchery adults, 29 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), 1985-2019.

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
2017	70	3.55	249	111	152	512	1	13
2018	109	2.02[f]	335	160	50	545	0	15
2019	11	1.97	22	170[g]	11	203	2	22

[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. During 2017, jacks were killed at LFH.

[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 2017).

[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.

[g] This total includes 149 adults kept for spawning and 21 jacks that were held and then outplanted but not recovered.

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 (e.g., 1.02 males: 1 female = 2.02 fish/redd) 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 2019 was 22 fish (8 natural-origin, 14 hatchery-origin) based on 1.97 fish per redd. The estimated spawning escapement for 1985 to 2019 is found in Table 12.

Table 12. Estimated spawning escapement and the calculation methodology used for the 1985 to 2019 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
2017	70	249	0.195:0.805	3.55	Sex ratio at Adult Trap
2018	109	220	0.134:0.866	2.02	Sex ratio at Adult Trap
2019	11	22	0.364:0.636	1.97	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 2017).

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 2019, based on the estimated escapement of hatchery and natural origin fish to the river, we sampled approximately 80% of the run (Table 14).

Table 13. Coded-wire tag codes of hatchery salmon sampled at LFH and the Tucannon River, 2019.

	Broodstock Collected			Held at TFH/LFH		Recovered in Tucannon River			
CWT Code	**Pre-spawn Mortality**	**Killed Outright**	**Spawned**	**Killed Outright**	**Died in Pond**	**Dead in Trap[a]**	**Pre-spawn Mortality**	**Spawned**	**Totals**
63-72-01					9				9
63-70-39	50		61				2		113
63-68-84	2								2
-Strays-									
AD/No Wire						1			1
Totals	**52**		**61**		**9**	**1**	**2**		**125**

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

Table 14. Spring Chinook salmon (natural and hatchery) sampled from the Tucannon River, 2019.

	2019		
	Natural	**Hatchery**	**Total**
Total escapement to river	45	158	203
Broodstock collected	36	113	149
Fish dead in adult trap	0	1	1
Fish held at TFH/LFH	1	9	10
Total hatchery sample	37	123	160
Total fish left in river	8	35	43
In-river pre-spawn mortalities observed	0	2	2
Spawned carcasses recovered	1	0	1
Total river sample	1	2	3
Carcasses sampled	38	125	163

Stray Salmon into the Tucannon River

Spring Chinook from other river systems (strays) are periodically recovered in the Tucannon River, although they were 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 (but 100% CWT) beginning with the 2009 BY. Unfortunately, because of that mark/tag, they are identical to Tucannon fish. As such, 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.

One stray (AD clip/no wire) was killed outright at the adult trap during 2019 (Appendix E). After expansions, strays accounted for an estimated 0.5% of the total 2019 run (Appendix E).

An added concern for the future is the implementation of a new hatchery program for the Touchet River using Carson stock spring Chinook that will begin to return as early as 2021 (BY18). Potential straying from this hatchery program into the Tucannon River would be additive to the current stray rates being observed in the Tucannon River and could lead to outbreeding depression. All juveniles from the new Touchet River spring Chinook program will be 100% AD-clipped, with 34% of the production receiving CWT and 6% receiving PIT tags to monitor potential straying into the Tucannon River.
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 2019. Thirteen fish originally PIT tagged at locations other than the Tucannon River were detected in the Tucannon

River (Table 15). The majority of these fish (12) 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. One stray (Sawtooth Fish Hatchery, IDFG) originally PIT tagged as a juvenile (2014 BY) was also detected in the Tucannon (Table 15).

Table 15. Tucannon River PIT tag array detections of spring Chinook originally tagged at locations other than the Tucannon River during 2019.

PIT Tag	Origin	Tag Date	Life Stage At Tagging	Tag Release Location	Detection Date	Tucannon Site[a]
3DD.0077870782	H	4/01/16	Juvenile	Sawtooth Hatchery	10/01/19	MTR
3DD.00775E4D5F	W	5/14/19	Adult	Lower Granite Dam	6/02/19	TFH
3DD.00775EC3EE	W	5/14/19	Adult	Lower Granite Dam	6/02/19	TFH
3DD.00775F49C3	H	5/14/19	Adult	Lower Granite Dam	5/30/19	TFH
3DD.00775F9A4A	W	5/15/19	Adult	Lower Granite Dam	6/06/19	TFH
3DD.00775E6DD8	W	5/16/19	Adult	Lower Granite Dam	6/01/19	TFH
3DD.00775EEBCF	W	5/20/19	Adult	Lower Granite Dam	6/04/19	TFH
3DD.00775FFF04	W	5/22/19	Adult	Lower Granite Dam	6/11/19	TFH
3DD.00775F3271	W	5/24/19	Adult	Lower Granite Dam	6/11/19	TFH
3DD.00775F852B	W	5/24/19	Adult	Lower Granite Dam	6/09/19	TFH
3DD.00775EB4FD	W	5/28/19	Adult	Lower Granite Dam	6/05/19	UTR
3DD.00775F5E27	W	6/03/19	Adult	Lower Granite Dam	6/21/19	TFH
3DD.00775EC381	H	6/06/19	Adult	Lower Granite Dam	6/24/19	TFH

[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).

Adult PIT Tag Returns

Five hundred eighty-six Tucannon River spring Chinook originally PIT tagged as juveniles have been detected returning to the Columbia River System (Table 16).

Table 16. Number of Tucannon River spring Chinook juvenile fish PIT tagged by origin and 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%)	10 (1.98%)	4 (0.40%)
2008	4,989	1,915	997	47 (0.94%)	47 (2.45%)	6 (0.60%)
2009	4,987	1,232	---	13 (0.26%)	17 (1.38%)	---
2010	15,000	2,800	---	85 (0.57%)	17 (0.61%)	---
2011	24,976	5,267	---	38 (0.15%)	23 (0.44%)	---
2012	22,982	3,889	---	26 (0.11%)	22 (0.57%)	---
2013	14,987	4,026	---	32 (0.21%)	41 (1.02%)	---
2014	14,969	660	---	35 (0.23%)	0	---
2015	14,962	368	---	25 (0.17%)	1 (0.27%)	---
2016	14,983	1,429	---	51 (0.34%)	4 (0.28%)	---
2017	14,984	870	---	16 (0.11%)	1 (0.11%)	---
2018	14,937	366	---	2 (0.01%)	0	---
Totals	**176,232**	**24,342**	**6,028**	**383 (0.22%)**	**193 (0.79%)**	**10 (0.17%)**

From the detected returns, 140 (24%) of the returning PIT tagged spring Chinook were detected upstream of the Tucannon River (Table 17; Appendix F). Forty-two of these fish (7%) had their last detections at or above Lower Granite Dam (Table 17; Appendix F). The overshoot rate has generally 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 17). This does not appear to be a hatchery effect as both natural and hatchery origin fish overshoot the Tucannon River (Table 17). Non-direct homing behavior has been documented for adult Chinook in the Columbia River System (Keefer et al. 2008), and similar percentages of natural origin spring Chinook from the John Day River have been documented bypassing that river (Jim Ruzycki, ODFW, personal communication). However, more research into these events should be conducted to examine whether they are natural straying occurrences, or if it is related to hydropower operations. The installation of PIT tag arrays in the Tucannon River during the past few years [Lower 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 70%) to the Tucannon River (Table 17). 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 (e.g., injuries from additional dam crossings, added energy expenditure), and may partially explain why this population has been slow to respond to recovery and supplementation actions.

Table 17. Number and origin of PIT tagged Tucannon River spring Chinook returns that overshot the Tucannon River (includes fish that were last detected returning 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 – 2018) 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	150	20	13.3	35.0	65.0	14	42.9	57.1	9.3
2010-2014	319	80	25.1	37.5	62.5	12	41.7	58.3	3.8
2015-2018	100	30	30.0	3.3	96.7	6	0.0	100.0	6.0
Totals	**586**	**140**	**23.9%**	**29.0%**	**71.0%**	**42**	**34.9%**	**65.1%**	**7.2%**
2005-2018	**569**	**130**	**22.8%**			**32**			**5.6%**

Juvenile Salmon Evaluation

Hatchery Rearing, Marking, and Release

The BY18 supplementation juveniles (196,275) were tagged with CWT (63/74/21) at LFH from 5 March to 12 March 2019. Fish were transferred to Dworshak NFH during 21-24 May. While rearing at Dworshak NFH over the summer, a subset of the 2018 BY were exposed to and contracted infectious hematopoietic necrosis virus. However, the low-level mortality resolved on its own, thus no supportive care was deemed necessary. The fish were transferred back to LFH during 12-15 August. Upon return, fish were put into one of the large rearing lakes for the remainder of the rearing cycle until release. This represents a change compared to previous years when fish would be transported to TFH for overwinter rearing. Fish were PIT tagged (target 15,000) on 17 March 2020 at the LFH release structure about one week prior to release. PIT tags are used for outmigration survival (Comparative Survival Study) and adult return estimates.

Brood year 2018 fish were sampled just prior to release by WDFW evaluations staff (Table 18). A total of 1,822 fish were sampled for precocity (external observation only) and mark/tag quality and 262 were sampled for length and weight statistics. The target release size was 38 g fish (12 fpp). Mortalities were scanned for PIT tags and 14,986 PIT tagged fish were released. The 2018 BY smolts were direct stream released on 23-24 March just below Beaver/Watson Bridge (rkm 61.9) as the road to the acclimation pond was washed out due to flooding in early February 2020. An estimated 192,521 BY18 smolts were released. Estimated numbers and size of fish released are provided in Table 19. Historical release numbers are found in Appendix G.

Table 18. Sample size (N), mean length (mm), coefficient of variation (CV), condition factor (K), mean weight (g), and precocity of 2018 BY juveniles sampled at LFH lake outlet.

Date	Sample Location	N	Mean Length (mm)	CV	K	Mean Wt. (g)	% Precocity
3/17/20	LFH Lake	262	146.3	8.9	1.14	36.4	0.22

Table 19. Spring Chinook salmon released into the Tucannon River (rkm 61.9), 2020 release year.

Release Date	CWT Code	Total Released	Number CWT	VIE Mark	Size Total (kg)	Size Mean (g)
3/23-3/24	63/74/21	192,521	185,758	None	6,993	36.4

Smolt Trapping

Evaluation staff operated a 1.5 m rotary screw trap at rkm 3 on the Tucannon River from 15 October 2018 through 12 July 2019 to estimate numbers of migrating juvenile natural spring Chinook. Numbers of each fish species captured by month during the 2019 outmigration can be found in Appendix H. The main outmigration of natural origin spring Chinook for the 2018/2019 outmigration occurred during the spring, with a limited outmigration during the fall and winter months (Figure 10). Prior years have shown increased outmigration in the fall and winter from larger adult returns (Gallinat and Ross 2014, Gallinat and Ross 2015), although even in those years, the majority of the outmigration occurred in the spring.

