

**Washington Department of Fish and Wildlife
Puget Sound Treaty Indian Tribes**

Puget Sound Chinook Comprehensive Harvest Management Plan

Annual Report
The 2018-2019 Fishing Season

October 2019

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Puget Sound Treaty Tribes:

Pete Kairis and Casey Ruff (Skagit River System Cooperative); Breena Apgar-Kurtz, Ben Starkhouse, Donald Kruse, and Tom Chance (Lummi Nation); Ned Currence and Treva Coe (Nooksack Tribe); Bob McClure (Upper Skagit Tribe); Mike Mahovich, Jason Shaffler, and Eric Warner (Muckleshoot Tribe); Abby Welch (Port Gamble S'Klallam Tribe); Aaron Brooks (Jamestown S'Klallam Tribe); Lyle Almond (Lower Elwha Klallam Tribe); Cindy Gray (Skokomish Tribe); Diego Holmgren (Tulalip Tribes); Jon Oleyar and Andy Rankis (Suquamish Tribe); Chris Phinney (Puyallup Tribe); Joe Peters (Squaxin Island Tribe); and Craig Smith and Walker Duval (Nisqually Tribe).

Northwest Indian Fisheries Commission:

Bill Patton, Amy Seiders, and Chris James.

Washington Department of Fish and Wildlife:

Aaron Dufault, Mark Downen, Randy Cooper, Brett Barkdull, Andrew Fowler, Kurt Perry, Pete Verhey, Jennifer Whitney, Julie Klacan, Aaron Bosworth, James Losee, Tara Livingood-Schott, Gabe Madel, Nathanael Overman, Kendall Henry, and Derek Dapp.

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Executive Summary

This annual report on the Puget Sound Chinook Comprehensive Harvest Management Plan summarizes harvest information about commercial salmon fisheries occurring between May 1, 2018 and April 30, 2019, and Chinook spawning escapement in 2018. It also includes harvest information relevant to the 2017-2018 non-treaty sport fishing season and a review of the coded wire tag sampling rates in fisheries during calendar year (January-December) 2017.

Commercial Chinook catch in Puget Sound pre-terminal fisheries was substantially lower than projected pre-season. Commercial catches in some terminal areas were above expectations, primarily in fisheries targeting higher than anticipated terminal hatchery runs (i.e. Bernie Kai-Kai, Gorst Creek, and Hoodport Hatcheries).

Marine and freshwater landed recreational Chinook catch, based on catch record cards, in the 2017-2018 season was estimated at 56,758 and was 36% higher than the pre-season projection of 41,763. Creel survey-based estimates of catch in 2018-2019 mark-selective recreational fisheries in Areas 5, 7, 9, 10, and 11 are included in this report. Total encounter estimates for the 2018-19 summer marine area selective fisheries are presented and compared to pre-season projections for these areas.

Escapement for summer/fall populations varied between management units with greater than projected escapement for some management units (Snohomish, Green, Puyallup, and Skokomish R. falls) while others were below preseason projections (Skagit R summer/falls, Stillaguamish R. summer/falls, Cedar R fall, Nisqually, and Mid Hood Canal).

Coded-wire tag sampling rates for calendar year 2017 commercial fisheries exceeded 20% in most areas except for Tulalip Bay, MCA 13, Hood Canal terminal areas, and Strait of JDF troll fishery. Sampling rates for marine recreational fisheries exceeded the 10% objectives in all areas except marine areas 12 and 13.

1 Introduction

The Puget Sound Chinook Harvest Management Plan mandates annual reporting of the performance of Chinook harvest management relative to the standards and guidelines of the plan (PSIT and WDFW 2010). This report partially fulfills that requirement and that of the Terms and Conditions in the 2018 Harvest Biological Opinion (F/WCR-2018-9134) by assessing the performance and effectiveness of treaty and non-treaty commercial fishery management actions adopted for the most recent management year, May 2018 through April 2019. Included in this report are:

- Management objectives for the 2018-2019 management year (May 1, 2018 through April 30, 2019)
- Projected and actual commercial landed catch in Puget Sound and descriptions of fisheries for the 2018-2019 management year
- Projected and actual landed catch for 2018 Puget Sound recreational fisheries where creel surveys were conducted and for all 2017 Puget Sound recreational sport fisheries
- Estimates of total encounters for mark-selective fisheries and non-landed mortality for commercial fisheries with Chinook non-retention where data are available.
- Projected and actual spawning escapement for all Puget Sound Chinook populations in 2018 with details on estimation methods and surveys.
- Summaries of biological sampling of spawning escapement, and estimates of contributions of hatchery- and natural-origin spawners where available.
- Coded-wire tag sampling rates for commercial and recreational fisheries in calendar year 2017 (January to December, 2017).

1.1 Management Objectives

General management objectives for Puget Sound Chinook populations, including Exploitation Rate Ceilings (ERCs), Critical Exploitation Rate Ceilings (CERC's), Upper Management Thresholds (UMTs), and Low Abundance Thresholds (LATs) were implemented in 2018 (Table 1-1). The final pre-season FRAM model run (Chin3218) highlighted the rates that were used as the ceilings for each Management Unit (MU) in 2018, and the projected exploitation rates and escapements for each unit (Table 1-2).

Pre-season fishery planning for 2018-2019 fisheries projected that natural spawning escapement would fall below the Low Abundance Thresholds (LAT) for the Nooksack early and Mid-Hood Canal MUs, so CERC's were implemented for those units. Escapement projections for other MUs exceeded their LAT's.

Table 1-1. 2018 Puget Sound Chinook Harvest Management Objectives.

Management Unit	ER Ceiling	Critical ER Ceiling	Low Abundance Threshold
Nooksack			
North Fork		10.5% SUS	1,000
South Fork			1,000
Skagit summer / fall	47%	15% SUS	6,500
Upper Skagit summer			2,200
Sauk summer			400
Lower Skagit fall			900
Skagit spring	38%	18% SUS	690
Upper Sauk			130
Cascade			170
Suiattle			170
Stillaguamish	24% Total/13% SUS Max.	8% SUS Max.	1,200 ^a
Snohomish	21%	15% SUS	3,375
Skykomish			2,092
Snoqualmie			700
Lake Washington	13% PT SUS	12% SUS	
Cedar River			200
Green	13% PTSUS	12% SUS	805
White River spring	22% SUS	15% SUS	400
Puyallup fall	50%	15% SUS	319
Nisqually	47%	50% Reduction of SUS ER	7,000
Skokomish	48%	12% PTSUS	1,300 aggregate; 800 natural
Mid-Hood Canal	15% PTSUS	12% PTSUS	400
Dungeness	10% SUS	6% SUS	500
Elwha	10% SUS	6% SUS	1,500
Western SJDF	10% SUS	6% SUS	500

^a Stillaguamish LAT is terminal runsize and does not account for terminal fishery impacts.

Table 1-2. Management guidelines implemented and projected exploitation rates and escapements for Puget Sound Chinook Management Units for 2018 – 2019 pre-season planning (FRAM Chin3218).

Management Unit	ERC or CERC implemented	Projected ER	Projected Escapement
Nooksack	10.5% SUS	10.5% SUS	201
Skagit summer fall	47%	37.2%	12,219
Skagit spring	38%	28.4%	1,967
Stillaguamish	24%Tota/13% SUS	20.8%Total/ 12.2% SUS	1,551 ^a
Snohomish	21% Total	19.1%	3,382
L. Washington (Cedar)	13% PT SUS	12% PT SUS	1,722
Green	13% PT SUS	12% PT SUS	5,079
White	22% SUS	18.9% SUS	1,945
Puyallup	50%	49.9%	1,713
Nisqually	47%	47.0%	16,576
Skokomish	48%	47.9%	2,432
Mid Hood Canal	12% PT SUS	12% PT SUS	365
Dungeness	10% SUS	3.3% SUS	810
Elwha	10% SUS	4.0% SUS	4,599
Western SJDF	10% SUS	2.2% SUS	1,295

^a Stillaguamish LAT is forecasted terminal runsize and does not account for terminal fishery impacts.

2 Commercial Harvest

This chapter provides post-season estimates of Chinook catch for Puget Sound commercial fisheries, catch from tribal ceremonial and subsistence (C&S) fisheries, and test or research fisheries. Catch is projected pre-season through modeling of the fishery regime, which is developed and agreed upon in the Pacific Fisheries Management Council (PFMC) and North of Cape Falcon (NOF) forums, using the Fishery Regulation Assessment Model (FRAM). The 2018–19 List of Agreed Fisheries (<http://s3.amazonaws.com/nwifc-fisherinesservices/wp/wp-content/uploads/20180703102637/2018-19-LOAF-w-errata.pdf>) describes all salmon fisheries for all areas of Puget Sound and ocean fisheries off the Washington coast. The final pre-season projections of catch under this regime were made in FRAM run number Chin3218.

Commercial, ceremonial and subsistence, and test fishery catch is accounted for on fish tickets, i.e., receipts from transactions between fishers and buyers. Fish ticket data are stored in joint databases maintained by WDFW and the Puget Sound Tribes. In some commercial fisheries with Chinook non-retention, particularly non-treaty purse seine fisheries, estimates of non-landed mortality are also available for comparison to pre-season expectations (Table 2-8 and Table 2-9). WDFW conducts on-the-water observations of by-catch in commercial fisheries, concentrating on areas and gears where Chinook retention is not allowed.

Non-treaty troll, treaty troll, and recreational catches in Washington coastal fisheries north of Cape Falcon were less than their expected quotas (Table 2-1). Comparisons of projected and actual Puget Sound catch are provided for two pre-terminal areas (Strait of Juan de Fuca and San Juan Islands), and six regional terminal fisheries

(Nooksack/Samish, Skagit, Stillaguamish/Snohomish, South Puget Sound, Hood Canal, and Strait of Juan de Fuca). General information is presented for the 2018–19 fisheries, including in-season management actions that deviated from the pre-season plan, and explanations for differences in projected and actual catch.

Table 2-1. Projected and actual Chinook catch in waters of the Washington coast and Puget Sound fisheries in 2018.

Fishery	Projected	Actual
Washington ocean non-treaty troll	27,500	23,889
Washington ocean recreational	27,500	11,821
Washington ocean treaty troll	40,000	23,903
Puget Sound pre-terminal net & troll total		
Strait of Juan de Fuca troll	4,035	1,946
Strait of Juan de Fuca net	508	2,144
PSC Test Fishery		43
San Juan Islands net ^a	7,974	4,459
Nooksack-Samish terminal net	17,302	10,631
Skagit terminal net	3,740	2,640
Stillaguamish-Snohomish net	5,699	9,868
South Puget Sound terminal net	41,757	44,574
Hood Canal terminal net	43,568	43,707
Strait Tributaries terminal net	5	0

^a includes non-retention mortality in NT purse seine fishery.

2.1 Strait of Juan de Fuca and San Juan Islands

Treaty net fisheries in the Strait of Juan de Fuca and the San Juan Islands caught 2,144 and 3,346 Chinook, respectively. Catch in the Strait of Juan de Fuca and San Juan Islands areas occurred mostly during the Fraser Sockeye directed fishery in the summer, primarily in August 2018.

Non-treaty fisheries targeting Fraser sockeye in Areas 7 and 7A landed 4 Chinook. Because purse seines are required to release all Chinook, release mortality estimates are calculated using available data from on-water by-catch monitoring. Post-season analysis estimated 1,086 Chinook mortalities in the sockeye fishery and 63 Chinook in the Chum fishery.

The PSC Fraser sockeye Test Fishery in Area 5 caught 43 chinook during July 2018.

The Treaty troll fishery in the Strait of Juan de Fuca (SJD), exclusive of catch in Area 4B when it was managed under PFMC quotas, caught 1,946 Chinook. Eight-hundred three Chinook were caught during the summer SJD troll fishery while 1,143 were caught during the winter SJD troll fishery.

2.2 Nooksack/Samish Terminal Area

Treaty Spring Chinook Ceremonial and Subsistence Fishery

The Lummi Nation conducted fishing with tangle-net gear on 22 days from April 6 to June 29, 2018. Total landed catch was 394 hatchery-origin Chinook with an additional 17 natural-origin and 61 Skookum Creek hatchery-origin Chinook released. Genetic results for the released NORs indicated two of the NORs were assigned to South Fork origin, 14 were North Fork origin NORs, and one fall-run origin NOR. Applying the expected release mortality rate of 30% to the 16 early-run NOR encounters results in five NOR estimated mortalities and 18 Skookum Creek hatchery-origin release mortalities. The total encounter rate of NORs (n=17) was lower than the pre-season projection of 35 fish.

In 2018, the Nooksack Tribe conducted a permit only, subsistence fishery on May 8th, 18th, 21st, 24th, and June 1st, 2019^h. A total of 72 Chinook were caught in the traditional C&S fisheries and all were sampled. Sixty-seven of the 72 chinook were clipped indicating Kendall hatchery origin. Otolith results confirm that of the remaining five fish, two were natural origin with the remaining three fish most likely hatchery-origin fish but are awaiting additional laboratory analysis of biological samples to confirm origin. Genetic results for all NORs are still pending.

The Tribes 2018 total NOR mortality is estimated to be seven early-run NORs, pending additional analysis of remaining biological samples.

Table 2-2. Expected and observed Chinook catches in the Nooksack/Samish terminal area, 2018.

Area	Management Period	Projected	Actual
7B, 7C, 7D, Treaty net ¹	Chinook, coho, chum	9,891	5,468
7B, 7C Non-treaty net	Chinook, coho, chum	4,050	3,691
Nooksack River Treaty net	Early Chinook, May-Jun	1,167	489
	Fall Chinook, Aug-Oct	2,194	983

¹ Includes 7A on-reservation catch during coho management.

Fall Chinook, Coho, and Chum Fisheries

The tribal fall Chinook fishery in Bellingham Bay (Area 7B), and Lummi Bay (7D) operated as planned from August 1st through September 7th and in Samish Bay (7C) from August 1st through September 14th, with a catch of 4,030 Chinook. The coho fishery operated as planned from September 9th through October 20th, with an incidental harvest of 1,419 Chinook. During the 7A on-reservation Coho fishery from September 9th through October 3rd, 19 Chinook were incidentally harvested. No Chinook were harvested incidentally during the chum fishery. The total fall Chinook catch of 5,468 for Areas 7B, 7C and 7D was less than the preseason projection of 9,891 (Table 2-2).

The non-treaty fishery in Area 7B and 7C landed 3,691 Chinook from July through September, lower than the pre-season projection of 4,031. Nineteen Chinook were forecasted to be landed during the chum fishery, with zero landed.

Fisheries for fall Chinook, coho, and chum in the Nooksack River occurred as planned from August 1 – September 8, Sept. 9 – October 20, and October 21 – December 12, respectively. The total Chinook catch was 983, less than the projected catch of 2,194 fish; 179 were caught

during the Chinook period and 804 during the coho fishery. No Chinook were harvested during the chum period.

2.3 Skagit Bay/Skagit River Terminal Areas

Skagit Terminal Area Treaty Fisheries – 2018

Spring Chinook Fisheries: Treaty commercial fisheries in the Skagit terminal area directed at hatchery spring Chinook were conducted in 2018 as scheduled preseason, with some adjustments in timing. Incidental catch of spring Chinook also occurred during week 26 and 27 of the directed sockeye fishery, as Skagit River sub-areas 78D-2, 78D-3, 78D-4 were still in the spring management period during some or all of that time. A total of 172 wild and 1,164 hatchery spring Chinook were caught in these fisheries, compared to 286 wild and 856 hatchery spring Chinook expected pre-season based on Chinook FRAM 3218. An additional 18 hatchery spring Chinook were harvested for ceremonial purposes, compared to 30 wild and 45 hatchery expected.

Summer/Fall Chinook Fisheries: No treaty commercial fisheries directed at summer/fall Chinook were scheduled in the Skagit terminal area for 2018. However, as anticipated, incidental catch of summer/fall Chinook occurred in the sockeye and coho fisheries. The sockeye and coho fisheries were adjusted from the preseason schedule as noted in Table 2-3 due to in-season management needs and intertribal sharing agreements. Total summer/fall Chinook mortality in these fisheries was 639 fish, compared to the pre-season expectation of 1,220 based on Chinook FRAM 3218. An additional 214 summer/fall Chinook were harvested for ceremonial purposes, which was less than the pre-season modeled value of 700.

Terminal Area Test Fisheries: A suite of Skagit terminal area test fisheries targeting steelhead, Chinook, sockeye, coho, and chum were conducted by the Skagit tribes in 2018. Some weeks of these fisheries were adjusted or cancelled, as noted in Table 2-3, in response to weather, flow concerns, or staffing issues. A total of 20 wild spring Chinook, 21 hatchery spring Chinook, and 392 summer/fall Chinook mortalities occurred in these fisheries. The pre-season expectation of mortalities in the test fisheries was 52 wild spring Chinook, 44 hatchery spring Chinook, and 516 summer/fall Chinook.

Summary: Overall, a total of 192 wild spring Chinook, 1,203 hatchery spring Chinook, and 1,245 summer/fall Chinook were killed in treaty commercial, C&S, and test fisheries. The preseason expectation based on FRAM Chin3218 was 368 wild springs, 945 hatchery springs, and 2,436 summer/falls.

Table 2-3. Skagit terminal area projected and actual Chinook catches for treaty fisheries in 2018. Weekly projections were made by plugging the FRAM Chin3218 run sizes into the Skagit weekly harvest rate model, so totals may differ slightly from FRAM.

Fishery	Preseason Projected			Post-season Observed/Estimated			Difference	
	Schedule	Encounters	Mortality	Schedule	Encounters	Mortality	Encounters	Mortality
Test:								
Chinook	1 site, wks 19-35	182	182	No week 19,24,26,27	122	122	-60	-60
Sockeye	2 sites: Area 3 wks 23-30, Blakes wks 24-29	87	87	Area 3 Same; No Blakes weeks 24,27,28	45	45	-42	-42
Coho	3 sites: Blakes wks 38 - 42, Area 3 wks 34-42, Spudhouse wks 35-44	340	340	Blakes no wk 45 but wks 34-37 and 43-44 added; Area 3 no wks 34,40,41; Spudhouse no wks 40,43,44 but added wk 34	266	266	-74	-74
Chum	3 sites, wks 44-45	0	0	No Jetty/Blakes wk 45, No Bay wks 44-45	0	0	0	0
Steelhead	2 sites, wks 8-17	10	2	2 sites, wks 8-17	1	0	-9	-2
Area 8/78C Spring Chinook Fishery Swinomish and Sauk-Suiattle Tribes:								
Week 19	3 days	130	130	None	0	0	-130	-130
Week 20	3 days	173	173	1.292 days	268	268	95	95
Week 21	3 days	129	129	2 days	194	194	65	65
Week 22	None	0	0	2 days	128	128	128	128
Area 78C/78D Spring Chinook Fishery Upper Skagit Tribe:								
Week 19	0.833 day	163	163	1 day	348	348	185	185
Week 20	0.833 day	260	260	1 day	256	256	-4	-4
Week 21	0.833 day	208	208	None	0	0	-208	-208
Area 8/78C/78D Chinook C&S Fishery Swinomish, Sauk-Suiattle, Upper Skagit Tribes:								
Sum/Fall-Spring Chin.	As needed	775	775	As needed	232	232	-543	-543
Areas 8/78C Sockeye Fishery Swinomish and Sauk-Suiattle Tribes:								
Week 26	3 days	40	40	3 days	45	45	5	5
Week 27	5 days	58	58	4.167 days	73	73	15	15
Week 28	5 days	109	109	3.333 days	58	58	-51	-51
Week 29	5 days	270	270	None	0	0	-270	-270
Area 78D/78O Sockeye Fishery Swinomish Tribe:								
Week 29	1 day	4	4	None	0	0	-4	-4

		Preseason Projected		Post-season Observed/Estimated			Difference	
Areas 78C/78D/78O Sockeye Fishery Upper Skagit Tribe (wks 27-30 Chinook non-retention):								
Week 26	.833 day	77	77	1.229 day	124	124	47	47
Week 27	0.542 day	23	23	1.229 day	50	50	27	27
Week 28	0.542 day	31	31	None	0	0	-31	-31
Week 29	0.542 day	36	36	None	0	0	-36	-36
Areas 8/78C Coho Fishery Swinomish and Sauk-Suiattle Tribes:								
Week 37	1 day	69	69	1 day	96	96	27	27
Week 38	1 day	87	87	1 day	41	41	-46	-46
Week 39	2 days	41	41	2 days	41	41	0	0
Week 40	2 days	15	15	None	0	0	-15	-15
Week 41	1 day	2	2	3.667 days	1	1	-1	-1
Week 42	1 day	3	3	3.667 days	0	0	-3	-3
Areas 78C/78D Coho Fishery Upper Skagit Tribe:								
Week 39	1 day	187	187	None	0	0	-187	-187
Week 40	1 day	181	181	1.417 days	164	164	-17	-17
Week 41	0.833 day	69	69	1 day	78	78	9	9
Week 42	None	0	0	Same	0	0	0	0
Week 43	None	0	0	1 day	10	10	10	10
Areas 8/78C Chum Fishery Swinomish and Sauk-Suiattle Tribes:								
None	None	0	0	None	0	0	0	0
Total Skagit Terminal Area:		3,759	3,751		2,641	2,640	-1,118	-1,111

2.4 Stillaguamish/Snohomish Terminal Area

The tribal net fishery in Area 8A was open for the 2018/2019 fishing season for C&S fishing and a one-month commercial coho fishery. One Chinook salmon was anticipated to be caught during the coho fishery, and 37 Chinook were harvested in the first two weeks of the fishery. Thirty-two Chinook, of the 100 set aside, were harvested for C&S purposes (Table 2-4). Non-treaty commercial fishing in Area 8A was closed after less than one week due to higher than anticipated encounters of Chinook.

