

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

Puget Sound Chinook Comprehensive Harvest Management Plan

Annual Report
The 2021-2022 Fishing Season

May 2023

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Puget Sound Treaty Tribes:

Pete Kairis (Swinomish); Casey Ruff (Swinomish); Grant Kirby (Sauk-Suiattle); Ben Starkhouse, Mark Nelson, Devin Flawd, Donald Kruse, and Tom Chance (Lummi Nation); Ned Currence and Treva Coe (Nooksack Tribe); Bob McClure and Garret Rowles (Upper Skagit Tribe); Robert Roose (Stillaguamish); Mike Mahovich, Jason Schaffler, 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 Casey Schmidt (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:

Mark Downen, Randy Cooper, Andrew Fowler, Pete Verhey, Jennifer Whitney, Julie Klacan, Aaron Bosworth, Gabe Madel, Nathanael Overman, Dave Low, Kwasi Addae, Derek Dapp, Ty Garber, Christina Iverson, and Chad Herring.

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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, 2021 and April 31, 2022, and Chinook spawning escapement in 2021. It also includes harvest information relevant to the 2020-2021 non-treaty sport fishing seasons where Chinook retention was allowed and a review of the coded wire tag sampling rates in marine sport salmon fisheries during calendar year (January-December) 2020.

Commercial Chinook catch in Puget Sound pre-terminal and terminal fisheries was lower than projected pre-season in most fisheries except for some select terminal areas targeting terminal hatchery runs (i.e. Gorst Creek, Minter Creek, and Hoodspout Hatcheries).

Marine and freshwater landed recreational Chinook catch in fisheries where Chinook retention was allowed, based on catch record cards, in the 2020-2021 season was estimated at 32,946 compared to the pre-season projection of 40,963. Creel survey-based estimates of catch in 2021-2022 summer mark-selective recreational fisheries in Areas 5, 6, 7, 9, 10, and 11, winter MSF in Areas 10 and 11 as well as the North Fork Nooksack recreation spring Chinook MSF are included in this report. Total encounter estimates for intensively monitored 2020-21 summer marine area selective fisheries and the North Fork Nooksack recreational spring Chinook fishery are presented and compared to pre-season projections for these areas.

Escapement for summer/fall management units were generally comparable or greater than projected while most spring management unit escapement were generally greater than projected.

Coded-wire tag sampling rates for calendar year 2019 commercial fisheries exceeded 20% in most areas except for MCA 13D-F, Hood Canal marine areas, and Strait of JDF net and troll fishery. Sampling rates for marine recreational fisheries exceeded the 10% objectives in all areas except marine area 12.

1 Introduction

The Puget Sound Chinook Harvest Management Plan (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 fulfills that requirement and that of the Terms and Conditions in the 2021 Harvest Biological Opinion (F/WCR-2020-00690) by assessing the performance and effectiveness of treaty and non-treaty commercial fishery management actions adopted for the most recent management year, May 2021 through April 2022. Included in this report are:

- Management objectives for the 2021-2022 management year (May 1, 2021 through April 30, 2022)
- Projected and actual commercial landed catch in Puget Sound and descriptions of fisheries for the 2021-2022 management year
- Projected and actual landed catch for 2021 Puget Sound recreational fisheries where Chinook retention was allowed, and creel surveys were conducted as well as for 2020 Puget Sound recreational sport fisheries where Chinook retention was allowed.
- Estimates of total encounters for 2021 summer mark-selective fisheries and non-landed mortality for commercial fisheries with Chinook non-retention where data are available.
- Projected and actual 2021 spawning escapements for nearly all, except Nooksack spring Chinook, Puget Sound Chinook populations with details on estimation methods and surveys. For Nooksack Spring Chinook escapement estimates, details are provided for 2019 and 2020 escapements.
- 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 2020 (January to December 2020).

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 2021 (Table 1-1). The final pre-season FRAM model run (Chin3721) highlighted the rates that were used as the ceilings for each Management Unit (MU) in 2021, and the projected exploitation rates and escapements for each unit (Table 1-2).

Pre-season fishery planning for 2021-2022 fisheries projected that natural spawning escapement would fall below the Low Abundance Thresholds (LAT) for the Nooksack early, Skagit springs, Skagit summer/fall, Stillaguamish summer/fall, Snohomish summer/fall, 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. 2021 Puget Sound Chinook Harvest Management Objectives.

Management Unit	ER Ceiling	Critical ER Ceiling	Low Abundance Threshold
Nooksack			
North Fork		10.5% SUS	400 ^a
South Fork			200 ^a
Skagit summer / fall	48%	17% SUS	9,100 ^a
Upper Skagit summer			2,200 ^a
Sauk summer			400 ^a
Lower Skagit fall			900 ^a
Skagit spring	37.5%	10.3% SUS	823 ^a
Upper Sauk			130 ^a
Cascade			170 ^a
Suiattle			170 ^a
Stillaguamish	22% Total/13% SUS Max.	8% SUS Max.	1,200 ^b
Snohomish	9% SUS	8% SUS	3,250 ^a
Skykomish			2,015 ^a
Snoqualmie			1,132 ^a
Lake Washington	500	12% SUS	200
Cedar River	Escapement (13% PT SUS)		
	2,003		
Green	Escapement (13% PTSUS)	12% SUS	802
White River spring	22% SUS	15% SUS	400
	1,170		
Puyallup fall	Escapement (13% PT SUS)	15% SUS	400
Nisqually	47% + 2% Exp. Fishery	50% Reduction of SUS ER	6,300
Skokomish	50%	12% PTSUS	1,300 aggregate; 800 natural
Mid-Hood Canal	15% PTSUS	12.4% PTSUS	400
Dungeness	10% SUS	6% SUS	500
Elwha	10% SUS	6% SUS	1,500
Western SJDF	10% SUS	6% SUS	500

^a Abundance Thresholds are NOR specific.

^b 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 2021 – 2022 pre-season planning (FRAM Chin3721).

Management Unit	ERC or CERC implemented	Projected ER	Projected Escapement
Nooksack	10.5% SUS	10.5% SUS	464 ^a
Skagit summer fall	17% SUS	17.0% SUS	8,837 ^a
Skagit spring	10.3% SUS	10.3% SUS	1,442 ^a
Stillaguamish	22%Total/8% SUS	18.1%Total/7.4% SUS	990 ^b
Snohomish	8% SUS	6.3% SUS	2,936 ^a
L. Washington (Cedar)	500 Escapement / 13% PT SUS	11.5% PT SUS	778
Green	2,003 Escapement / 13% PT SUS	11.5% PT SUS	3,741
White	22% SUS	16.6% SUS	2,281
Puyallup	1,170 Escapement / 13% PT SUS	11.5% PT SUS	2,536
Nisqually	47% + 2% Exp. Fishery	47.7%	8,047
Skokomish	50%	49.2%	3,787
Mid Hood Canal	12.4% PT SUS	12.1% PT SUS	18
Dungeness	10% SUS	3.6% SUS	699
Elwha	10% SUS	3.8% SUS	4,089
Western SJDF	10% SUS	2.0% SUS	1,054

^a NOR specific escapement estimates.

^b 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 2021–22 List of Agreed Fisheries (<https://nwifc-fisherinesservices.s3.amazonaws.com/wp/wp-content/uploads/2022/11/04/172758/2021-2022-Active-LOAF-4-23-2021-REDUCED-.pdf>) describes 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 Chin3721.

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 2021–22 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 net and troll catch, including release mortalities from selective net fisheries, in waters of the Washington coast and Puget Sound fisheries in 2021.

Fishery	Projected	Actual
Washington ocean non-treaty troll	30,750	19,263
Washington ocean recreational	27,250	17,814
Washington ocean treaty troll	40,000	8,227
Puget Sound pre-terminal net & troll total		
Strait of Juan de Fuca troll	2,721	3,302
Strait of Juan de Fuca net	124	24
PSC Test Fishery		0
San Juan Islands net ^a	8,454	2,658
San Juan Islands/Bell. Bay C&S		11
Nooksack-Samish terminal net	13,186	9,840
Skagit terminal net	3,188	2,889
Stillaguamish-Snohomish net	6,007	1,674
South Puget Sound terminal net	30,117	36,728
Hood Canal terminal net	32,975	32,565
Strait Tributaries terminal net	0	3

^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 24 and 1,957 Chinook, respectively. Catch in the San Juan Islands areas occurred during the Fraser pink salmon directed fishery in late-August to mid-September, 2021.

Non-treaty fisheries targeting pink salmon in Areas 7 and 7A landed one Chinook. Because non-tribal purse seines are required to release all Chinook, release mortality estimates are calculated using available data from on-water by-catch monitoring. An estimated 700 Chinook release mortalities occurred during the chum directed non-tribal purse seine fishery in Area 7A.

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 3,302 Chinook. One thousand six hundred thirty-six Chinook were caught during the summer SJD troll fishery while 1,666 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 from during the 2021 season along with four limited community C&S openings. Total landed catch was 821 hatchery-origin Chinook and 15 natural-origin Chinook with an additional 41 natural-origin Chinook, along 62 CWT-only fish and one ad-clipped HOR encountered and released. Applying the expected release mortality rate of 30% to the 41 early-run NOR encounters results in 13 NOR estimated mortalities. The total encounter of NORs (n=56, including released and retained fish) was lower than the pre-season projection of 97 NORs. Genetic results for the released NORs are not currently available to determine population origin.

In 2021, the Nooksack Tribe conducted a permit only, subsistence fishery from May 21 through June 10, 2021. A total of 285 Chinook were caught in the traditional C&S fisheries and all were sampled. Two hundred fifty-one of the 285 chinook were clipped indicating Kendall hatchery origin. Twenty-six were non-clipped but with CWT indicating Skookum program origin. Of the eight with no ad-clip and no CWT, one was determined to be South Fork hatchery origin and two were Skookum HOR by parentage analysis. Of the remaining five NORs, four were determined to be NF/MF NOR origin and one SF NOR origin.

The Tribes 2021 total NOR mortality is estimated to be 33 early-run NORs, pending additional analysis of remaining biological samples. The pre-season projection was 39 NOR mortalities.

Table 2-2. Expected and observed Chinook catches in the Nooksack/Samish terminal area, 2021.

Area	Management Period	Projected	Actual
7B, 7C, 7D, Treaty net ¹	Chinook, coho, chum	6,294	5,347
7B, 7C Non-treaty net	Chinook, coho, chum	2,961	1,231
Nooksack River Treaty net	Early Chinook, May-Jun	2,154	1,293
	Fall Chinook, Aug-Oct	1,777	2,001

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 10th and in Samish Bay (7C) from August 1st through September 17th, with a catch of 5,017 Chinook. The coho fishery operated as planned from September 12th through October 23rd, with an incidental harvest of 316 Chinook. During the 7A on-reservation Coho fishery from September 8th through October 2nd, 14 Chinook were incidentally harvested. No Chinook were harvested incidentally during the chum fishery. The total fall Chinook catch of 5,347 for Areas 7B, 7C, and 7D was less than the preseason projection of 6,294 (Table 2-2).

The non-treaty fishery in Area 7B and 7C landed 1,223 Chinook from July through September, lower than the pre-season projection of 2,948. Thirteen Chinook were forecasted to be landed during the chum fishery, with eight landed.

Fisheries for fall Chinook, coho, and chum in the Nooksack River occurred as planned from August 1 – September 11, September 12 – October 23, and October 25 – December 14, respectively. The total Chinook catch was 2,001, more than the projected catch of 1,777 fish;

1,637 were caught during the Chinook period and 364 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

Spring Chinook Fisheries: Tribal commercial fisheries in the Skagit terminal area directed at hatchery spring Chinook were conducted in 2021 as scheduled preseason, although adjusted in timing and duration in response to ESA, tribal, and environmental needs. A total of 77 wild and 1,061 hatchery spring Chinook were encountered in these directed spring Chinook fisheries. Of the total wild encounters, 5 caught during the Sauk-Suiattle Tribe's Cascade River fishery were released. Assuming an agreed-to 52.4% release mortality rate, 3 mortalities were associated with those released encounters, for a total of 75 wild spring Chinook mortalities in directed spring Chinook fisheries.

An additional 29 wild and 44 hatchery spring Chinook were caught and retained during the Sauk-Suiattle Tribe's Cascade River coho fishery. The Cascade River coho fishery bycatch is accounted as spring chinook even though there may be some overlap with the summer-run Chinook¹. Coded-wire-tag fish from this fishery have not been verified with read results. This brings total mortalities during tribal commercial fisheries to 104 wild and 1,105 hatchery spring Chinook, compared to the pre-season modeled 81 wild and 1,175 hatchery mortalities in Chinook FRAM 3721.

Tribal ceremonial and subsistence (C&S) spring Chinook fisheries caught and retained 3 wild and 66 hatchery spring Chinook, compared to 10 wild and 24 hatchery expected pre-season.

Total wild spring Chinook mortalities across all of these tribal commercial and C&S fisheries were 107 wild and 1,171 hatchery fish, compared to the pre-season modeled 91 wild and 1,199 hatchery mortalities.

Summer/Fall Chinook Fisheries: No treaty commercial fisheries directed at summer/fall Chinook were scheduled in the Skagit terminal area for 2021. However, as anticipated, incidental catch of summer/fall Chinook occurred in the sockeye, pink, and coho fisheries. The sockeye, pink, 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. The Upper Skagit Tribe released summer/fall Chinook during their commercial coho fishery and part of their pink fishery, as was planned pre-season.

Total summer/fall Chinook encounters in these fisheries were 1,478 fish. Of these, 187 were released. Assuming an agreed-to 52.4% release mortality rate, that equates to 98 release mortalities. Total summer/fall Chinook mortality in these fisheries was therefore 1,389 fish, compared to the pre-season expectation of 1,492 based on Chinook FRAM 3721. No summer/fall Chinook were harvested for ceremonial purposes, and none were planned to be pre-season.

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 2021. 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 8 wild spring Chinook, 5 hatchery spring Chinook, and 329 summer/fall Chinook mortalities occurred in these fisheries. The pre-

¹ See Skagit River MUP in the 2010 Puget Sound Chinook RMP for description of spawning distribution of various Skagit River Chinook salmon stocks.

season expectation of mortalities in the test fisheries was 26 wild spring Chinook, 34 hatchery spring Chinook, and 350 summer/fall Chinook.

Summary: Overall, a total of 115 wild spring Chinook, 1,176 hatchery spring Chinook, and 1,718 summer/fall Chinook were killed in treaty commercial, C&S, and test fisheries. The preseason expectation based on Chinook FRAM 3721 was 117 wild springs, 1,233 hatchery springs, and 1,842 summer/falls.