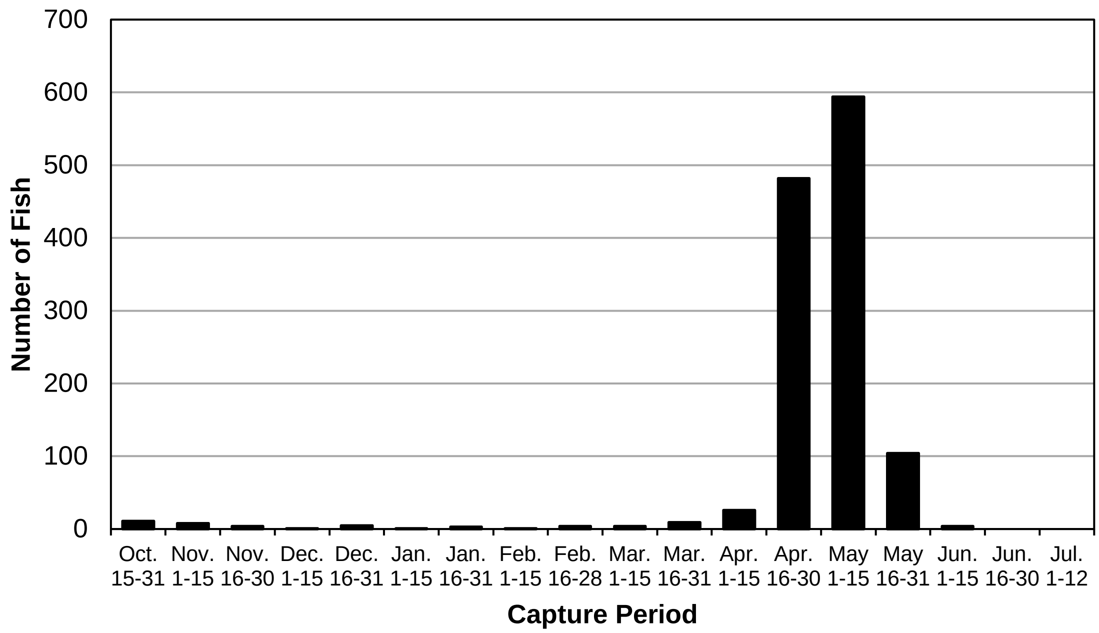

Figure 10. Emigration timing of natural spring Chinook salmon captured during smolt trap operations (rkm 3) on the Tucannon River for the 2018-19 migration year.

Natural spring Chinook emigrating from the Tucannon River (BY 2017) averaged 106 mm (Figure 11), with a CV of 7.5%. This is in comparison to a mean length of 131 mm for hatchery-origin fish (BY 2017) released from Curl Lake Acclimation Pond (Gallinat and Kiefel 2019).

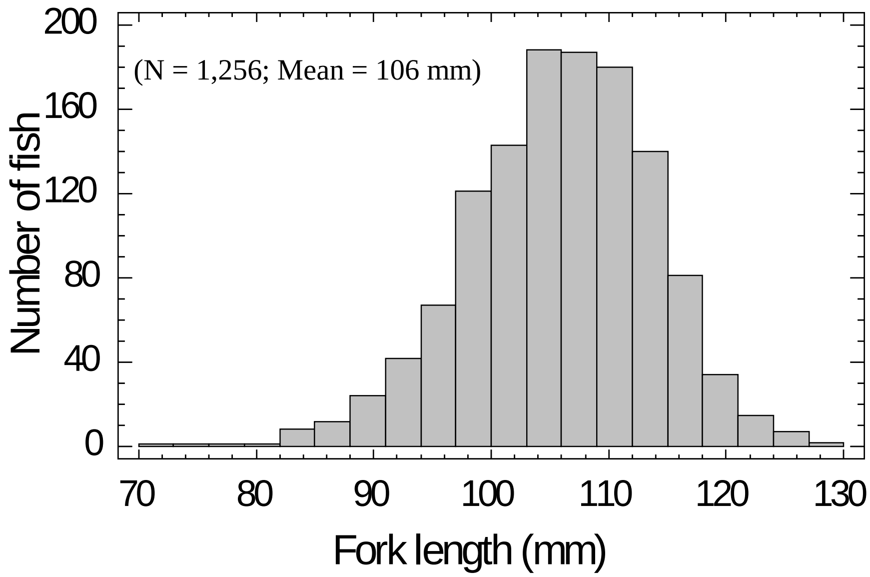

Figure 11. Length frequency distribution of sampled natural spring Chinook salmon captured in the Tucannon River smolt trap, 2018/2019 season.

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 (≤ 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.

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 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 17,972 (S.E. 3,181.9; 95% C.I. 13,302-25,871) migrant natural-origin spring Chinook (2017 BY) passed the smolt trap during 2018-2019.

Smolt Migration to Lower Monumental and McNary Dams

With the use of PIT tags, we monitored the migration travel time and speed of juvenile spring Chinook from the Tucannon River (both hatchery and natural origin) to Lower Monumental and McNary Dams for the 2019 outmigration (Table 20). Hatchery fish were PIT tagged prior to transfer to Curl Lake AP (rkm 66) for acclimation, while natural origin fish were PIT tagged at the Tucannon River smolt trap (rkm 3), described earlier.

Hatchery fish were volitionally released from Curl Lake AP from 4 April to 3 May 2019. Given the length of the volitional release period, we chose the midway point of 18 April as the "release date" for this analysis. Natural origin spring Chinook were released immediately following PIT tagging at the smolt trap, so the release date/time provided in the PTAGIS tagging files have been used for travel time/speed calculations. Natural origin fish used in this analysis were PIT tagged at the smolt trap and released between 19 February to 31 May 2019 (Table 20). Natural-origin fish tend to have faster migration time to the dams than hatchery-origin fish (Table 20).

From 2007 to 2017, barge transportation at Lower Monumental Dam typically began between 1-12 May (PTAGIS website 2020). In 2018 and 2019, transportation began on 24 and 23 April, respectively. For 2018 and 2019, spring Chinook were released later (last week of April, first week of May) per the request of the co-managers to allow for greater potential transportation at Lower Monumental Dam. The releases in 2019 resulted in a shift in the emigration timing compared to previous years (Figure 12).

Table 20. Median and mean travel time and outmigration speed of hatchery and natural-origin Tucannon River spring Chinook to Lower Monumental and McNary Dams in 2019.

Release Dates	Sample Size	Median Travel Days	Mean Travel Days	Mean Travel Days (S.D.)	Median Travel Speed (km/day)	Mean Travel Speed (km/day)	Mean Travel Speed S.D.
Hatchery-origin – Lower Monumental Dam							
4/18/19	294	24.0	23.4	5.6	5.5	6.2	2.4
Natural-origin – Lower Monumental Dam							
2/19/19 to 5/31/19	210	2.0	3.3	4.9	35.0	34.8	20.0
Hatchery-origin – McNary Dam							
4/18/19	178	27.0	26.8	5.2	6.9	7.3	1.9
Natural-origin – McNary Dam							
2/19/19 to 5/31/19	74	9.0	9.3	3.8	13.6	15.3	5.8

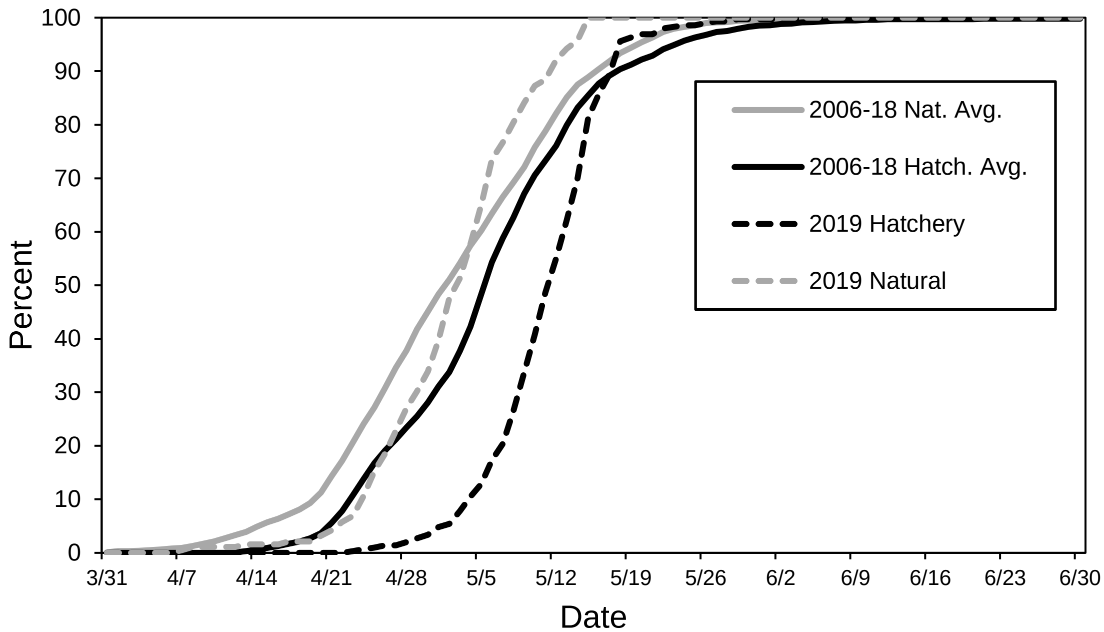

Figure 12. The cumulative timing to Lower Monumental Dam for natural and hatchery origin Tucannon River spring Chinook emigrants from 2019 compared to the 2006-2018 average.

Survival Rates

Point estimates of population sizes have been calculated for various life stages (Tables 21 and 22) of natural and hatchery-origin spring Chinook from spawning ground and juvenile mid-summer population surveys, smolt trapping, and fecundity estimates. Survivals between life stages have been calculated for both natural and hatchery salmon to assist in the evaluation of the hatchery program. These survival estimates provide insight as to where efforts should be directed to improve not only the survival of fish produced within the hatchery, but fish in the river as well.