Tribal Chinook catch in Area 8D occurred from May through late-September, with most of the catch occurring during June. Total 8D catch was 9,766, including 95 for ceremonial or subsistence purposes (Table 2-4). Chinook catch was greater than projected in area 8D, however this terminal fishery primarily harvests hatchery fish.

Non-treaty Chinook catch in Area 8D was zero Chinook during the Coho fishery.

The Stillaguamish Tribes harvested 19 Chinook for ceremonial and subsistence purposes from the Stillaguamish River in 2018, and one Chinook incidentally harvested during the Coho fishery (Table 2-4).

Table 2-4. Projected (FRAM Chin3218) and actual Chinook net fishery harvest in the Stillaguamish - Snohomish terminal area in 2018.

Area		Projected	Actual
8A Commercial	Treaty	1	37
	Treaty C&S	Up to 100	32
	Ntrty	2	13*
8A Test		0	0
8D Commercial	Treaty	5,490	9,671
	Treaty C&S		95
	Ntrty	1	0
Stillaguamish R. Net	Treaty C&S	105	20

*No landed chinook, composed entirely of release mortalities

2.5 South Puget Sound Terminal Areas

Table 2-5. Projected and actual Chinook catch in 2018 South Puget Sound net fisheries.

Area	Management Period	Projected	Actual
Area 9/10/11	Coho (A10 - Test)	21	0
	Chum (A9 - Test)	225	38
	A9 (Trty. C&S + chum)	511	18
	Trty coho/chum (A10/11)	99	9
	NT chum (A10/11)	203 ^b	53 ^b
Area 10E	Treaty Chinook/coho/chum	5,968	7,150
Area 10A	Chinook (test/C&S)	511	175
	Chinook/Coho/chum	1,249	424
Duwamish River	Chinook/Coho/chum	6,675	10,469
	Coho (Test/C&S)		36
L Washington/Ship Canal	Sockeye/coho/ C&S	550	153
	Test/Research	N/A	--
Lake Sammamish	Chinook	0	0
Puyallup River	Spring/Fall C&S	794	358
	Chinook/Coho	3,754	6,225
White River	Spring C&S	-- ^c	560
Areas 13, 13D-K	Chinook/Coho/Chum	6,350	7,812
Area 13A	Chinook/Coho/Chum	5,140	2,182
Areas 13C/Chambers	Chinook	1,148	135
Nisqually River	Chinook/coho	8,568	8,298
McCallister Cr.	Chinook		479

^a Fishery was non-retention for chinook and values reported as release mortalities

^b Values include landed catch and release mortalities

^c White River C&S Projected harvest is incorporated in the Puyallup River Spring/Fall C&S catch of 455 fish.

Marine Areas 9, 10 & 11

The coho test fishery in area 10 was not implemented in 2018. The chum test fishery at Apple Cove Point (Area 9) incidentally caught a total of 38 Chinook (Table 2-5), well below the estimated 225.

The non-treaty chum-directed fishery in Area 10 and 11 incidentally harvested 22 Chinook along with 31 estimated release mortalities. The treaty coho fishery in Area 10 harvested nine Chinook, while harvesting zero Chinook during the chum fishery. Fisheries directed at Chinook and coho in Area 10E harvested 7,150 Chinook (Table 2-5). No Chinook were harvested during the chum fishery in area 10E.

Eighteen Chinook were harvested in Area 9 for C&S purposes, while no Chinook were harvested during the chum fishery.

Lake Washington

There were no Chinook directed fisheries in Lake Washington, the Ship Canal, or North Lake Washington. Sockeye returns to Lake Washington were insufficient to allow any directed fisheries. The Suquamish tribe conducted C&S fisheries in the Lake Ship Canal targeting sockeye, with a total by-catch of 20 Chinook. Neither, the Muckleshoot Tribe nor Suquamish Tribe conducted any C&S fishery on Chinook in the ship canal (fish ladder). Incidental Chinook catch during the coho fishery in Lake Union, and the upper and lower Ship Canal harvested 132 Chinook, which was less than expected. The Muckleshoot Tribe conducted a coho directed commercial fishery in North Lake Washington with a total by-catch of one Chinook. There were no coho directed fisheries in Lake Sammamish.

Elliott Bay/Duwamish River

The Muckleshoot Tribe harvested 20 Chinook as C&S in the Duwamish River in 2018. The Chinook test fishery in Area 10A harvested 175 Chinook in 2018. A Chinook-directed commercial fishery occurred in Area 10A and the Duwamish River, harvesting 378 and 9,259 Chinook salmon, respectively. In 10A, there were 46 Chinook caught in September during the coho directed fishery. In the Duwamish River, 16 Chinook were caught during the coho test fishery to determine Chinook clearance. During the coho directed fishery in the Duwamish River, 1,208 Chinook were caught incidentally and none during the chum fishery.

Puyallup River and White Rivers

Ceremonial and subsistence fisheries in the Puyallup River caught 349 adult Chinook salmon along with nine jacks during management weeks 20 – 28. Based on fisheries sampling data, approximately 53 of the adult and none of the jacks are assumed to be fall-run based on ad-clip marks. The Muckleshoot Tribe had an additional C&S fishery in the White River which caught 560 Chinook. The pre-season projected C&S catch was 794.

Fall Chinook catch was 3,667 during the Chinook fishery. The coho fishery occurred from management week 36 (September 2nd) to management week 42 (October 14th) and incidentally harvested 2,558 Chinook salmon, mostly during early September. Except for the estimated 53 fall Chinook captured during the spring Chinook C&S fishery, no directed fall Chinook C&S fisheries occurred (Table 2-5).

Marine area 13 & sub areas (Deep South Sound)

The Chinook fishery in Carr Inlet (13A) caught 2,180 Chinook (Table 2-5), in August and early September (weeks 32 – 36). Pre-season projected catch was 5,075. This fishery targets Minter Creek Hatchery Chinook returns where no natural origin fish are returning to spawn. The coho fishery in 13A incidentally harvested two Chinook in late-September, with a preseason expectation of 65.

The Chinook fishery at Chambers Bay (13C) occurred between July 29 through October 13 with 135 Chinook harvested (Table 2-5). The preseason catch projection was 1,148.

Chinook directed fisheries in 13D and Budd Inlet (13F) occurred from early-August through early-September; total catch was 7,132. Chinook caught incidentally during the coho fishery in (Week 37-44) 13D totaled 680 fish. Zero Chinook were caught during the Fox Island (Area 13) coho fishery. The total preseason catch projection for both areas was 6,350.

Nisqually River

The treaty commercial fishery in the Nisqually River harvested an estimated 8,298 Chinook, excluding jacks, but including fish for Ceremonial and Subsistence purposes, with a pre-season projected commercial catch, excluding jacks, of 8,568 (Table 2-5).

2.6 Hood Canal

Tribal Chinook directed fishing in 12C occurred as planned from July 22 thru August 31 (weeks 30 – 35) with a catch of 5,853. Three Chinook were landed in 12C in early-October during the coho directed fishery. In marine catch area 12B, one Chinook was harvested during the tribal coho directed fishery and one Chinook during the chum directed fishery. Catch exceeded pre-season expectations despite the returns consistent with expected levels for the Skokomish River.

Chinook harvest in the Hoodsport Hatchery Zone (12H) was 17,838 and occurred as planned from July 9 through September 13. Catch was less than the preseason expectation of 19,983.

Chinook harvest in the Skokomish River occurred as planned from August 6 through August 30 landing 9,971 fish with one additional Chinook caught during the first week of October in the Coho fishery. Chinook harvest also occurred in Purdy Creek (tributary of Skokomish River that feeds the George Adams Hatchery) to access Chinook returning to George Adams Hatchery each Saturday from July 7 through August 18 landing 1,666 fish.

In Port Gamble (Area 9A), 60 Chinook were harvested, primarily in mid-August to mid-September during coho fisheries.

Non-treaty commercial fisheries in the Hoodsport Zone (12C) harvested 9,978 Chinook salmon (Table 2-6). There were no Chinook landed in other non-treaty fisheries in Hood Canal in 2018 (Table 2-6 and Table 2-9).

Table 2-6. Pre-season projected and observed catch of Chinook in Hood Canal terminal area net fisheries in 2018.

Area	Target Species	Projected	Actual
(12, 12B-12D, 9A) (T)	Chin, coho, chum	5,045	5,918
(12-12C, 9A) (NT)	chum, coho	71	0 ^a
12A Net (T)	Coho	76	1
12H Net (T)	Chinook, chum	19,983	17,838
12C Hoodsport Zone Net (NT)	Chinook, chum	10,000	9,978
Skokomish River (82G) (T)	Chin, coho, chum	8,483	9,972
(82J) (T)	Chinook		1,666
	Total	43,568	43,707 ^b

^a Values reported are release mortalities.

^b Total does not include catch from area 82J.

2.7 Strait of Juan de Fuca

Due to the continued depressed status of Chinook populations, terminal fisheries in the Elwha River and Dungeness River were closed or provided very limited fishing opportunity, with no Chinook harvested in either terminal area in 2018.

Table 2-7. Projected and actual catches of Chinook in Strait of Juan de Fuca terminal net fisheries in 2018.

Terminal Area	Projected	Actual
Area 6D & Dungeness River Treaty	0	0
Area 6D Non-Treaty	1	0
Elwha River Treaty (C&S)	4	0
Hoko River Treaty	0	0

^a NT fisheries were non-retention for Chinook and values are reported as release mortalities.

2.8 Non-Treaty Commercial Monitoring and Total Mortality

Because non-treaty vessels are required to release non-target species in many fisheries, WDFW conducts on-water monitoring to provide data on encounters of non-target species. Summaries of observer data for 2018 are presented in Table 2-8. Expanded estimates of total mortality, where available, were presented above in the summaries for individual fisheries, and are summarized and compared to pre-season expectations below in Table 2-9.

Table 2-8. Commercial fishery observation data for 2018 Puget Sound non-treaty salmon net fisheries.

Area	Gear type	# sets observed	Chinook	Coho	Sockeye	Pink	Chum	Steelhead
7	PS	42	86	28	18,311	4	168	1
7A	PS	41	73	53	3,115	1	328	0
8A	PS	16	40	308	1	0	2	0
10	PS	24	2	6	0	0	1,883	0
11	PS	26	1	0	0	0	3,566	0
12	PS	11	0	12	0	0	877	0
12B	PS	35	0	100	0	0	8,260	0
7	GN	10	0	0	117	1	25	1
7A	GN	21	2	1	949	2	9	0
12	GN	4	0	0	0	0	188	0
12B	GN	2	0	0	0	0	60	0

Table 2-9. Total pre-season projected and post-season estimated Chinook mortality (landed + released) in Puget Sound non-treaty commercial salmon fisheries in 2018.

Area	Total Mortality	
	Projected	Actual
6D	1	0
7/7A	3,123	1,149
8	N/A	Closed
8A	2	13
10/11	326	53
12/12B	67	0
12C Hoodspout	10,000	9,978
9A/12A	8	0

3 Recreational Harvest

This chapter summarizes expected recreational catch in Puget Sound marine waters and freshwater tributaries for the 2018-2019 management year, and presents catch estimates available from creel studies for that period. Due to the cycle of recovery and analysis of Catch Record Cards (CRCs) used by recreational anglers, complete catch estimates for all areas are not yet available. Since complete catch estimates were not available for all areas in the annual report covering the previous management cycle, projected and actual recreational catches for the 2017-2018 management year are also included here.

3.1 2017-2018 Recreational Catch

Total Recreational Chinook harvest in 2017-2018, estimated from preliminary Catch Record Card (CRC) data and creel estimates where available, was 56,758, compared to a preseason projection of 41,763. The CRC estimates are preliminary and subject to revision. Projected and actual catches for individual fisheries are shown in Table 3-1. Updated estimates of total mortality in mark-selective fisheries, for those fisheries where estimates are available, are presented in final reports available at <https://wdfw.wa.gov/publications>.

Table 3-1. Projected (FRAM 2017) and actual (preliminary, where available) Chinook catches in Puget Sound recreational fisheries during the 2017-2018 season.

Area/Fishery	Projected	Actual
Area 5-6		
Area 5 Summer MSF	4,427	2,316
Area 5 Winter MSF	365	342
Area 6 Summer MSF	3,445	4,335
Area 6 Winter MSF	871	1,118
Other		
Strait Tributaries		
Area 7		
Non MSF	950	3,637
MSF (December-April)	3,512	2,227
Nooksack/Samish FW	3,276	7,406
Area 8-1 & 8-2		
MSF	966	1,135
Skagit River		
Spring MSF	328	260
Area 8D SAF	219	269
Stillaguamish River	0	0
Snohomish River		
Skyokomish MSF	556	500
Area 9		
Summer MSF	5,599	5,458
Winter MSF	2,625	2,884
Area 10		
Summer MSF	2,166	2,226
Winter MSF	415	317
Area 11		
Summer MSF	5,325	3,597
Winter MSF	350	997
Area 10E SAF ¹	104	200
Lake Sammamish	21	0
Area 10A SAF	414	626
Green River	234	295
Puyallup River		
Carbon R MSF	138	392
Puyallup R MSF	597	921
Area 13		
Summer MSF	952	3,805
Winter MSF	50	219*
Chambers Cr	57	0
Nisqually	2,440	8,473
Deschutes	103	10
Area 12		
Summer MSF	1,013	2,459
Winter MSF	246	334*
Skokomish River	0	NA

* All CRC estimates of catch through 3/31/2018

¹ 10E SAF catch could not be estimated using traditional methods. Using 2016 as a conservative surrogate for 2017.

3.2 2017-2018 Recreational Catch

Projected Chinook catches for 2018-2019 recreational fisheries are listed in Table 3-2. The recreational fishing regime included mark selective fisheries (MSF) for portions of the year in Marine Areas 5 through 13 and in a number of rivers. WDFW conducted intensive sampling and monitoring of MSFs in Marine Areas 5, 7, 9, 10 and 11, which provided the estimates in Table 3-2. Brief summaries of Chinook catch and encounters resulting from these sampling programs are included below. The analysis of 2018 winter fisheries is still in draft. When complete, this analysis will be made available on the WDFW website:

<https://wdfw.wa.gov/publications>

For fisheries without intensive sampling and/or creel data available, catch will be estimated using CRC data and data from baseline dockside sampling of marine fisheries. Baseline sampling provides data on catch per unit effort (CPUE), species composition, as well as CWT and biological sampling data. For freshwater fisheries, catch estimates are made using CRC data, unless creel studies were conducted and harvest estimates are available. For marine fisheries, species-specific catch estimates are made using CRC estimates of total catch, combined with species composition data obtained from the baseline sampling program. These estimates will be included in the 2019 annual report.

Table 3-2. Projected (FRAM 2318) and actual (preliminary, where available) Chinook catches in Puget Sound recreational fisheries during the 2018-2019 season.

Area/Fishery	Projected	Actual
Area 5-6		
Area 5 Summer MSF	3,527	3,839
Area 5 Winter MSF	568	
Area 6 Summer MSF	4,241	
Area 6 Winter MSF	2,003	2,047*
Other		
Strait Tributaries		
Area 7		
Summer (July MSF)	1,727	2,295
Winter MSF	3,739	3,855*
Nooksack/Samish FW	4,572	
Area 8-1 & 8-2		
Winter MSF	975	1,284*
Skagit River		
Spring MSF	456	
Area 8D SAF	256	
Stillaguamish River	0	
Snohomish River		
Skykomish MSF	757	
Area 9		
Summer MSF	5,587	6,031
Winter MSF	2,090	3,754*
Area 10		
Summer MSF	4,743	4,886
Winter MSF	227	792*
Area 11		
Summer MSF	5,344	5,673
Winter MSF	552	
Area 10E SAF	135	
Lake Sammamish	1	
Area 10A SAF	0	
Green River	386	
Puyallup River		
Carbon R MSF	500	
Puyallup R MSF	1,831	
Area 13		
Summer MSF	1,269	
Winter MSF	83	
Chambers Cr	34	
Nisqually	3,218	
Deschutes	6	
Area 12		
Summer MSF	1,127	
Winter MSF	390	
Skokomish River		

*Preliminary MSF catch estimate.

3.2.1 Marine Area 5 Summer MSF

2018 was the 16th year of summer mark-selective Chinook fishing in Marine Area 5. The 2018 fishery was open for a set season, from July 1 through August 15.

WDFW conducted comprehensive fishery monitoring activities during the Area 5 MSF. Sampling activities included dockside creel sampling and intensive efforts to distribute and collect voluntary trip reports (VTRs) from the angling public. An enhanced Salmon Trip Report (STR) program was used to obtain estimates of Chinook encounter rates by size class (legal or sub-legal) and mark status (ad-marked or unmarked), similar to the approach used successfully during summer 2009. Detailed descriptions of the sampling program and results are available in WDFW (2018).

For Area 5, WDFW estimates that 3,839 Chinook were landed, compared to preseason projections of 3,527 (Table 3-3).

Table 3-3. Comparison of modeled (FRAM 3218) and estimated total Chinook encounters for the 2018 Area 5 summer Chinook MSF.

Data Source	Group	Total Encounters	Legal	Sublegal	Landed Only
FRAM Encounters	UM	5,042	1,724	3,318	17
	AD	12,720	4,034	8,686	3,510
	Total	17,762	5,758	12,004	3,527
	% Marked	72	70	72	100
Estimated (Creel) Encounters	UM	6,827	2,562	4,264	0
	AD	13,818	4,173	9,645	3,839
	Total	20,645	6,735	13,910	3,839
	% Marked	67	62	69	100

3.2.2 Marine Area 7 Summer MSF

2018 was the third year of summer mark-selective Chinook fishing in Marine Area 7. The 2018 fishery was open from July 1 through July 30, 2018.

WDFW conducted comprehensive fishery monitoring activities during the Area 7 MSF. Sampling activities included intensive dockside creel sampling, on-the-water effort surveys, test fishing and collection of voluntary trip reports (VTRs) from the angling public. Detailed descriptions of the sampling program and results are available in WDFW (2018).

For Area 7, WDFW estimates that 2,295 Chinook were landed, compared to preseason projections of 1,727 (Table 3-4).

Table 3-4. Comparison of modeled (FRAM 3218) and estimated total Chinook encounters for the 2018 Area 7 summer Chinook MSF.

Data Source	Group	Total Encounters	Legal	Sublegal	Landed Only
FRAM Encounters	UM	3177	1,813	1,364	18
	AD	3,950	1,964	1,986	1,709
	Total	7,127	3,777	3,350	1,727
	% Marked	55	52	59	99
Estimated (Creel) Encounters	UM	1,392	1,033	359	4
	AD	3,440	2,552	888	2,291
	Total	4,832	3,584	1,248	2,295
	% Marked	71	71	71	100

3.2.3 Marine Area 9 Summer MSF

In 2018, a recreational MSF occurred for the twelfth consecutive summer in Marine Area 9. This fishery was scheduled to open from July 16 through August 15, 2018, but due to achieving the harvest quota early, in-season action was taken and the fishery was closed July 29, 2018. As in previous years, WDFW's Puget Sound Sampling Unit (PSSU) implemented an intensive monitoring program in Area 9 during the summer season to collect the data needed to provide in-season catch estimates and to estimate key parameters characterizing the fishery and its impacts on unmarked salmon. Detailed descriptions of the sampling program and results are available in WDFW (2018).

An estimated 6,031 Chinook were landed in Area 9, compared to preseason projections of 5,587 (Table 3-5).

Table 3-5. Comparison of modeled (FRAM 3218) and estimated Chinook encounters for the 2018 Area 9 summer Chinook MSF.