Table 2-3. Skagit terminal area projected and actual hatchery and wild Chinook catches for Skagit terminal area tribal fisheries in 2021. Weekly projections were made by plugging the FRAM Chin3721 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	112	112	No weeks 19,20,22,25-27	75	75	-37	-37
Sockeye	2 sites: Area 3 wks 23-30, Blakes wks 24-29	57	57	Area 3 no week 23; Blakes none	60	60	3	3
Coho	3 sites: Blakes wks 38 - 42, Area 3 wks 34-42, Spudhouse wks 35-44	236	236	Blakes same; Area 3 no wk 34,36-38,41-42 added wk 44; Spudhouse added wk 34, no wks 36,40-44	207	207	-29	-29
Chum	3 sites, wks 44-45	0	0	No Bay wk 45; No Jetty; No Blakes	0	0	0	0
Steelhead	2 sites, wks 5-17	3	3	None	0	0	-3	-3
Area 8/78C Spring Chinook Fishery Swinomish Tribe:								
Week 18	4 days	185	185	Same	231	231	46	46
Week 19	4 days	113	113	0 days	0	0	-113	-113
Week 20	None	0	0	Same	0	0	0	0
Week 21	None	0	0	2.458 days	97	97	97	97
Area 78P Spring Chinook Fishery Sauk-Suiattle Tribes:								
Wk 21-30	Wk 21-22 7 days/wk, Wk 23-30 2 days/wk	300	295	Wk 20 1 day, wk 21-22 7 days/wk, wk 23 2 days	235	233	-65	-62
Area 78C/78D Spring Chinook Fishery Upper Skagit Tribe:								
Week 18	None	0	0	None	0	0	0	0
Week 19	1.25 days	247	247	None	0	0	-247	-247
Week 20	1.5 days	405	405	2.375 days	575	575	170	170
Week 21	None	0	0	None	0	0	0	0
Area 8/78C/78D/78P Chinook C&S Fishery Swinomish, Sauk-Suiattle, Upper Skagit Tribes:								
Sum/Fall-Spring Chin.	As needed	34	34	As needed	69	69	35	35
Areas 8/78C Sockeye Fishery Swinomish Tribe:								
Week 25	None	0	0	None	0	0	0	0
Week 26	None	0	0	None	0	0	0	0

Week 27	2 days	17	17	Same	28	28	11	11
Week 28	2 days	23	23	None	0	0	-23	-23
Week 29	None	0	0	1 days	58	58	58	58
Week 30	None	0	0	None	0	0	0	0
Area 78D/78O Sockeye Fishery Swinomish Tribe:								
Week 28	1 day	4	4	None	0	0	-4	-4
Week 29	1 day	3	3	0.708 days	4	4	1	1
Week 30	None	0	0	0.708 days	3	3	3	3
Areas 78C/78D/78O Sockeye Fishery Upper Skagit Tribe:								
Week 26	None	0	0	None	0	0	0	0
Week 27	None	0	0	None	0	0	0	0
Week 28	0.208 days	8	8	0.167 days	49	49	41	41
Week 29	0.208 days	8	8	0.583 days	131	131	123	123
Week 30	None	0	0	None	0	0	0	0
Area 8/78C Pink Fishery Swinomish Tribe:								
Week 35	1 day	175	175	Same	115	115	-60	-60
Week 36	5 days	425	425	5.667 days	264	264	-161	-161
Week 37	2 days	117	117	3.333 days	190	190	73	73
Area 78P Pink Fishery Sauk-Suiattle Tribe								
Weeks 34-38	2 days/wk	0	0	None	0	0		
Area 78B Pink Fishery Sauk-Suiattle Tribe								
Weeks 34-38	7 days/wk	15	15	None	0	0		
Area 78C/D Pink Fishery Upper Skagit Tribe:								
Week 36	1.5 days	223	223	1.417 days	225	225	2	2
Week 37	2.167 days (Ck release)	177	93	2.417 days (Ck release)	61	32	-116	-61
Week 38	2.167 days (Ck release)	228	119	2.417 days (Ck release)	24	13	-204	-106
Areas 8/78C Coho Fishery Swinomish Tribe:								
Week 38	None	0	0	None	0	0	0	0
Week 39	1.5 days	27	27	0.875 days	56	56	29	29
Week 40	1.5 days	9	9	None	0	0	-9	-9
Week 41	None	0	0	1.417 days	0	0	0	0

Week 42	None	0	0	3 days	2	2	2	2
Areas 78P Coho Fishery Sauk-Suiattle Tribe:								
Wk 39-45	2 days/wk	200	200	wk 34, 1 day; wk 35, 2 days; wk 38-43 2 days/wk	238	238	38	38
Areas 78B Coho Fishery Sauk-Suiattle Tribe:								
Wk 45-48	7 days/wk	9	9	wk 44 1 day, wk 45 7 days, , wk 46 3 days, wk 48 1 day, wk 49 7 days, wk 50 2 days	0	0	-9	-9
Areas 78C/78D Coho Fishery Upper Skagit Tribe:								
Week 39	None	0	0	None	0	0	0	0
Week 40	None	0	0	None	0	0	0	0
Week 41	0.333 days (Ck release)	22	11	2.375 days (Ck release)	78	41	56	30
Week 42	0.333 days (Ck release)	14	8	1.417 days (Ck release)	18	9	4	1
Week 43	0.333 days (Ck release)	18	9	1.417 days (Ck release)	6	3	-12	-6
All Terminal Area Chum Fishery Swinomish, Upper Skagit Sauk-Suiattle Tribes:								
None	None	0	0	None	0	0	0	0
Total Skagit Terminal Area:		3,414	3,190		3,099	3,008	-300	-167

2.4 Stillaguamish/Snohomish Terminal Area

The tribal net fishery in Area 8A was open for the 2021/2022 fishing season for Ceremonial Chinook, a four week pink salmon fishery, and a five-week commercial coho fishery. Twelve chinook salmon were taken during the pink salmon directed fishery in August to early September. No commercial or ceremonial Chinook were harvested in Area 8A during 2021 (Table 2-4). Non-treaty commercial fishing in Area 8A was closed for the 2021-2022 season.

Tribal Chinook catch in Area 8D occurred from May through early-September, with most of the catch occurring during June. Total 8D catch was 1,661, including 370 for ceremonial or subsistence purposes (Table 2-4). Tribal Chinook catch was less than projected in area 8D.

Non-treaty commercial fishing in Area 8D was closed for the 2021-2022 season.

The Stillaguamish Tribe harvested one chinook for ceremonial purposes from the Stillaguamish River in 2021 (Table 2-4). No chinook were harvested incidentally during the coho directed fishery.

Table 2-4. Projected (FRAM Chin3721) and actual Chinook net fishery harvest in the Stillaguamish - Snohomish terminal area in 2021.

Area		Projected	Actual
8A Commercial	Treaty	342	12
	Treaty C&S	Up to 100	0
	Ntrty	0	0
8A Test		N/A	--
8D Commercial	Treaty	5,638	1,291
	Treaty C&S		370
	Ntrty	3	0
Stillaguamish R. Net	C&S/Coho	24	1

2.5 South Puget Sound Terminal Areas

Table 2-5. Projected and actual Chinook catch in 2021 South Puget Sound net fisheries.

Area	Management Period	Projected	Actual
Area 9/10/11	Coho (A10 - Test)	21	0
	Chum (A9 - Test)	135	47
	A9 (Trty. C&S + chum)	501	25
	Trty Pink/Coho/Chum (A10/11)	140	0
	NT Pink/Chum (A10/11)	338 ^a	92 ^a
Area 10E	Treaty Chinook/coho/chum	3,770	8,794
Area 10A	Chinook (test/C&S/Comm)	528	843
	Coho/chum	973	48
Duwamish River	Chinook/Coho/Chum	8,333	7,617
	Coho (Test/C&S)		37
L Washington/Ship Canal	Sockeye/coho/ C&S	610	220
	Test/Research	N/A	--
Lake Sammamish	Chinook/Coho	0	16
Puyallup River	Spring/Fall C&S	586	120 ^b
	Chinook/Coho	5,329	8,302
White River	Spring C&S	-- ^c	310
	Coho		249
Areas 13, 13D-K	Chinook/Coho/Chum	1,349	1,899
Area 13A	Chinook/Coho/Chum	1,651	2,050
Areas 13C/Chambers	Chinook	481	1,095
Nisqually River	Chinook/coho	5,077	4,757 ^b
McCallister Cr.	Chinook	298	207

^a Values include landed catch and release mortalities

^b Adult (Age 3+) catch only, does not include jacks.

^c White River C&S Projected harvest is incorporated in the Puyallup River Spring/Fall C&S catch of 606 fish.

Marine Areas 9, 10 & 11

The coho test fishery in area 10 was not implemented in 2021. The chum test fishery at Apple Cove Point (Area 9) incidentally caught a total of 47 Chinook (Table 2-5), well below the estimated 135.

An estimated 92 Chinook release mortalities occurred during the chum directed non-treaty purse seine fishery in area 10 and 11. The treaty pink, coho, and chum salmon fishery in Area 10 harvested zero chinook. Fisheries directed at Chinook and coho in Area 10E harvested 8,794 Chinook (Table 2-5). No Chinook were harvested during the chum fishery in area 10E.

Twenty-five 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 Muckleshoot Tribe conducted a C&S fishery in the Lake Washington Ship Canal in 2021 which harvested 101 Chinook. Incidental Chinook catch during the coho fishery in Lake Union, and the upper and lower Ship Canal harvested 69 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 50 Chinook. The coho directed fisheries in Lake Sammamish incidentally harvested 16 chinook salmon.

The Lake Washington ship canal abundance and diet study of piscivorous fish was conducted by WDFW in 2021 after taking a year off in 2020 due to COVID. The study was conducted between May 11 and June 24. Five adult Chinook mortalities were projected to occur. Sampling work in 2021 encountered no adult or juvenile Chinook.

The Lake Washington warm water test fishery, conducted by the Muckleshoot Tribe was prosecuted in spring (May-June) of 2021. Monthly reports were provided separately to NOAA for this research..

Elliott Bay/Duwamish River

The Suquamish Tribe harvested 60 Chinook during the Chinook directed fishery and zero incidental Chinook in Elliot Bay during the coho directed fishery in 2021. The Chinook test fishery in Area 10A harvested 231 Chinook in 2021. A Chinook-directed commercial fishery occurred in Area 10A and the Duwamish River, with Muckleshoot Indian Tribe harvesting 552 and 7,033 Chinook salmon, respectively. In 10A, there were 48 Chinook caught in September during the coho directed fishery by Muckleshoot Indian Tribe. In the Duwamish River, 37 Chinook were caught during the coho test fishery to determine Chinook clearance. During the coho directed fishery in the Duwamish River, 501 Chinook were caught incidentally as well as 83 chinook caught during the chum directed fishery in late-October to mid-November.

Puyallup River and White Rivers

Ceremonial and subsistence fisheries in the Puyallup River caught 72 adult spring Chinook salmon along with six estimated jacks during management weeks 22–29. Based on fisheries sampling data, an additional 48 adults presumed to be fall-run Chinook, based on ad-clip marks, were taken during the spring C&S fishery, mostly during the final week. The Muckleshoot Tribe had an additional spring Chinook C&S fishery in the White River which caught 304 spring Chinook and 6 presumed fall Chinook based on ad-clip marks and GSI analysis. Besides the 54 fall Chinook taken during the spring C&S, no other fall Chinook C&S fisheries occurred. The pre-season projected C&S catch was 586.

Fall Chinook catch was 3,295 during the Chinook directed fishery. The coho fishery in the Puyallup River occurred from management week 37 (September 5th) to management week 42 (October 10th) and incidentally harvested 4,996 Chinook salmon, mostly during early September. During the Coho directed fishery in the White River, scheduled to occur from August 30th through October 13th, harvested 247 Chinook mostly during early September (Table 2-5).

Marine area 13 & sub areas (Deep South Sound)

The Chinook fishery in Carr Inlet (13A) caught 1,910 Chinook (Table 2-5), in August and early September (weeks 32 – 36). Pre-season projected catch was 1,930. This fishery targets Minter Creek Hatchery Chinook returns where no natural origin fish are returning to spawn. The coho fishery in 13A incidentally harvested 140 Chinook, with a preseason expectation of 21.

The Chinook fishery at Chambers Bay (13C) occurred between July 26 through October 10 with 1,295 Chinook harvested (Table 2-5). The preseason catch projection was 1,095.

Chinook directed fisheries in 13D and Budd Inlet (13F) occurred from mid-July through early-September; total catch was 1,714 all in 13F. Chinook caught incidentally during the coho fishery (Week 37-40) in 13D totaled 185 fish. Zero Chinook were caught during the Fox Island (Area 13) coho fishery. The total preseason catch projection for both areas was 1,346.

Nisqually River

The treaty commercial fishery in the Nisqually River harvested an estimated 4,757 Chinook, excluding jacks, but including fish for Ceremonial and Subsistence purposes, with a pre-season projected commercial catch, excluding jacks, of 5,077 (Table 2-5).

The short term release mortality study in the Nisqually River encountered and released 129 adult Chinook salmon during 2021. Given a sample size of 129 at 95% confidence interval the mortality estimate for 2021 is 5.4% plus or minus 8.65%. One additional chinook was collected during the study but was stolen prior to release.

2.6 Hood Canal

Tribal Chinook directed fishing in 12C occurred as planned from July 19 through August 31 with a catch of 2,090. No Chinook were landed in 12C during the Coho directed fishery. In marine catch areas 12 and 12B, zero Chinook were harvested during the tribal Coho directed fishery.

Tribal Chinook harvest in the Hoodspout Hatchery Zone (12H) was 17,066 and occurred as planned from July 12 through September 12. Catch was greater than the preseason expectation of 11,508.

Tribal chinook troll fishery in areas 12/12B landed eight Chinook in 2021, much less than the pre-season projection of 1,711.

Chinook harvest in the Skokomish River occurred as planned from August 3 (wb 8/2) through August 27 (wb 8/23) landing 7,274 fish. 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 11 through August 7 landing 195 fish.

In Port Gamble (Area 9A), 41 Chinook were harvested, primarily in mid-August to mid-September during Coho fisheries.

Non-treaty commercial fisheries in the Hoodspout Zone (12C) harvested 6,084 Chinook salmon (Table 2-6). There were no Chinook landed in other non-treaty fisheries in Hood Canal in 2021 but two release mortalities were estimated to have occurred in purse seine fisheries (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 2021.

Area	Target Species	Projected	Actual
(12, 12B-12D, 9A) (T)	chin, coho, chum	6,724	2,131
(12-12C, 9A) (NT)	chum, coho	76	2 ^a
(12, 12B) Troll (T)	chinook, coho	1,711	8
12A Net (T)	coho	72	0
12H Net (T)	chinook, chum	11,508	17,066
12C Hoodsport Zone Net (NT)	chinook, chum	5,000	6,084
Skokomish River (82G) (T)	chin, coho, chum	7,884	7,274
(82J) (T)	<i>chinook</i>		195
Total		32,975	32,565

^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 2021.

Table 2-7. Projected and actual catches of Chinook in Strait of Juan de Fuca terminal net fisheries in 2021.

Terminal Area	Projected	Actual
Area 6D & Dungeness River Treaty	0	0
Area 6D Non-Treaty	0	3
Elwha River Treaty (C&S)	0	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 2021 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 2021 Puget Sound non-treaty salmon net fisheries.

Area	Gear type	# sets observed	Chinook	Coho	Sockeye	Pink	Chum	Steelhead
7	PS	7	463	181	2,400	64,809	0	0
7A	PS	27	123	20	3,512	28,002	0	0
8A	PS	CLOSED						
10	PS	86	170	44	15	23,332	27,279	0
11	PS	13	0	9	0	0	29,790	0
12	PS	32	0	244	0	0	6,543	0
12B	PS	0	0	0	0	0	0	0
7	GN	0	0	0	0	0	0	0
7A	GN	1	0	18	0	400	0	0
12	GN	1	0	29	0	0	7,436	0
12B	GN	1	0	1	0	0	160	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 2021.