As expected, juvenile (egg-parr-smolt) survival rates for hatchery fish are considerably higher than for naturally reared salmon (Table 23) because they have been protected in the hatchery. However, SARs to the Tucannon River of natural salmon were almost eight times higher (based on geometric means) than for hatchery-reared salmon (Tables 24 and 25). With the exception of the 2006 brood year, hatchery SARs (mean 0.24%; geometric mean 0.17%) documented from the 1985-2014 broods have been well below the original LSRCP survival assumption of 0.87% (which was used to size the original hatchery program of 132,000 smolts). 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 poor smolt-to-adult return survival rates.

Table 21. Estimates of *natural in-river produced* Tucannon spring Chinook salmon (both hatchery and natural origin parents) abundance by life stage for 1985-2019 broods.

Brood Year	Females in River Natural	Females in River Hatchery	Mean Fecundity[a] Natural	Mean Fecundity[a] Hatchery	Number of Eggs	Number of Parr[b]	Number of Smolts	Returning Progeny[c]
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	69
2014	105	19	3,699	3,290	450,905	---	6,604	89
2015	64	127	3,839	3,468	686,132	---	14,305	42
2016	53	101	3,704	3,179	517,391	---	8,058	2
2017	12	58	3,393	3,034	216,688	---	17,972	
2018	12	97	2,977	2,860	313,144	---		
2019	4	7	3,420	2,841	33,567	---		

[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 2017).
[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 22. Estimates of Tucannon spring Chinook salmon abundance (*spawned and reared in the hatchery*) by life stage for 1985-2019 broods.

Brood Year	Females Spawned Natural	Females Spawned Hatchery	Mean Fecundity[a] Natural	Mean Fecundity[a] Hatchery	Number of Eggs	Number of Parr	Number of Smolts	Returning Progeny[b]
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	514
2013	48	30	3,798	3,185	275,188	263,630	207,859	362
2014	39	27	3,699	3,290	231,026	226,300	221,099	458
2015	55	20	3,839	3,468	280,519	266,134	199,686	165
2016	31	41	3,704	3,179	245,174	230,106	209,031	29
2017	8	52	3,393	3,034	181,664	166,590	144,219	
2018	9	67	2,977	2,860	212,973	204,364	192,521	
2019	7	38	3,420	2,841	126,102	118,159		

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

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

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

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

Table 23. Percent survival by brood year for juvenile salmon and the multiplicative advantage of hatchery-reared salmon over naturally-reared salmon in the Tucannon River.

	Natural			Hatchery			Hatchery Advantage		
Brood Year	**Egg to Parr**	**Parr to Smolt**	**Egg to Smolt**	**Egg to Parr**	**Parr to Smolt**	**Egg to Smolt**	**Egg to Parr**	**Parr to Smolt**	**Egg to Smolt**
1985	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	---	---	2.1	94.9	75.0	71.2	---	---	34.1
2016	---	---	1.6	93.9	90.8	85.3	---	---	54.7
2017	---	---	8.3	91.7	86.6	79.4	---	---	9.6
2018				96.0	94.2	90.4			
2019				93.7					
Mean	10.0	56.2	4.7	87.2	87.3	75.7	11.3	1.6	23.0
SD	4.8	22.7	2.8	13.8	12.0	15.1	11.2	0.6	15.8

Table 24. Adult returns and SARs of natural salmon to the Tucannon River for brood years 1985-2016. (2015 and 2016 are incomplete brood years included for comparison.)

Brood Year	Estimated Number of Smolts	Number of Adult Returns, observed (obs) and expanded (exp)[a] Age 3 Obs	Age 3 Exp	Age 4 Obs	Age 4 Exp	Age 5 Obs	Age 5 Exp	SAR (%) With Jacks	SAR (%) No Jacks
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	0	0	1.65	1.15
2013	3,831	2	8	25	60	1	1	1.80	1.59
2014	6,604	9	9	44	79	1	1	1.35	1.21
2015	14,305	0	0	36	42	---	---	0.29	0.29
2016	8,058	1	2	---	---	---	---	0.00	0.00
Mean								**2.31[d]**	**2.17[d]**
Geometric Mean								**1.29[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 2015 and 2016 SARs are not included in the mean.

Table 25. Adult returns and SARs of hatchery salmon to the Tucannon River for brood years 1985-2016. (2015 and 2016 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	3	11	0.25	0.16
2013	207,859	100	116	116	246	0	0	0.17	0.12
2014	221,099	128	140	166	316	2	2	0.21	0.14
2015	199,686	8	39	113	126	---	---	0.08	0.06
2016	209,031	9	29	---	---	---	---	0.01	0.00
Mean								**0.24[b]**	**0.19[b]**
Geometric Mean								**0.17[b]**	**0.13[b]**

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

[b] The 2015 and 2016 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 23). With the exception of eleven brood years (35%), naturally produced fish have been below the replacement level (Figure 13; Table 26). Based on adult returns from the 1985-2015 broods, naturally reared salmon produced only 0.67 adults for every spawner, while hatchery reared fish produced 2.05 adults (based on geometric means).

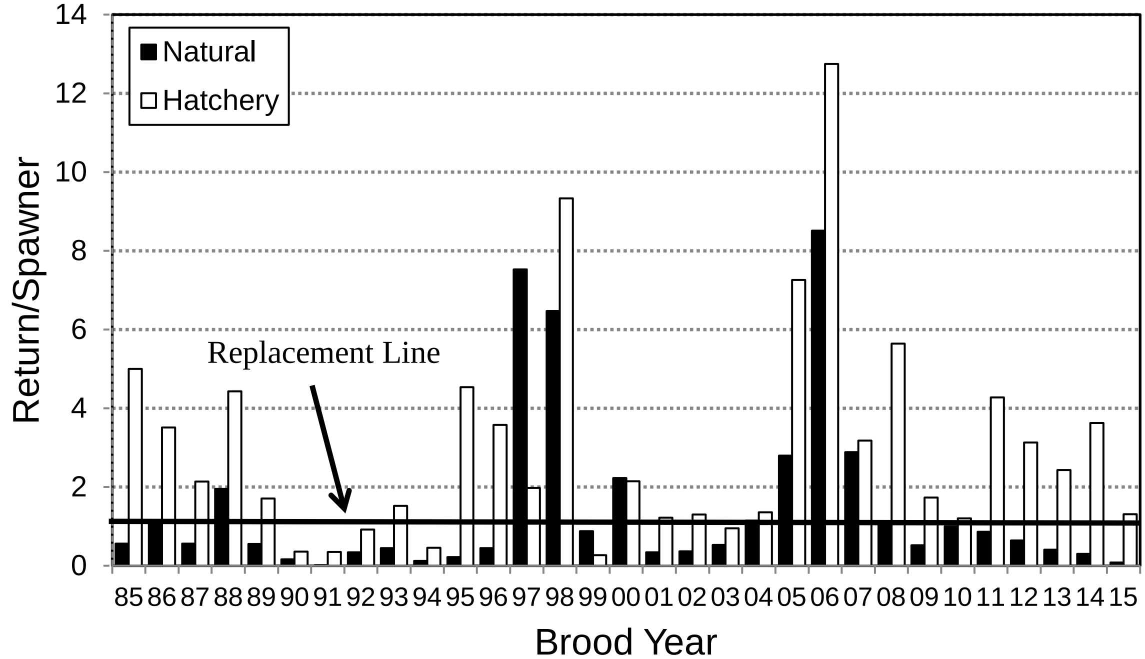

Figure 13. Return per spawner (with replacement line) for the 1985-2015 brood years (2015 incomplete brood year).

Table 26. Progeny-to-parent survival estimates of Tucannon River spring Chinook salmon from 1985 through 2015 brood years (2015 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	514	3.13	4.9
2013	170	69	0.41	149	362	2.43	6.0
2014	294	89	0.30	126	458	3.63	12.0
2015	220	42	0.08	126	165	1.31	16.3
Mean			**1.45**			**3.02**	**4.8**
Geometric Mean			**0.67**			**2.05**	**3.1**

Beginning with the 2006 brood year, the annual smolt goal was increased from 132,000 to 225,000 to help offset for the higher mortality of hatchery-origin fish after they leave the hatchery. This should increase adult salmon returns back to the Tucannon River. However, based on current hatchery SARs the increase in production would still not produce enough adult returns to reach the LSRCP mitigation goal. 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 I).

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 spring Chinook salmon 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, but decreased during recent years (2016-2019), likely due to poor ocean conditions (Figure 14).

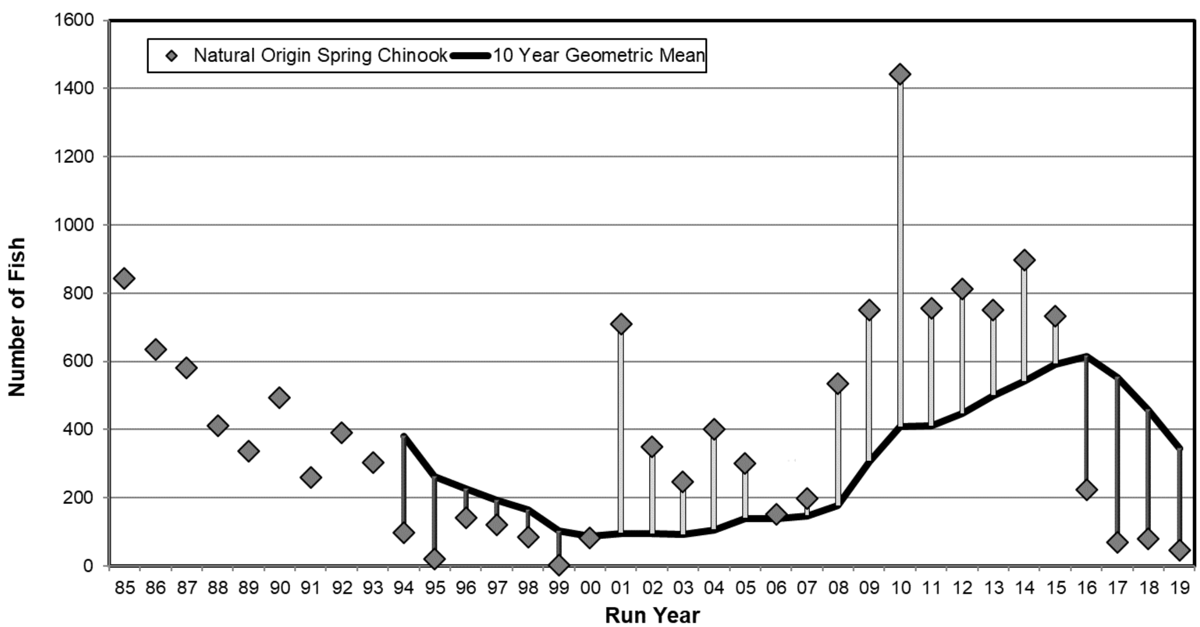

Figure 14. Tucannon River spring Chinook natural origin returns with the moving ten-year geometric mean (black line) for the 1985-2019 run years.