Data Source	Group	Total Encounters	Legal	Sublegal	Landed Only
FRAM Encounters	UM	1,530	1019	511	10
	AD	12,899	6,411	6,488	5,577
	Total	14,429	7,430	6,999	5,587
	% Marked	89	86	93	100
Estimated (Creel) Encounters	UM	1551	1085	465	3
	AD	10,543	6,822	3721	6,028
	Total	12,094	7,908	4,186	6,031
	% Marked	87	86	89	100

3.2.4 Marine Area 10 Summer MSF

In 2018, a summer recreational MSF was implemented in Area 10 for the eleventh consecutive year, running from July 16 through August 30, 2018. WDFW's Puget Sound Sampling Unit (PSSU) implemented an intensive monitoring program in Area 10 throughout the season in order

to collect the data needed to estimate key parameters characterizing the fishery and its impacts on unmarked salmon. An estimated total of 4,886 Chinook were landed during this fishery, compared to the pre-season projection of 4,743 (Table 3-6).

Table 3-6. Comparison of modeled (FRAM 3218) and estimated Chinook encounters for the 2018 Area 10 summer Chinook MSF.

Data Source	Group	Total Encounters	Legal	Sublegal	Landed Only
FRAM Encounters	UM	3,033	1,049	1,984	21
	AD	12,400	5,428	6,972	4,722
	Total	15,433	6,477	8,956	4,743
	% Marked	80	84	78	100
Estimated (Creel) Encounters	UM	2,143	1,032	1,111	35
	AD	9,285	5,396	3,889	4,850
	Total	11,428	6,428	5,000	4,886
	% Marked	81	84	78	99

3.2.5 Marine Area 11 Summer MSF

In 2018, a summer recreational MSF was implemented in Area 11 for the twelfth consecutive year, running from June 1 through September 30. Due to in-season action, the fishery was closed on August, 25 2018 when the quota was reached. WDFW's Puget Sound Sampling Unit (PSSU) implemented an intensive monitoring program in Area 11 to collect the data needed to provide in-season catch estimates and to estimate key parameters characterizing the fishery and its impacts on unmarked salmon. An estimated total of 5,673 Chinook were landed during this fishery, compared to the pre-season projection of 5,344 (Table 3-7). Unmarked legal and sublegal encounters were greater than pre-season projections.

Table 3-7. Comparison of modeled (FRAM 3218) and estimated Chinook encounters for the 2018 Area 11 summer Chinook MSF.

Data Source	Group	Total Encounters	Legal	Sublegal	Landed Only
FRAM Encounters	UM	2,526	889	1637	18
	AD	12,765	6,122	6,643	5,326
	Total	15,291	7,011	8,280	5,344
	% Marked	83	87	80	100
Estimated (Creel) Encounters	UM	4946	2248	2698	33
	AD	14,388	6,295	8,093	5,640
	Total	19,333	8,543	10,791	5,673
	% Marked	74	74	75	99

4 Spawning escapement

This section compares natural Chinook escapement estimates for 2018 with pre-season escapement projections, and management thresholds.

In general, FRAM projects natural escapement of unmarked adult (age-3 to age-5) Chinook. For some MUs where hatchery-origin adults contribute to natural spawning, the FRAM projections of escapement include adult natural-origin recruits (NOR) and adult hatchery-origin recruits (HOR) that spawn naturally. This includes projections for the Skagit, Cedar, Green, Puyallup, Skokomish, Mid-Hood Canal, Dungeness, and Elwha. For the White MU, the projection includes adult fish of natural origin and adult fish originating from the acclimation pond program. Natural-origin adults that are used for hatchery broodstock may be included in the projections of natural escapement.

FRAM projects adult natural-origin escapement for the Nooksack, Skagit spring, and Snohomish populations, so hatchery-origin fish must be subtracted from total escapement and the number of natural-origin fish used for broodstock added, to obtain an estimate comparable to the FRAM projections.

Escapements for available spring-run Chinook management units were all above projected estimates.

For summer/fall populations, escapement was greater than projected for some management units, except Skagit River summer/falls, Stillaguamish summer/falls, Cedar River fall, Nisqually, and Mid Hood Canal were below forecasted abundance.

Table 4-1. Preseason projections and estimates of Puget Sound Chinook natural spawning escapement in 2018.

Management Unit		NOR	HOR	Total	Projected (FRAM 3218)
Nooksack	NF			N/A	178 ¹
	SF			N/A	23 ¹
Skagit spring	Suiattle			645	596 ¹
	Cascade			128	261 ¹
	Sauk			1,603	1,110 ¹
	Total spring			2,376	1,967 ¹
Skagit summer/fall	Sauk summer			378	607 ¹
	Upper Skagit summer			8,602	9,108 ¹
	Lower Skagit fall			1,923	2,227 ¹
	Total summer/fall			10,920	12,219 ²
Stillaguamish	NF	118	508	626	
	SF	0	39	39	
	Total	161	656	817 ³	1,409
Snohomish	Skykomish	2,259	789	3,048	2,635 ¹
	Snoqualmie	823	339	1,162	747 ¹
	Total	3,082	1,128	4,210	3,382 ¹
Lake Washington	Cedar	675	138	813	1,722
Green		2,231	4,660	6,891	5,079
Puyallup		755	2,050	2,805	1,713
White		320	3,357	3,677	1,945 ⁴
Nisqually		428	168 ⁵	10,373 ⁵	16,576
Skokomish		103	2,356	2,459	2,432
Mid Hood Canal	Dosewallips	1	1	1	
	Duckabush	2	2	4	
	Hamma Hamma	0	58	58	
	Total			63	365
Dungeness		127	661	905 ⁶	810
Elwha		320	6,787	7,107 ⁷	4,599
Hoko				1,943	1,295

1. Natural-origin only.

2. Skagit Su/Fa projection total includes NOR and HOR escapement to the spawning grounds.

3. Includes additional 108 HORs and 44 NORs collected for broodstock from the North Fork which are part of the FRAM Projection.

4. Includes only adult NORs and adult vent-clipped acclimation pond fish trucked and released upstream of Mud Mountain; plus 1,837 acclimation pond fish

5. Includes 428 NOR and 168 HOR volitional spawners, as well as 9,781 hatchery rack return of which 1,679 HORs from Clear Creek Hatchery trucked, released upstream, and remained on the spawning grounds. Change-in-ratio (CIR) estimate will be revised with final sport-catch data when available. Total is adult (Age 3-5) escapement. Total fish on the spawning grounds 2,275.

6. Includes 117 fish (20 NORs and 97 HORs) removed from the river for use as broodstock.

7. Estimate does not include jacks.

4.1 Nooksack River Early Chinook

Currently, 2017 escapement data to inform stock assignments are still being evaluated by co-managers with an expectation to finalize the 2017 escapement estimate, with stock proportions, by early to mid December 2019.

4.2 Skagit River

Background

Six recognized Chinook populations spawn in the tributaries and mainstems of the Skagit River watershed. The Sauk River, Suiattle River, Baker River, and the Cascade River are major tributaries to the Skagit River, but there are also numerous smaller, anadromous fish bearing tributaries flowing both into the major tributaries and also into the Skagit River directly. Five hydroelectric projects are in the basin, two on the Baker River at river miles (RM) 1.6 and 9.3, and three on the Skagit River at RM 96.6, 100.9, and 105.1.

Escapements were calculated using various methodologies dependent on population and based on either total new redd counts, total visible redd counts, linear regression predictions, or a combination of methods. During spawning ground surveys, Chinook carcasses were sampled for fork length, sex, scales, and presence or absence of a hatchery mark. We also electronically sampled Chinook carcasses for coded wire tags (CWT) and collected CWT present snouts.

Surveys were performed on foot, by pontoon boat, jet boat, or by helicopter. Escapements estimates for Skagit hatchery spring Chinook, Upper Cascade spring Chinook, and Suiattle spring Chinook were calculated by multiplying total redd counts by 2.5 fish per redd. Upper Sauk spring Chinook, Skagit summer and Skagit fall Chinook, and Sauk River summer Chinook spawning escapement estimates were calculated by summing total redds observed during ground based surveys with area under the curve (AUC) calculated redds from aerial surveys, and multiplying the sum by 2.5 fish per redd.

Additional personnel from the Skagit Fisheries Enhancement Group (SFEG), Skagit River System Cooperative (SRSC, the management body for the Sauk-Suiattle and Swinomish Indian tribes), the Upper Skagit Indian Tribe (USIT), Seattle City Light, and Puget Sound Energy, also performed work and contributed data necessary to complete the escapement estimates and predictions for the Skagit River Basin Chinook salmon runs.

Methods and Results

Suiattle River Spring Chinook

Suiattle River spring Chinook spawn in the clear, large tributaries draining into the turbid mainstem of the Suiattle River. Some redds are found at tributary confluences with the mainstem and within the tributary's clear water lens in the mainstem created by unmixed tributary and mainstem water. Redds found within the tributary lenses are included in the tributary counts. Historically, limited spawning activity has been documented in the glacially influenced, high turbidity mainstem with the exception of spawning in the tributary clear water lenses. The only recorded exception to date was in 2011, when an unusual combination of environmental variables reduced turbidity in the mainstem and resulted in conditions the Chinook apparently deemed suitable for spawning.

Suiattle spring Chinook spawning Surveys were conducted from 1 August 2018 through 9 October 2018 by WDFW and USIT surveyors. Surveys of tributary indexes were attempted weekly for new redds to ensure all redds were enumerated. The indexes included all known spawning habitat for each tributary. Tributary spawning surveys were conducted on foot. All new redds were marked with survey flagging to prevent double counting during subsequent surveys. The total redd count was multiplied by 2.5 fish per redd to estimate escapement. All obtainable Chinook carcasses were scale sampled, measured for fork length, and sampled for coded wire tags.

The logjam that had been a passage barrier on Buck Creek in previous years (approximately river mile 1.2) remained in 2018. The logjam continues to be a total passage barrier with no live Chinook or Chinook redds observed upstream of the logjam

A total of 59 Suiattle spring Chinook carcasses were observed in 2018 and 49 were collected and sampled. There were 48 wild unmarked and no CWT Suiattle spring Chinook and one carcass that was adipose clipped but no CWT. The season total redd count was 258 redds. (Table 4-2).

Table 4-2. Suiattle River spring Chinook 2018 spawning ground survey redd counts.

Stream	WRIA	Survey method	Reach (RM)	Location ¹	Redds
Big Creek	3.0723	Foot	0.0-0.6	7.8	7
Tenas Creek	3.0761	Foot	0.0-0.5	9.6	8
Straight Creek	3.0797	Foot	0.0-0.1	15.1	3
Buck Creek	3.0813	Foot	0.0-1.7	18.1	25
Circle Creek	3.0892	Foot	0.0-0.2	18.4	0
Lime Creek	3.0897	Foot	0.0-0.5	20.8	5
Downey Creek	3.0919	Foot	0.0-2.1	24.4	184
Sulfur Creek	3.0973	Foot	0.0-0.9	26.3	13
Milk Creek	3.1022	Foot	0.0-0.1	28.6	13
Total redds					258

¹Location refers to river mile location of tributary mouth on a mainstem, or lower river mile terminus of a mainstem index.

The preliminary 2018 Suiattle River Spring Chinook escapement estimate was 645 fish (rounded). All data and estimates of escapement were preliminary at the time of reporting and remained subject to further review and agreement by the Skagit comanagers before finalization.

Upper Cascade River Spring Chinook

Cascade River spring Chinook spawn in the mainstem Cascade River and accessible tributaries from river mile 8.1 (just upstream of a high gradient canyon) up to and including the forks at RM 18.6. Spawning has also been documented in the North and South Fork Cascade Rivers, from the mouth of each fork upstream at varying distances (less than one river mile) dependent upon stream flow and available spawning habitat.

Cascade River spring Chinook surveys occurred from 7 August 2018 through 27 September 2018. The surveys of all known habitat were performed by WDFW and USIT spawning ground surveyors. Mainstem surveys were conducted by foot or pontoon boat depending on the stream features of the index. Historically the survey protocol has been to survey each index every ten to fourteen days. However, with the additional help provided by the USIT beginning in 2016, the interval goal was shortened to weekly surveys with the goal of collecting more carcasses. Carcasses are notoriously difficult to find from the upper Cascade population and it was hypothesized increasing the frequency of surveys would increase the number of carcasses sampled. All new redds were marked with survey flagging to ensure they were only counted once. The total redd count was multiplied by 2.5

fish per redd to estimate escapement. All recoverable carcasses were scale sampled, measured for fork length, and electronically checked for coded wire tags.

The weekly survey goal was not always met in 2018 due to competing work task priorities. A total of 4 upper Cascade spring Chinook carcasses were observed in 2018. Of the located carcasses, 2 could not be collected and 2 were collected and sampled. Both carcasses were wild adipose present (unmarked) and no coded wire tag (no beep). A total of 51 redds were located and marked in 2018 (Table 4-3).

The 2018 upper Cascade River spring Chinook spawning escapement estimate was 128 fish. All data and estimates of escapement were preliminary at the time of reporting and remain subject to further review and agreement by the Skagit comanagers before finalization.

Table 4-3. 2018 Cascade River spring Chinook redd counts.

Stream	WRIA	Survey method	Reach (RM)	Location ¹	Redds
Cascade River	3.1411	Foot	8.1-9.0	8.1	7
Marble Creek	3.1451	Foot	0.0-0.3	8.6	0
Cascade River	3.1411	Foot/Raft	9.0-12.4	9.0	18
Cascade River	3.1411	Foot	12.4-15.8	12.4	10
Cascade River	3.1411	Foot	15.8-18.6	15.8	15
Kindy Creek	3.1528	Foot	0.0-0.5	16.2	1
North Fork Cascade River	3.1605	Foot	0.0-0.1	18.6	0
South Fork Cascade River	3.1411	Foot	0.0-0.5	18.6	0
Total redds:					51

¹Location refers to river mile location of tributary mouth on mainstem, or lower river mile terminus of a mainstem index.

Upper Sauk River Spring Chinook

Upper Sauk River spring Chinook spawn in the mainstem Sauk River and in the North and South Fork Sauk Rivers. Mainstem Sauk River spawning has been documented between RM 31.0 to the forks at RM 39.7. Sauk spring Chinook spawn in the North Fork Sauk to the falls at river mile 41.3 and in the South Fork Sauk from the forks upstream as high as river mile 5.0 on a high water year. A high gradient section of the Sauk River beginning 0.9 river miles downstream of the White Chuck River acts as an assumed barrier to Sauk summer Chinook and serves as the lowest point of spawning of upper Sauk River spring Chinook.

Sauk River spring Chinook spawning areas were surveyed from 15 August 2018 through 10 October 2018. Surveys were conducted by foot or pontoon boat on indexes upstream of the White Chuck River at an attempted survey interval goal of every seven days. The survey goal for the index below the White Chuck River was every two weeks by helicopter due to the section being too treacherous to raft or walk. Recovered carcasses were sampled for scales, fork length, and presence of coded wire tags. Redds located during foot or pontoon boat surveys were counted and marked with survey flagging.

A total of 96 Sauk spring Chinook carcasses were observed in 2018 and 85 of the carcasses were able to be recovered and sampled. Of the sampled carcasses 84 were wild unmarked and untagged fish, and one fish was adipose present but the head had been scavenged so no CWT scan could be performed. There were 627 redds located upstream of the White Chuck River by ground based surveys and an estimated 14 redds downstream of the White Chuck River in the section surveyed by helicopter (Table 4-4). Total redds from ground based counts and the flown section were summed and multiplied by 2.5 fish per redd to estimate escapement.

The 2018 upper Sauk River spring Chinook escapement estimate was 1,603 fish. All data and estimates of escapement were preliminary at the time of reporting and remained subject to further review and agreement by the Skagit comanagers before finalization.

Table 4-4. Upper Sauk River spring Chinook redd counts from 2018 spawning ground surveys.

Stream	WRIA	Survey method	Reach (RM)	Location ¹	Redds
Sauk River	3.0673	Flight	31.0-31.9	31.0	14
Sauk River	3.0673	Foot/Float	31.9-34.5	31.9	172
Sauk River	3.0673	Foot/Float	34.5-37.8	34.5	307
Falls Creek	3.1182	Foot	0.0-0.2	34.9	3
Sauk River	3.0673	Foot/Float	37.8-39.7	37.8	18
South Fork Sauk River	3.1204	Foot	0.0-2.9	0.0	62
North Fork Sauk River	3.0673	Foot	39.7-40.1	39.7	33
North Fork Sauk River	3.0673	Foot	40.1-41.3	40.1	32
Total redds (rounded):					641

¹Location refers to river mile location of tributary mouth on mainstem, or lower river mile terminus of a mainstem index.

Skagit Summer Chinook

Skagit River summer Chinook spawn in the mainstem of the Skagit River from the mouth of the Sauk River at RM 67.2 to the Seattle City Light Powerhouse at Newhalem at RM 94.3. Spawning also occurs in tributary streams with suitable flow and spawning habitat. Tributaries were surveyed by foot or pontoon boat at an interval of every seven days to ensure all redds were enumerated before redd life expired. Tributary surveys covered most of the known spawning area with the exception of some limited spawning known to occur above the tributary index areas in years of high abundance, and in some other tributaries that have infrequent spawning activity. Time constraints due to limited personnel resources prevented us from surveying all known spawning habitat. The mainstem of the Skagit River was surveyed by helicopter.

Carcass recovery and sampling occurred incidentally during tributary surveys, and actively during mainstem carcass recovery surveys conducted on jet boats. Mainstem carcass surveys of approximately 22.3 river miles were attempted weekly. Recovered carcasses were sampled for scales, measured for fork length, and checked for presence of tags and marks. Not all carcasses encountered could be sampled; carcasses were often observed in deep pools beyond the reach of gaff hooks, or were badly decomposed and disintegrated upon disturbance. All new redds located during tributary surveys were counted and marked with survey flagging. The protocol for mainstem aerial redd surveys was to count all visible redds including redds that were recognizable from previous flight surveys.

Skagit summer Chinook tributary spawning surveys occurred regularly from 6 September 2018 through 31 October 2018 (Table 4-5). A total of 610 Skagit summer Chinook carcasses were observed in 2018 and 599 carcasses were recovered and sampled. A total of 531 carcasses were unmarked and untagged wild Skagit summer Chinook, 10 carcasses were adipose clipped only (no cwt), 51 carcasses were adipose clipped and coded wire tagged, 1 carcass was coded wire tagged but the adipose fin status could not be determined, 3 carcasses were CWT only, 2 carcasses were not clipped but the coded

wire tag status could not be determined, and one carcass was unknown adipose clip and unknown coded wire tag due to scavengers and decomposition..

Table 4-5. Skagit summer Chinook redd counts from 2018 spawning ground surveys.

Stream	WRIA	Survey method	Reach (RM)	Location ¹	Redds
Goodell Creek	3.1867	Foot	0.0-1.3	92.9	5
Falls Creek ³	3.1780	Foot	0.0-0.4	4.0	0
Bacon Creek	3.1774	Foot	0.0-4.2	82.9	59
Diobsud Creek	3.1750	Foot	0.0-1.3	80.7	44
Cascade River	3.1411	Foot/Float	0.0-4.2	78.1	106
Illabot Creek	3.1346	Foot	0.0-2.6	71.6	35
Skagit River	3.0176	Helicopter	85.9-94.3	85.9	1,464
Skagit River	3.0176	Helicopter	78.1-85.2	78.1	1,291
Skagit River	3.0176	Helicopter	67.2-78.1	67.2	437
Total redds:					3,441

¹Location refers to river mile location of tributary mouth on mainstem, or lower river mile terminus of a mainstem index.

²Falls Creek WRIA 03.1780 is a tributary of Bacon Creek. The mouth is located at river mile 4.0 of Bacon Creek on the right bank.

We observed 249 summer Chinook redds in the tributaries and using the AUC estimated 3,192 mainstem redds from four aerial mainstem surveys. Total redds from ground based counts and the flown sections were summed and multiplied by 2.5 fish per redd to estimate escapement. (Table 4-5).

The 2018 escapement estimate of Skagit River summer Chinook was 8,602 fish (rounded). All data and estimates of escapement were preliminary at the time of reporting and remained subject to further review and agreement by the Skagit comanagers before finalization. (Table 4-1).

Lower Sauk River Summer Chinook

Lower Sauk River summer Chinook spawn from the mouth of the Sauk River to approximately RM 31.0 (0.9 RM downstream of the White Chuck River). The only documented tributary spawning occurs in Dan Creek (WRIA 3.1079) but due to frequent low flows during spawning, summer Chinook use of Dan Creek has been intermittent. Any carcasses located in Dan Creek were sampled for scales, measured for fork length, and checked for presence of tags and marks. The lower Sauk River is too wide, braided, and spawning too sparsely distributed to be effectively surveyed by foot or pontoon boat, so mainstem Sauk River summer Chinook spawning was surveyed by helicopter.

The Sauk Suiattle Indian Tribe (SSIT) conducted carcass surveys for Sauk summer Chinook carcasses in the mainstem of the Sauk River in 2018. A total of 8 carcasses were located and 7 were able to be sampled. All seven sampled carcasses were wild unmarked, and no CWT fish.

Surveys of Dan Creek began 17 September and continued through 08 November. In 2018, two Sauk summer Chinook redds and zero carcasses were observed within the Dan Creek index (Table 4-6).