Area	Total Mortality	
	Projected	Actual
6D	0	3
7/7A	3,560	701
7B/7C	2,961	1,231
8	N/A	Closed
8A	N/A	Closed
8D	3	Closed
10/11	416	92
12-12C/9A	76	2
12C Hoodsport	5,000	6,084

3 Recreational Harvest

This chapter summarizes expected recreational catch in Puget Sound marine waters and freshwater tributaries for the 2021-2022 management year and presents catch estimates available from Chinook MSF that were intensively monitored using creel during 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 where Chinook retention was allowed are not yet available. Since complete Chinook MSF and NS catch estimates were not available for all areas in the annual report covering the previous management cycle, projected and actual recreational Chinook MSF and NS catches for the 2020-2021 management year are also included here, except for winter MSFs in marine catch areas 5 and 13, which only account for catch through March 31, 2021.

3.1 2020-2021 Recreational Chinook MSF and NS Catch

Mark-selective and non-selective Recreational Chinook harvest in 2020-2021, estimated from preliminary Catch Record Card (CRC) data through March 31, 2021, and creel estimates where available, was 29,614, compared to a preseason projection of 40,963. The CRC estimates are preliminary and subject to revision. Projected and actual catches for individual fisheries are shown in Table 3-1. Estimates of total mortality in mark-selective fisheries, for those fisheries where estimates are available, are presented in reports available by searching for “mark-selective” at <https://wdfw.wa.gov/publications>.

Table 3-1. Projected (FRAM 3120) and actual (preliminary, where available) Chinook catches in Puget Sound Chinook MSF and NS recreational fisheries during the 2020-2021 season.

Area/Fishery	Projected	Actual
Area 5-6		
Area 5 Summer MSF	3,999	3,878
Area 5 Winter MSF	527	2,755*
Area 6 Summer MSF	4,798	2,292
Area 6 Winter MSF	Closed	
Other		
Strait Tributaries		
Area 7		
Summer (July MSF)	1,562	1,650
Winter MSF	Closed	
Nooksack/Samish FW	4,155	8,135
NF Nooksack Spring Chinook	485	85
Area 8-1 & 8-2		
Winter MSF	Closed	
Skagit River		
Spring MSF	504	41
Area 8D SAF	377	441
Stillaguamish River	0	1 ^a
Snohomish River		
Skykomish MSF	691	517
Area 9		
Summer MSF	6,542	3,953
Winter MSF	Closed	
Area 10		
Summer MSF	4,158	1,543
Winter MSF	378	235*
Area 11		
Summer MSF	4,196	2,090
Winter MSF	Closed	
Area 10E SAF	200	86
Lake Sammamish	1	0
Area 10A SAF	502	161
Green River	513	131
Puyallup River		
Carbon R MSF	583	706
Puyallup R MSF	1,034	1,015
Area 13		
Summer MSF	2,578	1,131
Winter MSF	91	341*
Chambers Cr	5	14
Nisqually	1,965	1,137
Deschutes	7	7
Area 12		
Summer MSF	1,112	601
Winter MSF	Closed	
Skokomish River	Closed	

^a Represents illegally retained Chinook recovered by WDFW Law Enforcement

* All CRC estimates of catch through 3/31/2021

3.2 2021-2022 Recreational Chinook MSF Catch

Projected Chinook catches for 2021-2022 recreational Chinook MSF fisheries are listed in Table 3-2. The recreational fishing regime included Chinook mark selective fisheries (MSF) for portions of the year in Marine Areas 5 through 13 and in several rivers. WDFW conducted intensive sampling and monitoring of Chinook summer MSFs in Marine Areas 5, 6, 7, 9, 10 and 11 as well as the winter Chinook MSF in Marine Area 10, which provided the estimates in Table 3-2. Brief summaries of Chinook catch and encounters resulting from summer sampling programs are included below. The analysis of 2021-2022 winter fisheries is still in draft form, and reports summarizing the information have not been created, although preliminary estimates of catch are provided. When complete, this analysis will be made available on the WDFW publications website at <https://wdfw.wa.gov/publications>. Searching for “mark-selective” on that page will return links to individual reports.

For Chinook mark-selective 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 2022 annual report.

Table 3-2. Projected (FRAM 3721) and actual (preliminary, where available) Chinook MSF catches in Puget Sound recreational fisheries during the 2021-2022 season.

Area/Fishery	Projected	Actual
Area 5-6		
Area 5 Summer MSF	4,077	3,947
Area 5 Winter MSF	1,504	
Area 6 Summer MSF	4,769	5,098
Area 6 Winter MSF	Closed	
Other		
Strait Tributaries		
Area 7		
Summer MSF	1,382	2,504
Winter MSF	Closed	
Nooksack/Samish FW	4,668	
NF Nooksack Spring Chinook	801	174
Area 8-1 & 8-2		
Winter MSF	Closed	
Skagit River		
Spring MSF	475	
Area 8D SAF	495	
Stillaguamish River	1	
Snohomish River		
Skykomish MSF	551	
Area 9		
Summer MSF	4,700	5,288
Winter MSF	Closed	
Area 10		
Summer MSF	3,718	3,550
Winter MSF	836	1,048
Area 11		
Summer MSF	3,084	3,290
Winter MSF	238	171
Area 10E SAF	198	
Lake Sammamish	1	
Area 10A SAF	146	
Green River	526	
Puyallup River		
Carbon R MSF	706	
Puyallup R MSF	1,256	
Area 13		
Summer MSF	2,064	
Winter MSF	179	
Chambers Cr	34	
Nisqually	1,504	
Deschutes	7	
Area 12		
Summer MSF	2,309	
Winter MSF	Closed	
Skokomish River	Closed	

3.2.1 Marine Area 5 Summer MSF

2021 was the 19th consecutive year of summer mark-selective fishing in Marine Area 5. The fishery was planned preseason to be open from July 1 through August 15. The fishery was closed by emergency regulation on July 18 when the in season estimate of total landed catch indicated the fishery was nearing the preseason projection (Table 3.3).

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 (2022).

For Area 5, WDFW estimates that 3,947 Chinook were landed, compared to preseason projections of 4,077 (Table 3-3).

Table 3-3. Comparison of modeled (FRAM 3721) and estimated total Chinook encounters for the 2021 Area 5 summer Chinook MSF.

Data Source	Group	Total Encounters	Legal	Sublegal	Landed Only
FRAM Encounters	UM	11,401	2,912	8,489	29
	AD	13,205	4,653	8,552	4,048
	Total	24,606	7,565	17,041	4,077
	% Marked	54	62	50	99
Estimated (Creel) Encounters	UM	5,246	2,264	2,982	75
	AD	7,078	3,924	3,154	3,872
	Total	12,324	6,188	6,136	3,947
	% Marked	57	63	51	98

3.2.2 Marine Area 6 Summer MSF

2021 was the 19th consecutive year of summer mark-selective fishing in Marine Area 6. The fishery was planned preseason to be open from July 1 through August 15. The fishery was closed by emergency regulation on July 18 when in season estimates of landed catch indicated the fishery was nearing the preseason projection (Table 3-4).

WDFW's Puget Sound Sampling Unit (PSSU) implemented an intensive monitoring program, Reduced Murthy, using an aerial design in a sub-area of Marine Area 6 east of Ediz Hook throughout the season to collect the data needed to estimate key parameters characterizing the fishery and its impacts on unmarked salmon. Sampling activities included intensive dockside creel sampling, aerial surveys, test fishing and collection of voluntary salmon trip reports (STRs) from the angling public when possible. The fishery control for this Area was based on the preseason prediction of total legal-sized Chinook salmon encountered. Detailed descriptions of the sampling program and results are available in WDFW (2022).

For Area 6, WDFW estimates that 5,098 Chinook were landed, compared to preseason projections of 4,769 (Table 3-34).

Table 3-4. Comparison of modeled (FRAM 3721) and estimated total Chinook encounters for the 2021 Area 6 sub-area summer Chinook MSF.

Data Source	Group	Total Encounters	Legal	Sublegal	Landed Only
FRAM Encounters	UM	2,158	1,377	781	14
	AD	8,258	5,466	2,792	4,755
	Total	10,416	6,483	3,573	4,769
	% Marked	79	80	78	100
Estimated (Creel) Encounters	UM	3,238	1,932	1,306	40
	AD	9,688	5,710	3,978	5,058
	Total	12,926	7,642	5,284	5,098
	% Marked	75	75	75	99

3.2.3 Marine Area 7 Summer MSF

2021 was the 6th year of summer mark-selective Chinook fishing in Marine Area 7. The 2021 fishery was planned to be open from July 1 through July 31, 2021, and again from August 16 through August 31, 2020. Due to the total number of Chinook salmon encounters exceeding the preseason projection in July, the fishery was closed on July 7 by emergency regulation.

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 (2022).

For Area 7, WDFW estimates that 2,504 Chinook were landed, compared to preseason projections of 1,382 (Table 3-5).

Table 3-5. Comparison of modeled (FRAM 3721) and estimated total Chinook encounters for the 2021 Area 7 summer Chinook MSF.

Data Source	Group	Total Encounters	Legal	Sublegal	Landed Only
FRAM Encounters	UM	2,466	1,658	808	17
	AD	2,660	1,569	1,091	1,365
	Total	5,126	3,227	1,899	1,382
	% Marked	52	49	57	99
Estimated (Creel) Encounters	UM	1,352	759	593	0
	AD	3,266	2,879	387	2,504
	Total	4,618	3,638	981	2,504
	% Marked	71	79	40	100

3.2.4 Marine Area 9 Summer MSF

In 2021, a recreational MSF occurred for the 15th consecutive summer in Marine Area 9. The fishery was planned to be open from July 16 through August 15, 2021. The fishery was closed on August 5, 2021. 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 (2021).

An estimated 5,288 Chinook were landed in Area 9, compared to a preseason projection of 4,700 (**Error! Not a valid bookmark self-reference.6**).

Table 3-6. Comparison of modeled (FRAM 3721) and estimated Chinook encounters for the 2021 Area 9 summer Chinook MSF.

Data Source	Group	Total Encounters	Legal	Sublegal	Landed Only
FRAM Encounters	UM	2,110	1,036	1,074	10
	AD	11,633	5,390	6,243	4,690
	Total	13,743	6,426	7,317	4,700
	% Marked	85	84	85	100
Estimated (Creel) Encounters	UM	7,565	1,681	5,884	19
	AD	21,015	5,884	15,131	5,269
	Total	28,580	7,565	21,015	5,288
	% Marked	74	78	72	100

3.2.5 Marine Area 10 Summer MSF

In 2021, a summer recreational MSF was planned in Area 10 from July 16 through August 31, 2021. The fishery was closed on August 21, 2021, when in season estimates of encounters exceeded preseason projections. WDFW's Puget Sound Sampling Unit (PSSU) implemented an intensive monitoring program in Area 10 throughout the season to collect the data needed to estimate key parameters characterizing the fishery and its impacts on unmarked salmon.

An estimated total of 3,550 Chinook were landed during this fishery, compared to the pre-season projection of 3,718 (**Error! Not a valid bookmark self-reference.7**).

Table 3-7. Comparison of modeled (FRAM 3721) and estimated Chinook encounters for the 2021 Area 10 summer Chinook MSF.

Data Source	Group	Total Encounters	Legal	Sublegal	Landed Only
FRAM Encounters	UM	2,586	1,057	1,529	11
	AD	9,325	4,261	5,064	3,707
	Total	11,911	5,318	6,593	3,718
	% Marked	78	80	77	100
Estimated (Creel) Encounters	UM	4,396	1,119	3,277	82
	AD	13,747	3,757	9,991	3,468
	Total	18,143	4,876	13,268	3,550
	% Marked	76	77	75	98

3.2.6 Marine Area 11 Summer MSF

In 2021, a summer recreational MSF was planned in Area 11 from July 1 through August 31, 2021. The fishery was closed on August 24, 2021, when in season estimates of encounters exceeded preseason projections. WDFW's Puget Sound Sampling Unit (PSSU) implemented an intensive monitoring program in Area 11 throughout the season to collect the data needed to estimate key parameters characterizing the fishery and its impacts on unmarked salmon.

An estimated total of 3,290 Chinook were landed during this fishery, compared to the pre-season projection of 3,084 (In 2021, a summer recreational MSF was planned in Area 10 from July 16 through August 31, 2021. The fishery was closed on August 21, 2021, when in season estimates of encounters exceeded preseason projections. WDFW's Puget Sound Sampling Unit (PSSU) implemented an intensive monitoring program in Area 10 throughout the season to collect the data needed to estimate key parameters characterizing the fishery and its impacts on unmarked salmon.

An estimated total of 3,550 Chinook were landed during this fishery, compared to the pre-season projection of 3,718 (**Error! Not a valid bookmark self-reference.7**).

7).

Table 3-4. Comparison of modeled (FRAM 3721) and estimated Chinook encounters for the 2021 Area 11 summer Chinook MSF.

Data Source	Group	Total Encounters	Legal	Sublegal	Landed Only
FRAM Encounters	UM	1,586	729	857	15
	AD	6,902	3,527	3,375	3,069
	Total	8,488	4,256	4,232	3,084
	% Marked	81	83	80	100
Estimated (Creel) Encounters	UM	2,106	1,149	957	22
	AD	6,318	3,637	2,680	3,268
	Total	8,424	4,786	3,637	3,290
	% Marked	75	76	74	99

3.2.7 North Fork Nooksack Spring Chinook MSF

In 2021, a recreational spring Chinook MSF was prosecuted in the North Fork Nooksack River from May 29th through June 10th, and June 18th through July 9th. An estimated 174 ad-clipped adult chinook were harvested during the fishery of a projected 801 (Table 3-5).

Table 3-5. Comparison of modeled (FRAM 3721) and estimated Chinook encounters for the 2021 North Fork Nooksack spring Chinook MSF. Values are rounded.

Data Source	Group	Total Adult Encounters	Landed Adults Only
FRAM/TAMM Adult Encounters	UM	23	0
	AD	801	801
	Total	824	801
	% Marked	97	100
Estimated (Creel) Adult Encounters	UM	10	0
	AD	213	174
	Total	223	174
	% Marked	96	100

4 Spawning escapement

This section compares natural Chinook escapement estimates for 2020 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 Stillaguamish, Cedar, Green, Puyallup, Nisqually, 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, Skagit fall, 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, except for White River spring-run Chinook salmon.

For summer/fall populations, escapement were less than projected for all management units, except the Skagit River summer/falls and Green River fall-run escapements were greater than forecasted abundance.

Table 4-1. Preseason projections and estimates of Puget Sound Chinook natural spawning escapement in 2021.