Fishery Contribution and Out-of-Basin Straying

The 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 15). Based on CWT recoveries reported to the Regional Mark Information System (RMIS) database (Appendix J), sport and commercial 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 hatchery fish recoveries). As such, the WDFW subsequently stopped adipose fin clipping spring Chinook hatchery production from the Tucannon River (Gallinat et al. 2001) to lessen non-tribal fishery impacts from the Columbia River, and newly implemented Snake River fisheries. This change in marking has resulted in lower sport fishery impacts. Based on CWT recoveries for the 2000-2015 brood years, harvest (primarily commercial) has accounted for only 5.8% of the hatchery adult CWT recoveries (Appendix J).

Out-of-basin stray rates of Tucannon River spring Chinook have generally been low (Appendix J), with an average of 1.1% of the adult hatchery fish straying to other river systems/hatcheries for brood years 1985-2015 (range 0-20%). Recent (2005-2015 BYs) locations that Tucannon River spring Chinook have strayed are listed in Table 27.

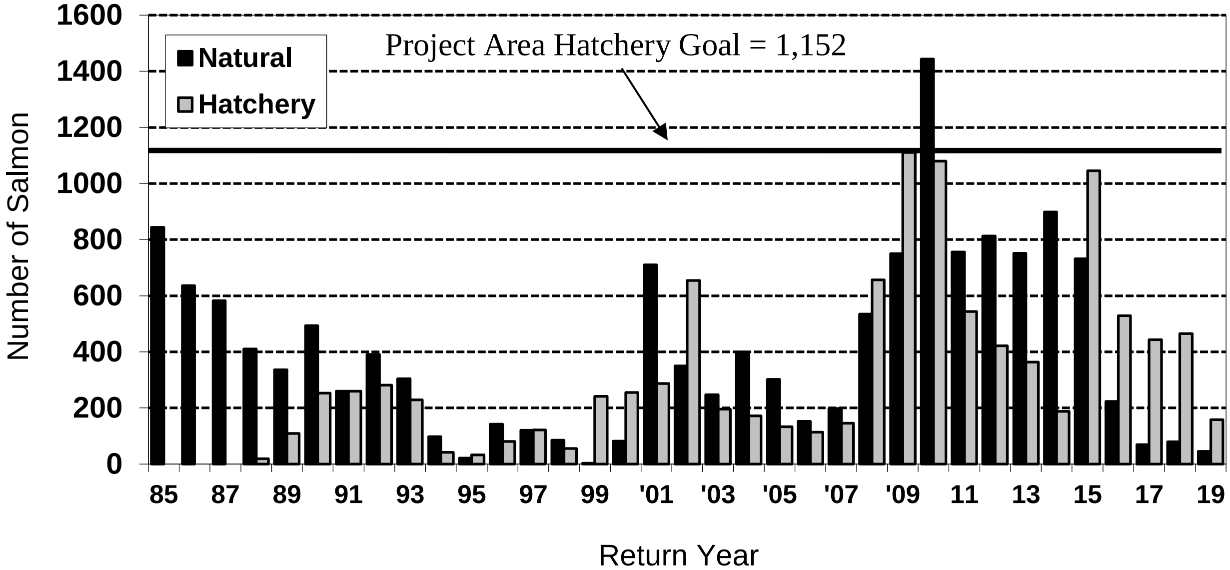

Figure 15. Total escapement for Tucannon River spring Chinook salmon for the 1985-2019 run years.

Table 27. Summary of Tucannon River spring Chinook recovered outside of the Tucannon River and represent possible strays to other areas (2005-2015 brood years).

Brood Year	CWT Codes	Recovery Location	Recovery Date	Number of CWT Recovered/Expanded
2005	633477,633599	None	N/A	0/0
2006	634093, 634094, 634194	Powell Rack, Lochsa River	08/27/09	1/1
2007	634687, 634688	None	N/A	0/0
2008	635174, 635175	None	N/A	0/0
2009	635565, 635566	Lower Granite Dam Trap	10/17/13	1/1
2010	636075, 636076	None	N/A	0/0
2011	636441, 636442	Lower Granite Dam Trap	09/24/14	1/1
2012	636585, 636586	Lewis River Hatchery	08/31/16	1/1
		SF Walla Walla River	09/13/16	1/1
2013	636742, 636743	None	N/A	0/0
2014	636884	None	N/A	0/0
2015	637039	Three Mile Dam, Umatilla River	09/04/18	1/1
Totals				**6/6**
Total recovery of Tucannon fish from all locations				**1,829/5,765**
Percent stray rate (recovered or expanded)				**0.33%/0.10%**

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 rates were still below the original LSRCP survival assumption of 0.87% (Table 28).

Table 28. Hatchery SAS adjusted for recoveries from outside the Tucannon River subbasin as reported in the RMIS database, 1985-2014 brood years. (Data downloaded from RMIS database on 12/16/19).

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	25	410	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	4	269	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	7	307	0.13	0.13
2010	201,585	194	1	195	0.10	0.10
2011	259,964	711	24	735	0.27	0.28
2012	203,510	514	3	517	0.25	0.25
2013	207,859	362	11	373	0.17	0.18
2014	221,099	458	2	460	0.21	0.21
Mean					**0.24**	**0.26**
Geometric Mean					**0.17**	**0.18**

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

Conclusions and Recommendations

Washington's LSRCP hatchery spring Chinook salmon program in the Tucannon River has failed to return adequate numbers of adults to meet the mitigation goal for Washington (1,152). This has occurred because SARs of hatchery origin fish have been consistently lower than what was originally assumed under the LSRCP program development. 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 overall Tucannon spring Chinook population during years when the population was at critically low levels. For a while, we had seen a significant rebound of natural origin fish and we came close to reaching the within river hatchery (LSRCP) goal of 1,152 fish in 2009 and 2010. Recent returns have been much lower, which is believed to be the result of recent poor ocean conditions. 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, and PIT tag data from the TFH PIT tag array, 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 and reduce migration delay 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 than their natural origin counterpart. We need to identify and address the factors that limit hatchery SARs in order to meet the mitigation goals and for natural production to meet recovery goals.

   Recommendation: Continue to compare hatchery and natural survival rates from other reference watersheds compare survival rates documented for Tucannon River spring Chinook. Continue to discuss alternative release strategies with the managers to see if survival rates can be improved to provide greater adult returns. Utilize fish carcasses from hatchery operations for stream nutrient enrichment to improve overall productivity and survival of Tucannon River spring Chinook. Continue to monitor straying into the Tucannon River to insure the addition of Touchet River Carson stock hatchery fish does not go above the NOAA Fisheries acceptable stray proportion of 5%.

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 thought to be due to a combination of drought years with higher water temperatures and pathogen load. 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 2019 have been collected and held 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. From 2016-2018, a range of 55-72% of outplanted fish successfully spawned.

   Recommendation: Continue to monitor in-river pre-spawn mortality. Continue intensive monitoring of adult outplants, when that strategy is employed, 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 NOAA Fisheries on future adult outplants. An agreed upon population threshold trigger is needed to determine whether to pass fish at the adult trap or hold fish at LFH for outplanting. A trigger has been suggested by M&E staff (allow outplanting below an estimated return of 400 adults) but has yet to be agreed upon by the co-managers.

Literature Cited

Bond, M. H., C. V. Hanson, R. Baertsch, S. A. Hayes, and R. B. MacFarlane. 2007. A new low cost instream antenna system for tracking passive integrated transponder (PIT)–tagged fish in small streams. Transactions of the American Fisheries Society 136: 562-566.

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

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

Bumgarner, J. D., and R. O. Engle. 2019. Assessment of bull trout passage during operation of the Tucannon River adult weir/trap. 2018 and 2019 Annual Progress Report. U.S. Fish and Wildlife Service, Lower Snake River Compensation Plan Office, Boise, ID. 61 pp.

Burke, B. J., and M. A. Jepson. 2006. Performance of passive integrated transponder tags and radio tags in determining dam passage behavior of adult Chinook salmon and steelhead. North American Journal of Fisheries Management 26: 742-752.

Busack, C., and C. M. Knudsen. 2007. Using factorial mating designs to increase the effective number of breeders in fish hatcheries. Aquaculture 273: 24-32.

Cheng, Y. W., and M. P. Gallinat. 2004. Statistical analysis of the relationship among environmental variables, inter-annual variability and smolt trap efficiency of salmonids in the Tucannon River. Fisheries Research 70: 229-238.

Gallinat, M. P. and W-Y Chang. 2013. Phenotypic comparisons among natural-origin, hatchery-origin, and captive-reared female spring Chinook salmon from the Tucannon River, Washington. North American Journal of Aquaculture 75 (4): 572-581.

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

Gallinat, M. P., J. D. Bumgarner, L. Ross, and M. Varney. 2002. Tucannon River Spring Chinook Salmon Hatchery Evaluation Program 2001 Annual Report to U.S. Fish and Wildlife Service, Cooperative Agreement 1411-01-J042. Washington Department of Fish and Wildlife, Olympia, Washington. Report # FPA02-10.

Gallinat, M. P., and L. A. Ross. 2014. Tucannon River Spring Chinook Salmon Hatchery Evaluation Program 2013 Annual Report to U.S. Fish and Wildlife Service, Cooperative Agreement F13AC00096. Washington Department of Fish and Wildlife, Olympia, Washington. Report #FPA14-05. 104 p.

Gallinat, M. P., and L. A. Ross. 2015. Tucannon River Spring Chinook Salmon Hatchery Evaluation Program 2014 Annual Report to U.S. Fish and Wildlife Service, Cooperative Agreement F14AC00010. Washington Department of Fish and Wildlife, Olympia, Washington. Report #FPA15-04. 108 p.

Gallinat, M. P., and L. A. Ross. 2018. Tucannon River Spring Chinook Salmon Hatchery Evaluation Program 2017 Annual Report to U.S. Fish and Wildlife Service, Cooperative Agreement F16AC00033. Washington Department of Fish and Wildlife, Olympia, Washington. Report #FPA18-08. 110 p.

Gallinat, M. P., and D. E. Kiefel. 2019. Tucannon River Spring Chinook Salmon Hatchery Evaluation Program 2018 Annual Report to U.S. Fish and Wildlife Service, Cooperative Agreement F16AC00033. Washington Department of Fish and Wildlife, Olympia, Washington. Report #FPA19-02. 117 p.