Table 4-6. Lower Sauk River summer Chinook redd counts from 2017.

Stream	WRIA	Survey method	Reach (RM)	Location ¹	Redds by method		
					Foot surveys	AUC	Linear regression
					Actual	Estimated	Predicted
Sauk River	3.0673	Flight	0.0-13.2	0.0		31	N/A
Sauk River	3.0673	Flight	13.2-21.1	13.2		87	
Dan Creek	3.1079	Foot	0.0-0.8	16.8	2		
Sauk River	3.0673	Flight	21.1-31.0	21.1		32	
Grand total redds from all methods (rounded):						151	

¹Location refers to river mile location of tributary mouth on mainstem, or lower river mile terminus of a mainstem index.

Mainstem Sauk summer Chinook spawning is often difficult to monitor due to turbidity inputs from the Suiattle River and the White Chuck River, but conditions throughout most of the Sauk summer Chinook spawning period were favorable this year. From four mainstem flights the AUC method estimated 149 Sauk summer Chinook redds in the indexes. Total redds from ground based counts and flown sections were summed and multiplied by 2.5 fish per redd to estimate escapement.

The 2018 escapement estimate of lower Sauk River summer Chinook was 378 fish (rounded). All data and estimates of escapement were preliminary at the time of reporting and remained subject to further review and agreement by the Skagit comanagers before finalization.

Lower Skagit River Fall Chinook

Skagit fall Chinook spawn in the mainstem Skagit River from the vicinity of RM 24.5 to the mouth of the Sauk River (RM 67.2). They have also been documented spawning in a variable number of large and small tributary streams depending on flow conditions. Tributary surveys were conducted by foot every seven to fourteen days. Encountered carcasses were sampled for scales, measured for fork length, and checked for coded wire tags. Tributary redds were counted and marked with flagging to prevent repeated counting.

Skagit fall Chinook spawning surveys began 17 September 2018 and continued through 20 November 2018. Four total visible redd aerial surveys were conducted over the two mainstem spawning indexes. The aerial surveys were conducted by helicopter. (Table 4-7).

A total of 16 Skagit fall Chinook carcasses were observed in 2018 and 14 of the carcasses were recovered and sampled. All 14 of the sampled carcasses were wild unmarked and untagged fish.

A total of 96 Skagit fall Chinook redds were observed during tributary surveys. The tributary redds were summed with 673 AUC estimated mainstem redds from the four aerial surveys. Total redds were multiplied by 2.5 fish per redd to estimate escapement

The 2018 escapement estimate of Skagit River fall Chinook was 1,923 fish (rounded). All data and estimates of escapement were preliminary at the time of reporting and remained subject to further review and agreement by the Skagit comanagers before finalization.

Table 4-7. Lower Skagit River fall Chinook redd counts from 2018 spawning ground surveys. The Upper Skagit Indian Tribe surveyed the Grandy Creek and upper Finney Creek indexes. The East Fork Nookachamps Creek index was not surveyed in 2018 due to a landowner access issue. Hansen Creek was not surveyed due to a miscommunication.

Stream	WRIA	Survey method	Reach (RM)	Redds
Skagit River	3.0176	Flight	24.5-56.5	327
Skagit River	3.0176	Flight	56.5-67.2	346
Hansen Creek	3.0265	Foot	3.0-4.3	DNS
Day Creek	3.0299	Foot	0.0-2.2	14
Jones Creek	3.0332	Foot	0.0-1.3	5
Grandy Creek	3.0337	Foot	0.0-1.1	14
Alder Creek	3.0359	Foot	0.0-1.6	1
O'Toole Creek	3.0365	Foot	0.0-0.2	2
Pressentin Creek	3.0385	Foot	0.0-0.4	5
Finney Creek	3.0392	Foot	0.0-6.0	55
Jackman Creek	3.0626	Foot	0.0-0.7	0
EF Nookachamps	3.0230	Foot	3.5-5.1	DNS
Total redds:				769

4.3 Stillaguamish River

The Stillaguamish River basin has two populations of Chinook distinguished by genetic characteristics: summers and falls. These two populations overlap in spawn timing and distribution with both populations spawning in both forks of the Stillaguamish River. The summer stock is a composite of natural and hatchery-origin supplemental production with the majority of spawning occurring in the North Fork Stillaguamish and its major tributaries, including Boulder River and Deer, Grant, French, and Squire Creeks. The fall stock is a composite of natural and hatchery-origin supplemental production with the majority of spawning primarily in the mainstem and South Fork Stillaguamish Rivers, in Pilchuck, Jim, and Canyon Creeks, and in the North Fork Stillaguamish River. Escapement is currently estimated for North Fork and South Fork Stillaguamish Rivers rather than summer and fall populations of Chinook.

Escapement estimates for Stillaguamish Chinook were calculated by multiplying the cumulative redd count by 2.5 and by the genetic mark recapture (GMR) correction factor. This is an annual provisional estimate. The GMR correction factor is a multiplier resulting from regression analysis of redd-based escapements compared to GMR-based escapement estimate results from the years 2008 through 2016. GMR based escapement estimates are considered more accurate than redd-based estimates and can be produced with statistical confidence intervals (whereas redd-based estimates cannot), but are not available until the following year. GMR escapement estimates require genetic sampling of adult fish in the Fall and juvenile fish in the following Spring. When the final GMR escapement estimate is completed, it then replaces the initial redd-based GMR corrected (provisional) result.. Since 2008, Chinook redds found in the North and South Forks have been individually counted during periodic foot or raft surveys using the marked redd census method. Previous to 2008, redd counts in the North and South Forks were estimated using area under the curve methodology based on aerial surveys of North and South Fork mainstem reaches as well as

ground-based surveys of tributary streams. Aerial surveys continue to provide redd count data for the Lower Mainstem and upper South Fork. Since 2008, the Stillaguamish Tribe Department of Natural Resources has provided ground coverage of the North Fork Stillaguamish River from its mouth to river mile (RM) 30.0. WDFW staff surveyed the remaining known Chinook spawning areas in the Stillaguamish basin.

Surveys were conducted from mid-August to mid-November to encompass the spawn timing of both stocks. All known spawning habitat was surveyed either by foot or raft on a seven to fourteen day cycle, or by helicopter every fourteen to twenty-one days. All ground-counted redds were flagged, enumerated and recorded with a GPS waypoint. Helicopter surveys counted total visible redds during each flight and total redds were estimated using area-under-the-curve methods. Carcasses encountered were sampled for scales, DNA, CWT, and adipose fin mark status.

North Fork Stillaguamish summer and fall Chinook

North Fork Stillaguamish Chinook spawning surveys covered the entire known distribution. Surveyed areas were the North Fork from RM 0.0 to 34.4 and North Fork tributaries including Squire, Segelson, French, Brooks, and Grant creeks, and Boulder River. Escapement was estimated using expansion of cumulative redd counts (2.5 fish per redd) from raft and foot surveys, and multiplying by the GMR correction factor. Survey conditions for counting Chinook in the North Fork Stillaguamish were generally good during the spawning period until mid-October rains pulsed flows and impeded the survey schedule. The first redds were detected August 28th in the North Fork, and last one was detected October 24 in the North Fork. A total of 211 Chinook redds were counted on the North Fork of the Stillaguamish in 2018 (Table 4-8). The redd-based escapement estimate was 529 fish (Table 4-8 and Table 4-10). The GMR adjusted provisional escapement estimate is 626 fish (118 NOR, 508 HOR). An additional 152 fish (108 NOR, 44 HOR) were taken for hatchery brood stock and were not included in the escapement estimate. Total NOR North Fork Stillaguamish River escapement (natural spawning + broodstock collection) was 702 Chinook.

Table 4-8. North Fork Stillaguamish summer and fall Chinook redd counts in 2018.

Stream	WRIA	Method	Reach (RM)	Redds	Escapement
North Fork	5.0135	Foot/Float	0.0-14.3	3	13
North Fork	5.0135	Foot/Float	14.3-30.0	166	415
North Fork	5.0135	Foot/Float	30.0-34.4	12	30
Grant Creek	5.0156	Foot	0.0-0.4	0	0
Deer Creek	5.0173	Foot	0.0-6.0	1	3
Brooks Creek	5.0215	Foot	0.0-0.1	0	0
Boulder River	5.0229	Foot	0.0-2.9	12	30
French Creek	5.0246	Foot	0.0-3.0	0	0
Squire Creek	5.026	Foot	0.0-4.0	15	38
Brown Creek	5.0265	Foot	0.0-1.0	0	0
Total Redds				211	
Redd-based Escapement Estimate					529
GMR adjusted EE (provisional)					626

South Fork and Mainstem Stillaguamish summer and fall Chinook

South Fork and Mainstem Stillaguamish summer and fall Chinook escapement in 2017 was estimated using expansion of cumulative redd counts (2.5 fish per redd) from aerial, foot, and raft surveys. Areas surveyed were the Mainstem between the juvenile trap (near the town of Sylvana and the confluence at Arlington (river miles 6.0 to 17.8), the South Fork from the confluence to Granite Falls (river miles 17.8 to 34.7), and Canyon, Jim, Siberia, and Pilchuck Creeks. River mile 34.7 to 55.1 include Granite Falls and Robe Canyon and are neither surveyable nor good Chinook spawning habitat.

The mainstem aerial index reach, from the juvenile trap (RM 6.0) to the forks (RM 17.8) was flown twice in 2018, October 5 and 18. Rain generated flow pulses in late October and November reduced visibility and precluded further survey efforts.

A total of 13 Chinook redds were found in the Mainstem Stillaguamish and South Fork Stillaguamish River and tributaries in 2018 (Table 4-9). The red-based escapement estimate was 33 adult fish, which expanded to 39 adult fish with the application of the GMR correction factor (Table 4-10).

Table 4-9. South Fork and Mainstem Stillaguamish summer and fall Chinook redd counts in 2018.

Stream Reach	WRIA	Method	Reach (RM)	Redds	Escapement
Mainstem	5.0001	Flight	6.0-17.8	0	0
South Fork	5.0001	Foot/Float	17.8-34.7	9	23
South Fork (upper)	5.0001	Foot	34.7-65.0	0	0
Pilchuck Creek	5.0062	Foot/Float	0.0-6.2	0	0
Jim Creek	5.0322	Foot/Float	0.0-4.1	4	10
Siberia Creek	5.0324	Foot	0.0-0.4	0	0
Canyon Creek	5.0359	Foot	0.0-0.5	0	0
Total Redds				13	
Redd-based Escapement Estimate					33
GMR adjusted EE (provisional)					39

Carcass sampling and escapement composition

WDFW and Stillaguamish Tribe Natural Resources staff conducted spawning ground survey work and carcass sampling in the North and South Forks of the Stillaguamish River and their tributaries. Tribal staff focused their Chinook carcass sampling efforts in the North Fork between the mouth and Swede Heaven Bridge (RM 0.0 to 30.0) and WDFW staff focused on the remaining spawning grounds. In total, 65 complete carcasses (status of both adipose fin and CWT was determined) were sampled in the Stillaguamish River; 64 in the North Fork reaches and one in the South Fork reaches (Table 4-10). An additional three sampled carcasses were categorized as “unknown” because either the adipose status or the CWT status was undetermined. The sampling rates of Chinook carcasses, not including those with unknown mark dispositions, were 12.1% for North Fork reaches, and 3.0% for South Fork reaches. These rates were calculated by dividing the number of carcasses sampled by the escapement estimate for each population.

Escapement of Chinook by origin (hatchery or natural) was determined by applying ratios of hatchery marked carcasses and unmarked carcasses and marked and unmarked live fish collected for broodstock to the total escapement estimate (Table 4-11).

Table 4-10. Stillaguamish Chinook sample proportions and HOR:NOR composition in 2018

	Sampled	Sampled Hatchery	Sampled Natural	% Hatchery	% Natural	GMR Esc EST	% Sampled
North Fork and Tributaries	64	52	12	81.3%	18.8%	626	10.2%
South Fork and Tributaries	1	1	0	100.0%	0.0%	39	2.6%
Broodstock (NF)	152	44	108	28.9%	71.1%	152	100%
Stillaguamish Totals	217	97	120	44.7%	55.3%		

Table 4-11. Stillaguamish Chinook escapement estimate (GMR provisional) HOR:NOR composition, 2018.

	GMR Escapement Est.	% Hatchery	% Natural	Esc Est. HOR	Esc. Est. NOR
North Fork and Tributaries	626	81.2%	18.8%	508	118
South Fork and Tributaries	39	100.0%	0.0%	39	0
Stillaguamish Totals	665			547	118

4.4 Snohomish River

There are two populations of Chinook in the Snohomish River basin: Skykomish summer/fall Chinook and Snoqualmie fall Chinook. The Skykomish stock spawns in the mainstem of the Skykomish River and its tributaries, including the Wallace and Sultan Rivers, Bridal Veil Creek, the South Fork Skykomish River (between RM 49.6 and RM 51.1 and above Sunset Falls) and the North Fork Skykomish River (occasionally above Bear Falls at RM 13.1). The Snoqualmie stock spawns in the Snoqualmie River and its tributaries, including the Tolt and Raging Rivers, and Tokul Creek.

Escapement estimates of naturally spawning Chinook salmon returning to the Snohomish watershed are calculated from cumulative redd counts made from physical surveys of their spawning grounds, and from counts of adult fish passed at Sunset Falls. Additionally, redd estimates for unsurveyed reaches on Raging River, North Fork Tolt River and Cherry Creek were expanded based on redds per mile of adjacent surveyed reaches. Survey methods included ground based walking, raft, and jet sled surveys, as well as aerial surveys conducted from a helicopter. Ground counted redds were monitored using marked-redd-census methodology. Ground surveys were done at a frequency of seven to ten days so as to not miss new redds. Redds in ground-surveyed reaches were enumerated, marked with a GPS waypoint, and flagged to prevent re-counting on subsequent surveys. Aerial surveys were conducted on the Snohomish, Skykomish and North Fork Skykomish Rivers at target intervals of two weeks. Aerial surveys provided total visible redd counts per survey flight and were plotted against survey date for the area-under-curve (AUC) method yielding total redd days. Total redd days were then divided by the assumed standard 21-day redd life to yield the estimated cumulative redds from aerial surveyed reaches. The cumulative redd count was then expanded by 2.5 (fish per redd) to estimate escapement. Additionally, a count of Chinook passed above the trap at Sunset Falls on the South Fork of the Skykomish was made. Carcasses encountered were sampled for scales, DNA, CWT, adipose fin mark status, and otoliths.

Skykomish summer/fall Chinook

Spawning ground surveys were conducted throughout the known spawning distribution of Skykomish summer/fall Chinook. Survey reaches were the mainstem Snohomish and

Skykomish Rivers, Pilchuck, Sultan, and Wallace Rivers, Woods, Elwell, Bridal Veil, Olney, and Proctor Creeks, and in the North and South forks of the Skykomish River.

Survey conditions were good for most of the spawning season. High flows late-October made survey conditions difficult. Survey intervals were kept to seven to ten days except for when rain-fed flow pulses in mid-October and November caused survey delays. Five aerial surveys were flown on the Mainstem Snohomish, Skykomish and North and South Fork Skykomish Rivers at two-week intervals between mid-September and mid-November.

A total of 1,180 Chinook redds were found in the Skykomish River and its tributaries, and Pilchuck River in 2018 (Table 4-12). The spawning escapement estimate (including Sunset Falls trap counts) was 3,048 adult fish (2,259 NOR, 789 HOR; Table 4-14). An additional 4,819 adult hatchery origin fish (including 355 jacks) and four natural origin fish recruited to Wallace Hatchery and were not included in this escapement estimate. Total NOR Skykomish escapement (natural spawning + broodstock collection) was 2,263 Chinook.

Table 4-12. Skykomish summer/fall Chinook redd counts and escapement, 2018.

Stream Reach	WRIA	Method	Reach (RM)	Redds	Escapement
Snoh-Sky (Mainstems)	7.0012	Float/Flight	20.5-51.5	649	1,623
NF Skykomish	7.0982	Foot/Flight	0.0-13.5	110	275
SF Sky (Sunset Falls)	7.0012	Trap/Haul	51.5-up	*	97
Pilchuck River	7.0125	Foot/Float	2.0-26.5	29	73
Woods Creek	7.0826	Foot/Float	0.0-3.5	4	10
Elwell Creek	7.0865	Foot	0.0-1.0	2	5
Sultan River	7.0881	Foot/Float	0.0-9.7	234	585
Wallace River (lower)	7.094	Foot/Float	0.0-4.4	121	303
Wallace River(upper)	7.094	Foot/Float	4.4-7.3	4	10
Olney Creek	7.0946	Foot	0.0-0.6	0	0
Proctor Creek	7.097	Foot	0.0-0.4	1	3
Bridal Veil Creek	7.1248	Foot	0.0-0.4	26	64
Total Redds				1,180	
Escapement					3,048

Snoqualmie summer/fall Chinook

The escapement estimates for Snoqualmie summer/fall Chinook were made using cumulative redd counts from boat, foot, and aerial surveys of known spawning habitat. Surveyed reaches were the Snoqualmie River and its tributaries, including the Tolt and Raging Rivers and Cherry and Tokul Creeks. Chinook redds were observed from early September to mid-November.

Survey conditions were good for monitoring chinook spawning until mid-October when Fall rainstorms significantly increased stream flows, delaying or preventing some surveys.

In 2018, 1,162 Chinook are estimated to have escaped to the Snoqualmie Basin, based on a total count of 456.5 redds (Table 4-13). Based on carcass sampling results, the escapement estimate is composed of 823 NORs and 339 HORs (Table 4-14).

Table 4-13. Snoqualmie fall Chinook redd counts and escapement by reach, 2018.

Stream Reach	WRIA	Method	Reach (RM)	Redds	Escapement
Snoqualmie River (Lower)	7.0219	Float	20.5-24.9	70	175
Snoqualmie River (Upper)	7.0219	Float	32.9-39.6	126	315
Cherry Creek	7.0240	Foot	1.8-3.5	2	5
Tolt River (Lower)	7.0291	Foot/Float	0.0-6.0	95	238
Tolt River (Upper)	7.0291	Foot/Float	6.0-8.9	37	93
NF Tolt River	7.0291	Foot	8.9-11.3	31	78
SF Tolt River	7.0302	Foot	0.0-2.3	7	18
Raging River	7.0384	Foot	0.0-4.6	34	85
Raging River (Upper)	7.0384	Foot	4.6-13.2	30.5	76
Tokul Creek (Lower)	7.044	Foot	0.0-0.3	20	69
Tokul Creek (Upper)	7.044	Foot	0.3-0.6	4	10
Total Redds				456.5	
Escapement Estimate					1,162

Sampling and HOR:NOR summary

Field staff sampled 442 complete Chinook carcasses (status of CWT, otolith mark, and adipose fin mark are known) within the Snohomish basin. Additionally, adipose fin and CWT status was determined for 76 live Chinook passed at Sunset Falls. In total, the Chinook carcass sampling rate on the spawning grounds and at Sunset Falls was 12.3% (Table 4-14). This was calculated by dividing the number of carcasses and live fish sampled by the escapement estimate.

Escapement of Chinook by origin (hatchery or natural) was determined by applying ratios of hatchery marked carcasses and unmarked carcasses (and live fish sampled at Sunset Falls) to the escapement estimate by reach groupings (Table 4-14). Grouping reaches into subsets of the populations allows the calculation of hatchery origin recruits (HOR) and natural origin recruits (NOR) for escapement reaches where sample sizes were small or no carcasses were sampled.

These escapement by origin (hatchery origin and natural origin) numbers are preliminary pending co-manager agreement.

Table 4-14. Snohomish Chinook carcass sampling and escapement composition in 2018, preliminary.

Stratum	Escapement	No. Hatchery	No. Natural	% Hatchery	% Natural	Number Sampled	Percent Sampled
Skykomish	1,641	290	1,351	17.65%	82.35%	85	5.2%
Bridal Veil	339	118	221	34.67%	65.33%	75	22.1%
SF Sky *	97	13	84	13.16%	86.84%	76	78.4%
Pilchuck River	73	13	60	18.18%	81.82%	3	4.1%
Sultan River	585	66	519	11.36%	88.64%	44	7.5%
Wallace River	313	289	24	92.19%	7.81%	64	20.4%
Skykomish Population	3,048	789	2,259	25.89%	74.11%	347	11.4%
Snoqualmie	1,083	282	801	26.00%	74.00%	100	9.2%
Tokul	79	57	22	71.83%	28.17%	71	89.9%
Snoqualmie Population	1,162	339	823	29.17%	70.83%	171	14.7%
Snohomish Total	4,210	1,128	3,082	26.79%	73.21%	518	12.3%

*Sunset Falls sample: A sub-sample of Chinook passed upstream were sampled for cwt wire and adipose mark.