Management Unit		NOR	HOR	Total	Projected (FRAM 3721)
Nooksack	NF			N/A	154 ¹
	SF			N/A	310 ¹
Skagit spring	Suiattle	433		433	431 ¹
	Cascade	145		145	141 ¹
	Sauk	1,024		1,024	871 ¹
	Total spring	1,602	235	1,837	1,442 ¹
Skagit summer/fall	Sauk summer	233		233	400 ¹
	Upper Skagit summer	6,410		6,410	6,587 ¹
	Lower Skagit fall	664		664	1,420 ¹
	Total summer/fall	7,307		7,307	8,837 ²
Stillaguamish	Total	486	352	838 ³	906
Snohomish	Skykomish	1,414	607	2,201	1,876 ¹
	Snoqualmie	611	367	978	1,060 ¹
	Total	2,025	974	2,999	2,936 ¹
Lake Washington	Cedar	607	356	963	778
Green		1,200	1,870	3,070	3,741
Puyallup		1,513	3,947	4,985	2,536
White		3,642	706	4,348 ⁴	2,281 ⁴
Nisqually		417	8,504	8,921 ⁵	8,047
Skokomish		208	785	993	3,787
Mid Hood Canal	Dosewallips			3	
	Duckabush			2	
	Hamma Hamma			3	
	Total			8	18
Dungeness		349	307	656 ⁶	699
Elwha				2,630 ⁷	4,089
Hoko				1,070 ⁸	1,054

1. Natural-origin only.

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

3. Includes NORs and HORs collected for broodstock (n=106) from the North Fork which are part of the FRAM Projection.

4. Includes NORs, HORs, and 1,552 vent-clipped acclimation pond fish trucked and released upstream of Mud Mountain.

Actual spawning escapement is unknown but likely lower due pre-spawn mortalities from trap and haul and other environmental effects. Uncertainty exists around the NOR estimate as there is no ability to validate USACOE sampling.

5. Includes 554(417 NOR and 137 HOR) volitional spawners, as well as 8,367 hatchery rack return of which 1,458 adults were trucked upstream to spawn naturally for a total natural spawning estimate of 2,012.

6. Includes 92 fish (56 HORs and 36 NORs) removed from the river for use as broodstock.

7. TRS estimated from SONAR. Includes adult fish collected for broodstock. Estimate does not include jacks.

8. 2021 did not have adequate survey data to estimate escapement due to high flows and road washout. The 2021 escapement estimate is the 5-year average. Recent trends in abundance and escapement for Hoko chinook suggest that the most recent 5-year average would reflect the magnitude of the return in 2021.

4.1 Nooksack River Early Chinook

Nooksack River early (spring) Chinook escapement estimates are summarized by population (North and Middle Fork (NF/MF) and South Fork (SF)) and accounts for all spawners of each population regardless of where they spawn (i.e. accounting for each population of spawners in both the NF/MF and SF). These stock assignments are supported by a comprehensive genetic sampling program carried out by the Nooksack co-managers, which assigns probable population identification to aid in differentiating each individual by population.

North/Middle Fork early (spring) Chinook

The North and Middle Forks of the Nooksack River originate from Mount Baker glaciers and are typically turbid with moderate or lower flows during summer due to glacial melt. Co-managers have modified their escapement methods as needed, depending on the survey conditions to reflect what they believe to be the most accurate estimates. The 2019 and 2020 escapement estimates are presented here. The 2021 estimates are in preparation, but are not yet available.

Because of the unpredictability of redd viewing conditions during spring Chinook spawning seasons (mid-July through late-September) within the North and Middle Forks and their tributaries, a carcass-based methodology is the norm instead of a redd based methodology. This methodology was developed from five years of surveys with good substrate visibility (1991, 1992, 1995, 1996, 2000) which enabled annual cumulative redd counts. Redd counts in those years were multiplied by 2.5 fish per redd to estimate basin population abundances. The carcass counts in each of those five years was then expanded to match the respective redd based population abundance estimates. The averaged expansion needed in those five years was 3.48 fish per carcass enumerated to match the redd based estimates.

Beginning in 2005, an alternative method was developed in the Middle Fork. From 2005 through 2008, water flows and good viewing conditions enabled the spawning ground surveys to enumerate a high percentage of total redds in the river. As a result, co-managers shifted to a redd based methodology for those four years, expanding total enumerated redds by 2.5 adults per redd in the Middle Fork and applying the 3.48 fish per carcass expansion factor only to the North Fork carcass counts during those years.

Beginning in 2009 and continuing through 2020, visibility was lower in the Middle Fork which limited redd visibility during the early Chinook spawning season. As a result, co-managers adjusted the Middle Fork escapement methodology to account for these less than optimal viewing conditions. A Middle Fork specific carcass expansion factor was calculated in a method similar to the North Fork's, by expanding carcass counts observed during 2005 through 2008 when good viewing conditions were present during the spawning season. The total number of redds was multiplied by 2.5 fish per redd to estimate total spawners and then divided by the number of carcasses observed resulting in a 1.91 average expansion factor per observed carcass. The carcass expansion factor of 1.91 continues to be used for Middle Fork surveys due to persistent limited redd visibility.

From 2013-2020, Peat Bog Creek and to an extent Bear Creek (which are tributaries to the Middle Fork) also began having higher carcass counts than prior to 2013. From 2013 through 2020, carcass counts from all tributaries to the Middle Fork were enumerated but not expanded. Surveys were frequent and the unexpanded tributary carcass counts were considered to more accurately reflect total Chinook in these low flow and clear water tributaries.

Beginning in 2010 and continuing through 2020, another significant change in early Chinook escapement estimate methodology was applied in the Kendall Creek basin, a tributary to the

North Fork. The change resulted in carcasses observed in Kendall Creek and Kendall Slough no longer being expanded, and instead were considered the total counts. Unexpanded counts were considered to more accurately reflect total abundance in this area. The prior assumption was that the Kendall Creek and Slough carcass enumerations should be expanded by 3.48, like all other North Fork carcasses. High densities in this limited area and frequent surveys resulted in co-managers no longer expanding these near-hatchery spawners.

Starting in 2016, co-managers began using genetic-based stock assignments to apportion total basin escapement estimates to different genetic stocks present in the system. Tissues are collected from all carcasses sampled to genetically assign individuals to one of the three Nooksack baseline stocks using probability estimates: South Fork early returning Chinook, North/Middle Fork early returning Chinook, or Samish/Nooksack fall Chinook. The DNA results from the natural origin return (NOR) carcasses were applied to apportion the estimated total NORs in the North/Middle Fork basin to one of the three genetic baseline stocks. As such, the North/Middle Fork Chinook escapement estimates are the number of naturally spawning natural-origin early-timed North/Middle Fork chinook and Kendall Creek Hatchery origin Chinook in the Nooksack forks, including those within the South Fork (see next section and Table 2). Further, hatchery origin (HOR) fish were identified based on adipose fin clip marks, otolith marks, and/or CWT presence and subsequently assigned to their respective hatchery stock origin. These data are used to estimate respective hatchery contributions.

For 2019, the North Fork origin escapement estimate is 863 in the North Fork (32 NORs and 831 HORs; Table 4-2), plus an additional 15 in the South Fork (6 NORs and 10 HORs excluding one prespawn mort; Table 4-3). For 2020, the North Fork origin escapement estimate is 236 in the North Fork (38 NORs and 198 HORs; Table 4-2) plus an additional 112 in the South Fork (45 NOR and 67 HORs, excluding one prespawn mort; Table 4-3).

Table 4-2. Early timed Chinook spawning escapements for 2019 and 2020 return years within the North Fork and Middle Fork Basins. South Fork early NOR and HOR spawning escapement in the North/Middle Fork basins are additional to those within the South Fork basin.

Year	North./Middle Fork Nooksack Basins					
	NF/ MF NORs	Kendall HORs	SF NORs	SF HORs	Fall NORS	Fall HORs
2019	32	831	10	79	11	1
2020	38	198	7	100	15	15

South Fork Nooksack early (spring/summer) Chinook

The South Fork watershed is a non-glacial system and the summer low flow visibility is much better than in the North and Middle Forks, although visibility can deteriorate after fall rain freshets begin. The South Fork escapement methodology is a redd-based estimate instead of carcass-based. Escapement estimates are calculated by multiplying the total number of redds observed by 2.5 adults per redd.

Odd-year Pink salmon returns in 2013 and 2015 were substantial and resulted in redd superimposition coincident with Chinook spawning. Therefore, Chinook estimates in those years are considered minimum estimates. Odd-year Pink salmon returns in 2017 and 2019 were more modest, and the Chinook escapement estimates in the South Fork basin those years are not minimum estimates.

Beginning in 2017 the methodology has applied the following assumptions:

- 1) All redds are accurately counted in all geographic spawning areas utilized.

- 2) No spawning Chinook after October 8 are early returning Chinook.
- 3) Chinook that spawn through October 8 die within 1 week (by October 15).

Prior to 2017, assumption #3 only included redds that were built through September 30 and carcass recoveries through October 7. However, coded wire tag (CWT) recoveries and DNA results indicated spawning occurred later than was understood when the escapement estimates were much smaller, and Nooksack co-managers agreed to amend the assumption. Starting in 2016, co-managers began using genetic-based stock assignments to apportion South Fork basin escapement estimates to Chinook stocks known to occur in the basin. DNA is collected from all carcasses in order to assign individuals to one of the three Nooksack baseline stocks using probability estimates: South Fork early returning Chinook, North/Middle Fork early returning Chinook, or Samish/Nooksack fall Chinook. The DNA stock assignment results are then used to apportion the redd based South Fork escapement estimate to each of the three baseline genetic stocks (Table 2).

Hatchery origin (HOR) fish are identified based on adipose fin clip marks, otolith marks, and/or CWT presence and subsequently assigned to their respective hatchery stock origin. Further, because the WDFW Molecular Genetics Lab (Lab) staff has genotyped the adult broodstock spawned for the Skookum Hatchery chinook program, they are able to use parentage-based molecular techniques to identify individual offspring that had a single parent and both parent assignments of hatchery chinook broodstock. From 2017 through 2020, the Lab used this parentage-based technique for field sampled carcasses which assigned to the South Fork baseline but did not have field observed indicators recorded that identified them as hatchery-origin fish (primarily CWTs). The Lab recommended that Nooksack co-managers consider individuals as South Fork HORs that assigned as offspring of two hatchery broodstock parents if spawning records were consistent, or at least were spawned on the same date. Therefore, these individuals are included as South Fork HORs instead of South Fork NORs. As of brood-year 2017, the Skookum hatchery program now otolith marks all South Fork Skookum hatchery releases. By return year 2022, all returning HORs will be otolith marked and we will no longer assess stock assignments based on genetic parentage based assignments for natural escapement purposes. As such, the South Fork Chinook escapement estimates are the number of naturally spawning natural-origin early-timed South Fork chinook and Skookum Creek Hatchery origin Chinook in the Nooksack forks, including those within the North/Middle Forks (see previous section and Table 1). Prespawn mortalities are not included in South Fork basin escapement estimates.

For 2019, the South Fork origin escapement estimate is 430 in the South Fork (61 NORs excluding two prespawn morts and 369 HORs excluding 30 prespawn morts; Table 4-3), plus an additional 89 in the North Fork (10 NORs and 79 HORs; Table 4-2). For 2020, the South Fork origin escapement estimate is 1,328 in the South Fork (243 NORs excluding one prespawn mort and 1,085 HORs excluding 34 prespawn morts; Table 4-3) plus an additional 107 in the North Fork (7 NOR and 100 HORs; Table 4-2).

Table 4-3. Early timed Chinook spawning escapements for 2019 and 2020 return years in the South Fork basin. North Fork early NOR and Kendall Creek HOR spawning escapement in the South Fork basin are in addition to those spawning within the North/Middle Fork basins.

Year	South Fork Nooksack Basin					
	SF Native NOR	SF HOR	NF/MF Early NOR	Kendall. HOR	Fall NOR	Fall/other HOR
2019	61(2)	369(30)	6(0)	9(1)	8(0)	27(0)
2020	243(1)	1,085(34)	45(0)	67(1)	30(0)	10(4)

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

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 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. Escapement 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 except for 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.

Surveys were conducted from July 14 through October 4. The survey goal was to cover each index every 7 -10 days to ensure all redds were enumerated. The indexes included all known spawning habitat for each tributary and the survey was performed on foot and wading the stream. The logjam that had been a passage barrier on Buck Creek in previous years (approximately RM 1.2) remained in 2021. The logjam continues to be a total passage barrier with no live Chinook or Chinook redds observed upstream of the logjam. A total of 173 redds were observed in 2021.

A total of 25 Suiattle spring Chinook carcasses were observed, and all were collected and sampled; All 25 were wild unmarked fish. The season total redd count was 173 (Table 4-4).

Table 4-4. Suiattle River spring Chinook 2021 spawning ground survey redd counts. This table includes only observed redds.

Stream	WRIA	Survey method	Reach (RM)	Location ^{*1}	Redds
Big Creek	3.0723	Foot	0.0-0.6	7.8	4
Tenas Creek	3.0761	Foot	0.0-0.5	9.6	0
Straight Creek	3.0797	Foot	0.0-0.1	15.1	1
Buck Creek	3.0813	Foot	0.0-1.7	18.1	0
Circle Creek	3.0892	Foot	0.0-0.2	18.4	0
Lime Creek	3.0897	Foot	0.0-0.5	20.8	0
Downey Creek	3.0919	Foot	0.0-2.1	24.4	128
Sulfur Creek	3.0973	Foot	0.0-0.9	26.3	22
Milk Creek	3.1022	Foot	0.0-0.1	28.6	3
Total redds					173

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

The preliminary 2021 Suiattle River Spring Chinook escapement estimate was 433 fish (rounded). All data and estimates of escapement were final and agreed to by the Skagit co-managers.

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 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.

Surveys of all known habitat occurred from August 11 through October 12. Mainstem surveys were conducted by foot or pontoon boat depending on the stream features of the index. Beginning in 2016, with help from USIT, the interval goal was shortened from 10 to 14 days to weekly surveys with the goal of collecting more carcasses.

Carcasses are notoriously difficult to find from this upper Cascade population. A total of 12 carcasses were observed and sampled in the upper Cascade spring Chinook area in 2021. 11 of the carcasses were unmarked and untagged wild Chinook. The condition of one carcass was too poor to sample for tag or hatchery mark, but scales were collected. The carcass was recorded as unknown origin.

Fifty-eight redds were identified in 2021 (Table 4-5). The 2021 upper Cascade River spring Chinook spawning escapement estimate was 145 fish. All data and estimates of escapement were final at the time of reporting and agreed to by the Skagit co-managers.

Table 4-5. 2021 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	4
Marble Creek	3.1451	Foot	0.0-0.3	8.6	0
Cascade River	3.1411	Foot/Raft	9.0-12.4	9.0	22
Cascade River	3.1411	Foot	12.4-15.8	12.4	22
Cascade River	3.1411	Foot	15.8-18.6	15.8	10
Kindy Creek	3.1528	Foot	0.0-0.5	16.2	0
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:					58

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

This population spawns in the mainstem Sauk River and in the North and South Fork Sauk Rivers. Mainstem spawning has been documented between RM 31.0 to the forks at RM 31.9. A high gradient section of the Sauk River beginning 0.9 river miles downstream of the White Chuck River is an assumed barrier to Sauk *summer* Chinook and the beginning and lowest point of spawning of Upper Sauk River *spring* Chinook. Spawning in the North Fork Sauk occurs from the forks to an impassable falls 1.6 RM upstream. Spawning in the South Fork Sauk has been documented from the forks upstream to approximately RM 5.0, upstream of the area known as Monte Cristo Lake. However, spawning in the South Fork River upstream of RM 2.9 has only been documented once and was after a substantial flow increase from rain.