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

HSRG (Hatchery Scientific Review Group). 2009. Columbia River Hatchery Reform System-Wide Report. February 2009. 271 p.

ICTRT (Interior Columbia Technical Recovery Team). 2008. Current status assessments. U.S. Dept. Commer., NOAA, National Marine Fisheries Service, Northwest Region, Portland, Ore.

Keefer, M. L., C. C. Caudill, C. A. Peery, and C. T. Boggs. 2008. Non-direct homing behaviours by adult Chinook salmon in a large, multi-stock river system. Journal of Fish Biology 72: 27-44.

Kintisch, E. 2015. "The Blob" invades Pacific, flummoxing climate experts. Science 348: 17-18.

Kohler, A. E., T. N. Pearsons, J. S. Zendt, M. G. Mesa, C. L. Johnson, and P. J. Connolly. 2012. Nutrient enrichment with salmon carcass analogs in the Columbia River Basin, USA: a stream food web analysis. Transactions of the American Fisheries Society 141: 802-824.

Meekin, T. K., 1967. Report on the 1966 Wells Dam Chinook tagging study. Report to Douglas County PUD, Contract 001-01-022-4201. Washington Department of Fisheries, Olympia, WA. 41 p. (Available from Douglas County PUD, 1151 Valley Mall Parkway, East Wenatchee, WA 98801.)

Murdoch, A. R., T. N. Pearsons, and T. W. Maitland. 2009. The number of redds constructed per female spring Chinook salmon in the Wenatchee River basin. North American Journal of Fisheries Management 29: 441-446.

Murdoch, A. R., T. N. Pearsons, T. W. Maitland. 2010. Estimating the spawning escapement of hatchery- and natural-origin spring Chinook salmon using redd and carcass data. North American Journal of Fisheries Management 30: 361-375.

Nehlsen, W., J. E. Williams, and J. A. Lichatowich. 1991. Pacific salmon at the crossroads: stocks at risk from California, Oregon, Idaho, and Washington. Fisheries 16 (3): 4-21.

Peterson, J. T., R. F. Thurow, and J. W. Guzevich. 2004. An evaluation of multipass electrofishing for estimating the abundance of stream-dwelling salmonids. Transactions of the American Fisheries Society 113: 462-475.

Peterson, W. T., J. L. Fisher, J. O. Peterson, C. A. Morgan, B. J. Burke, and K. L. Fresh. 2014. Applied fisheries oceanography: Ecosystem indicators of ocean conditions inform fisheries management in the California Current. Oceanography 27: 80-89.

PTAGIS website 2020. Information of the initiations of barge transportation at Lower Monumental Dam.

Rosenberger, A. E., and J. B. Dunham. 2005. Validation of abundance estimates from mark-recapture and removal techniques for rainbow trout captured by electrofishing in small streams. North American Journal of Fisheries Management 25: 1395-1410.

Scheuerell, M. D., P. S. Levin, R. W. Zabel, J. G. Williams, and B. L. Sanderson. 2005. A new perspective of marine-derived nutrients to threatened stocks of Pacific salmon (Oncorhynchus spp.). Canadian Journal of Fisheries and Aquatic Sciences 62: 961-964.

Seiler, D., L. Kishimoto, and S. Neuhauser. 1999. 1998 Skagit River wild 0+ Chinook production evaluation. Washington Department of Fish and Wildlife. Olympia, Washington. 73 pp.

Snake River Lab. 2015. Tucannon River spring Chinook salmon pre-spawn mortality investigations for 2014. Washington Department of Fish and Wildlife. 23 p.

Snake River Salmon Recovery Board (SRSRB). 2006. Technical Document Snake River Salmon Recovery Plan for S.E. Washington. Prepared for the Washington Governor's Salmon Recovery Office. 408 pages, plus appendices.

Steinhorst, K., Y. Wu, B. Dennis, and P. Kline. 2004. Confidence intervals for fish outmigration estimates using stratified trap efficiency methods. Journal of Agricultural, Biological, and Environmental Statistics 9 (3): 284-299.

Tucannon Subbasin Summary. 2001. L. Gephart and D. Nordheim, editors. Prepared for the Northwest Power Planning Council. Dayton, Washington.

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

Washington Department of Fish and Wildlife (WDFW). 2017. Washington Department of Fish and Wildlife Salmonid Stock Inventory Database. WDFW, Olympia. Available: http://wdfw.wa.gov/conservation/fisheries/sasi/ (May 2017).

Zar, J. H. 1996. Biostatistical analysis, 3rd edition. Prentice-Hall, Upper Saddle River, New Jersey.

Zhou, S. 2002. Size-dependent recovery of Chinook salmon in carcass surveys. Transactions of the American Fisheries Society 131: 1,194-1,202.

Zydlewski, G. B., G. Horton, T. Dubreuil, B. Letcher, S. Casey, and J. Zydlewski. 2006. Remote monitoring of fish in small streams: a unified approach using PIT tags. Fisheries 31 (10): 492-502.

Appendix A: Annual Section 10 Permit #18024 Takes for 2019, and NEOR/SEWA Terms and Conditions Biological Opinion Reporting Requirements

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 2019 calendar year. NMFS must be notified within two days if the number handled, tagged, or killed are exceeded.

Origin and Life Stage	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 (1,490)	7,000 (1,465)	Up to 160 (25)
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 (10,918)	7,000 (1,459)	Up to 245 (29)
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 2019 calendar year. NMFS must be notified within two days if the number handled, tagged, or killed are exceeded.					
Origin and Life Stage	**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 (37)	Up to 1,824[b] (passed live with fin-clip or operculum punch, PIT and/or radio tagged) (1 passed upstream) (0 outplanted upstream)	Up to 232[b] broodstock and fish used for outplants (36 broodstock) 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 (2)	Up to 200 (passed live with fin-clip or operculum punch, PIT and/or radio tagged) (0 passed upstream; 1 outplanted upstream; 1 DIP/PSM)	Up to 9 broodstock. (0) Plus up to 2 trap mortalities. (0)
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) (115)	Up to 1,400[b] (passed live with fin-clip or operculum punch, PIT and/or radio tagged) (1 passed upstream) (0 outplanted upstream)	Up to 232[b] broodstock and fish held for later outplanting. (113 broodstock) Up to 100% of total handled may be removed, killed, or transported as described in the HGMP (1 stray KO and 0 A.O. DIPs)
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 (29)	Up to 135 (more may be passed to mimic natural-origin jack proportions, with NMFS concurrence) (passed live with fin-clip or operculum punch) (0 passed upstream) (20 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 (0 stray KO and 9 A.O. DIP/PSM)
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 (126,102 BY19) (Maximum eggs/juveniles on hand annually prior to any juvenile rearing loss)	280,125 196,275 BY18 CWT 14,218 BY17 PIT tagged	Up to 55,125 total rearing mortality (2,265 BY18) (1,370 BY19)
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 A. Table 3. NOAA Terms and Conditions Biological Opinion reporting requirements for Tucannon River spring Chinook.	
Metric of Interest	**Location within Report**
Number and composition of broodstock, dates of collection, and number that die.	Appendix B.
Numbers, pounds, CV, dates, location, and tag/mark information of hatchery released fish, with precocial maturation rates.	Table 18; Appendix G.
Survival rates of Tucannon hatchery-origin fish life stages.	Tables 22 and 23.
Disease occurrence at Lyons Ferry Hatchery, Tucannon Hatchery, and Curl Lake AP.	Pages 10 and 32.
The number of returning hatchery and natural-origin adults and age structure.	Page 23; Table 11; Figure 6; Appendix C.
Distribution of hatchery and natural-origin spawners.	Table 7.
pHOS, pNOB, and PNI for the Tucannon River program.	Appendix I.
Survival rates of natural-origin fish.	Tables 21 and 23.
Smolt-to-adult survival rate (hatchery and natural-origin fish.	Tables 24 and 25.
The contribution of spring Chinook from this program into other populations (2005 to 2015 brood years).	Table 27.
The contribution of spring Chinook from other programs into the Tucannon River.	Page 28; Table 15; Appendix E.
Post release out-of-basin migration timing (median travel time and speed) of juvenile hatchery-origin fish to Lower Monumental Dam.	Table 20.
Mean length, coefficient of variation, number, and age of natural-origin juveniles.	Pages 33 to 35.
Any problems that may have arisen during hatchery activities.	Well pipeline crack at LFH so juveniles were reared at Dworshak NFH for a short period. High pre-spawn loss while adults were held at TFH.
Any unforeseen effects on listed fish.	None.

Appendix B: Spring Chinook Captured, Transported to Lyons Ferry Hatchery, or Passed Upstream at the Tucannon Hatchery Trap in 2019

Appendix B. Spring Chinook salmon captured, transported to Lyons Ferry Hatchery, or passed upstream at the Tucannon Hatchery trap in 2019. (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
5/24		1		1						
5/25	1		1							
5/27	2	1	1	1			1			
5/28		1		1						
5/29	1	1	1							1
5/30	2	6	2	5				1		
5/31	5	5	5	5						
6/01		1		1						
6/04	4	15	4	10				5		
6/05		2		2						
6/06		2		2						
6/08	1	1		1			1			
6/10	2	11	2	9				2		
6/11		5		4				1		
6/12	4	15	4	12				3		
6/13	1	3		2			1	1		
6/14	1	3	1	1				2		
6/15		2						2		
6/16		5		3				2		
6/17	1	7	1	6				1		
6/18	2	6	2	5				1		
6/19		2		2						
6/20		2		2						
6/22	1	1	1					1		
6/23	1	3	1	1				2		
6/24	2	3	2	2				1		
6/25		3		1				2		
6/26	1	1	1	1						
6/29	1	1	1	1						
6/30	1	1	1	1						
7/01		2		1				1		
7/02		3						3		
7/03		2						2		
7/05		4		3				1		
7/06		1		1						
7/07		2		1				1		
7/08		2						2		
7/09		2						2		
7/10		2		1				1		
7/13		2						2		
7/18		2		2						
7/23	1	1	1					1		
7/24	1		1							
7/25	2	1	2					1		
7/26		1		1						
7/27		2		2						
8/02		1						1		
8/15		1						1		
8/23		1		1						
9/03	1	1			1	1				
9/12		1		1						
Total	**39**	**144**	**35**	**96**	**1**	**1**	**3**	**46**	**0**	**1**
Final Total[c]	**39**	**144**	**36**	**113**	**1**	**1**	**2**	**29**	**0**	**1**

[a] These fish were held at Lyons Ferry Hatchery for outplanting, however due to high pre-spawn broodstock mortality, all adults were used for broodstock and only jacks were available for outplanting.
[b] Fin clipped strays that were killed outright at the trap.
[c] Corrected numbers after spawning.