Key for Grouped Stratum and Populations:

Skykomish Population:

Bridal Veil: Bridal Veil Creek, NF Skykomish River, SF Sky (Sunset Falls)

Sultan: Sultan River

Skykomish: Snoh-Sky (Mainstems), Elwell Creek, Olney Creek, Woods Creek, Proctor Creek

Pilchuck: Pilchuck River

Wallace: Wallace River (Upper and Lower)

Snoqualmie Population:

Snoqualmie: Snoqualmie River (Lower and Upper), Raging River, Tolt River (Lower and Upper), SF

Tokul: Tokul Creek (Lower), Tokul Creek (Upper)

4.5 Cedar River

Prior to 1999, live counts and Area Under the Curve (AUC) methods were used to estimate Chinook spawning abundance in the Cedar River. Since 1999, Chinook redds have been enumerated and mapped in the Cedar River via floating surveys, and escapement estimated by expanding the redd count by 2.5. Cedar River redd surveys are considered to be a complete census of the mainstem river, where every Chinook redd in the Cedar system is counted. Redd surveys are conducted between RM 4.2 and RM 21.8 (Landsburg Dam) 2-3 times per week for the duration of the Chinook spawning period. The portion of the river upstream from the Landsburg Dam to the Cedar Falls powerhouse (RM 34.5), and the lower 4.2 miles of the Cedar mainstem are each surveyed once per week. Due to the overlap with sockeye spawning timing, Chinook redds are only included in the count if a female Chinook is present and actively attending to a redd.

In 2018, a total of 325 Chinook redds were observed in the Cedar River during the spawning season (including the surveyed area upstream from Landsburg Dam and including all small tributaries). Of the 325 Chinook redds, 321 were observed in the Cedar River mainstem (294 below Landsburg Dam and 27 above), and 4 were observed in small tributaries to the Cedar River. Expansion by 2.5 fish per redd resulted in the estimated escapement of 813 Chinook

(Table 4-1). Carcass surveys in the Cedar River indicated that 83% of the naturally spawning adult Chinook were natural origin fish (unclipped) and 17% were hatchery origin (clipped) fish.

4.6 Sammamish River/North Lake Washington Tributaries

The Sammamish Chinook population is composed of naturally spawning Chinook in the Big Bear/Cottage Lake Creek watershed and in the Issaquah Creek watershed downstream of Issaquah Hatchery. Chinook natural escapement to the Sammamish River/ North Lake Washington tributaries in 2018 was estimated at 659 fish (Table 4-1).

Big Bear/Cottage Lake Creeks

Escapement estimation to Big Bear Creek and Cottage Lake Creek involves weekly surveys of all known Chinook spawning areas to enumerate live Chinook. Total spawning escapement is estimated using the AUC method, where live fish counts and a 10-day stream life estimate are used to calculate escapement.

The Bear Creek/Cottage Creek index area was surveyed weekly during the 2018 spawning season. The escapement estimate was 248 fish. Of these, 75 fish were counted in the Bear Creek mainstem, and 173 fish were counted in the Upper and Lower Cottage Creek Indexes. Carcass surveys in the Big Bear/Cottage Lake system indicated that 23% of the naturally spawning adult Chinook were natural origin fish (unclipped) and 77% were hatchery origin fish.

Issaquah Creek System

Issaquah Creek is surveyed weekly from the Issaquah Hatchery (located at river mile 3.0), downstream to its confluence with Lake Sammamish to count Chinook carcasses. All Chinook carcasses are assumed to have spawned, and the cumulative carcass count is used as the escapement estimate for this reach of Issaquah Creek. East Fork Issaquah Creek is also surveyed weekly from its confluence with the Issaquah Creek mainstem, upstream to the High Point Trail crossing at approximately RM 3.0. Similar to the Issaquah Creek mainstem, the cumulative carcass count is used as the escapement estimate for the East Fork.

The Issaquah Creek system was surveyed weekly during the 2018 spawning season, and total escapement was estimated at 411. This estimate includes 384 fish in the mainstem below the hatchery, and 27 fish from the East Fork. Carcass surveys in the Issaquah Creek system indicated that 11% of the naturally spawning adult Chinook were natural origin fish (unclipped) and 89% were hatchery origin fish.

Chinook escapement to Issaquah Hatchery in 2018 was 1,857 (1,786 adults and 71 jacks); of which 33 (32 adults and 1 jack) were intentionally released upstream to spawn in upper Issaquah Creek.

4.7 Green River

Beginning in 2009, Muckleshoot (MIT) and WDFW Biologists agreed to attempt weekly counts of new Chinook redds in all survey-able reaches of the Green River and Newaukum Creek during Chinook spawning ground surveys, reasoning that so few redds were being dug, it was possible to count all redds in all reaches. This estimation methodology uses season total redd counts, without adjustment, in four of the six sections of the mainstem Green River. At the conclusion of the spawning season, the observed number of redds in these sections of the river is known, and the variance is zero. There may be observational error in these sections or

spawning outside these sections. However these factors operate in all sampling programs and are not included in any variance estimates.

New Chinook redds were counted weekly over three days by boat and twice during the season from aerial surveys in the mainstem river between River Mile (RM) 25.4 to 48.5 (Lower River (aerial only), Middle River, and Lower Gorge) and 59.2 to 61.0 (Headworks). Using two, one-man pontoon boats or two, two-man boats, crews worked in tandem to count redds left and right of the center of the river. Foot surveys of Chinook naturally spawning in Newaukum Creek were conducted weekly by WDFW crews from the creek mouth to river mile 3.9. Redds in the Metzler Side Channel (MSC) were counted opportunistically when adequate water filled the side channel, in a similar manner. Only those redds that could reasonably be presumed to be Chinook redds were counted, based on the presence of a female observed digging or guarding the redd, or when redd size and substrate size were unambiguous.

A rigorous surveying schedule began on September 5 and continued through October 31. Although visibility was sometimes limited, no surveys were suspended because of high flows. Redd counts from Metzler Side Channel were conducted on September 24, October 9, and October 23. These counts were added to the weekly counts for the Middle River. The weekly number of redds counted in each section, was summed, without adjustment, to produce the season total redd count by section.

On October 4 and 17, a count of visible redds in each reach was made by helicopter in all 6 sections, encompassing the entire "spawnable area" of the mainstem river between RM 25.4 and approximately RM 60.4. Pending amenable weather conditions, flights were timed to coincide with the historical peak of natural Chinook spawning activity which typically occurs the first or second week in October. Flight scheduling was limited by availability of the helicopter and weather and river conditions.

Escapement was calculated for the sections of the river not surveyed by boat: "Gorge", RM 48.5 to 56.2 and "Hwy 167 to Transfer Shack", RM 25.4 to 26.7, the lowermost reach in the Lower River. The season total redd count from the section just below the Gorge; Lower Gorge section: RM 44.3 to 48.5, was divided by the number of redds in the Lower Gorge section counted on the flight, resulting in the "Ground to Air Ratio" (G/A). The G/A was then applied to the number of redds observed in the Gorge on the day of the flight. For the Lower River (274 redds) and Hwy 167 to Transfer Shack (6 redds) reaches, the sum of redds observed during five floats (Lower River) and two aerial surveys (Hwy 167 to Transfer Shack) was used to estimate a combined season total of 280 redds.

Season total redd counts from boat and foot surveys of the mainstem Green River and Newaukum Creek and calculated values from the aerial sections of the Green River, were multiplied by 2.5 fish per redd to estimate total Chinook spawning naturally in the Green River basin. This multiplier is intended to account for the number of males and females and is derived from the sex ratio of 1.5 males for every female.

Post season analysis of the season totals indicates that peak spawning activity varied by section, but was generally highest during the first two weeks of October for the mainstem and the last week of September for Newaukum Creek (Table 4-15 and Table 4-16). By the end of surveys the week of October 14, 93.8% of the redds (2,259 of 2,409) observed during boat and foot spawning ground surveys were complete.

Table 4-15. Chinook redd counts from foot and boat surveys of the Green River in 2018.

Section	Week ¹									Total
	2-Sep	9-Sep	16-Sep	23-Sep	30-Sep	7-Oct	14-Oct	21-Oct	28-Oct	
Headworks	0	4	77	169	176	180	56	3	-	665
Lower Gorge	-	0	1	9	51	72	53	4	0	190
Middle River	-	1	11	119	427	303	171	77	7	1,116
Lower River ¹	-	3	-	80	-	132	-	59	0	274
Newaukum Creek	0	0	33	51	45	26	9	0	-	164
Total	0	8	122	428	699	713	289	143	7	2,409

¹Aerial surveys on October 4 and 17 were used to estimate 6 redds in the Hwy 167 to transfer shack reach.

Table 4-16. Aerial survey counts of Chinook redds in the Green River, 2018.

Section	Week ¹									Total
	2-Sep	9-Sep	16-Sep	23-Sep	30-Sep	7-Oct	14-Oct	21-Oct	28-Oct	
Headworks	-	-	-	-	289	-	-	-	70	359
Gorge	-	-	-	-	151	-	-	-	59	210
Lower Gorge	-	-	-	-	84	-	-	-	53	137
Middle River	-	-	-	-	591	-	-	-	188	779
Lower River	-	-	-	-	185	-	-	-	39	224
Hwy 167- Transfer Shack	-	-	-	-	4	-	-	-	2	6
Total	-	-	-	-	1,304	-	-	-	411	1,715

¹Aerial counts can include redds still visible from prior weeks and thus exceed boat counts for the same week.

The season total redds from the Middle River was 2,537 redds plus 56 from MSC, 190 from the Lower Gorge, 665 from the Headworks, and 274 in the Lower River plus 6 in the Hwy 167-Transfer Shack reach. The G/A ratio for the Lower Gorge was 2.26 (190/84) resulting in a calculated 342 redds for the "Gorge". A total of 2,593 redds were counted or calculated in the mainstem Green River, including MSC, by census. In Newaukum Creek, the season total redds for the section "400th to Whitney Hill Bridge" was 61 and for the section "Whitney Hill Bridge" to mouth" was 103, totaling 164 redds in Newaukum Creek.

Applying the constant 2.5 fish/redd (1.5 males:1.0 female), an estimate of 6,891 naturally spawning Chinook was generated for the Green River Basin (Table 4-1).

During the season, 542 adults and 89 jacks that returned to the Soos Creek and Keta Creek hatcheries were tagged by the Muckleshoot Indian Tribe, hauled upstream, and released in the mainstem. Although duration of survival and spawning success of these fish may be variable, any redds created by these fish would have been counted during surveys, meaning that they are included in the natural spawning escapement estimate.

River flows during the 2018 Chinook spawning season were low to moderate until the final week of surveys (Table 4-17). This resulted in excellent conditions for the survey season without any surveys being suspended due to high water.

Table 4-17. Average weekly discharge (cfs) at three locations on the Green River (Palmer USGS Gage 12106700, Auburn USGS Gage 12113000, and Newaukum Creek USGS Gage 12108500) in 2018. Weekly discharges are 7-day averages of mean daily discharge beginning with the day listed.

USGS Gauge	Week								
	2-Sep	9-Sep	16-Sep	23-Sep	30-Sep	7-Oct	14-Oct	21-Oct	28-Oct
Palmer	171	187	194	260	286	289	242	257	1,041
Auburn	271	315	320	359	401	417	357	367	1,174
Newaukum Creek	11	15	13	12	12	15	12	14	32

Carcass sampling

Naturally spawning Chinook carcasses (clipped and unclipped) were sampled opportunistically during spawning ground surveys in the mainstem and Newaukum Creek. Biological data were collected from these carcasses, and a “Percent Egg Retention” variable was determined. The “Percent Egg Retention” variable was determined by inspection of the gonads of all female carcasses. The proportion of eggs estimated to have been retained was noted for carcasses where eggs remained in the body cavity. A carcass noted as having 25% egg retention was estimated to have expelled 75% of her total eggs. Additionally, tagged fish from re-released hatchery returns were noted for all sampled carcasses.

A total of 1,113 carcasses were sampled for standard biological data by Green River crews in 2018; 755 (16 DIT+ 52 CWT&AD + 309 AD + 378 thermal marked with no adipose fin and no CWT) or 67.8% were of hatchery origin as indicated by the presence of an adipose fin, CWT tag, or hatchery thermal mark (Table 4-18).

Table 4-18. Summary of Chinook biological sampling in the Green River, 2018.

Section	Biological Samples	Adipose Clipped	Thermal Marks	MIT Tags ¹	Acoustic MIT Tags ²	CWT ³ & Ad-Clipped	DIT ³
Headworks	477	39	273	1	3	2	4
Lower Gorge	65	17	23	3	0	9	1
Middle River	388	187	61	54	2	28	9
Lower River	52	44	0	1	0	0	0
Metzler Side Channel	8	7	0	0	0	0	0
SubTotal: River	990	294	357	59	5	39	14
Newaukum: 400th to Whitney Hill Br	36	22	3	0	0	5	1
Newaukum: Whitney Hill Br to Mouth	87	45	18	3	0	8	1
SubTotal: Newaukum	123	67	21	3	0	13	2
Grand Total:	1,113	361	378	62	5	52	16

¹“MIT tags”; the number of sampled fish with MIT tags, or those otherwise identified as hatchery re-release.

²Acoustic MIT Tags: the number of carcasses retrieved with MIT acoustic tags (MIT supplemental study)

³CWT: Coded wire tag present (unconfirmed) DIT = (Double Index Tag) Adipose fin present, coded wire tag present.

Table 4-19. Coded wire tag sampling, thermal mark analysis of otoliths¹, and origin of natural Chinook spawners² in the Green River, 2018.

	Sampled						NM with no Thermal Mark		AD or NM with Thermal Mark		Unknown Origin ³	
	Number	NOS	HOS	Unknown Origin ³	CWT	No CWT	DIT	No CWT	CWT	No CWT	CWT	No CWT
Green River	990	316	665	9	53	937	14	316	39	612	0	9
Newaukum Creek	123	33	90	0	15	108	2	33	13	75	0	0
Green River Basin Total	1,113	349	755	9	68	1,045	16	349	52	687	0	9

¹Since 2014, Chinook released from the Palmer Hatchery have been thermal marked but not adipose fin clipped.

²NOS= Natural origin spawner; HOS= Hatchery origin spawner; NM = Adipose fin present; AD = Adipose fin clipped; CWT = Coded wire tag present (unconfirmed); DIT = Double Index Tag; Adipose fin present, coded wire tag present; TM = Thermal Marked.

³Unknown origin = otoliths not analyzed for thermal mark or adipose fin presence unknown

4.8 White River

By definition, the escapement estimate for White River Spring Chinook is derived from trap counts at the Army Corps of Engineers' Buckley Diversion Dam fish trap (Buckley Trap) and hatchery returns to the White River Hatchery (WRH). The WRH and Buckley Trap are on opposite sides of a diversion dam on the White River. Off-site propagation of White River Spring Chinook also occurs at the Minter Creek/Hupp Springs Hatchery, and returns to that facility are recorded separately. Under ideal conditions, the Buckley Trap allows sampling and enumeration of all fish transported to the upper White River watershed. During odd years when pink salmon return and during years of relatively high Coho returns (2003-2012), sampling at the Buckley trap is limited, particularly during the latter part of the Chinook run. As a consequence, the proportions of hatchery and natural-origin spring and fall Chinook transported above the dam are uncertain. Records of trap and haul operations conducted in the absence of state or tribal fisheries managers are a subject of ongoing concern. In 2018, complete sampling occurred through August 27th, but 660 Chinook (374 adults and 286 jacks) of unknown origin were transported upstream after this date.

The number of adult fish sampled at the WRH and at the Buckley Trap prior to the termination of sampling was 7,538. Of these, 3,806 were natural-origin (NOR) and acclimation pond (AP) recruits. NORs are assumed to be primarily spring Chinook although based on DNA analysis, fall-run Chinook and potential hybrids have been passed. NORs made up 9% and APs made up 37% of the sampled adult Chinook. At the Buckley Trap, the ratios of coded wire tagged, non-coded wire tagged, and vent clipped fish among sampled adults and jacks, were applied to un-sampled adults and jacks passed upstream after the termination of sampling. In addition, 46 of the adult NORs were collected at, or taken to, the White River Hatchery for use as broodstock.

Table 4-20. Estimated number NOR and Acclimation Pond Chinook salmon hauled upstream of Mud Mountain Dam in 2018. Results are a combination of returns sampled White River Hatchery and sampled and un-sampled fish at Buckley Trap.

Origin	Adults	Jacks	Totals
Wild (NOR)	320	251	571
Acclimation Pond	1,837	1,594	3,431
Totals	2,157	1,845	4,002

There are two hatchery programs for White River spring Chinook: the Minter Creek/Hupp Springs program and the White River Hatchery. The Minter Creek/Hupp Springs program was initiated in the mid-1970's in response to steep declines in population abundance. The spring Chinook program was subsequently expanded following completion of the Muckleshoot Tribe's White River Hatchery in 1989. In 2018, escapement to the Minter Creek/Hupp Springs hatchery was 1,523 adults. None of these fish nor their gametes were taken to the White River Hatchery. Escapement to the White River Hatchery in 2018 was 1,299 adults and 44 jacks. These fish were either collected at the Buckley fish trap on the south side of the diversion dam, or volunteered to the WRH trap on the north side of the diversion dam.

4.9 Puyallup River

The Puyallup Tribal Fisheries (PTF) and Washington Department of Fish and Wildlife (WDFW) staff agree that the ability to quantify fall Chinook escapement in the Puyallup River during odd years is difficult due to abundant pink salmon spawning in the system simultaneously. Due to these challenges, the co-managers agreed to use an adjusted AUC-based methodology to estimate escapement for Chinook in the Puyallup River basin during odd years.

South Prairie Creek

Survey coverage of the South Prairie system was very good in 2018. The cumulative redd count of 530 in South Prairie Creek, expanded by 2.5, yielded an escapement estimate of 1,325 spawners. In Wilkeson Creek, the cumulative redd count of 26, expanded by 2.5, yielded an escapement estimate of 65 spawners. The South Prairie Creek (SPC) sub-basin total spawning escapement estimate for 2018 is 1,390. Based on mark-sampling of carcasses observed, about 84% of these fish were marked, so the escapement was made up of 265 NORs and 1,125 HORs.

Carbon River

Because conditions in the Carbon River seldom allow accurate Chinook escapement surveys, estimates are based on the relationship between SPC and Carbon River escapement in 1999, when there was an accurate redd count for the Carbon River. Carbon River reaches with complete data tracked the SPC spawn timing remarkably well. Therefore, reaches with incomplete data were expanded using the SPC spawn timing curve with a high degree of confidence. The 2018 SPC escapement, including Wilkeson Creek, utilized in the Carbon River escapement expansion is an adjusted area under the curve (AUC) escapement estimate accounting for the average even-year (1994-2018) ratio of redd-based escapement and live fish AUC estimate exclusively in SPC multiplied by the 2018 AUC live fish estimate for SPC sub-basin.

Survey conditions were not suitable on the Carbon River during the 2018 spawning period. Consistent with the last ten years, the 2018/1999 SPC AUC escapement ratio ($1390 / 1422 = 0.9775$) was applied to the 1999 Carbon River escapement (250) to estimate the 2018 value. This method estimated 244 Chinook spawning in the Carbon during 2018 ($250 * 0.9775 = 244$). Based on mark sampling ratios observed in South Prairie Creek, the escapement was made up of 39 NORs and 205 HORs.

Puyallup River Tributaries

Aggregate escapement to Puyallup River tributaries in 2018 was estimated at 118 (Table 4-21). Based on mark sampling in these tributaries, excluding Clark's Creek, 15 of these fish are NORs and 103 HORs.

Table 4-21. Chinook escapement estimates for Puyallup River tributaries, 2017.

Tributary	Escapement
Fennel Creek (WRIA 10.0406)	10
Canyon Falls Creek (10.0410)	3
Kapowsin Creek (10.0600)	0
Clear Creek (10.0022)	105
Clarks Creek (10.0027)	0
Tributary total	118

Mainstem Puyallup River

Chinook spawning escapement to the mainstem Puyallup River was estimated to be 675. This escapement comprised 277 NOR and 398 HOR Chinook, based on mark sampling ratios observed in mainstem tributaries.

As with the Carbon River, surveys of Puyallup River were not possible in 2018. WDFW and PTF staff believe that mainstem spawning escapement is closely related to the tributaries (Fennel, Canyon Falls, Clear, Kapowsin, and Clarks creeks). Therefore, the 2018/1999 Puyallup tributary AUC ratio ($391/113 = 3.4604$) was applied to the estimated 1999 Puyallup mainstem escapement (195) to estimate 2018 escapement of 675 Chinook ($195 * 3.4604 = 675$). The same even-year (1994-2018) average AUC adjustment used for the Carbon River was applied to the Puyallup tributary AUC live-fish estimate to develop the 2018 Puyallup tributary AUC estimate for this analysis.

Lower White River

The fall component of Chinook spawning in the lower White River and its tributaries, downstream of the Buckley trap, are included in the 2018 Puyallup River basin fall Chinook escapement estimate. Spawning ground surveys indicate that, in some years, a sizeable number of Chinook spawn in these areas.