WDFW surveyed upper Sauk River spring Chinook spawning areas from August 5 through October 7. The survey interval goal was to survey all indexes upstream of the White Chuck River every 7-10 days by foot or pontoon boat. The index below the White Chuck River was surveyed by helicopter with a goal of a survey every two weeks; this reach is too treacherous to raft or walk. A total of 274 Sauk River spring Chinook carcasses were observed and 247 were recovered and sampled. 202 carcasses sampled were wild unmarked and untagged fish, 7 carcasses had a hatchery mark or tag, and 38 carcasses were undetermined tag and-or undetermined mark. There were 407 redds located upstream of the White Chuck River by ground based surveys, and 2 AUC estimated redds downstream of the White Chuck River in the section surveyed by helicopter (Table 4-6).

The 2021 upper Sauk River spring Chinook preliminary escapement estimate was 1,024 fish; all data and estimates of escapement are final and agreed to by the Skagit co-managers.

Table 4-6. Upper Sauk River spring Chinook redd counts from 2021 spawning ground surveys.

Stream	WRIA	Survey method	Reach (RM)	Location ¹	Redds
Sauk River	3.0673	Flight	31.0-31.9	31.0	2
Sauk River	3.0673	Foot/Float	31.9-34.5	31.9	145
Sauk River	3.0673	Foot/Float	34.5-37.8	34.5	181
Falls Creek	3.1182	Foot	0.0-0.2	34.9	5
Sauk River	3.0673	Foot/Float	37.8-39.7	37.8	10
South Fork Sauk River	3.1204	Foot	0.0-2.9	0.0	42
North Fork Sauk River	3.0673	Foot	39.7-40.1	39.7	13
North Fork Sauk River	3.0673	Foot	40.1-41.3	40.1	11
Total redds (rounded):					409

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 except for some limited spawning known to occur above the tributary index areas in years of high abundance, and in some other tributaries which have infrequent spawning activity. Skagit summer Chinook tributary spawning surveys occurred regularly from September 8 through November 8 (Table 4-7).

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 mainstem of the Skagit River was surveyed by helicopter. The protocol for mainstem aerial redd surveys was to count all visible redds including redds that were recognizable from previous flight surveys.

A total of 289 Skagit summer Chinook carcasses were observed, and 285 carcasses were recoverable and sampled; 236 carcasses were unmarked and untagged wild Skagit summer Chinook, 16 carcasses were adipose clipped only (no cwt), 30 carcasses were adipose clipped and CWT present, 1 carcass was CWT only, and 2 carcasses could not be sampled for adipose clip and-or tag.

We observed 119 Skagit summer Chinook redds in the tributaries.

The 2021 summer Chinook surveys were confounded by pink salmon spawning, turbid water conditions, and high flows at the end of October which ended surveys for the season. An alternate escapement regression methodology was used for 2021. The 2021 expected escapement of Skagit River summer Chinook was 6,410 fish (rounded). All data and estimates of escapement were final and agreed to by the Skagit co-managers.

Table 4-7. Skagit summer Chinook redd counts from 2021 spawning ground surveys.

Stream	WRIA	Survey method	Reach (RM)	Location ¹	Redds
Goodell Creek	3.1867	Foot	0.0-1.3	92.9	0
Falls Creek ³	3.1780	Foot	0.0-0.4	4.0	0
Bacon Creek	3.1774	Foot	0.0-4.2	82.9	27
Diobsud Creek	3.1750	Foot	0.0-1.3	80.7	14
Cascade River	3.1411	Foot/Float	0.0-4.2	78.1	64
Illabot Creek	3.1346	Foot	0.0-2.6	71.6	14
Total redds:					119

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.

Lower Sauk River Summer Chinook

These fish 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 has occurred in Dan Creek (WRIA 3.1079) but due to frequent low flows this has been intermittent. Spawning is surveyed on the mainstem by helicopter flights; the lower Sauk River is too wide, too braided, and spawning is too sparsely distributed to be effectively surveyed by foot or pontoon boat. Surveys of Dan Creek began August 26 and continued through October 18, with 24 Sauk summer Chinook redds and a preliminary seven carcasses observed for the spawn year (Table 4-8). No carcasses were sampled in Dan Creek. Six of the carcasses were unmarked untagged wild fish, and one carcass was adipose clipped and had a coded wire tag.

Mainstem Sauk summer Chinook spawning is often difficult to monitor due to turbidity inputs from the Suiattle River and the White Chuck River. Due to abnormally poor visibility conditions an alternate escapement methodology was used resulting in an expected escapement of 233 lower Sauk River summer Chinook (rounded). All data and estimates of escapement were final and agreed to by the Skagit co-managers.

Table 4-8. Lower Sauk River summer Chinook redd counts from 2021.

Stream	WRIA	Survey method	Reach (RM)	Location ¹	Redds by method		
					Foot surveys	AUC	Linear regression
					Actual	Estimated	Predicted
Dan Creek	3.1079	Foot	0.0-0.8	16.8	24	N/A	N/A
Hilt Creek	3.0678	Foot	0.0-0.5	0.6	0	N/A	N/A
Grand total redds from all methods (rounded):					24		

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

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 few 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 August 17 and continued through December 20 (Table 4-9). A total of 44 carcasses were sampled in the Skagit fall Chinook area in 2021. 43 carcasses were from wild unmarked and untagged fish, and for one carcass the mark and tag status could not be determined due to carcass condition. Four helicopter flight redd surveys were conducted and tributary surveys were conducted by foot every seven to fourteen days. Tributary surveys identified 62 redds, and these were summed with 204 AUC estimated mainstem redds from the four aerial surveys. Redd counts were multiplied by 2.5 fish per redd to calculate escapement.

The 2021 escapement estimate of Skagit River fall Chinook was 664 fish (rounded). All data and estimates of escapement were final and agreed to by the Skagit co-managers.

Table 4-9. Lower Skagit River fall Chinook redd counts from 2021 spawning ground surveys.

Stream	WRIA	Survey method	Reach (RM)	Redds
Skagit River	3.0176	Flight	24.5-56.5	104
Skagit River	3.0176	Flight	56.5-67.2	100
Hansen Creek	3.0265	Foot	3.0-4.5	0
Day Creek	3.0299	Foot	0.0-2.2	11
Jones Creek	3.0332	Foot	0.0-1.3	0
Grandy Creek	3.0337	Foot	0.0-1.4	0
Alder Creek	3.0359	Foot	0.0-1.6	0
O'Toole Creek	3.0365	Foot	0.0-0.2	0
Mill Creek	3.0375	Foot	0.0-0.2	2
Pressentin Creek	3.0385	Foot	0.0-0.4	0
Finney Creek	3.0392	Foot	0.0-7.0	49
Jackman Creek	3.0626	Foot	0.0-0.7	0
EF Nookachamps Creek	3.0230	Foot	3.5-5.1	0
Mundt Creek	3.0235	Foot	0.0-0.9	0
Total Redds				266

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 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 then multiplying by the GMR correction factor. Survey conditions for counting Chinook in the North Fork Stillaguamish were generally good during the spawning period until streamflows increased in early November. The first redds were detected on August 30th in the North Fork, and last one was detected October 25 in the North Fork. A total of 199 Chinook redds were counted on the North Fork of the Stillaguamish in 2021 (Table 4-10). The redd-based escapement estimate was 555 fish (Table 4-10). The GMR-adjusted provisional escapement estimate is 732 fish (425 NOR, 307 HOR). An additional 106 fish (61 NOR, 45 HOR) were taken for hatchery broodstock and were not included in the GMR adjusted provisional escapement estimate but are included in agreed to total watershed spawner escapement. Total NOR North Fork Stillaguamish River escapement (natural spawning + broodstock collection) was 485 Chinook.

Table 4-10. North Fork Stillaguamish summer and fall Chinook redd counts in 2021.

Stream	WRIA	Method	Reach (RM)	Redds	Escapement
North Fork	5.0135	Foot/Float	0.0-14.3	8	20
North Fork	5.0135	Foot/Float	14.3-30.0	151	378
North Fork	5.0135	Foot/Float	30.0-34.4	19	48
Grant Creek	5.0156	Foot	0.0-0.4	1	3
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	4	10
French Creek	5.0246	Foot	0.0-3.0	2	5
Squire Creek	5.026	Foot	0.0-4.0	13	33
Brown Creek	5.0265	Foot	0.0-1.0	0	0
Total Redds				199	
Redd-based Escapement Estimate					555
GMR adjusted EE (provisional)					732

South Fork and Mainstem Stillaguamish summer and fall Chinook

South Fork and Mainstem Stillaguamish summer and fall Chinook escapement in 2021 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 miles 34.7 to 55.1 include Granite Falls and Robe Canyon and are rarely surveyable, nor good Chinook spawning habitat. However, one Chinook redd was observed in the upper SF in 2021.

The mainstem aerial index reach, from the juvenile trap (RM 6.0) to the forks (RM 17.8), was flown three times in 2021, September 15, September 24, and October 8.

A total of 21 Chinook redds were found in the Mainstem Stillaguamish and South Fork Stillaguamish River and tributaries in 2021 (Table 4-11). The redd-based escapement estimate was 55 adult fish, which expanded to 73 adult fish with the application of the GMR correction factor (Table 4-11).

Table 4-11. South Fork and Mainstem Stillaguamish summer and fall Chinook redd counts in 2021.

Stream Reach	WRIA	Method	Reach (RM)	Redds	Escapement
Mainstem	5.0001	Flight	6.0-17.8	9	23
South Fork	5.0001	Foot/Float	17.8-34.7	5	13
South Fork (upper)	5.0001	Foot	34.7-65.0	1	3
Pilchuck Creek	5.0062	Foot/Float	0.0-6.2	2	5
Jim Creek	5.0322	Foot/Float	0.0-4.1	3	8
Siberia Creek	5.0324	Foot	0.0-0.4	1	3
Canyon Creek	5.0359	Foot	0.0-0.5	0	0
Total Redds				21	
Redd-based Escapement Estimate					55
GMR adjusted EE (provisional)					73

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. Stillaguamish Tribal staff also sample the broodstock collected from the spawning grounds for hatchery production. 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, 280 complete carcasses (status of both adipose fin and CWT was determined) were sampled in the Stillaguamish River; 106 in broodstock collection, 174 combined in the North Fork and South Fork reaches (Table 4-12). The sampling rates of Chinook carcasses, not including those with unknown mark dispositions, were 23.4% for the spawning grounds and 100% for the broodstock. These rates were calculated by dividing the number of carcasses sampled by the escapement estimate for each sampling location.

Escapement of Chinook by origin (hatchery or natural) was determined in a two-step method. First by taking the ratio of hatchery origin carcasses to natural origin carcasses and then applying the spawning ground GMR adjusted escapement. For 2021, 73 of 174 samples were determined to be of hatchery origin, which estimates 42% of the provisional GMR adjusted escapement is 307 adults. Then the number of hatchery origin adults known in the broodstock (45) are added to the estimated spawning ground hatchery adults (307), for a watershed escapement hatchery proportion of 42.1%. This methodology is used due to the reduced sampled sizes on the spawning grounds and differences in timing of broodstocking that can in some years cause the broodstock samples to weight the total proportion in a magnitude not reflective of the returning population (Table 4-12).

Table 4-12. Stillaguamish Chinook sample proportions and HOR:NOR composition in 2021.

	Sampled	Sampled Hatchery	Sampled Natural	% Hatchery	% Natural	GMR Esc EST	% Sampled
GMR Adjusted EE1	174	73	101	42.0	58.0%	732	23.4%
Broodstock (NF)	106	45	61	42.5%	57.5%	106	100.0%
Stillaguamish Totals				42.1%	58.0%	838	

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 non-surveyed 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 and float 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, 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. Normal Fall rains came at the end of October that interrupted survey coverage, but frequency and number of surveys was acceptable. For the most part, survey intervals were kept at seven to ten days. Four 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 738 Chinook redds were found in the Skykomish River and its tributaries, and Pilchuck River in 2021 (Table 4-13). The spawning escapement estimate (including Sunset Falls trap counts) was 2,021 adult fish (1,414 NOR, 607 HOR; Table 4-15). An additional 5,475 adult hatchery origin fish (including 84 jacks) and 176 adult and 1 jack natural origin fish recruited to Wallace Hatchery and were not included in this escapement estimate. Total adult NOR Skykomish escapement (natural spawning + broodstock collection) was 1,567 Chinook.

Table 4-13. Skykomish summer/fall Chinook redd counts and escapement, 2021.

Stream Reach	WRIA	Method	Reach (RM)	Redds	Escapement
Snoh-Sky (Mainstems)	7.0012	Float/Flight	13.2-51.5	370	925
NF Skykomish	7.0982	Foot/Flight	0.0-13.5	54	135
SF Sky (Sunset Falls)	7.0012	Trap/Haul	51.5-up		174
Pilchuck River	7.0125	Foot/Float	2.0-26.5	22	55
Woods Creek	7.0826	Foot/Float	0.0-3.5	1	3
Elwell Creek	7.0865	Foot	0.0-1.0	10	25
Sultan River	7.0881	Foot/Float	0.0-9.7	150	375
Wallace River (lower)	7.094	Foot/Float	0.0-4.4	33	83
Wallace River(upper)	7.094	Foot/Float	4.4-7.3	58	145
Olney Creek	7.0946	Foot	0.0-0.6	3	8
Proctor Creek	7.097	Foot	0.0-0.4	6	15
Bridal Veil Creek	7.1248	Foot	0.0-0.4	31	78
Total Redds				738	
Escapement					2,021

Snoqualmie summer/fall Chinook

The escapement estimates for Snoqualmie summer/fall Chinook were made using cumulative redd counts from boat and foot 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 mid-September to early November.

Survey conditions were good for monitoring Chinook spawning until the end of October when Fall rainstorms significantly increased stream flows, delaying or preventing some surveys.

In 2021, 978 Chinook are estimated to have escaped to the Snoqualmie Basin, based on a total count of 390.5 redds (Table 4-14). Based on carcass sampling results, the escapement estimate is composed of 611 NORs and 367 HORs (Table 4-15).

Table 4-14. Snoqualmie fall Chinook redd counts and escapement by reach, 2021.

Stream Reach	WRIA	Method	Reach (RM)	Redds	Escapement
Snoqualmie River (Lower)	7.0219	Float	20.5-24.9	42	105
Snoqualmie River (Upper)	7.0219	Float	32.9-39.6	61	153
Cherry Creek	7.0240	Foot	1.8-3.5	1	3
Tolt River (Lower)	7.0291	Foot/Float	0.0-6.0	62	155
Tolt River (Upper)	7.0291	Foot/Float	6.0-8.9	8	20
NF Tolt River	7.0291	Foot	8.9-11.3	7	18
SF Tolt River	7.0302	Foot	0.0-2.3	6	15
Raging River	7.0384	Foot	0.0-4.6	58	145
Raging River (Upper)	7.0384	Foot	4.6-13.2	52.5	131
Tokul Creek (Lower)	7.044	Foot	0.0-0.3	75	187
Tokul Creek (Upper)	7.044	Foot	0.3-0.6	18	46
Total Redds				390.5	
Escapement Estimate					978

Sampling and HOR:NOR summary

Field staff sampled 732 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 77 live Chinook passed at Sunset Falls. In total, the Chinook carcass sampling rate on the spawning grounds and at Sunset Falls was 24.4% (Table 4-15). 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 4-15). 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 sampling occurred.