Appendix C: Age Composition by Brood Year for Tucannon River Spring Chinook Salmon (1985-2014 BYs)

Appendix C. Age composition by brood year for natural and hatchery origin Tucannon River spring Chinook salmon (1985-2014 BYs). (Number at age is found in Tables 25 and 26).

Brood	**Natural origin**			**Hatchery origin**		
Year	**% Age 3**	**% Age 4**	**% Age 5**	**% Age 3**	**% Age 4**	**% Age 5**
1985	4.85	65.05	30.10	42.22	57.78	0.00
1986	0.43	80.30	19.27	26.02	68.97	5.02
1987	0.00	73.25	26.75	10.67	81.46	7.87
1988	0.60	63.35	36.06	25.71	63.38	10.91
1989	7.84	75.16	16.99	6.22	85.65	8.13
1990	8.51	76.60	14.89	21.43	71.43	7.14
1991	0.00	71.43	28.57	20.00	80.00	0.00
1992	1.24	85.71	13.04	14.47	82.89	2.63
1993	1.13	56.50	42.37	10.87	77.54	11.59
1994	0.00	83.33	16.67	12.50	71.88	15.63
1995	0.00	16.67	83.33	9.04	88.70	2.26
1996	0.00	91.30	8.70	22.26	72.45	5.28
1997	1.77	87.86	10.37	7.39	92.61	0.00
1998	2.32	66.75	30.93	12.23	68.85	18.92
1999	6.38	87.94	5.67	33.33	57.58	9.09
2000	0.67	87.50	11.83	16.56	83.44	0.00
2001	0.00	95.72	4.28	14.96	84.25	0.79
2002	1.42	63.21	35.38	4.96	81.82	13.22
2003	4.05	66.47	29.48	2.82	91.55	5.63
2004	2.01	88.22	9.77	15.00	81.67	3.33
2005	17.73	80.51	1.76	42.17	57.83	0.00
2006	6.74	80.76	12.50	35.83	60.52	3.65
2007	6.72	74.75	18.52	28.35	65.52	6.13
2008	9.62	78.39	11.99	41.84	57.39	0.78
2009	1.13	89.50	9.37	2.67	97.00	0.33
2010	9.70	85.18	5.12	34.02	58.25	7.73
2011	5.64	85.14	9.22	8.64	88.16	3.20
2012	30.52	69.48	0.00	36.36	61.46	2.17
2013	11.59	86.96	1.45	32.23	67.77	0.00
2014	10.11	88.76	1.12	30.57	69.00	0.44
Means	**5.95**	**79.83**	**14.22**	**24.67**	**70.47**	**4.86**

Appendix D: Total Estimated Run-Size of Tucannon River Spring Chinook Salmon (1985-2019)

Appendix D. Total estimated run-size of spring Chinook salmon to the Tucannon River, 1985-2019. (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
2017	9	60	140	257	---	---	19	27	69	443	512
2018	0	80	39	316	---	---	1	109	80	465	545
2019	2	43	29	128	---	---	0	1	45	158	203

Appendix E: Stray Hatchery-Origin Spring Chinook Salmon in the Tucannon River (1990-2019)

Appendix E. Summary of identified stray hatchery origin spring Chinook salmon that escaped into the Tucannon River (1990-2019).

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 (1990-2019).

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 (1990-2019).

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**
2017	090910	ODFW	Umatilla R.	Umatilla Hatch./Umatilla River	1/1	
	090918	ODFW	Umatilla R.	Umatilla Hatch./Umatilla River	2/6	
	090861	ODFW	Umatilla R.	Umatilla Hatch./Umatilla River	2/6	
	190418	Yakama	Yakima R.	Cle Elum Hatch./Yakima River	1/5	
	Ad clip	Unknown	Unknown	Unknown	17/28	
				Total Strays	**46**	**9.0**
2018	090903	ODFW	Umatilla R.	Umatilla Hatch./Umatilla River	2/2	
	090910	ODFW	Umatilla R.	Umatilla Hatch./Umatilla River	3/9	
	090918	ODFW	Umatilla R.	Umatilla Hatch./Umatilla River	5/15	
	Ad clip	Unknown	Unknown	Unknown	47/84	
				Total Strays	**110**	**20.2**
2019	Ad clip	Unknown	Unknown	Unknown	1/1	
				Total Strays	**1**	**0.5**

[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, 2015 to 2018 Calendar Years

Appendix F. Final PIT tag detections of returning Tucannon River spring Chinook from fish originally tagged as juveniles from the Tucannon River during the 2015 to 2018 calendar years (Data for the 1995 to 2014 calendar years can be found in Gallinat and Kiefel 2019).

	Release Data			Adult Return Final Detection Data[a]			
PIT Tag ID	Origin	Length (mm)	Release Date	OBS	OBS Date	Travel Time	Est. Age
3DD.00775150D8	W	118	4/28/15	LTR	6/14/17	778	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.007747D619	H	176	4/06/15	TDA	7/19/17	835	4
3DD.007747F7ED	H	137	4/06/15	LMO	5/29/17	784	4
3DD.00774888D6B	H	129	4/06/15	LTR	5/27/17	782	4
3DD.0077499F22	H	141	4/06/15	LTR	6/10/17	796	4
3DD.007749C0F4	H	---	4/06/15	LMO	6/10/17	794	4
3DD.007749CEEB	H	134	4/06/15	BON	5/07/17	762	4
3DD.007749D2D4	H	149	4/06/15	TFH[b]	5/30/17	785	4
3DD.007749E193	H	146	4/06/15	LMO	6/18/17	804	4
3DD.00774A053B	H	139	4/06/15	TFH	6/26/17	790	4
3DD.00774A2D48	H	149	4/06/15	MTR	7/11/17	827	4
3DD.00774A3E6D	H	128	4/06/15	LTR	5/05/17	760	4
3DD.00774A3F26	H	139	4/06/15	TFH	9/06/17	807	4
3DD.00774A5ED9	H	158	4/06/15	BON	5/22/17	777	4
3DD.00774A9148	H	118	4/06/15	TDA	6/08/17	794	4
3DD.00774A97E7	H	139	4/06/15	LMO	6/09/17	795	4
3DD.0077710EA3	H	118	4/08/16	LGR	6/06/17	424	3
3DD.007774D735	H	133	4/08/16	LGR	7/03/17	420	3
3DD.0077751EB0	H	128	4/08/16	TFH[b]	6/19/17	437	3
3DD.0077754705	H	124	4/08/16	MCN	5/30/17	417	3
3DD.0077754B3C	H	123	4/08/16	TFH[b]	7/06/17	452	3
3DD.0077757758	H	163	4/08/16	TFH[b]	7/05/17	445	3
3DD.00777577C7	H	159	4/08/16	TFH	6/24/17	435	3
3DD.007775AC37	H	152	4/08/16	BON	5/22/17	409	3
3DD.007775B4A4	H	159	4/08/16	LMO	6/07/17	425	3

Abbreviations are as follows: BON – Bonneville Dam, TDA – The Dalles Dam, MCN – McNary Dam, ICH – Ice Harbor Dam, LMO – Lower Monumental Dam, LTR – Lower Tucannon River, MTR – Middle Tucannon River, UTR – Upper Tucannon River, TFH – Tucannon Fish Hatchery, 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 during the 2015 to 2018 calendar years (Data for the 1995 to 2014 calendar years can be found in Gallinat and Kiefel 2019).

	Release Data			Adult Return Final Detection Data[a]			
PIT Tag ID	Origin	Length (mm)	Release Date	OBS	OBS Date	Travel Time	Est. Age
3DD.007775C8C1	H	128	4/08/16	TFH	8/04/17	446	3
3DD.007775D09B	H	126	4/08/16	TFH[b]	6/13/17	431	3
3DD.00777F78DD	H	161	4/08/16	LMO	5/31/17	418	3
3DD.00777FBA6E	H	154	4/08/16	LGR	6/11/17	421	3
3DD.0077800113	H	135	4/08/16	LGR	6/04/17	421	3
3DD.007780EAC4	H	135	4/08/16	LGO	6/09/17	427	3
3DD.007780F56C	H	150	4/08/16	TFH	6/21/17	439	3
3DD.007781CE48	H	140	4/08/16	TFH[b]	6/07/17	420	3
3DD.007781CF34	H	137	4/08/16	LMO[b]	6/08/17	424	3
3DD.00778D992C	H	118	4/08/16	TFH	6/20/17	435	3
3DD.00776F6554	H	120	4/08/16	TFH[b]	6/08/18	791	4
3DD.00777169D1	H	161	4/08/16	MTR	5/26/18	778	4
3DD.0077719998	H	149	4/08/16	TFH	6/27/18	781	4
3DD.007771ADFE	H	123	4/08/16	TFH	6/19/18	799	4
3DD.007771F0BE	H	138	4/08/16	BON	5/24/18	776	4
3DD.007771FE88	H	113	4/08/16	TFH	6/20/18	794	4
3DD.0077721C1E	H	126	4/08/16	TFH	6/07/18	787	4
3DD.0077722AB9	H	161	4/08/16	BON	5/27/18	779	4
3DD.007772D04C	H	171	4/08/16	TFH	6/19/18	772	4
3DD.007774B9D1	H	165	4/08/16	TFH	6/14/18	796	4
3DD.007774DA7E	H	148	4/08/16	BON	5/05/18	757	4
3DD.007774DAB6	H	154	4/08/16	MTR	5/22/18	774	4
3DD.007775295C	H	138	4/08/16	TFH[b]	6/15/18	798	4
3DD.007775463E	H	118	4/08/16	JOD	5/27/18	779	4
3DD.0077756BB3	H	118	4/08/16	TFH[b]	6/20/18	802	4
3DD.0077757EDF	H	106	4/08/16	BON	4/26/18	748	4
3DD.00777583DD	H	128	4/08/16	TFH	6/20/18	777	4
3DD.0077759EED	H	137	4/08/16	TDA	5/03/18	755	4
3DD.007775AB57	H	166	4/08/16	TFH	6/12/18	792	4
3DD.007775AB97	H	102	4/08/16	TFH[b]	6/13/18	791	4
3DD.007775ABD7	H	132	4/08/16	BON	5/19/18	771	4
3DD.007775C5A1	H	130	4/08/16	LGR	6/07/18	790	4
3DD.007775C7BD	H	142	4/08/16	JOD	5/27/18	779	4
3DD.007775E060	H	117	4/08/16	MTR[b]	6/02/18	785	4
3DD.007775E19A	H	154	4/08/16	TFH	6/16/18	791	4

Abbreviations are as follows: BON – Bonneville Dam, TDA – The Dalles Dam, MCN – McNary Dam, ICH – Ice Harbor Dam, LMO – Lower Monumental Dam, LTR – Lower Tucannon River, MTR – Middle Tucannon River, UTR – Upper Tucannon River, TFH – Tucannon Fish Hatchery, 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 during the 2015 to 2018 calendar years (Data for the 1995 to 2014 calendar years can be found in Gallinat and Kiefel 2019).