Spring and fall Chinook spawn in the White River. The fall component in the lower White River and tributaries was identified by mark sampling during spawning ground surveys and the genetic analysis conducted by Ford et al. (2004). Carcass sampling during spawning ground surveys provides a ratio of hatchery-origin fall Chinook (i.e. fish with a clipped adipose fin), to unmarked fish. Based on previous genetic analysis of samples collected in Boise Creek (Ford et al 2004), 60% of the unmarked fish are assumed to be fall Chinook.

Fall Chinook spawning escapement into the lower mainstem White River and its tributaries in 2018 was estimated to be 378 fish. This escapement is made up of 159 NORs and 219 HORs based on mark sampling ratios observed during spawning ground surveys.

Total Puyallup Escapement

The estimated total number of naturally spawning fall Chinook in the Puyallup basin in 2018 was 2,805. Based on carcass sampling, we estimated that 755 were NORs, and 2,050 were HORs. The estimate of NORs assumes the proportions of hatchery and natural origin spawners is the same in Puyallup River tributaries, the Puyallup River mainstem, South Prairie Creek, and the Carbon River..

4.10 Nisqually River

Escapement to the Nisqually River in 2018 was estimated using a change in ratio methodology (Seber 1982). This method uses (1) the proportion of marked fish entering the river (as estimated by sampling tribal gillnet catch), (2) the total removals below the video counting slot in the Yelm Diversion dam and proportion of those removals marked, and (3) the proportion of marked fish passing above the Yelm Diversion Dam video counting slot to estimate the total return to the river.

Escapement to the Nisqually River was estimated to be 2,275 adult Chinook salmon (Table 4-1). This includes 428 natural-origin and 168 hatchery-origin adult fish voluntarily escaping to the spawning grounds, as well as an additional 1,679 adult HOR's, which originally returned to Clear Creek and Kalama Creek Hatcheries and were trucked, released, and remained upstream to spawn naturally. The goal of this effort is to supplement natural spawning and increase the number of juvenile outmigrants and corresponding adult returns, which is outlined in the Nisqually Fall Chinook Recovery Plan.

4.11 Hood Canal

Natural Chinook escapement to the Skokomish River and Mid-Hood Canal rivers in 2018 were 2,459 and 63, respectively (Table 4-22).

Mid-Hood Canal

The Mid-Hood Canal population is comprised of Chinook produced in the Dosewallips, Duckabush, and Hamma Hamma watersheds.

In the Dosewallips and Duckabush rivers, the lower reaches surveyed are spawning and transit areas. Upper reaches of the Dosewallips and Duckabush rivers have also been regularly surveyed since 1998, but few adults have been observed. Current escapement estimates are derived from combinations of live Chinook adult counts and Chinook redd expansions, depending on flow conditions and fish distributions.

In the Hamma Hamma River, most of the Chinook spawning area is currently being surveyed. A cooperative supplementation program was initiated in 1995 to rebuild Chinook abundance. Prior to 1998, escapement had been estimated from counts of cumulative new redds and/or from live Chinook using the area-under-the curve (AUC) method. However, since returns increased as the result of supplementation, the AUC method has been employed as the primary method of escapement estimation.

Summer chum salmon and pink salmon (in odd years) spawn at the same time as Chinook in the lower reaches of these three streams. Consequently, it can be difficult to distinguish Chinook redds from summer chum or pink redds unless Chinook are actively spawning and observed on redds. Pink salmon spawn predominately downstream of RM 6.7 on the Dosewallips, downstream of RM 2.6 on the Duckabush and throughout the reaches surveyed

on the Hamma Hamma. Summer chum salmon spawn predominately downstream of RM 3.6 on the Dosewallips, downstream of RM 2.6 on the Duckabush and throughout the reaches surveyed on the Hamma Hamma. It has been possible to count Chinook redds in the upper Dosewallips and Duckabush River reaches (especially in years without pink salmon).

The WDFW conducted spawner surveys on the Dosewallips, Duckabush, and Hamma Hamma rivers every 7 to 10 days from late August or early September through October. The escapement estimate to all three systems combined was 63 adults: 1, 4, and 58 Chinook in Dosewallips, Duckabush, and Hamma Hamma rivers, respectively (Table 4-22). During 2018, it is possible that some Chinook redds were not identifiable on the Dosewallips and Duckabush rivers in areas with summer chum spawning. However, based on the number of Chinook redds and adults observed during surveys and carcasses recovered during intensive weekly surveys, few very Chinook were present and the escapement estimates for Dosewallips and Duckabush rivers are considered in line with the actual order of magnitude for very low numbers.

The Dosewallips River was surveyed from RM 0 to RM 2.3, RM 3.6 to RM 6.7, but not RM 7 to RM 11; Rockybrook Creek, a tributary, was surveyed from RM 0 to RM 0.3. No Chinook redds were observed and the escapement estimate based on peak live/dead with 1 live fish observation in the Dosewallips River during 2018. The Duckabush River was surveyed from RM 0 to RM 2.6, RM 4.8 to RM 6. Although no Chinook redd was conclusively identified, an AUC estimate of 4 individual live adults was made based on observations made in September and October. The Hamma Hamma River was surveyed from RM 0.3 to RM 1.8; John Creek, a tributary, was also accessible to Chinook and was surveyed from RM 0 to RM 1.6. The estimated total escapement to the Hamma Hamma is 58 which is the AUC estimate of natural spawners in the mainstem. Flows were low in John Creek late into the season that the fish counted there had been previously accounted for in several Hamma Hamma mainstem surveys. No Chinook were collected for broodstock. The FRAM preseason escapement projection was 365 for the Mid-Hood Canal (FRAM 3218) while the estimated escapement is 63 Chinook. Escapements to the Dosewallips River and Duckabush River were low as anticipated.

Skokomish River

Chinook spawning takes place in the mainstem Skokomish River up to the confluence with the South and North Forks at RM 9, in the South Fork (primarily up to RM 5.5), and in the North Fork from RM 9 to 15.7 (where Little Falls once blocked further access). Natural escapement estimates have historically been based on counts of Chinook redds in the principal spawning habitat in the mainstem Skokomish (RM 2.2 to 9.0), North Fork (R.M. 9.0 to 15.6), and South Fork (R.M. 0 to 2.2). Since 2008, surveys have been conducted from RM 0 to RM 5.5 in the South Fork and included in the total escapement estimate. In addition, escapement estimates are made for Vance Creek and Hunter Creek. However, dramatically increasing numbers of summer chum spawning in the mainstem Skokomish since 2014 led the co-managers to re-evaluate the redd-based spawning methodology, and ultimately shift to a modified Area under the Curve (AUC) methodology applied elsewhere in Hood Canal. This change was necessary because summer chum spawning has become so prolific and Chinook spawning has become increasingly concentrated in preferred habitat. These conditions lead to widespread superimposition and difficulties in individual redd detection.

Live and dead adults, along with visible redds, were counted in Skokomish River index areas during foot and raft surveys (e.g., see Smith and Castle 1994). Surveys are conducted every seven to ten days. Historically, the fall Chinook survey season extended from late August through October, but with the first returns of North Fork spring Chinook, there is no break between steelhead survey season and Chinook season, now running from May through October or November if flows allow. Weekly instantaneous live fish counts for the entire

mainstem, South Fork and North Fork are used to calculate fish days, which are then divided by a stream life value of 21 days to estimate total Chinook escapement. In addition, foot surveys are made in Hunter and Vance creeks. Escapements to these tributaries are estimated based on redd counts and/or live Chinook observed.

In recent years, low flows at the mouth of the South Fork have prevented Chinook from accessing the lower South Fork early in the season. In 2018, however, Chinook had limited access the South Fork Skokomish after a brief period of increased flow in early September.

The total estimated spawner escapement to the Skokomish River is 2,459 (Table 4-22). This total includes 1,614 in the mainstem Skokomish, 665 Chinook in the North Fork, and 180 Chinook in the lower (RM 0 to RM 5.5) South Fork Skokomish. These numbers were apportioned based on calculating a redd-based escapement estimate for the north and south forks where summer chum spawning was limited, then using those numbers to apportion the total AUC estimate. The preseason escapement prediction was 2,432 (FRAM 3218).

Table 4-22. Summary of Chinook escapement to Hood Canal streams during 2018.

Area	Stream	Escapement	Comments
82 G/J	Skokomish R.	1,614	AUC based on live fish (MS+NF), then apportioned using redd-based esc for NF and SF, due to large summer chum return in MS
	N.F. Skokomish R.	665	
	S.F. Skokomish R.	180	
Total		2,459	
12A	Little Quilcene R.	0	No Chinook observed
	Big Quilcene R.	0	No Chinook observed
Total		0	
12B	Dosewallips R.	1	Peak live/dead fish
	Duckabush R.	4	AUC based on live fish
	Hamma Hamma R. a/	58	AUC Hamma
Total		63	
12C	Dewatto R.	45	AUC
	Eagle Cr.	449	AUC
	Lilliwaup Cr.	2	AUC
Total		496	
12D	Tahuya R.	2	AUC
	Union R.	70	Trap
Total		72	
Hood Canal total		3,090	

a/ Hamma natural escapement =63, broodstock = 0, John Ck = 0 (John Creek fish previously counted in Hamma AUC due to late access)

Mark Sampling

Mass marking has been implemented for releases from George Adams Hatchery, Hoodsport Hatchery, and Endicott Ponds. Double index tag (DIT) groups have been released from George Adams Hatchery since 1998. The proportion of all Hood Canal hatchery Chinook that were either tagged and/or marked has incrementally increased since brood year 2003. In addition, all of the Chinook released from the Hamma Hamma supplementation program were tagged and/or marked. Coded-wire tag (CWT), age, and sex composition data have been routinely collected from Chinook returning to George Adams Hatchery since 1988.

There has been more intensive sampling of Chinook on the spawning grounds since 1998. During 2017, the Skokomish, Dosewallips, Duckabush, and Hamma Hamma rivers were targeted for enhanced mark and CWT sampling and WDFW also sampled Chinook carcasses for marks and CWTs on the Dewatto, Tahuya, and Lilliwaup rivers.

Of the 386 Chinook sampled in Hood Canal rivers during 2018, 303 Chinook were adipose-clipped and, of these, 49 had CWTs. 26 unmarked Chinook were coded-wire tagged. We sampled 10.6% of the Chinook spawning escapement in the Skokomish River, 6.3% of the Mid-Hood Canal Chinook escapement (in the Hamma Hamma, Duckabush, and Dosewallips rivers), with an overall sampling rate of 12.5% in all Hood Canal rivers combined (Table 4-23).

Jacks are not included in Chinook spawning escapement estimates in Hood Canal, but few jacks were sampled during 2018.

Conservative estimates of hatchery contribution to natural the spawning escapement were made based on the total number of CWT tags and marks recovered (CWT's + adipose-clips + otoliths). However, these estimates are subject to correction for clip error and tag detection rates for the returning brood years. Thus, the proportion of hatchery fish on the spawning escapement is most rigorously estimated by expanding adipose-clipped fish based on proportions of clipped fish released from each brood year. Age composition in the escapement, carcass sampling rate, and the proportion of hatchery production releases that were marked and/or tagged from BY 2013 (age 5), BY 2014 (age 4), and BY 2015 (age 3).

In 2018 there was close agreement in the two aforementioned methods, with mark sampling-based pHOS estimated as 96% and expanded clip pHOS of 93.5% in the Skokomish River system (Table 4-23 and Table 4-24). Clip rate expansion estimate, the preferred method of the co-managers, does not include Purdy Creek samples because of the likely bias associated with hatchery mortality. However, a total of 260 Chinook sampled, 229 were adipose-marked (88.6%). Spawning escapement in the Skokomish River was comprised of about 93% hatchery-origin Chinook and 7% natural-origin Chinook, with a high proportion of NOR returns to the North Fork where they accounted for 25% (Table 4-23). These estimates may be further refined as CWT data becomes available next fall.

Hatchery releases into the Hamma Hamma River for the purposes of supplementation are 100% CWT and otolith marked, with the exception of BY 2013, when all broodstock were collected directly from the Hamma Hamma River and therefore only otolith marked. The 2013 BY was 100% tagged but not otolith marked since the purpose of otolith marking has been primarily to assess differences in the survival of Hamma Hamma origin supplementation fish versus George Adams origin supplementation fish. All Chinook carcasses were sampled for CWT and otoliths during 2018. Origin for the 2013 BY were determined by CWT, while origin for all other brood years were determined by otolith mark. The CWT rate was then adjusted for tag loss based on a seven-year average of otolith marks without tags from Mid-Hood Canal.

In the Hamma Hamma River, 1 of 3 (33%) Chinook sampled had a CWT, which was consistent with otolith marks and corrections for tag loss produced final estimates for spawning escapement composition comprised of 50% supplementation-origin Chinook, 0% natural-origin Chinook, and 50% hatchery-origin strays in the Hamma Hamma River, based on combined CWT and otolith analysis. No Chinook carcasses were sampled in the Duckabush or the Dosewallips River in 2018. Because no carcasses were recovered from the Duckabush and Dosewallips rivers, a long term pHOS average (50%) was applied to the 2018 escapements (Table 4-23). Due to only a single fish returning to the Dosewallips, we chose to classify that fish as an HOR. The low carcass recovery sample size along with the extremely low escapement, highlight the uncertainty in the 2018 Mid Hood Canal HOR/NOR estimates.

Table 4-23. Chinook salmon spawner escapement origin based on carcasses sampled for marks and coded-wire tags (CWTs) in Hood Canal rivers, 2018.

Management Unit	Escapement	Chinook Sampled		Tagged ^{1/}			Untagged ^{1/}			Unknown Tagged ^{2/}			Totals			Escapement	
		No.	%	AD	NM	Unk	AD	NM	Unk	AD	NM	Unk	CWT's Recovered	Ad-clips observed	Rate	HOR	NOR
Skokomish																	
Mainstem River	1,614	237	14.7%	19	24	0	192	2	0	0	0	0	43	211	0.99	1600	14
North Fk. River	665	16	2.4%	0	0	0	12	4	0	0	0	0	0	12	0.75	499	166
South Fk. River	180	7	3.9%	0	0	0	6	1	0	0	0	0	0	6	0.86	154	26
Skokomish River Total	2,459	260	10.6%	19	24	0	210	7	0	0	0	0	43	229	0.96	2,356	103
12A																	
Big Quilcene R.	0	0	0.0%	0	0	0	0	0	0	0	0	0	0	0	NA		
Little Quilcene R.	0	0	0%	0	0	0	0	0	0	0	0	0	0	0	NA		
12B																	
Hamma Hamma R. ^{3/}	58	4	6.9%	0	2	0	1	0	0	1	0	0	2	2	1.00	58	0
Duckabush R.	4	0	0.0%	0	0	0	0	0	0	0	0	0	0	0	0.50	2	2
Dosewallips R.	1	0	0.0%	0	0	0	0	0	0	0	0	0	0	0	0.50	1	0
Mid-Hood Canal Total	63	4	6.3%	0	2	0	1	0	0	1	0	0	2	2	0.96	61	2
12C																	
Dewattor R.	45	3	6.7%	1	0	0	0	0	0	2	0	0	1	3	1.00	45	0
Eagle Creek	449	49	10.9%	3	0	0	37	0	6	3	0	2	3	43	1.00	449	0
Lilliwaup R.	2	0	0.0%	0	0	0	0	0	0	0	0	0	0	0	0.00	0	2
12D																	
Tahuya R.	2	0	0.0%	0	0	0	0	0	0	0	0	0	0	0	0.37	1	1
Union R.	70	70	100.0%	0	0	0	26	44	0	0	0	0	0	26	0.37	26	44
Hood Canal Total	3,090	386	12.5%	23	26	0	274	51	6	6	0	2	49	303	0.95	2,937	153

^{1/} AD = Adipose fin-clipped; NM = No Mark; Unk = Unknown

^{2/} Visual detection only life fish at the trap

^{3/} Supplementation Origin Fish calculated from otolith recoveries

^{4/} SOR for Hamma applied due to low sample size

^{5/} Estimates based on mark sampling data only, not yet corrected for clip error or cwt detection rates, resulting in conservative, provisional estimates

Table 4-24. Chinook salmon spawner escapement origin based on carcasses sampled for marks and coded-wire tags (CWTs) in Hood Canal rivers, 2018.

	Age				Total
	2.1	3.1	4.1	5.1	
Mark rate	0.876	0.867	0.896	0.918	
ADB	0	6	5	0	
ADNB	17	55	34	1	
ADUkn				8	
ADNH					
Total ad-clipped	17	61	39	9	126
expanded	19	70	44	10	143
UMB	4	6	4	0	
UMNB	2	2	3	6	
UMNH	0	0	1	0	
Total no clip	6	8	8	6	
Total mark status known	23	69	46	15	153
Proportion Hatchery Origin Spawners (pHOS)					0.935

*Excluding fish < 49cm in sample

AD = Adipose-clipped (marked)

UM = Unmarked

NB = no CWT detected

B = CWT detected

NH = No head

4.12 Dungeness

Since 1986, surveys by foot have been conducted throughout the spawning season from RM 0.0 to 18.7 in the mainstem Dungeness, and from RM 0 to 5.1 in the Gray Wolf mainstem, to generate a cumulative redd count for the season. The total redd count is multiplied by 2.5 to estimate the total number of adults. In 2018, 303 Chinook redds were counted in the Dungeness River and 12 redds were counted in the Gray Wolf (Table 4-25). The estimated number of natural spawners in the river was 758 and 30 adults, respectively. There were an additional 117 adults either trapped or netted from the river for the hatchery broodstock program including five pond mortalities. The total estimated return to the river was 905.

Table 4-25. The distribution of Chinook redds in the Dungeness Rivers system, 2018.

2018 Dungeness River and Gray Wolf Chinook Redds				2.5 adults/redd		
Season summary				New redds	Proportion	Est. adults
Upper River						
	WRIA	Lower RM	Upper RM			
Gold Cr (18.0121)	18.0121	RM 0.0	RM 0.3	0	0.0000	0
Dungeness R (18.0018)	18.0018	RM 17.5	RM 18.7	5	0.0159	13
Dungeness R (18.0018)	18.0018	RM 15.8	RM 17.5	30	0.0952	75
Dungeness R (18.0018)	18.0018	RM 13.8	RM 15.8	13	0.0413	33
Dungeness R (18.0018)	18.0018	RM 10.8	RM 13.8	24	0.0762	60
Gray Wolf R (18.0048)	18.0048	RM 0.0	RM 1.0	6	0.0190	15
Gray Wolf R (18.0048)	18.0048	RM 1.0	RM 2.5	6	0.0190	15
Gray Wolf R (18.0048)	18.0048	RM 2.5	RM 4.0	0	0.0000	0
Gray Wolf R (18.0048)	18.0048	RM 4.0	RM 5.1	0	0.0000	0
				84	0.2667	210
Lower River						
Canyon Cr (18.0038)	18.0038	RM 0.0	RM 0.2	0	0.0000	0
Dungeness R (18.0018)	18.0018	RM 9.2	RM 10.8	31	0.0984	78
Dungeness R (18.0018)	18.0018	RM 6.4	RM 9.2	76	0.2413	190
Dungeness R (18.0018)	18.0018	RM 3.3	RM 6.4	77	0.2444	193
Dungeness R (18.0018)	18.0018	RM 0.3	RM 3.3	47	0.1492	118
				231	0.7333	578
Grand total				315	1.0000	788

Since 1986, the Dungeness River Chinook total returns have ranged from 50 in 1997 to 1,543 in 2006. The decreases in escapement of Dungeness spring Chinook relative to recent years and relative to forecast are partially due to the termination of the captive brood program after the 2002 brood, and resulting decrease in numbers of hatchery juveniles released.

CWT Recoveries

Each carcass observed on the spawning ground and those collected and used for broodstock were sampled. Information, such as, fork length, post orbital hypural (POH) length, gender, mark status (adipose fin present or absent), scales, otoliths, DNA, gill

condition, and tag presence were collected. If a CWT had been detected, the snout was removed and a label was attached for identification.

We sampled 196 carcasses (n=117 broodstock collection and mortalities and 79 from natural spawners in the river). Of the total number of carcasses sampled, 160 of 196 (81.6%) were tagged (Table 4-26). Eight Chinook carcasses with CWT were strays originating from other watersheds. Age-2 Chinook were not used for escapement expansion estimates.

Table 4-26. The number of CWT recoveries from Dungeness River Chinook salmon collected from broodstock collections and on spawning ground surveys (SGS) in the Dungeness and Gray Wolf rivers in 2018.