Table 4-15. Snohomish Chinook carcass sampling and escapement composition in 2021.

Stratum	Escapement	No. Hatchery	No. Natural	% Hatchery	% Natural	Number Sampled	Percent Sampled
Skykomish	976	227	749	23.26%	76.74%	86	8.8%
Bridal Veil	213	76	137	35.71%	64.29%	42	19.7%
SF Sky *	174	20	154	11.69%	88.31%	77	44.3%
Pilchuck River	55	8	47	14.29%	85.71%	14	25.5%
Sultan River	375	74	301	19.67%	80.33%	61	16.3%
Wallace River	228	202	26	88.46%	11.54%	78	34.2%
Skykomish Population	2,021	607	1,414	30.03%	69.97%	358	17.7%
Snoqualmie	745	219	526	29.41%	70.59%	170	22.8%
Tokul	233	148	85	63.73%	36.27%	204	87.6%
Snoqualmie Population	978	367	611	37.53%	62.47%	374	38.2%
Snohomish Total	2,999	974	2,025	32.47%	67.53%	732	24.4%

*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 2021, a total of 385 Chinook redds were observed in the Cedar River during the spawning season (including the surveyed area upstream from Landsburg Dam and including two small tributaries below Landsburg, Rock and Taylor). Of the Chinook redds, 376 were observed in the Cedar River mainstem (359 below Landsburg Dam and 17 above), and 9 were observed in the small tributaries to the Cedar River. Expansion by 2.5 fish per redd resulted in the estimated escapement of 963 Chinook (Table 4-1). Carcass surveys in the Cedar River indicated that 63% of the naturally spawning adult Chinook were natural origin fish (unclipped) and 37% were hatchery origin (clipped) fish.

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 2021 was estimated at 2454 fish.

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 area under the curve (AUC) method, where live fish counts and a 10-day stream life estimate are used to calculate escapement.

The Bear Creek/Cottage Creek area was surveyed weekly during the 2021 spawning season. The escapement estimate was 668 fish. Of these, 175 fish were estimated in the Bear Creek mainstem, and 493 fish were estimated in Upper and Lower Cottage Creek. Carcass surveys in the Big Bear/Cottage Lake system indicated that 16% of the naturally spawning adult Chinook were natural origin and 84% were hatchery origin.

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 2021 spawning season, and total escapement was estimated at 1786. This estimate includes 1739 fish in the mainstem below the hatchery, and 47 fish from the East Fork. Carcass surveys in the Issaquah Creek system indicated that 9% of the naturally spawning adult Chinook were natural origin and 91% were hatchery origin.

Chinook escapement to Issaquah Hatchery in 2021 was 4037 (2,303 adults and 278 jacks); of which 563 adults and 131 jacks were intentionally released upstream to spawn in upper Issaquah Creek.

4.6 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 with zero assumed variance. 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 an aerial survey in the mainstem river between River Mile (RM) 25.4 to 48.5 (Lower River

(counted every other week), 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 8 and continued through November 4. Although visibility was sometimes limited, no surveys were suspended because of high flows. Redd counts from Metzler Side Channel were conducted on October 3, October 19, and November 2. 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 12, 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. A second aerial survey was conducted on October 30; however, visibility was too low to obtain a redd count in most reaches. 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 (14 redds) and Hwy 167 to Transfer Shack (2 redds) reaches, the sum of redds observed during four floats (Lower River) and an estimate of redds extrapolated from one aerial survey (Hwy 167 to Transfer Shack) was used to estimate a combined season total of 16 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 Chinook 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 an assumed sex ratio of 1.5 males for every female.

Post season analysis of the season totals indicates that peak spawning activity varied by section, and was highest during either the last week of September or the first two weeks of October (Table 4-16 and Table 4-17). By the end of surveys the week of October 17, 98.8% of the redds (1120 of 1134) observed during boat and foot spawning ground surveys were complete.

Table 4-16. Chinook redd counts from foot and boat surveys of the Green River in 2021.

Section	Week ¹									Total
	5-Sep	12-Sep	19-Sep	26-Sep	3-Oct	10-Oct	17-Oct	24-Oct	31-Oct	
Headworks	0	4	34	182	136	156	30	3	0	545
Lower Gorge	-	1	0	4	19	33	22	3	0	82
Middle River	0	-	7	37	71	154	69	7	1	346
Lower River ¹	-	1	0	12	-	1	-	0	-	14
Newaukum Creek	0	0	17	41	60	25	4	0	-	147
Total	0	6	58	276	286	369	125	13	1	1134

¹An aerial survey on October 12 was used to estimate 2 redds for the survey season in the Hwy 167 to transfer shack reach.

Table 4-17. Aerial survey counts of Chinook redds in the Green River, 2021.

Section	Week ¹									Total
	5-Sep	12-Sep	19-Sep	26-Sep	3-Oct	10-Oct	17-Oct	24-Oct ²	31-Oct	
Headworks	-	-	-	-	-	221	-	3	-	224
Gorge	-	-	-	-	-	55	-	8	-	63
Lower Gorge	-	-	-	-	-	49	-	11	-	60
Middle River	-	-	-	-	-	135	-	-	-	135
Lower River	-	-	-	-	-	13	-	-	-	13
Hwy 167- Transfer Shack	-	-	-	-	-	2	-	-	-	2
Total	-	-	-	-	-	475	-	22	-	497

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

²Visibility was too low in the October 30 survey to obtain a redd count in most reaches. A best attempt was made in the stretch from Cristy Creek to Kanaskat Bridge.

The season total redds from the Middle River was 344 redds plus 2 from MSC, 82 from the Lower Gorge, 545 from the Headworks, and 14 in the Lower River plus 2 in the Hwy 167-Transfer Shack reach. The G/A ratio for the Lower Gorge was 1.67 (82/49) resulting in a calculated 92 redds for the “Gorge”. A total of 1,081 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 100 and for the section “Whitney Hill Bridge” to mouth” was 47, totaling 147 redds in Newaukum Creek.

Applying the constant 2.5 Chinook/redd (1.5 males:1.0 female), an estimate of 3,070 naturally spawning Chinook was generated for the Green River Basin (Table 4-1).

Although surplus returns to the Soos Creek Hatchery were not used in 2021, 319 adults and 26 jacks that returned to the Keta Creek Hatchery 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 2021 Chinook spawning season were moderate through most of the season and no surveys had to be suspended because of high flows (Table 4-18).

Table 4-18. 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 2021. Weekly discharges are 7-day averages of mean daily discharge beginning with the day listed.

USGS Gauge	Week								
	5-Sep	12-Sep	19-Sep	26-Sep	3-Oct	10-Oct	17-Oct	24-Oct	31-Oct
Palmer	234	259	319	349	381	400	409	918	868
Auburn	325	348	435	478	492	539	535	1120	1204
Newaukum Creek	-	-	18	17	17	17	18	22	25

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. In years where surplus Chinook are transferred from a hatchery to the spawning ground, tags from those releases are noted for all sampled carcasses.

A total of 673 carcasses were sampled for standard biological data by Green River crews in 2021; 452 (2 DIT+ 19 CWT&AD + 241 AD (no CWT) + 190 thermal marked with no adipose fin and no CWT) or 68.9% were of hatchery origin as indicated by the presence of an adipose fin, CWT tag, or hatchery thermal mark (Table 4-19).

Table 4-19. Summary of Chinook biological sampling in the Green River, 2021.

Section	Biological Samples	Adipose Clipped	Thermal Marks	MIT Tags ¹	CWT ² & Ad-Clipped	DIT ²
Headworks	331	115	125	0	0	2
Lower Gorge	23	7	4	1	1	0
Middle River	90	24	10	5	6	0
Lower River	0	0	0	0	0	0
Metzler Side Channel	0	0	0	0	0	0
SubTotal: River	444	146	139	6	7	2
Newaukum: 400th to Whitney Hill Br	162	81	29	0	10	0
Newaukum: Whitney Hill Br to Mouth	67	33	22	0	2	0
SubTotal: Newaukum	229	114	51	0	12	0
Grand Total:	673	260	190	6	19	2

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

² CWT: Coded wire tag present (unconfirmed); DIT: (Double Index Tag) Adipose fin present, coded wire tag present.

Table 4-20. Coded wire tag sampling, thermal mark analysis of otoliths¹, and origin of natural Chinook spawners² in the Green River, 2021.

	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	444	147	286	11	9	435	2	145	7	279	0	11
Newaukum Creek	229	58	165	6	12	217	0	58	12	153	0	6
Green River Basin Total	673	205	451	17	21	652	2	203	19	432	0	17

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

4.7 White River

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), the new Mud Mountain Dam Fish Passage Facility (MMD FPF), 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 and the FPF 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 is limited, particularly during the latter part of the Chinook run. Consequently, 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 2021, sampling occurred into September, but 7,287 Chinook (2,950 adults and 4,337 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 3,032. Of these, 2,094 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 30% and APs made up 31% of the sampled adult Chinook. At the Buckley Trap and FPF, 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, 125 of the adult NORs were collected at, or taken to, the White River Hatchery for use as broodstock.

Table 4-21. Estimated number NOR and Acclimation Pond Chinook salmon hauled upstream of Mud Mountain Dam in 2021. Results are a combination of returns sampled White River Hatchery and sampled and un-sampled fish at the Buckley Trap and FPF.

Origin	Adults	Jacks	Totals
Wild (NOR)	2,090	1,360	3,450
Acclimation Pond	1,552	1,676	3,228
Totals	3,642	3,036	6,678

There are two hatchery programs for White River spring Chinook: 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 2021, escapement to the Minter Creek/Hupp Springs hatchery was 1,508 adults and 119 jacks. Escapement to the White River Hatchery in 2021 was 792 adults and 7 jacks. These fish were either collected at the Buckley fish trap on the south side of the diversion dam, the FPF, or volunteered to the WRH trap on the north side of the diversion dam. An additional 706 adults and 1,762 jacks were passed above Mud Mountain Dam that originated from the White River Hatchery program. These fish were identified through CWT sampling.

4.8 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.

The escapement estimate includes fall-timed Chinook spawning in the lower White River downstream of the Buckley diversion dam trap. These fish have been enumerated by PTF biologists through spawning ground surveys since 2002 but were not accounted for in escapement estimates prior to 2009.

South Prairie Creek

Odd-year estimates for SPC are based on live count AUC adjusted by the mean South Prairie redd-based estimate/AUC-based estimate ratio. This adjustment is necessary because pink returns in odd years often preclude objective Chinook redd accounting and historic live count-based estimates have been very conservative when compared to redd-based estimates in this system. The South Prairie Creek (SPC) sub-basin spawning escapement estimate for 2021 is 1393 spawners. This escapement is made up of 617 NORs and 776 HORs. The 2021 SPC redd estimate/AUC estimate ratio was 1.80, based on even-year data from 1994 to 2020. The 2021 AUC spawner curve yielded an escapement estimate of 776 spawners for SPC. Expanding the SPC AUC-based escapement (776 x 1.80) yielded a South Prairie escapement of 1393. Wilkeson Creek contributed an additional 787 Chinook (355 NORs and 432 HORs) to the escapement estimate.

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 2020 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 (1994-2020) ratio of redd-based escapement and live fish AUC estimate exclusively in SPC multiplied by the 2021 AUC live fish estimate for SPC sub-basin.

Survey conditions were not suitable on the Carbon River during the 2021 spawning period. Consistent with the last ten years, the 2021/1999 SPC AUC escapement ratio (2807 / 1422 =

1.9742) was applied to the 1999 Carbon River escapement (250) to estimate the 2021 value. This method estimated 494 Chinook spawning in the Carbon during 2021 ($250 * 1.9742 = 494$). Based on mark sampling ratios observed in South Prairie Creek, the escapement was made up of 219 NORs and 275 HORs.

Puyallup River Tributaries

Aggregate escapement to Puyallup River tributaries in 2021 was estimated at 519 (Table 4-22). Based on mark sampling in these tributaries, 28 of these fish are NORs and 419 HORs.

Table 4-22. Chinook escapement estimates for Puyallup River tributaries, 2021.

Tributary	Escapement
Fennel Creek (WRIA 10.0406)	75
Canyon Falls Creek (10.0410)	21
Kapowsin Creek (10.0600)	73
Clear Creek (10.0022)	185
Clarks Creek (10.0027)	165
Tributary total	519

Mainstem Puyallup River

Chinook spawning escapement to the mainstem Puyallup River was estimated to be 464. This escapement comprised 85 NOR and 379 HOR Chinook, based on mark sampling ratios observed in mainstem tributaries.

As with the Carbon River, surveys of Puyallup River were not possible in 2021. 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 2021/1999 Puyallup tributary AUC ratio ($269/113 = 2.3801$) was applied to the estimated 1999 Puyallup mainstem escapement (195) to estimate 2021 escapement of 464 Chinook ($195 * 2.3801 = 464$). The same even year (1994-2020) average AUC adjustment used for the Carbon River was applied to the Puyallup tributary AUC live-fish estimate to develop the 2021 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 2021 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 2021 was estimated to be 1328 fish. This escapement is made up of 209 NORs and 1119 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 2021 was 4,985. Based on carcass sampling, we estimated that 1,513 were NORs, and 3,472 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.

4.9 Nisqually River

Natural escapement to the Nisqually River in 2021 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 adult sampling location at RM 13 and proportion of those removals marked, and (3) the proportion of marked fish passing above the sampling location at RM 13 to estimate the total return to the river.

Total escapement to the spawning grounds and the hatcheries in the Nisqually River was estimated to be 8,921 adult Chinook salmon (Table 4-1) with a preliminary natural spawning escapement of 2,012. The spawning escapement was composed of 417 natural-origin and 137 hatchery-origin adult fish voluntarily escaping to the spawning grounds and an additional 1,458 adult hatchery origin fish trucked from Clear and Kalama hatcheries and remaining on the spawning grounds.

4.10 Hood Canal

Natural Chinook escapement to the Skokomish River and Mid-Hood Canal rivers in 2021 were 993 and 8, respectively (Table 4-23).

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. When returns increased as the result of supplementation, the AUC method was employed as the primary method of escapement estimation. However, since the supplementation program ended with the 2016 brood year, no

supplementation-origin fish are now returning. Numbers have dropped to pre-supplementation levels and estimation methods have reverted to those previously used at low abundances.

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 8 adults; three, two, and three Chinook in Dosewallips, Duckabush, and Hamma Hamma rivers, respectively (Table 4-23). During 2021, 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, very few 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 identified and only 3 live fish were observed in the Dosewallips River during 2021. The Duckabush River was surveyed from RM 0 to RM 2.6, RM 4.8 to RM 6. Although no Chinook redds were conclusively identified, an AUC estimate of two 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 River is three which is the peak/live dead 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 River mainstem surveys. No Chinook were collected for broodstock. The FRAM preseason escapement projection was 18 for the Mid-Hood Canal (FRAM 3721) while the estimated escapement is 5 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, raft and snorkel surveys (e.g., see Smith and Castle 1994). Surveys are conducted every seven to ten days. Historically, the fall Chinook survey season extended from early 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 mainstem above the 101 Bridge are used to calculate fish days, which are then divided by a stream life value of 14 days (the average difference between peak average live counts and peak average redd deposition) then combined with redd-based escapement estimates for the North and South forks to estimate total Chinook escapement. In 2021,

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 2021, Chinook had limited access to the South Fork Skokomish as the channel remained dry from August 12 through September 18 when increased flow again allowed passage.