	Release Data			Adult Return Final Detection Data[a]			
PIT Tag ID	Origin	Length (mm)	Release Date	OBS	OBS Date	Travel Time	Est. Age
3DD.007775F701	H	134	4/08/16	TFH[b]	6/03/18	780	4
3DD.007780CF9E	H	118	4/08/16	BON	4/30/18	752	4
3DD.007780FEA9	H	129	4/08/16	MTR[b]	6/03/18	786	4
3DD.0077813299	H	126	4/08/16	TFH	6/07/18	789	4
3DD.00778C2417	H	158	4/08/16	TFH[b]	6/18/18	797	4
3DD.007774F3D6	H	110	4/08/16	TFH	7/18/19	1149	5
3DD.0077758E24	H	123	4/08/16	UTR	6/07/19	1155	5
3DD.0077510CED	W	103	4/23/16	TFH[b]	6/16/18	784	4
3DD.0077512587	W	100	4/25/16	BON	5/16/18	751	4
3DD.00775159BE	W	104	3/31/16	BON	5/10/18	770	4
3DD.007751E527	W	115	4/29/16	TFH	6/15/18	777	4
384.3B23A8F17E	W	119	3/01/17	MTR	6/13/19	834	4
3DD.0077B5E4B2	H	178	4/12/17	TFH[b]	6/12/18	426	3
3DD.0077B6E3B1	H	150	4/12/17	UTR	6/01/18	415	3
3DD.0077B90D27	H	154	4/12/17	LMO	5/30/18	413	3
3DD.00778C9423	H	116	4/12/17	MTR[b]	6/21/19	800	4
3DD.00778EDD6A	H	147	4/12/17	MTR	6/09/19	788	4
3DD.00778F01BD	H	164	4/12/17	UTR[b]	6/01/19	780	4
3DD.0077AE2FFB	H	115	4/12/17	MTR	6/11/19	790	4
3DD.0077B5EF67	H	130	4/12/17	MTR	6/04/19	783	4
3DD.0077B61920	H	117	4/12/17	MTR	6/26/19	805	4
3DD.0077B63DEF	H	177	4/12/17	UTR	6/01/19	780	4
3DD.0077B64FED	H	121	4/12/17	MTR	6/09/19	788	4
3DD.0077B68776	H	119	4/12/17	UTR	6/03/19	782	4
3DD.0077B697B3	H	153	4/12/17	BON	5/11/19	759	4
3DD.0077B90306	H	118	4/12/17	UTR	5/28/19	776	4
3DD.0077B92203	H	117	4/12/17	UTR	5/30/19	778	4
3DD.0077B972B0	H	148	4/12/17	TFH	6/17/19	779	4
3DD.0077A5D971	H	158	4/09/18	LTR	7/05/19	452	3
3DD.0077A637B7	H	117	4/09/18	TFH	7/12/19	441	3

Abbreviations are as follows: BON – Bonneville Dam, TDA – The Dalles Dam, MCN – McNary Dam, ICH – Ice Harbor Dam, LMO – Lower Monumental Dam, LTR – Lower Tucannon River, MTR – Middle Tucannon River, UTR – Upper Tucannon River, TFH – Tucannon Fish Hatchery, 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 (1987-2020 Release Years)

Appendix G. Historical hatchery spring Chinook releases from the Tucannon River, 1987-2020 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, 1987-2020 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, 1987-2020 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					**187,601**	**12,085[f]**			
2018	2016	C-Acc	4/09-4/27	72/01	202,952	6,079	Mixed	11,434	55
Total					**202,952**	**6,079[f]**			
2019	2017	C-Acc	4/04-5/03	73/96	140,262	3,957	Mixed	4,308	30
Total					**140,262**	**3,957[f]**			
2020	2018	Direct	3/23-3/24	74/21	185,758	6,763	Mixed	6,993	36
Total					**185,758**	**6,763[f]**			

[a] Release types are: Tucannon Hatchery Acclimation Pond (H-Acc); Portable Acclimation Pond (P-Acc); Curl Lake Acclimation Pond (C-Acc); and Direct Stream Release (Direct).
[b] All tag codes start with agency code 63.
[c] Codes listed in column are as follows: BWT - Blank Wire Tag; CB - Captive Brood; VI-Visual Implant (elastomer); LR - Left Red, RR - Right Red, LG-Left Green, RG - Right Green, LY - Left Yellow, RY - Right Yellow, LB - Left Blue, RB - Right Blue, LP – Left Purple; Oxytet. – Oxytetracycline Mark; Crosses: WxW - wild x wild progeny, HxH - hatchery x hatchery progeny, Mixed – wild x hatchery progeny.
[d] No tag loss data due to presence of both CWT and BWT in fish.
[e] VI tag only.
[f] No wire.

Appendix H: Numbers of Fish Species Captured by Month in the Tucannon River Smolt Trap during the 2019 Outmigration

Appendix H. Numbers of fish species captured by month in the Tucannon River smolt trap during the 2019 outmigration sampling period (15 October 2018 – 12 July 2019).

Species	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Total
Nat. spring Chinook	11	12	6	4	5	13	508	698	4		1,261
Hatch. spring Chinook							181	10,694	42		10,917
Fall Chinook				16	20	140	264	1,107	2,456	22	4,025
Coho salmon						11	67	206	23		307
Steelhead < 80 mm									18	3	21
Steelhead 80-124 mm	27	16	6	7	2		2				60
Steelhead ≥ 125 mm	70	95	51	64	16	8	480	1,323	31		2,138
Hat. endemic steelhead							1,631	1,222	41	1	2,895
Pacific lamprey - Ammocoetes	3	13	65	35	29	120	89	29	101	34	518
Pacific lamprey - Macropthalmia	4	5	19	13	24	74	50				189
Pacific lamprey - Adults								4	2		6
American shad				1	3						4
Smallmouth bass	2				2	2	7	13	2	20	48
Pumpkinseed sunfish	2		1			1	1				5
Bluegill									2		2
Chiselmouth	30	6	8			4	8	64	94	26	240
Longnose dace	7	3	5			4	3	38	87	16	163
Speckled dace								5	3		8
Redside shiner	3		2				9	62	97	29	202
Bridgelip sucker	22	16	35	5	3	40	48	48	37	12	266
Northern pikeminnow	1	1	1			3	2	86	62	2	158
Brown bullhead								1	1		2
Sculpin sp.									7		7

Appendix I: Proportionate Natural Influence (PNI) for the Tucannon Spring Chinook Population (1985-2019)

Appendix I. Proportionate Natural Influence (PNI)[a] for the Tucannon River spring Chinook population (1985-2019). 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	*
2017	99	19.19	249	80.32	0.19	*
2018	138	23.91	220	86.82	0.22	*
2019	85	28.24	22	63.64	0.31	*

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

Appendix J: Recoveries of Coded-Wire Tagged Salmon Released into the Tucannon River for the 1985-2015 Brood Years

Appendix J. Observed and estimated recoveries of coded-wire tagged salmon released into the Tucannon River with percent return to the Tucannon Basin, out-of-basin returns, and estimated survival and exploitation rates for the 1985-2015 brood years. (Data downloaded from RMIS database on 12/16/19.)

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.						
Treaty Troll			1	2		
Lyons Ferry Hatch.[b]	32	38	136	280	53	71
F.W. Sport			1	4		
ODFW						
Test Net, Zone 4	1	1	1	1		
Treaty Ceremonial			2	4	1	2
Three Mile, Umatilla R.						
Spawning Ground						
Fish Trap - F.W.						
F.W. Sport						
Hatchery						
CDFO						
Non-treaty Ocean Troll			1	4		
Mixed Net & Seine						
Ocean Sport						
USFWS						
Warm Springs Hatchery						
Dworshak NFH						
IDFG						
Hatchery						
Total Returns	33	39	172	379	82	203
Tucannon (%)	97.4		96.0		99.0	
Out-of-Basin (%)	0.0		0.0		0.0	
Commercial Harvest (%)	2.6		1.8		0.0	
Sport Harvest (%)	0.0		1.1		0.0	
Treaty Ceremonial (%)	0.0		1.1		1.0	
Other (%)	0.0		0.0		0.0	
Survival	0.30		0.26		0.13	

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

Appendix J (continued). Observed and estimated recoveries of coded-wire tagged salmon released into the Tucannon River with percent return to the Tucannon Basin, out-of-basin returns, and estimated survival and exploitation rates for the 1985-2015 brood years. (Data downloaded from RMIS database on 12/16/19.)

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	108	371	61	191	2	6
Kalama R., Wind R.						
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 (%)	94.8		95.3		100.0	
Out-of-Basin (%)	0.2		0.0		0.0	
Commercial Harvest (%)	0.6		1.6		0.0	
Sport Harvest (%)	0.8		0.0		0.0	
Treaty Ceremonial (%)	3.5		3.1		0.0	
Other (%)	0.0		0.0		0.0	
Survival	0.35		0.26		0.03	

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

Appendix J (continued). Observed and estimated recoveries of coded-wire tagged salmon released into the Tucannon River with percent return to the Tucannon Basin, out-of-basin returns, and estimated survival and exploitation rates for the 1985-2015 brood years. (Data downloaded from RMIS database on 12/16/19.)