Recovery type	Carcass sample size	# carcasses with CWT	Prop. Snouts detected with CWT	No. carcasses with no tag detected	Prop. no tag detected
Broodstock collection and mortalities	117	92	0.7863	25	0.2136
Spawning Ground Surveys (SGS)	79	68	0.8607	11	0.1392
Total sample size	196	160 ¹	0.8163	36	0.1837

¹ One tag was lost

Of the 159 tagged fish decoded and excluding one tag that was lost, 2 (1.3%) were age 2, 65 (40.9%) age 3, 91 (57.2%) age 4, and 1 (0.6%) were age 5. Eight-Elwha Hatchery origin Chinook had strayed into the Dungeness River (Table 4-26).

Based on the CWT results and scale samples analyzed, the preliminary NOR/HOR composition for Return Year (RY) 2018 was 147 (16.2%) NOR and 758 (83.8%) HOR. The ages of the NOR Chinook for RY2018 consisted of 44.9% age-3, 51.7% age-4, 3.4% age-5, and 0.0% age-6. The ages of the HOR Chinook for RY2018 consisted of 0.7% age-2, 40.5% age-3, 58.2% age-4, 0.7% age-5, and 0.0% age-6. The ages of all Chinook for RY2018 combined were 0.6% age 2, 41.2%% age-3, 57.1% age-4, 1.1% age-5, and 0.0% age-6 (Table 4-27).

Table 4-27. Total number and percentages of Age 3, Age 4, and Age 5 HOR and NOR Chinook returns in 2018. Does not include nine age 2 HOR in broodstock collection.

	NOR	Percentage	HOR	Percentage	Total	Percentage
Age-2	0	0.0%	5	0.7%	5	0.6%
Age-3	66	44.9%	307	40.5%	373	41.2%
Age-4	76	51.7%	441	58.2%	517	57.1%
Age-5	5	3.4%	5	0.7%	10	1.1%
Age-6	0	0.0%	0	0.0%	0	0.0%
Total	147	100.0%	758	100.0%	905	100.0%

From 2006 to 2017, the total Dungeness River Chinook NOR plus HOR returns ranged from 204 to 1,543 (Table 4-28). The number of NOR Chinook returns ranged from 43 to 339 and the number of HOR returns ranged from 90 to 1,204. The thirteen year averages for NOR and HOR were 149 (27.1%) NOR and 400 (72.9%) HOR, respectively.

Table 4-28. Total number of NOR and HOR natural spawners and broodstock in the Dungeness River for return years 2006-2018.

Return year	Natural spawners NOR ¹	Natural spawners HOR ¹	Natural spawners NOR+HOR	Broodstock collection NOR ²	Broodstock collection HOR ²	Broodstock collection NOR+HOR	Natural spawners + Broodstock NOR	Natural spawners + Broodstock HOR	Total returns NOR+HOR
2006	293	1,112	1,405	46	92	138	339	1,204	1,543
2007	146	159	305	47	51	98	193	210	403
2008	86	54	140	53	36	89	139	90	229
2009	71	57	128	42	50	92	113	107	220
2010	76	269	345	18	94	112	94	363	457
2011	83	452	535	21	109	130	104	561	665
2012	212	296	508	38	68	106	250	364	614
2013	46	122	168	31	79	110	77	201	278
2014	21	87	108	22	74	96	43	161	204
2015	65	200	265	37	105	142	102	305	407
2016	135	273	408	30	77	107	165	350	515
2017	149	456	605	26	74	100	175	530	705
2018	127	661	788	20	97	117	147	758	905
Avg.	116.2	322.9	439.1	33.2	77.4	111.2	149.3	400.3	550.2

¹ Natural spawners: Chinook that spawned naturally in the river. Natural spawner estimate based on redd surveys.

² Broodstock collection: Chinook that were collected in the river or returned to the hatchery and used for broodstock. Total includes pre-spawn mortalities.

³ NORs and HORs determined by CWT detection, otolith marks, scales, or visible marks (adipose clips) from broodstock and river carcasses sampled.

4.13 Elwha River

The Elwha Dam removal project began in September 2011 and was completed by March 2012. The natural river flow was restored through the former Lake Aldwell. Prior to September 2012, Chinook spawning in the Elwha River was limited to the 4.8 miles below the dam with most natural spawning concentrated between RM 2.8 and 4.4. In August 2014, the Glines Canyon Dam was removed. Before dam removal, Chinook surveys were conducted by raft and foot surveys. SONAR technology is being used in the Elwha River as a method to improve enumeration of Chinook passage during the entire run from June through September. This technology will improve Chinook escapement estimates due to the difficulty of observing redds and fish in turbid water conditions caused by the removal of the two dams. Denton et. al. (2018) used an ARIS 1800 and a DIDSON LR (long-range) multi-beam sonar system to enumerate Chinook salmon in the Elwha River on a daily basis from June 6h to September 18, 2018. For RY 2018, their best total return estimate for Chinook salmon was 7,107 fish with a calculated 95% CI (6,598 – 7,821).

The 2018 hatchery component of the Elwha Chinook Forecast terminal run size employed the return per spawner rates, with 4, 5, and 6 year old rates adjusted by the brood's previous performance. The adjustment is a multiplier consisting of the previous year's return rate divided by the mean return for that age. The wild (natural origin) return was estimated from 3 years of breakouts using otoliths and CWTs. The wild component of the returns has been rather consistently 5.5% of the total but otoliths have not been analyzed for 2018.

Peak Spawning Ground Surveys and Redd Distribution

To determine the 2018 spatial distribution and density of Chinook redds in the Elwha River after dam removal, the Lower Elwha Klallam Tribe (LEKT), Washington Department of Fish and Wildlife (WDFW), and Olympic National Park (ONP) personnel conducted extensive surveys during the peak spawning period (September 19-27) in the upper, middle, and lower watersheds. The Upper Elwha section is from Mills at Rkm 23.4 to Rkm midpoint 43.8, the Middle Elwha from Glines Power (Rkm 20.6) to Aldwell North (Rm 8.8), and the Lower Elwha from Lower Dam (Rkm 7.3) to Hunt Channel (Rkm 2.0). Of 1601 redds observed, 211 (13.2%) redds were in the Upper Elwha, 909 (56.8%) in the Middle Elwha, and 481 (30.0%) in the Lower Elwha. In addition to recording the number of redds, surveyors recorded the number of live and dead Chinook (Table 4-29, McHenry et al. 2018).

Table 4-29. 2017 Elwha River Chinook salmon spawners from Upper Watershed Dam to the mouth (McHenry et al. 2018).

Survey Reach	Rkm midpoint	Redds	Redds/km	Live Chinook	Dead Chinook	Jacks
Upper Elwha						
Upper Watershed	43.8	5	0.2	6	0	0
Long Creek		0	0	0	0	0
Geyser Valley	28.8	11	1.8	5	3	0
Cat Creek		25	25	26	10	0
Boulder Creek		21	42	91	25	1
Mills	23.4	149	32.4	129	32	1
UE Subtotal		211		257	70	2
		13.2%				
Middle Elwha						
Glines Power.	20.6	71	64.5	91	26	0
Altaire Bridge	19.5	28	28	112	45	0
Griff Creek	18.5	42	42	38	55	0
Rabbit Hole (Hughes)	17.3	132	88	133	65	0
Fisherman's C.	16.1	49	61.2	18	37	0
ONP Boundary	14.7	33	16.5	26	18	1
McDonald Br.	12.9	43	26.9	49	15	0
Little River	12.2	63	33.2	108	52	0
Indian Creek	12.1	144	75.8	97	58	0
Aldwell South	11	206	89.6	149	115	0
Aldwell North		98		62	71	0
ME Subtotal	8.8	909	51.6	883	557	1
		56.8%				
Lower Elwha						
Elwha Dam	7.3	84	70	151	40	0
Hwy 112 Bridge	6.1	186	97.9	182	104	0
County Bridge	3.8	87	43.5	-	-	-
East Channel	1.4	82	29.3	-	-	-
Hunt Rd. Chan.	2	42	26.3	26	29	0
LE Subtotal		481		359	17	
		30.0%				
TOTAL		1,601		1,499	800	3

Source: McHenry et al. 2018. Spatial distribution of Chinook salmon (*Oncorhynchus tshawytscha*) spawning in the Elwha River, Washington State during dam removal and early stages of recolonization (2012-2018).

In addition to SONAR enumeration and peak spawning ground surveys, adult Chinook were collected by various methods for broodstock purposes in the lower river. WDFW hatchery staff collected salmon for broodstock by net, seine, gaff, and trap methods. Hatchery personnel collected 2,320 Chinook (1,420 males, 880 females, 20 jacks) from the traps and river for broodstock for the hatchery program. Due to an excess of males and females, 500 males, 29 females and 16 jacks, hatchery staff trucked the fish upstream and released them into the river to spawn naturally. The number of males, females, and jacks used for broodstock were 794, 744, and 2,

respectively. The terminal run size to the river was based on the SONAR estimate of 7,101 Chinook. Excluding jacks, the total number of Chinook that spawned naturally in the Elwha River and its tributaries was 5,330 adults. This number was calculated by subtracting the number of Chinook that were collected for broodstock from the SONAR estimate (Table 4-30).

Table 4-30. Chinook broodstock collection, estimated total adult return, and estimated number of natural spawning fish Elwha River in 2018.

Capture method	No. Males	No. Females	Total adults	No. Jacks	Total adults incl jacks
Gaff-Hook and line	52	214	266	0	266
Seining-Gill netting	616	438	1,054	2	1,056
Elwha Hatchery Trap Volunteers	731	177	908	18	926
Lower Elwha Hatchery transfers	21	51	72	0	72
Total broodstock collection	1,420	880	2,300	20	2,320
<u>Minus</u> Elwha Hatchery Trap Volunteers Returned back to the river to spawn naturally	-500	-29	-529	-16	-545
Total broodstock collection	920	851	1,771	4	1,775
Mortalities in raceways	126	107	133	2	135
SONAR adult estimate			7,101		
Estimated natural spawners in river			5,330		

Natural spawners = SONAR estimate of 7,101 minus adult broodstock collection of 1,771 = 5,330 natural escapements.
Data source: Hatchery broodstock collection numbers from Troy Tisdale, WDFW Hatchery Manager.

Sampling Collection

WDFW personnel sampled carcasses using the methods described in Weinheimer et al (2018). Carcasses were sampled in the mainstem river (CS) and from broodstock collected by WDFW hatchery staff using seines and nets (Net) and fish returning to the Lower Elwha Klallam tribal hatchery (LEKT) and WDFW Elwha Rearing Channel (Volunteers). WDFW staff sampled carcasses for fork length (cm), post-orbital hypural length (POH), sex, scales, otoliths, presence of CWT tag, checked for clipped adipose fin, and a DNA fin clip if fish gills showed a coloration of better than 50%. During each sampling day and after all samples were collected (sampled group), personnel would tally the remaining spawned fish for sex, marks, and tags (non-sampled group). No scales, otoliths, or DNA were collected from this group. If a tag was detected in a fish, then the snout was removed, labeled, and bagged. Summaries of the sampled and non-sampled groups were given to the hatchery manager for their records. Four hundred and fifty carcasses were sampled in the river and 312 broodstock carcasses were sampled at the WDFW Elwha Hatchery adult raceways for a total of 762. All broodstock and carcass survey results in this report are preliminary until all age, mark, otolith and CWT results are verified.

Evaluating hatchery mark rates

The primary hatchery marking strategy for brood years of Elwha Chinook salmon expected to return in 2018 was a thermal otolith mark. Avoidance of the adipose clip was intended to reduce vulnerability to mark selective fisheries. Most hatchery Chinook salmon are released

into the Elwha River as sub-yearlings, but there is also a smaller yearling release group (Table 4-31).

In some years, equipment malfunctions limited the capacity to induce thermal otolith marks. Thermal otolith marks require sequentially altering water temperature during embryonic development in a prescribed protocol over the course of approximately 1-3 weeks, and specialized chillers are required to accomplish this task.

Table 4-31. Releases of hatchery Chinook in the Elwha River Basin, brood years 2013-2016.

Brood Year	Type	Thermal Otolith	Thermal Otolith + CWT	CWT	AD + CWT + Thermal Otolith	Total
2013	Subyearling	2,388,947	0	0	251,024	2,639,971
	Yearling	0	177,945	0	0	177,269
2014	Subyearling	2,429,097	0	0	250,295	2,679,392
	Yearling	0	158,799	0	0	158,799
2015	Subyearling	2,429,097	0	0	250,072	2,646,442
	Yearling	0	155,400	0	0	158,400
2016	Subyearling	585,431	0	0	249,206	834,637
	Yearling	0	154,760	0	0	154,760

River Carcass Recoveries

WDFW, LEKT, and ONP biologists and technicians sampled river carcasses from fish that spawned naturally in the river. Chinook carcasses were sampled between September 12 and October 4, 2018. Based on redd numbers from previous spawning seasons, the period between September 19 and September 26 provided the best opportunity for the peak redd count and sampling carcasses.

Biologist and technicians sampled 450 Chinook river carcasses throughout the spawning season. Of this total, 374 (83.1%) had readable scales. The highest number of river carcass samples collected in a one-week period occurred during the week of Sept 19-26, 389 (86.4%). Ten percent of the carcasses were sampled after October 1 as spawning declined significantly. Of the 374 carcasses that were successfully aged, 1 (0.3%) was age 2, 203 (54.3%) were age 3, 168 (44.9%) were age 4, and 0.5% were age 5 (Table 4-32).

Table 4-32. 2018 readable scale samples taken from Elwha Chinook collected during river carcass surveys.

Method	Mark	Age 2 ₁	Age 3 ₁	Age 3 ₂	Age 4 ₁	Age 4 ₂	Age 5 ₁	Age 5 ₂	Total	Percentage
CS	ADB	0	12	0	5	0	0	0	17	4.55%
CS	ADNB	0	0	0	2	0	0	0	2	0.53%
CS	UMB	0	6	1	0	1	0	2	10	2.67%
CS	UMNB	0	155	1	138	1	0	0	295	78.88%
CS	UDNB	0	0	0	1	0	0	0	1	0.27%
CS	Blank	1	28	0	20	0	0	0	49	13.10%
Total		1	201	2	166	2	0	2	374	100.00%
Percentage		0.27%	53.74%	0.53%	44.39%	0.53%	0.00%	0.53%	100.00%	

The abbreviations in the Mark column represent the number of fish in each of the following categories: ADB = adipose clipped + Beep (CWT detected); ADNB = adipose clipped + No Beep (no CWT detected); UMB = Unmarked + Beep (CWT detected); UMNB = Unmarked + No Beep (No CWT detected); UDNB=Undetermined mark + No Beep (No CWT detected); BLANK= Unknown marking.

Broodstock Collection:

We sampled 66% of the netted fish that were transported from the river to the WDFW Hatchery. One hundred percent of the adults collected at the LEKT Hatchery (29) and the volunteers to the WDFW Hatchery (77) were sampled. We did not sample any river-gaffed fish during the 2018 season.

Biologists and technicians sampled broodstock (BS) carcasses on three different spawning days. The following dates, September 11, 18, and 25, provided an excellent opportunity to collect scale, otolith, DNA, and to check for marked and tagged fish during the prime spawning period. For the three spawning days, 312 of 950 or 32.8% of the fish were sampled. Of the total sampled and non-sampled fish, 160 of 502 males (31.8%) and 152 of 448 females (33.9%) were sampled.

Of the 312 broodstock scale samples collected, 285 (86.5%) were successfully aged in the laboratory. Of the 285 carcasses that were successfully aged, 129 (45.3%) were age 3, 153 (53.6%) were age 4, and 1.1% were age 5 (Table 4-33).

Table 4-33. Readable scale samples collected from Elwha Chinook broodstock, LEKT transfers to the WDFW Elwha hatchery, and volunteers.

Method	Mark	Age 2 ₁	Age 3 ₁	Age 3 ₂	Age 4 ₁	Age 4 ₂	Age 5 ₁	Age 5 ₂	Total	Percentage
LEKT, NET, VOL	ADB	0	11	0	3	0	0	1	15	5.26%
LEKT, NET, VOL	ADNB	0	1	0	2	0	0	0	3	1.05%
LEKT, NET, VOL	UMB	0	1	0	3	2	0	2	8	2.81%
LEKT, NET, VOL	UMNB	0	116	0	143	0	0	0	259	90.88%
LEKT, NET, VOL	UDNB	0	0	0	0	0	0	0	0	0.00%
LEKT, NET, VOL	Blank	0	0	0	0	0	0	0	0	0.00%
Total		0	129	0	151	2	0	3	285	100.00%
Percentage		0.00%	45.26%	0.00%	52.98%	0.70%	0.00%	1.05%	100.00%	

Of the 762 scale samples collected, 659 (86.5%) were successfully aged in the laboratory. Of the 659 carcasses that were successfully aged, 332 (50.4%) were age 3, 321 (48.7%) were age 4, and 0.8% were age 5 (Table 4-34).

Table 4-34. Redable scales samples from carcass surveys and Elwha chinook transferred and volunteered to WDFW Elwha hatchery.

Method	Mark	Age 2 ₁	Age 3 ₁	Age 3 ₂	Age 4 ₁	Age 4 ₂	Age 5 ₁	Age 5 ₂	Total	Percentage
CS, LEKT, NET, VOL	ADB	0	23	0	8	0	0	1	32	4.86%
CS, LEKT, NET, VOL	ADNB	0	1	0	4	0	0	0	5	0.76%
CS, LEKT, NET, VOL	UMB	0	7	1	3	3	0	4	18	2.73%
CS, LEKT, NET, VOL	UMNB	0	271	1	281	1	0	0	554	84.07%
CS, LEKT, NET, VOL	UDNB	0	0	0	1	0	0	0	1	0.15%
CS, LEKT, NET, VOL	Blank	1	28	0	20	0	0	0	49	7.44%
Total		1	330	2	317	4	0	5	659	100.00%
Percentage		0.15%	50.08%	0.30%	48.10%	0.61%	0.00%	0.76%	100.00%	

Hatchery mark rates

Four-hundred and forty five and 312 otolith samples were taken during river carcass surveys and hatchery broodstock, respectively. Of the 659 fish that could be aged by scales, 37 were adipose clipped, 572 were unmarked, and 50 fish could not be positively identified for a mark.

Hatchery Origin Returns (HOR) and Natural Origin Returns (NOR) will be finalized after all of the otolith samples have been analyzed and CWTs have been matched with individual fish. False CWT detections can occur and the number of CWT fish in the table could be lower. Fish that could not be aged because of unreadable scale samples may be aged from otolith marked samples or decoded tags.

CWT Data

We collected CWTs from 55 fish in the Elwha River watershed during fall 2018. In addition, three snouts were submitted to the CWT Lab but they did not have a tag. Thirty of the CWTs were recovered from river carcasses and the remaining 25 from Chinook broodstock (Table 4-35). The majority of the CWTs originated from releases into the Elwha River, but some were derived from releases into the neighboring Morse Creek (N = 3), Dungeness (N= 2) and Gray Wolf (N=1) watersheds. The Morse Creek Chinook are Elwha stock origin. We sampled one fish that originated from East Sound Bay (N=1). Of the 55 CWTs recovered, 36 were from adipose clipped fish originating from Elwha releases. Of the 36 marked fish, 1 was from brood year 2013, 8 from brood year 2014, and 27 from brood year 2015. The ages of the tagged fish were (67.3%) age 3, 20.0% age 4, and 12.7% age 5 (Table 4-35).

Table 4-35. 2018 CWT's recovered from naturally spawning chinook during carcass surveys and from broodstock collections.

2018 CWTs Recovered from Naturally Spawning Chinook during Carcass Surveys and from Broodstock Collections							
Collection Method-Tag Code	Tag Code	Release Site	Mark Status	Brood year 2013	Brood year 2014	Brood year 2015	Grand Total
Carcass Survey	211109	GRAY WOLF R 18.0048	Unmarked			1	1
Carcass Survey	211112	DUNGENESS R 18.0018	Unmarked			2	2
Carcass Survey	636614	MORSE CR 18.0185	Unmarked	1			1
Carcass Survey	636624	MORSE CR 18.0185	Unmarked	1			1
Carcass Survey	636671	ELWHA R 18.0272	Unknown mark	1			1
Carcass Survey	636812	ELWHA R 18.0272	Unmarked		1		1
Carcass Survey	636833	ELWHA R 18.0272	AD Fin Clip		5		5
Carcass Survey	636956	ELWHA R 18.0272	Unmarked			1	1
Carcass Survey	636963	ELWHA R 18.0272	AD Fin Clip			12	12
Carcass Survey	636963	ELWHA R 18.0272	Unmarked			2	2
Carcass Survey	636963	ELWHA R 18.0272	Unknown mark			2	2
Carcass Survey	637047	EAST SOUND BAY (SAN)	AD Fin Clip			1	1
Carcass Survey				3	6	21	30
LEKT	636812	ELWHA R 18.0272	Unmarked		2		2
LEKT	636963	ELWHA R 18.0272	AD Fin Clip			2	2
LEKT				0	2	2	4
NET	636614	MORSE CR 18.0185	Unmarked	1			1
NET	636671	ELWHA R 18.0272	AD Fin Clp	1			1
NET	636671	ELWHA R 18.0272	Unmarked	2			2
NET	636833	ELWHA R 18.0272	AD Fin Clp		2		2
NET	636963	ELWHA R 18.0272	AD Fin Clp			10	10
NET	636963	ELWHA R 18.0272	Unmarked			1	1
NET				4	2	11	17
VOL	636833	ELWHA R 18.0272	AD Fin Clp		1		1
VOL	636963	ELWHA R 18.0272	AD Fin Clp			3	3
VOL				0	1	3	4
Grand Total				7	11	37	55
Percentage				12.7%	20.0%	67.3%	100.0%

DNA Collection

We collected 460 DNA fin clips, 148 from river carcasses and 312 from the broodstock collection. These samples are stored for future analysis at the WDFW Molecular Genetics Laboratory.