The total estimated spawner escapement to the Skokomish River is 993 (Table 4-23). This total includes 433 in the mainstem Skokomish, 505 Chinook in the North Fork, and 55 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, an AUC estimate from the mainstem above the 101 Bridge. The preseason escapement prediction was 3,787 (FRAM 3721).

Table 4-23. Summary of Chinook escapement to Hood Canal streams during 2021.

Area	Stream	Escapement	Comments
82 G/J	Skokomish R.	433	AUC based on live fish (MS3 and 4), plus redd-based esc for NF Hunter Cr.
	N.F. Skokomish R.	505	
	S.F. Skokomish R.	55	
	Total	993	
12A	Little Quilcene R.	0	No Chinook observed
	Big Quilcene R.	0	No Chinook observed
	Total	0	
12B	Dosewallips R.	3	AUC based on live fish
	Duckabush R.	2	AUC based on live fish
	Hamma Hamma R. a/	3	AUC Hamma
	Total	8	
12C	Dewatto R.	7	AUC
	Eagle Cr.	11	AUC
	Lilliwaup Cr.	4	AUC
	Total	22	
12D	Tahuya R.	0	No Chinook observed
	Union R.	68	Trap
	Total	68	
Hood Canal total		1,091	

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. Since 2017, the Skokomish, Dosewallips, Duckabush, and Hamma Hamma rivers continue to be targeted for enhanced mark and CWT sampling, with WDFW also sampling Chinook carcasses for marks and CWTs on the Dewatto, Tahuya, and Lilliwaup rivers.

Of the 124 Chinook sampled in Hood Canal rivers during 2021, 50 Chinook were adipose-clipped and, of these, 1 had CWTs. 5 unmarked Chinook were coded-wire tagged. We sampled 5.4% of the Chinook spawning escapement in the Skokomish River. In the Mid-Hood Canal rivers Chinook escapement, only three fish were live sampled in the Hamma Hamma River through snorkeling, and no carcasses were present in the Duckabush and Dosewallips Rivers. Overall, the sampling rate was 11.4% for all Hood Canal rivers combined (Table 4-24).

Jacks are not included in Chinook spawning escapement estimates in Hood Canal, but few jacks were sampled during 2021.

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 can be subject to clip error and tag detection rates for the returning brood years. Thus, the proportion of hatchery fish on the spawning escapement is also estimated by expanding adipose-clipped fish based on proportions of clipped fish released from each brood year, based on co-manager agreement. Age composition in the escapement, carcass sampling rate, and the proportion of hatchery production releases that were marked and/or tagged from BY 2016 (age-5), BY 2017 (age-4), and BY 2018 (age-3).

In 2021 there was close agreement in the two aforementioned methods, with mark sampling-based pHOS weighted estimated as 79% and expanded clip pHOS of 87.2% in the Skokomish River system (Table 4-24 and Table 4-25). 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. A total of 39 Chinook sampled, 29 were adipose-marked (87.2%). Spawning escapement in the Skokomish River was comprised of about 79% hatchery-origin Chinook and 21% natural-origin Chinook, with a higher proportion of NOR returns to the Mainstem where they accounted for 90.1% (Table 4-24). Also, the commercial sampling of the tribal gillnet fishery in the mainstem was similar in composition with 97.7% hatchery-origin Chinook and 2.3% natural-origin Chinook. These estimates may be further refined as CWT data becomes available next fall. The low carcass recovery sample size along with the extremely low escapement, highlight the uncertainty in the 2021 Skokomish River HOR/NOR estimates.

Hatchery releases into the Hamma Hamma concluded with the last brood year release was 2014 making 2018 the last year Age 4 adults returned to the Hamma from the supplementation program, and Age-5 Chinook from the last supplementation release would have returned in 2019. Since supplementation origin fish are no longer returning, otoliths are no longer collected. Any Chinook carcasses encountered will continue to be 100% sampled for sex, length, scales, mark status, and coded wire tag. However, very few carcasses are recovered, due the low numbers of Chinook and scavenging and predation. Thus, snorkeling is now being employed to monitor for ad-clipped fish.

Because so few carcasses were recovered from the Duckabush and Dosewallips rivers, a long term HOR average for the Hamma Hamma (15%) was applied to the 2021 escapements (Table 4-24). The low carcass recovery sample size along with the extremely low escapement, highlight the uncertainty in the 2021 Mid Hood Canal HOR/NOR estimates.

Table 4-24. Chinook salmon spawner escapement origin based on carcasses sampled for marks and coded-wire tags (CWTs) in Hood Canal rivers, 2021.

Mgmt Unit and River	Spawner escapement	Chinook sampled		Tagged 1/			Untagged 1/			Unk. tagged 2/			Totals		Rate 5/	HOR	NOR	pHOS (weighted)	
		Number	%	AD	NM	Unk	AD	NM	Unk	AD	NM	Unk	CWTs recovered	AD-clips observed					
Skokomish																			
Mainstem	433	22	5.1%	0	1	0	19	1	0	0	1	0	1	19	0.91		394	39	
Hunter	NA	100	na	6	16	0	78	2	0	0	0	0	22	84	1.00				
North Fk	505	24	4.8%	1	3	0	11	7	2	0	0	0	4	12	0.68		344	161	
South Fk	55	8	14.5%	0	1	0	3	2	1	1	0	0	1	4	0.86		48	8	
Skokomish River total	993	154	15.5%	7	21	0	111	12	3	1	1	0	28	119	0.93		785	208	0.79
Skokomish Total w/o Hunter	993	54	5.4%	1	5	0	33	10	3	1	1	0	6	35	0.78		785	208	0.79
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	0	NA				
12B																			
Hamma Hamma R. 3/	3	1	33.3%	0	0	0	1	0	0	0	0	0	0	1	1.00		1	2	
Duckabush R. 4/	2	1	50.0%	0	0	0	1	0	0	0	0	0	0	1	0.17		1	1	
Dosewallips R. 4/	3	0	0.0%	0	0	0	0	0	0	0	0	0	0	0	0.17		1	2	
Mid-Hood Canal total	8	2	25.0%	0	0	0	2	0	0	0	0	0	0	2	0.31		3	5	
12C																			
Dewatto R.	8	0	0.0%	0	0	0	0	0	0	0	0	0	0	0	0.00		0	8	
Eagle Creek	7	0	0.0%	0	0	0	0	0	0	0	0	0	0	0	0.00		0	7	
Lilliwaup R.	4	0	0.0%	0	0	0	0	0	0	0	0	0	0	0	0.00		0	4	
12D																			
Tahuya R.	0	0	0.0%	0	0	0	0	0	0	0	0	0	0	0	0.00		0	0	
Union R. 2/	68	68	100.0%	0	0	0	0	0	0	0	0	0	0	13	0.19		13	55	
Hood Canal total	1,088	124	11.4%	1	5	0	35	10	3	1	1	0	6	50	0.75		801	268	

1/ AD = adipose fin-clipped; NM = no mark; Unk = unknown

2/ Visual detection only live fish at the trap, expanded by hatchery clip rates

3/ Carcass sample size too small for estimate, longterm average

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

natural escapement = 268

hatchery escapement = 801

Table 4-25. Chinook salmon spawner escapement origin based on carcasses sampled for marks and coded-wire tags (CWTs) in Hood Canal rivers, 2021.

	Age				Total
	21	31	41	51	
Mark rate	0.862	0.871	0.868	0.860	
ADB	0	0	1	0	
ADNB	1	17	9	1	
ADUkn	0	0	0	0	
ADNH	0	0	1	0	
Total ad-clipped	1	17	11	1	29
expanded	1	20	13	1	34
UMB	1	1	1	0	
UMNB	0	5	3	0	
UMNH	0	0	0	0	
Total no clip	1	6	4	0	
Adjusted	1	3	2	0	
Total mark status known	2	23	15	1	39
Proportion Hatchery Origin Spawners (pHOS)					0.872

*Excluding fish < 49cm in sample
 AD = Adipose-clipped (marked)
 UM = Unmarked
 NB = no CWT detected
 B = CWT detected
 NH = No head

4.11 Dungeness

Since 1986, surveys by foot have been conducted throughout the spawning season from RM 0.0 to 18.7 in the mainstem Dungeness River, and from RM 0 to 5.1 in the mainstem Gray Wolf River, 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 2021, 221 Chinook redds were counted in the Dungeness River and 2 redds were counted in the Gray Wolf River (Table 4-26). The estimated number of natural spawners in the rivers were 553 in the Dungeness River and 5 adults in Gray Wolf River. There were an additional 98 adults either trapped or netted from the Dungeness River for the hatchery broodstock program including five pond mortalities. The total estimated return to the river was 656.

Table 4-26. The distribution of Chinook redds in the Dungeness Rivers system, 2021.

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	0	0.0000	0
Dungeness R (18.0018)	18.0018	RM 15.8	RM 17.5	3	0.0135	8
Dungeness R (18.0018)	18.0018	RM 13.8	RM 15.8	10	0.0448	25
Dungeness R (18.0018)	18.0018	RM 10.8	RM 13.8	4	0.0179	10
Gray Wolf R (18.0048)	18.0048	RM 0.0	RM 1.0	2	0.0090	55
Gray Wolf R (18.0048)	18.0048	RM 1.0	RM 2.5	0	0.0000	0
Gray Wolf R (18.0048)	18.0048	RM 2.5	RM 4.0	NS	0.0000	0
Gray Wolf R (18.0048)	18.0048	RM 4.0	RM 5.1	NS	0.0000	0
				19	0.0852	48
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	38	0.1704	95
Dungeness R (18.0018)	18.0018	RM 6.4	RM 9.2	69	0.3094	173
Dungeness R (18.0018)	18.0018	RM 3.3	RM 6.4	74	0.3318	185
Dungeness R (18.0018)	18.0018	RM 0.5	RM 3.3	23	0.1031	58
				204	0.9148	510
Grand Total				223	1.0000	558

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 was detected, the snout was removed and a label was attached for identification.

We sampled 236 carcasses (n=92 broodstock collection and mortalities and 144 from natural spawners in the river). Of the total number of carcasses sampled, 108 of 217 (54.2%) were tagged (Table 4-27).

Table 4-27. 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 2021.

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	92	52	0.5652	40	0.4348
Spawning Ground Surveys (SGS)	144	56	0.3889	88	0.6111
Total sample size	236	108 ¹	0.4576	128	0.5424

¹ One tag was lost

Based on the CWT results and scale samples analyzed, the preliminary NOR/HOR composition for Return Year (RY) 2021 is 349 (53.2%) NOR and 307 (46.8%) HOR. The ages of the NOR Chinook for RY2021 consisted of 0.0% age-2, 29.2% age-3, 64.2% age-4, 6.6% age-5, and 0.0% age-6. The ages of the HOR Chinook for RY2021 consisted of 0.0% age-2, 33.2% age-3, 61.2% age-4, 5.6% age-5, and 0.0% age-6. The ages of all Chinook for RY2021 combined were 0.0% age-2, 31.1% age-3, 62.8% age-4, 6.1% age-5, and 0.0% age-6 (Table 4-28).

Table 4-28. Total number and percentages of age-2, age-3, age-4, age-5, and age-6 HOR and NOR Chinook returns in 2021.

	NOR	Percentage	HOR	Percentage	Total	Percentage
Age-2	0	0.0%	0	0.0%	0	0.0%
Age-3	102	29.2%	102	33.2%	204	31.1%
Age-4	224	64.2%	188	61.2%	412	62.8%
Age-5	23	6.6%	17	5.6%	40	6.1%
Age-6	0	0.0%	0	0.0%	0	0.0%
Total	349	100.0%	307	100.0%	656	100.0%

From 2006 to 2021, the total Dungeness River Chinook NOR plus HOR returns ranged from 204 to 1,543 (

Table 4-29). The number of NOR Chinook returns ranged from 43 to 349 and the number of HOR returns ranged from 90 to 1,204. The 16-year average is 175.2 (32.4%) NOR and 422.6 (67.6%) HOR, respectively.

Table 4-29. Total number of NOR and HOR natural spawners and broodstock in the Dungeness River for return years 2006-2021.

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
2019	173	665	838	19	73	92	192	738	930
2020	294	439	733	27	70+3Unk	100	321	512	833
2021	312	246	558	37	61	98	349	307	656
Avg.	143.1	346.8	489.8	32.1	76.0	107.9	175.2	422.6	603.3

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.

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
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	515
2017	149	456	605	26	74	100	175	530	705
2018	127	661	788	20	97	117	147	758	905

2019	173	665	838	19	73	92	192	738	930
2020	294	439	733	27	70+3unk	100	321	512	833
2021	312	246	558	37	61	98	349	307	656

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.

4.12 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 as described in Denton et al (2022). This technology improved Chinook escapement estimates due to the difficulty of observing redds and fish in turbid water conditions caused by the removal of the two dams. Jacks are excluded from the SONAR estimate. The final 2021 Chinook estimate of total adult return to the river is 2,630 (95% CI 2,330-2,830) with a coefficient of variation of 9.5%.

Chinook Spawning Distribution:

To determine the 2021 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 14-24) in the upper, middle, and lower watersheds. The Upper Elwha section is from Mills at rkm 21.1 to rkm 56.0, the Middle Elwha from Glines Power (rkm 21.1) to Aldwell North (rkm 7.9), and the Lower Elwha from Lower Dam (rkm 6.6) to Hunt Channel (rkm 2.0). Of 494 redds observed, 89 (18.02%) redds were in the Upper Elwha, 325 (65.79%) in the Middle Elwha, and 80 (16.19%) in the Lower Elwha. In addition to recording the number of redds, surveyors recorded the number of live and dead Chinook (Table 4-30, McHenry et al., 2022).

Table 4-30. 2021 Elwha River Chinook salmon spawners from Upper Watershed Dam to the mouth (McHenry et al. 2022).