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.						
Treaty Troll						
Lyons Ferry Hatch.[b]	24	24	2	2	45	47
F.W. Sport						
ODFW						
Test Net, Zone 4						
Treaty Ceremonial	1	3			1	1
Three Mile, Umatilla R.						
Spawning Ground	1	1			2	2
Fish Trap - F.W.			1	1	5	9
F.W. Sport					2	2
Hatchery						
CDFO						
Non-treaty Ocean Troll						
Mixed Net & Seine			1	2		
Ocean Sport						
USFWS						
Warm Springs Hatchery					3	3
Dworshak NFH						
IDFG						
Hatchery						
Total Returns	26	28	4	5	69	98
Tucannon (%)	85.7		40.0		82.7	
Out-of-Basin (%)	3.6		20.0		14.3	
Commercial Harvest (%)	0.0		40.0		0.0	
Sport Harvest (%)	0.0		0.0		2.0	
Treaty Ceremonial (%)	10.7		0.0		1.0	
Other (%)	0.0		0.0		0.0	
Survival	0.04		0.01		0.12	

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

Appendix J (continued). Observed and estimated recoveries of coded-wire tagged salmon released into the Tucannon River with percent return to the Tucannon Basin, out-of-basin returns, and estimated survival and exploitation rates for the 1985-2015 brood years. (Data downloaded from RMIS database on 12/16/19.)

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.						
Treaty Troll						
Lyons Ferry Hatch.[b]	66	66	21	21	94	94
F.W. Sport						
ODFW						
Test Net, Zone 4						
Treaty Ceremonial	3	3				
Three Mile, Umatilla R.						
Spawning Ground	3	3			1	1
Fish Trap - F.W.	1	1				
F.W. Sport						
Hatchery	1	1			1	1
CDFO						
Non-treaty Ocean Troll						
Mixed Net & Seine						
Ocean Sport	1	3				
USFWS						
Warm Springs Hatchery						
Dworshak NFH						
IDFG						
Hatchery						
Total Returns	117	215	24	29	132	188
Tucannon (%)	94.9		100.0		98.9	
Out-of-Basin (%)	2.3		0.0		1.1	
Commercial Harvest (%)	0.0		0.0		0.0	
Sport Harvest (%)	1.4		0.0		0.0	
Treaty Ceremonial (%)	1.4		0.0		0.0	
Other (%)	0.0		0.0		0.0	
Survival	0.16		0.02		0.30	

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

Appendix J (continued). Observed and estimated recoveries of coded-wire tagged salmon released into the Tucannon River with percent return to the Tucannon Basin, out-of-basin returns, and estimated survival and exploitation rates for the 1985-2015 brood years. (Data downloaded from RMIS database on 12/16/19.)

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	44	140	17	85	147	680
Kalama R., Wind R.						
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 (%)	98.4		76.2		77.9	
Out-of-Basin (%)	1.6		2.3		1.2	
Commercial Harvest (%)	0.0		12.8		9.0	
Sport Harvest (%)	0.0		8.7		11.4	
Treaty Ceremonial (%)	0.0		0.0		0.5	
Other (%)	0.0		0.0		0.0	
Survival	0.32		0.73		0.79	

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

Appendix J (continued). Observed and estimated recoveries of coded-wire tagged salmon released into the Tucannon River with percent return to the Tucannon Basin, out-of-basin returns, and estimated survival and exploitation rates for the 1985-2015 brood years. (Data downloaded from RMIS database on 12/16/19.)

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.						
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 J (continued). Observed and estimated recoveries of coded-wire tagged salmon released into the Tucannon River with percent return to the Tucannon Basin, out-of-basin returns, and estimated survival and exploitation rates for the 1985-2015 brood years. (Data downloaded from RMIS database on 12/16/19.)

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.						
Treaty Troll						
Lyons Ferry Hatch.[b]			58	58	21	21
F.W. Sport						
Non-treaty Ocean Troll						
ODFW						
Test Net, Zone 4						
Treaty Ceremonial						
Three Mile, Umatilla R.						
Spawning Ground						
Fish Trap - F.W.						
F.W. Sport						
Hatchery						
Columbia R. Gillnet	1	1				
Columbia R. Sport						
CDFO						
Non-treaty Ocean Troll						
Mixed Net & Seine						
Ocean Sport						
USFWS						
Warm Springs Hatchery						
Dworshak NFH						
IDFG						
Hatchery						
Total Returns	1	1	69	105	26	42
Tucannon (%)	0.0		100.0		100.0	
Out-of-Basin (%)	0.0		0.0		0.0	
Commercial Harvest (%)	100.0		0.0		0.0	
Sport Harvest (%)	0.0		0.0		0.0	
Treaty Ceremonial (%)	0.0		0.0		0.0	
Other (%)	0.0		0.0		0.0	
Survival	0.01		0.09		0.06	

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

Appendix J (continued). Observed and estimated recoveries of coded-wire tagged salmon released into the Tucannon River with percent return to the Tucannon Basin, out-of-basin returns, and estimated survival and exploitation rates for the 1985-2015 brood years. (Data downloaded from RMIS database on 12/16/19.)

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.						
Treaty Troll						
Lyons Ferry Hatch.[b]	3	3	44	44	36	36
F.W. Sport						
Non-treaty Ocean Troll						
ODFW						
Test Net, Zone 4						
Treaty Ceremonial						
Three Mile, Umatilla R.						
Spawning Ground						
Fish Trap - F.W.						
F.W. Sport						
Hatchery						
Columbia R. Gillnet					3	14
Columbia R. Sport					1	4
CDFO						
Non-treaty Ocean Troll			1	1		
Mixed Net & Seine						
Ocean Sport						
USFWS						
Warm Springs Hatchery						
Dworshak NFH						
IDFG						
Hatchery						
Total Returns	8	24	69	147	57	127
Tucannon (%)	100.0		99.3		85.8	
Out-of-Basin (%)	0.0		0.0		0.0	
Commercial Harvest (%)	0.0		0.7		11.0	
Sport Harvest (%)	0.0		0.0		3.2	
Treaty Ceremonial (%)	0.0		0.0		0.0	
Other (%)	0.0		0.0		0.0	
Survival	0.02		0.22		0.10	

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

Appendix J (continued). Observed and estimated recoveries of coded-wire tagged salmon released into the Tucannon River with percent return to the Tucannon Basin, out-of-basin returns, and estimated survival and exploitation rates for the 1985-2015 brood years. (Data downloaded from RMIS database on 12/16/19.)

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.						
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 J (continued). Observed and estimated recoveries of coded-wire tagged salmon released into the Tucannon River with percent return to the Tucannon Basin, out-of-basin returns, and estimated survival and exploitation rates for the 1985-2015 brood years. (Data downloaded from RMIS database on 12/16/19.)

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.						
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 J (continued). Observed and estimated recoveries of coded-wire tagged salmon released into the Tucannon River with percent return to the Tucannon Basin, out-of-basin returns, and estimated survival and exploitation rates for the 1985-2015 brood years. (Data downloaded from RMIS database on 12/16/19.)

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.						
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 J (continued). Observed and estimated recoveries of coded-wire tagged salmon released into the Tucannon River with percent return to the Tucannon Basin, out-of-basin returns, and estimated survival and exploitation rates for the 1985-2015 brood years. (Data downloaded from RMIS database on 12/16/19.)

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	4	88	5	125	10	115
Kalama R., Wind R.						
Treaty Troll						
Lyons Ferry Hatch.[b]	16	16	40	40	17	17
F.W. Sport						
Non-treaty Ocean Troll						
Lower Granite Trap			1	1		
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 (%)	96.3		98.2		99.2	
Out-of-Basin (%)	0.0		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 J (continued). Observed and estimated recoveries of coded-wire tagged salmon released into the Tucannon River with percent return to the Tucannon Basin, out-of-basin returns, and estimated survival and exploitation rates for the 1985-2015 brood years. (Data downloaded from RMIS database on 12/16/19.)

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	92	673	5	36
Kalama R., Wind R.						
Treaty Troll						
Lyons Ferry Hatch.[b]	22	22	27	27	2	2
F.W. Sport						
Non-treaty Ocean Troll						
Lower Granite Trap			1	1		
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	125	724	7	38
Tucannon (%)	100.0		96.7		100.0	
Out-of-Basin (%)	0.0		0.1		0.0	
Commercial Harvest (%)	0.0		3.2		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		0.32		0.14	

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

Appendix J (continued). Observed and estimated recoveries of coded-wire tagged salmon released into the Tucannon River with percent return to the Tucannon Basin, out-of-basin returns, and estimated survival and exploitation rates for the 1985-2015 brood years. (Data downloaded from RMIS database on 12/16/19.)

Brood Year	2012		2012		2013	
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	96	406	7	36	108	233
Kalama R., Wind R.						
Treaty Troll						
Lyons Ferry Hatch.[b]	56	58	3	3	85	85
F.W. Sport						
Non-treaty Ocean Troll	1	1			2	4
ODFW						
Test Net, Zone 4					1	1
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	155	467	10	39	197	324
Tucannon (%)	99.4		100.0		98.2	
Out-of-Basin (%)	0.2		0.0		0.0	
Commercial Harvest (%)	0.2		0.0		1.2	
Sport Harvest (%)	0.0		0.0		0.0	
Treaty Ceremonial (%)	0.0		0.0		0.0	
Other (%)	0.2		0.0		0.6	
Survival	0.26		0.18		0.18	

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

Appendix J (continued). Observed and estimated recoveries of coded-wire tagged salmon released into the Tucannon River with percent return to the Tucannon Basin, out-of-basin returns, and estimated survival and exploitation rates for the 1985-2015 brood years. (Data downloaded from RMIS database on 12/16/19.)

Brood Year	2013		2014[c]		2015[c]	
Smolts Released	20,373		216,295		187,601	
Fish Size (g)	37		40		40	
CWT Codes[a]	67/43		68/84		70/39	
Release Year	2015		2016		2017	
Agency (fishery/location)	Observed Number	Estimated Number	Observed Number	Estimated Number	Observed Number	Estimated Number
WDFW						
Tucannon River	15	20	155	304	8	36
Kalama R., Wind R.						
Treaty Troll						
Lyons Ferry Hatch.[b]	6	6	139	140		
F.W. Sport						
Non-treaty Ocean Troll						
ODFW						
Test Net, Zone 4						
Treaty Ceremonial						
Three Mile, Umatilla R.						
Spawning Ground						
Fish Trap - F.W.					1	1
F.W. Sport						
Hatchery						
Columbia R. Gillnet	1	5	1	1		
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		
Total Returns	22	31	296	446	9	37
Tucannon (%)	83.9		99.6		97.3	
Out-of-Basin (%)	0.0		0.0		2.7	
Commercial Harvest (%)	16.1		0.2		0.0	
Sport Harvest (%)	0.0		0.0		0.0	
Treaty Ceremonial (%)	0.0		0.0		0.0	
Other (%)	0.0		0.2		0.0	
Survival	0.15		0.21		0.02	

[a] WDFW agency code prefix is 63.
[b] Fish trapped at TFH and held at LFH for spawning.
[c] Data for the 2015 brood year is incomplete.