4.14 Hoko

WDFW and Makah Fisheries Management staff conducted foot surveys to count live and dead Chinook and Chinook redds in the mainstem between river miles 2.8 to 21.7 and tributaries, which represents all Chinook spawning area in the Hoko basin. There are ten mainstem and 13 tributary reaches, which include the Little Hoko River, a tributary to the lower mainstem, and Browne's, Herman, North Fork Herman, Ellis, Bear, and Cub creeks, which are tributaries to the upper mainstem. WDFW conducted surveys from RM 2.8 to 10.1 during the 2018 return year and observed 219 redds (Table 4-36) and Makah Fisheries Management (MFM) counted 22 redds (Table 4-37).

Table 4-36. Chinook redd surveys in mainstem Hoko River from RM 2.8 - RM 10.1 by DFW in 2018.

Survey Date	End River Mile	Start River Mile	Total Live	Total Dead	New Redds	Visible Redds	Survey visibility	Stream flow	Survey Comment
2018-10-03	RM 9.80	RM 10.10	128	0	47	47	Excellent	Low	
2018-10-09	RM 9.80	RM 10.10	330	15	20	67	Excellent	Moderate	240 floy tags observed
2018-10-17	RM 9.80	RM 10.10	234	3	36	102	Excellent	Low	6 green floy tags observed
2018-10-22	RM 9.80	RM 10.10	141	6	30	115	Excellent	Low	
Total redds					133				
2018-10-17	RM 2.80	RM 3.40	0	0	1	1	Very good	Moderately-low	
Total redds									
2018-10-03	RM 3.40	RM 4.40	0	0	0	0	Excellent	Low	
2018-10-09	RM 3.40	RM 4.40	0	0	0	0	Very good	Moderately-low	
2018-10-17	RM 3.40	RM 4.40	0	0	0	0	Very good	Moderately-low	
2018-10-24	RM 3.40	RM 4.40	0	0	0	0	Excellent	Low	
Total redds					0				
2018-10-03	RM 4.40	RM 5.60	3	0	4	4	Excellent	Low	
2018-10-09	RM 4.40	RM 5.60	2	0	1	2	Very good	Moderate	
2018-10-17	RM 4.40	RM 5.60	1	0	5	10	Very good	Moderately-low	
2018-10-24	RM 4.40	RM 5.60	0	0	2	11	Excellent	Low	
Total redds					12				
2018-10-03	RM 5.60	RM 7.50	4	0	1	1	Good	Moderately-low	
2018-10-10	RM 5.60	RM 7.50	26	0	19	20	Very good	Moderately-low	
2018-10-17	RM 5.60	RM 7.50	20	0	8	19	Excellent	Low	
2018-10-24	RM 5.60	RM 7.50	9	0	15		Excellent	Moderately-low	
Total redds					43				
2018-10-03	RM 7.50	RM 8.70	1	0	8	8	Good	Moderately-low	
2018-10-10	RM 7.50	RM 8.70	28	0	5	13	Very good	Moderately-low	
2018-10-17	RM 7.50	RM 8.70	46	1	15	26	Excellent	Low	
2018-10-24	RM 7.50	RM 8.70	11	0	2	28	Very good	Moderately-low	
					30				
Season total redds					219				

Table 4-37. Summary of Hoko and Sekiu Chinook surveys by Makah Fisheries Management staff in 2018.

River	WRIA	Date	Upper RM	Lower RM	Live	Redd	Dead
Browns	19.0170	9/6/2018	0.59	0.00	0	0	0
Browns	19.0170	9/6/2018	0.97	0.59	0	0	0
Browns	19.0170	9/27/2018	0.59	0.00	0	0	0
Browns	19.0170	9/27/2018	0.97	0.59	0	0	0
Browns	19.0170	10/8/2018	0.59	0.00	20	0	0
Browns	19.0170	10/8/2018	0.97	0.59	0	0	0
Browns	19.0170	10/15/2018	0.59	0.00	0	0	0
Browns	19.0170	10/15/2018	0.97	0.59	0	0	0
Browns	19.0170	10/30/2018	0.97	0.59	0	0	0
Browns	19.0170	10/30/2018	0.59	0.00	0	0	0
Totals					20	0	0
Little Hoko	19.0149	9/18/2018	2.00	0.00	0	0	0
Little Hoko	19.0149	10/1/2018	2.00	0.00	0	0	0
Little Hoko	19.0149	10/11/2018	2.00	0.00	0	3	0
Little Hoko	19.0149	10/18/2018	2.00	0.00	0	0	0
Totals					0	3	0
NF Herman's	19.0183	10/5/2018	0.37	0.00	0	0	0
NF Herman's	19.0183	10/12/2018	0.37	0.00	0	0	0
Herman's	19.0182	10/5/2018	2.00	0.00	0	0	0
Herman's	19.0182	10/12/2018	2.00	0.00	3	0	0
NF Herman's	19.0183	10/24/2018	0.37	0.00	0	0	0
Herman's	19.0182	10/24/2018	2.00	0.00	0	0	0
Totals					3	0	0
Hoko	19.0148	10/17/2018	11.00	10.10	7	0	0
Hoko	19.0148	10/17/2018	13.00	11.00	6	1	0
Hoko	19.0148	9/20/2018	15.50	13.00	0	0	0
Hoko	19.0148	10/5/2018	15.50	13.00	6	3	0
Hoko	19.0148	10/12/2018	15.50	13.00	66	3	0
Hoko	19.0148	10/24/2018	15.50	13.00	0	11	0
Totals					72	17	0
Hoko	19.0148	9/20/2018	18.50	15.50	2	0	0
Hoko	19.0148	10/1/2018	18.50	15.50	6	0	0
Hoko	19.0148	10/12/2018	18.50	15.50	21	0	0
Hoko	19.0148	10/24/2018	18.50	15.50	14	1	3
Totals					43	1	3
Hoko	19.0148	10/4/2018	20.40	18.50	0	0	0
Hoko	19.0148	10/11/2018	20.40	18.50	1	0	0
Hoko	19.0148	10/22/2018	20.40	18.50	0	0	0
Totals					1	0	0
Hoko	19.0148	10/4/2018	21.70	20.40	0	0	0
Hoko	19.0148	10/11/2018	21.70	20.40	0	0	0
Hoko	19.0148	10/22/2018	21.70	20.40	0	0	0
Hoko	19.0148	10/11/2018	23.70	21.70	0	0	0
Totals					0	0	0
Ellis	19.0192	10/2/2018	0.45	0.00	0	0	0
Ellis	19.0192	10/12/2018	0.45	0.00	0	0	0
Ellis	19.0192	10/24/2018	0.45	0.00	0	0	0
Totals					0	0	0
Bear	19.0196	10/4/2018	0.66	0.00	0	0	0
Bear	19.0196	10/11/2018	0.66	0.00	0	0	0
Bear	19.0196	10/22/2018	0.66	0.00	0	0	0
Totals					0	0	0
Cub	19.0197	10/4/2018	0.37	0.00	0	0	0
Cub	19.0197	10/11/2018	0.37	0.00	0	0	0
Cub	19.0197	10/22/2018	0.37	0.00	0	0	0
Totals					0	0	0

In addition to the Hoko River surveys, Makah Fish Management staff surveyed the NF Sekiu River from RM 5.47 to RM 8.13 and the Sekiu River from RM 1.30 to RM 5.47. No Chinook redds were observed in either section and only two live Chinook were observed, one in each of the two streams.

Hoko Broodstock Collection

For the 2018 Hoko Chinook broodstock season, 175 females, 15,34 males, and 194 jacks returned to the Hoko Falls Hatchery pond facility. Of the 1,903 total fish that returned to the pond, 122 females, 114 males and 16 jacks were lethally spawned. The remaining 53 females and 1,420 males were released back to the river to spawn naturally (Table 4-38).

Table 4-38. Number of female, male, and jack Chinook that returned to the Hoko Falls Hatchery in 2018 that were spawned, released back to the river to spawn naturally, culled, surplused, and died before spawning.

Sex	Rack count	Mortality	Surplused	Lethal spawned (Viable)	Returned to stream
Female	175	0	0	-122	-53
Male	1,534	0	0	-114	-1,420
Total adults	1,709	0	0	-236	-1,473
Jack	194	0	0	-16	-178
Total fish	1,903	0	0	-252	-1,651

Source: Joe Hinton, Hoko Falls Hatchery Manager-Makah Tribe.

The 2018 escapement estimate for Hoko Chinook is 1,943 spawning in the river (natural origin and hatchery origin combined) and 236 returning to the hatchery for a terminal runsize (TRS) of 2,179. To prevent double counting salmon released from the hatchery back to the river to spawn naturally, the following methods were used to calculate the final TRS:

- 1) Hoko Falls Hatchery adult return 1,709 (175 females and 1,534 males).
- 2) Number of Chinook spawned at hatchery: 122 females and 114 males spawned = 236 adults broodstock.
- 3) To get an idea of hatchery returns released back to the river, 53 females and 1,420 males at the hatchery were released back to the river on October 8th. Of this total, 19 females, 740 males, and 130 jacks were floy tagged and released. On October 9, 345 live plus dead fish were counted, of which 240 were floy- tagged fish in the section close to the hatchery (RM 9.8-10.1). On October 12th, 19 females (12 tagged), 103 males (53 tagged), and 21 jacks (21 tagged) were recaptured at the hatchery and released back to the river for a second time. Six tags were observed on October 17 and 3 tags on October 23. Since there were only 53 females released back to the river, it was decided to calculate the number of river adult spawners before and after the release date.
- 4) Before the first release date October 8th, WDFW and Makah Fishery Management field staff (MFM) counted 67 redds (67 redds x 2.5 adults per redd = 167.5 fish). The 2.5 adults per redd is equal to one female and 1.5 males per redd.
- 5) After the October 8th release date, WDFW and MFM counted 174 redds (435 fish). We assumed that the 53 females returned to the river, spawned, and counted as part of the 174 redd count. The corrected redd count would be (174-53 =121 total redds or 302.5 fish).
- 6) Adding the corrected redd count of 121 to the 67 redds observed before the fish were released yields 188 redds or 470 adults.

- 7) Of the 1,709 adult Chinook returns to the Hoko Falls Hatchery, 1,473 adult Chinook (53 females and 1,420 males) were released back to the river to spawn naturally. Adding this number to the redd-based estimate of 470 adults from WDFW and MFM surveys, the number of natural spawners (HOR and NOR) in the river equals 1,943 fish. The Terminal Run Size (TRS) equals 2,179 adults when the 236 adult broodstock spawned at the hatchery were added. This total excludes jacks.

The number of hatchery origin and natural origin Chinook returning to either the Hoko falls Hatchery and the Hoko river could not be determined at the time of this report because scales have yet to be processed, however the totals are listed below (Table 4-39).

Table 4-39. Total broodstock and natural Chinook spawners in the Hoko river in 2018.

	Returns to Hatchery	In-River Spawners	Total	HOR Proportion
Total	236	1,943	2,179	NA

Data source: Hap Leon, Makah Fisheries Management.

5 Coded-wire Tag Sampling

Commercial and recreational catch is sampled to recover coded-wire tagged Chinook and coho. General objectives are to sample 20% of commercial catch in each area and week, and 10% of marine recreational catch in each area and month. Sampling rates for calendar year (January-December) 2017 are summarized below, and were based on catches reported by local biologists, and sample sizes queried from the RMIS database. Sampling rates of commercial fisheries in 2017 generally exceeded the 20% sampling objective, although 13A, 13C, 12C, and Strait of Juan de Fuca Troll were below 20% (Table 5-1). Marine area recreational fisheries were sampled at rates between 8.8% and 49% for the year (Table 5-2). Note that these data were updated just prior to completion of this report, and will be validated and corrected as needed prior to submission to update the RMIS (Regional Mark Information System) database.

Table 5-1. Chinook coded-wire tag sampling rates for commercial fisheries in 2017 (calendar year).

Catch Area/River	Catch	# Sampled	Sample Rate
7-7A	2,567	596	23%
7B-7C-7D-Nooksack River	19,912	6,944	35%
Skagit River/Bay	2,373	1,118	47%
8A	2	1	50%
8D	11,812	1,862	16%
Stillaguamish River	0	0	--
10	10	10	100%
10E	5,798	2,677	46%
10F	297	270	91%
10G	8	3	37%
10A	918	898	98%
Duwamish River	5,789	3,080	53%
Puyallup/White rivers	3,464	2,336	67%
Nisqually River	16,548	5,696	34%
13A	3,741	184	5%
13C	519	0	0%
13D-F	9,791	1,134	12%
9	45	15	33%
9A-12-12A-12B	252	34	13%
12C	16,995	1,256	7%
12H	24,592	6,573	27%
Skokomish River	16,640	2,119	13%
Purdy Creek	5,908	1,389	24%
Strait of JDF 4B-5-6 (Net)	53	17	32%
Strait of JDF 4B-5-6C (Troll) ^a	380	5	1%

^a Includes 4B Summer Troll catch for 2017.

Table 5-2. Chinook coded-wire tag sampling rates for marine recreational fisheries in 2017.

Catch Area	Catch	# Sampled	Sample Rate
Marine Sport Area 5	2,658	1,110	41.8%
Marine Sport Area 6	5,453	1,635	30.0%
Marine Sport Area 7	5,864	1,586	27.0%
Marine Sport Area 8.1/8.2	1,135	557	49.1%
Marine Sport Area 9	8,342	2,115	25.4%
Marine Sport Area 10	2,543	1,114	43.8%
Marine Sport Area 11	4,594	1,670	36.4%
Marine Sport Area 13	4,024	353	8.8%
Marine Sport Area 12	2,793	245	8.8%

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7 9-Year Spawning Escapements

Nooksack Early Management Unit. Spawning escapement in the South Fork Nooksack River, are a complex of multiple origin and run-timing Chinook populations. The portion of the complex estimated to be of SF early NOR returns are highlighted for convenience.

Year	N./Mid. Fork		South Fork					
	NOR	HOR	SF Native NOR	SF HOR	N. Fk Early NOR	Kendall Cr. HOR	Fall NOR	Fall/other HOR/Unk
2009	269	1,634	45		58	128	187	38
2010	204	1,844	21 (0)		43 (0)	293	107 (0)	29 (0)
2011	99	766	90 (3)		61 (1)	176	96 (1)	48 (8)
2012	281	477	116 (1)		172 (1)	79 (17)	93 (2)	42 (0)
2013	100	1,247	10 (1)		39 (0)	162 (39)	16 (2)	15 (2)
2014	91	1,307	22 (1)	10 (0)	56 (1)	99 (2)	11 (0)	10 (0)
2015	401	1,316	7 (0)	11 (0)	39 (0)	9 (0)	32 (0)	37 (0)
2016	187	735	319 (4)	302 (7)	179 (3)	32 (5)	86 (1)	39 (0)
2017								

Note: Numbers in parentheses represent additional pre-spawn mortalities encountered.

Skagit Springs Management Unit.

Year	Upper Sauk	Suiattle	Upper Cascade
2009	367	273	338
2010	768	263	330
2011	345	215	265
2012	1,826	460	488
2013	1,080	620	310
2014	923	460	225
2015	743	478	188
2016	1,502	648	295
2017	1,630	898	232

Skagit Summer/Falls Management Unit.

Year	Upper Skagit	Lower Sauk	Lower Skagit
2009	5,290	250	1,439
2010	6,644	356	1,017
2011	4,480	210	820
2012	9,808	715	3,295
2013	8,801	530	1,551
2014	8,308	364	1,785
2015	10,705	406	2,203
2016	15,423	1,044	2,921
2017	7,792	1,001	3,638

Stillaguamish Management Unit. Stillaguamish River escapement estimates for both summer and fall Chinook populations proportioned by HOR/NOR adult returns. Numbers in parentheses from represent additional fish (both HOR and NOR) collected for brood-stock (BS) utilization.

Year	MU Total	
	NOR (BS)	HOR (BS)
2009	434 (52)	805 (97)
2010	329 (58)	508 (82)
2011	521 (45)	1,116 (128)
2012	988 (109)	799 (70)
2013	602 (73)	395 (59)
2014	157 (57)	262 (87)
2015	399 (61)	320 (68)
2016	615 (76)	438 (65)
2017	730 (76)	685 (65)

Snohomish Management Unit.

Year	Skykomish		Snoqualmie	
	NOR	HOR	NOR	HOR
2009	1,146	268	649	246
2010	1,836	676	1,585	203
2011	881	299	479	221
2012	2,462	1,283	898	481
2013	1,860	495	770	119
2014	1,654	1,409	698	140
2015	1,585	1,449	694	135
2016	2,363	1,422	1,013	355
2017	2,783	1,591	1,401	344

Lake Washington Management Unit.

Year	Cedar River		Sammamish River	
	NOR	HOR	NOR	HOR
2009	574	139	25	899
2010	553	113	43	1,788
2011	647	163	25	715
2012	898	185	60	1,979
2013	1,591	260	93	2,240
2014	303	277	18	464
2015	1,176	632	49	939
2016	609	436	100	1,147
2017	1,557	491	N/A	N/A

Green River Management Unit.

Year	NOR	HOR
2009	165	523
2010	859	1,233
2011	459	534
2012	1,638	1,452
2013	524	1,517
2014	756	1,974
2015	864	3,223
2016	2,566	7,497
2017	2,011	6,346

Puyallup River Fall Management Unit.

Year	NOR	HOR
2009	538	1,027
2010	550	1,080
2011	487	1,093
2012	654	419
2013	252	596
2014	544	926
2015	984	1,140
2016	737	1,963
2017	840	1,079

White River Spring Management Unit.

Year	NOR	HOR	APP
2009	263	284	277
2010	239	126	362
2011	450	369	983
2012	808	204	1,119
2013	795	931	2,734
2014	218	105	637
2015	358	490	736
2016	645	501	2,851
2017	630		2,994

Nisqually River Management Unit.

Year	NOR	HOR
2009	185	687
2010	353	1,714
2011	302	1,962
2012	617	1,850
2013	738	933
2014	528	512
2015	715	790
2016	796	168
2017	1,049	1,991

Skokomish River Management Unit.

Year	NOR	HOR	Total
2009			1,066
2010	162	1,052	1,214
2011	54	1,267	1,321
2012	142	1,391	1,533
2013	171	1,551	1,722
2014	109	740	849
2015	117	315	432
2016	179	1,163	1,342
2017			8,058

Mid-Hood Canal Management Unit.

Year	Hamma Hamma	Duckabush	Dosewallips
2009	98	9	23
2010	91	0	15
2011	294	5	11
2012	425	6	7
2013	707	7	4
2014	117	13	11
2015	236	20	3
2016	268	15	8
2017	365	2	7

Dungeness River Management Unit.

Return year	Natural Spawners ^{1/}			Broodstock Collection ^{2/}			Total Returns (Natural Spawners + Broodstock)		
	NOR	HOR	Total	NOR	HOR	Total	NOR	HOR	Total
2009	71	57	128	42	50	92	113	107	220
2010	76	269	345	18	94	112	94	363	457
2011	83	452	535	21	109	130	104	561	665
2012	212	296	508	38	68	106	250	364	614
2013	46	122	168	31	79	110	77	201	278
2014	21	87	108	22	74	96	43	161	204
2015	65	200	265	37	105	142	102	305	407
2016	135	273	408	30	77	115	165	350	523
2017	166	439	605	26	74	100	192	513	705

1/ Natural spawners: Chinook that spawned naturally in the river. Natural spawner estimate based on redd surveys.

2/ Broodstock collection: Chinook that were collected in the river or returned to the hatchery and used for broodstock. Includes pre-spawned mortalities as well.

3/ NORs and HORs determined by CWT, otolith, scales, or visible marks from broodstock and river carcasses sampled.

Elwha River Management Unit.

Year	HOR/NOR
2009	2,192
2010	1,278
2011	1,862
2012	2,638
2013	4,243
2014	4,360
2015	4,112
2016	2,628
2017	3,100

Hoko River Management Unit.

Year	HOR/NOR
2009	385
2010	793
2011	1,504
2012	663
2013	1,406
2014	1,760
2015	2,877
2016	1,324
2017	1,225