Survey Reach	Rkm midpoint	Redds	Redds/km	Live Chinook	Dead Chinook	Jacks
Upper Elwha						
Upper Watershed	49.9	0	0	0	0	0
Geysler Valley	27.7	0	0.0	0	0	0
Cat Creek	0.7	4	2.7	3	1	0
Boulder Creek	0.2	27	54.0	43	4	0
Mills	21.5	58	14.5	137	4	2
UE Subtotal		89		183	9	2
		(17.9%)				
Middle Elwha						
Glines Power.	19.1	26	32.5	50	4	0
Altaire Bridge	18.1	2	1.7	4	1	0
Elwha RS	17.8	2	3.3	26	0	0
Hughes Creek	16.2	34	15.0	81	9	0
Fisherman's Corner	16.1	21	24.2	39	11	0
ONP Boundary	14.9	16	9.4	21	14	0
McDonald Br.	12.9	11	7.3	76	5	0
Little River	12.2	40	21.0	104	15	0
Indian Creek	12.0	94	49.4	104	36	0
Aldwell South	11.0	62	26.9	13	36	0
Aldwell North		18		13	12	0
ME Subtotal		326	7.5	523	143	0
		65.9%				
Lower Elwha						
Elwha Dam	6.1	4	5.0			
Hwy 112 Bridge	4.9	31	20.6			
County Bridge	3.2	28	14.7			
East Channel	1.1	17	7.4	236	59	-
Hunt Rd. Chan.	1.5	0		0	0	0
LE Subtotal		80		236	59	
		(16.2%)				
TOTAL		495		966	211	2

In addition to SONAR enumeration and peak spawning ground surveys, adult Chinook were collected from the lower river by various methods for broodstock purposes. Hatchery personnel collected 977 Chinook (736 males, 197 females, 44 jacks) as volunteers to the state and tribal hatcheries and fish netted from the river. An additional 294 fish were gaffed and spawned on the river (10 males, 284 females, including 101 non-viable females). Of the total broodstock collected, 170 adult males and 11 jacks were not needed for broodstock and subsequently returned to the river. The terminal run size to the river was based on the SONAR estimate of 2,630 adult Chinook. Excluding jacks, the total number of adult Chinook that spawned naturally in the Elwha River and its tributaries was 1,573. This number was calculated by subtracting the number of Chinook that were collected for broodstock, including the 101 non-viable females, from the SONAR estimate (**Error! Reference source not found.**).

Table 4-31. Chinook broodstock collection, SONAR estimate of total adult return, and estimated number of natural spawning fish Elwha River in 2021.

Capture method	No. Males	No. Females^{1/}	Total adults	No. Jacks	Total adults plus jacks
Gaff-Hook and line	10	284	294	0	294
Seining-Gill netting	162	61	223	0	223
Elwha Hatchery Trap Volunteers	381	72	453	26	479
Lower Elwha Hatchery transfers	193	64	257	18	275
Total broodstock collection	746	481	1,227	44	1,271
<u>Minus</u> Elwha Hatchery Trap Volunteers Returned back to the river to spawn naturally	-170	-0	-170	-11	-181
Total broodstock collection	576	481	1,057	33	1,090
Mortalities in raceways	29	5	34	6	40
SONAR adult estimate			2,630		
Estimated adult natural spawners in river 1/			1,573		

^{1/} Includes 101 females gaffed but were determined to be non-viable.

Natural spawners = SONAR estimate of 2,630 minus adult broodstock collection of 1,057 = 1,573 natural escapement.

Data source: 2021 Elwha Hatchery broodstock collection numbers from Troy Tisdale, WDFW Hatchery Manager.

Hatchery broodstock: total number of Chinook salmon collected for broodstock, including pond mortalities, gaffing from river and non-viable females.

Returned To river = Total number of Chinook salmon transported from WDFW hatchery facility to river release locations

Natural adult spawners= total number of Chinook salmon that spawn naturally, regardless of whether they are hatchery- or natural origin.

Sampling Collection:

WDFW personnel sampled carcasses using the methods described in Weinheimer et al (2015). Carcasses were sampled in the mainstem river (CS), 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. A summary of the sampled and non-sampled groups was given to the hatchery manager for their records. The number of DNA, otolith, and snout collected from the hatchery and carcass surveys were 269, 350, and 66, respectively (Table 4-32). For the 2021 season, 185 Chinook broodstock and 165 river carcasses were sampled (Table 4-33, Table 3-34).

Table 4-32. Number of DNA, otolith, and snouts sampled from Chinook carcasses in the Elwha River and broodstock collected for WDFW Hatchery facility in 2021.

Sample Type/ Sex ID	Natural River Spawners Carcass Surveys (CS)	Broodstock collection LEKT Hatchery	Broodstock collection Netted	Broodstock collection Volunteers	Broodstock collection Unknown	Sample Total
No. DNA samples						
Female	36	25	36	18	0	115
Male	58	20	36	40	0	154
Total	94	45	72	58	0	269
No. Otolith samples						
Female	60	25	37	18	1	141
Male	105	22	41	40	1	209
Total	165	47	78	58	2	350
No. Snout samples						
Female	6	8	10	5	0	29
Male	6	8	9	13	1	37
Total	12	16	19	18	1	66

Broodstock Collection:

Biologists and technicians sampled broodstock (BS) carcasses on three different spawning days. The following dates, September 7, 14, and 24, provided an excellent opportunity for to collect scale, otolith, DNA, and to check for marked and tagged fish during the prime spawning period (Table 4-33). For the three spawning days, 185 of 756 (24.5%) of the fish were sampled. Of the total sampled and non- sampled fish, 104 of 564 males (18.4%) and 81 of 192 females (42.3%) were sampled.

Table 4-33. Total number of female and male Chinook spawned on September 7, 14, and 21, 2021 at the WDFW Elwha Hatchery facility.

Collection Method and Date Sampled	Female Total	Male Total	Female+Male Total
LEKT	25	22	47
14-Sep	2	2	4
21-Sep	23	20	43
Net	37	41	78
7-Sep	12	11	23
14-Sep	13	14	27
21-Sep	12	16	28
Volunteers	18	40	58
7-Sep	7	9	16
14-Sep	8	20	28
21-Sep	3	11	14
Unknown	1	1	2
14-Sep	1	1	2
WDFW Hatchery Collection Total	81	104	185
7-Sep	19	20	39
14-Sep	24	37	61
21-Sep	38	47	85
Percentage Female and Male	43.78%	56.22%	100.00%

River Carcass Collections - Natural Spawners (HOR and NOR):

WDFW, LEKT, and ONP biologists and technicians sampled river carcasses from fish that spawned naturally in the river. Hatchery-Origin Returns (HOR) are the total number of Chinook salmon whose parents were spawned in a hatchery, regardless of whether they themselves were spawned in hatchery or spawned naturally. Natural-Origin Returns (NOR) are the total number Chinook salmon whose parents spawned in the river, regardless of whether they themselves were spawned in hatchery or spawned naturally. Hatchery Origin Returns and Natural Origin Returns will be determined after all 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.

Carcasses were sampled between September 15 and October 7, 2021. Based on redd numbers from previous spawning seasons, the period between September 21 and September 28 provided the best opportunity for the peak redd count and sampling carcasses. Of the 165 carcasses, (60 females,105 males),62.4% were sampled in the mainstem river and 37.6% were sampled in tributaries (Indian Creek and Little River combined) Table 4-34.

Table 4-34. Number of female and male Chinook carcasses sampled in the mainstem Elwha River and tributaries by survey reach and date in 2021.

River reach / Date(s) sampled	Female	Male	Total	Percent sampled in river
101 to Elwha	13	14	27	16.36%
21-Sep	13	14	27	
Altaire to Fishermans	6	13	19	11.52%
22-Sep	6	13	19	
Fishermans to 101	8	20	28	16.97%
15-Sep	2	0	2	
22-Sep	6	20	26	
Glines to Altaire	2	2	4	2.42%
22-Sep	2	2	4	
Glines to Fishermans	1	2	3	1.82%
15-Sep	1	2	3	
Indian Creek	19	26	45	27.27%
23-Sep	9	22	31	
28-Sep	8	4	12	
7-Oct	2	0	2	
Little River	6	11	17	10.30%
23-Sep	4	8	12	
28-Sep	2	3	5	
Rica to Glines	4	16	20	12.12%
15-Sep	1	5	6	
23-Sep	2	9	11	
29-Sep	1	2	3	
(blank)	1	1	2	
Unknown river section	1	1	2	1.21%
7-Oct.	1	1	2	
Total River Carcasses Sampled	60	105	165	100.00%

Broodstock and River Carcass Samples by Age and Sex

Eighty-five percent of the broodstock carcasses sampled had readable scales, 72 were females and 85 were males. Female age classes consisted of 13.9% age 3, 83.3% age 4, and 2.8% age 5. Male age classes consisted of 9.4% age 2, 60% age 3, 31.8% age 4, 1.2% age 5. Seventy-eight percent of the river carcasses sampled had readable scales, 50 were females and 79 males. Female age classes consisted of 0.0% age 2, 24.0% age 3, 76.0% age 4, and 0.0% age 5. Male age classes consisted of 1.3% age 2, 53.2% age 3, 45.5% age 4, and 0.0% age 5. The age composition of all samples combined was 3.2% age 2; 40.2% age 3; 55.6% age 4; and 0.011% age 5 (**Table A-35**).

Table 4-35. Number and ages of female and male Chinook broodstock and river carcasses sampled in the hatchery and mainstem Elwha River in 2021.

Collection method Age	Female Total	Female Prop.	Male Total	Male Prop.	Female +Male Total	Female + Male Prop. by age
Broodstock Collection						
Age 2	0	0.0000	8	0.0941	8	0.0510
Age 3	10	0.1389	51	0.6000	61	0.3885
Age 4	60	0.8333	25	0.2941	85	0.5414
Age 5	2	0.0278	1	0.0118	3	0.0191
Total	72	1.0000	85	1.0000	157	1.0000
River Carcass Survey (CS)						
Age 2	0	0.0000	1	0.0127	1	0.0078
Age 3	12	0.2400	42	0.5316	54	0.4186
Age 4	38	0.7600	36	0.4557	74	0.5736
Age 5	0	0.0000	0	0.0000	0	0.0000
Total	50	1.0000	79	1.0000	129	1.0000
River Carcass Survey + Broodstock Collection						
Age 2	0	0.0000	9	0.0549	9	0.0315
Age 3	22	0.1803	93	0.5671	115	0.4021
Age 4	98	0.8033	61	0.3720	159	0.5559
Age 5	2	0.0164	1	0.0061	3	0.0105
Total	122	1.0000	164	1.0000	286	1.0000

For 185 fish with marks and tags, 36 (19.5%) were adipose clipped with a tag, 4 (2.2%) were adipose clipped and not tagged, 18 (9.7%) were unmarked and tagged, 127 (68.6%) were unmarked and not tagged (Table 4-36). All broodstock and carcass survey results in this report are preliminary until all age, mark, otolith, and CWT results are verified. The male (104) to female (81) ratio in the sample was 1.284 to 1.000.

For 165 fish with marks and tags, 3 (1.8%) were adipose clipped only, 12 (7.3%) were adipose clipped with a tag, 3 (1.8%) were adipose clipped and not tagged, 1 (0.6%) was undetermined, 1 (0.6%) was unidentified mark and not tagged 54 (32.7%) were unmarked, 89 (53.9%) were unmarked and not tagged, and 2 (1.2%) with unknown mark and tag presence (Table 4-36). The male to female ratio in the sample was 1.75 to 1.000.

Table 4-36. Mark/Unmark status, tag presence/absence, and age of Elwha Chinook broodstock and river carcasses in 2021. 1/

Collection method Age	Mark/Unmark (ADP/UM) Fin Clip Status and Presence/Absence of CWT (B/NB)									Total CS+BS Female +Male	Proportion Readable scales
	AD	ADB	ADNB	UD	UDNB	UM	UMB	UMNB	(blank)		
Unknown collection	0	0	0	0	0	0	1	1	0	2	1.00000
Age 2	0	0	0	0	0	0	1	0	0	1	0.50000
Age 4	0	0	0	0	0	0	0	1	0	1	0.50000
Carcass Survey (CS)	3	12	3	1	1	54	0	89	2	165	1.00000
Age 2	0	1	0	0	0	0	0	0	0	1	0.00775
Age 3	0	6	1	0	0	13	0	34	0	54	0.41860
Age 4	1	4	2	1	0	25	0	41	0	74	0.57364
Unreadable/Not sampled	2	1	0	0	1	16	0	14	2	36	
LEKT Hatchery Transfer	0	9	2	0	0	0	7	29	0	47	1.00000
Age 2	0	1	0	0	0	0	2	1	0	4	0.10256
Age 3	0	4	1	0	0	0	2	11	0	18	0.46154
Age 4	0	4	0	0	0	0	1	12	0	17	0.43590
Unreadable/Not sampled	0	0	1	0	0	0	2	5	0	8	
Netted from river	0	16	1	0	0	0	3	58	0	78	1.00000
Age 3	0	3	0	0	0	0	0	9	0	12	0.18182
Age 4	0	11	1	0	0	0	2	37	0	51	0.77273
Age 5	0	1	0	0	0	0	0	2	0	3	0.04545
Unreadable/Not sampled	0	1	0	0	0	0	1	10	0	12	
Volunteers to Elwha Hatchery	0	11	1	0	0	0	7	39	0	58	1.00000
Age 2	0	2	0	0	0	0	1	0	0	3	0.06000
Age 3	0	5	0	0	0	0	3	23	0	31	0.62000
Age 4	0	3	1	0	0	0	2	10	0	16	0.32000
Unreadable/Not sampled	0	1	0	0	0	0	1	6	0	8	
Grand Total	3	48	7	1	1	54	18	216	2	350	
Proportion	0.00857	0.13714	0.02000	0.00286	0.00286	0.15429	0.05143	0.61714	0.00571		Readable scales
Mark /Unmark status	AD	ADB	ADNB	UD	UDNB	UM	UMB	UMNB	(blank)		286

1/ The numbers below the abbreviations represent the number of fish in each of the following categories: UMNB = Unmarked + No Beep (No CWT detected); ADB = adipose clipped + Beep (CWT detected); ADNB = adipose clipped + No Beep (no CWT detected); UMB = Unmarked + Beep (CWT detected).

For 350 fish sampled with marks and tags, 3 (0.9%) were adipose clipped only, 48 (13.7%) were adipose clipped with a tag, 7 (2.0%) were adipose clipped and not tagged, 1 (0.3%) was unidentified mark and not tagged, 1 (0.2%) was unidentified mark and tagged, 54 (15.4%) were unmarked, 18 (5.1%) were unmarked and tagged, 216 (61.7%) were unmarked and not tagged, and 2 (0.60%) with unknown mark and unknown tag presence (Table 4-37).

Table 4-37. Mark/Unmark (AD/UM) status and tag presence/absence (B/NB) of all Elwha Chinook female, male, and total carcasses sampled in 2021.

Mark /Unmark (AD/UM) and Tag Status (B/NB)	AD	ADB	ADNB	UD	UDNB	UM	UMB	UMNB	(blank)	Total
Female Total	1	27	2	1	0	27	2	80	1	141
Prop.	0.00709	0.19149	0.01418	0.00709	0.00000	0.19149	0.01418	0.56738	0.00709	1.00000
Male Total	2	21	5	0	1	27	16	136	1	209
Prop.	0.00957	0.10048	0.02392	0.00000	0.00478	0.12919	0.07656	0.65072	0.00478	1.00000
Female +Male Total	3	48	7	1	1	54	18	216	2	350
Prop.	0.00857	0.13714	0.02000	0.00286	0.00286	0.15429	0.05143	0.61714	0.00571	1.00000

The number of decoded tags recovered from river carcass surveys (CS) and from the Elwha Hatchery (HAT) were 12 and 51, respectively. All recovered tags were from Elwha River releases. The percentages for ages 2, 3, and 4 for the CWT recoveries were as follows: age 2 (12.8%), age 3 (34.9%), and age 4 (52.3%) Table 4-38.

Table 4-38. Number of decoded tags recovered from sampling carcasses in the Elwha River (CS) and the Elwha Hatchery (HAT), mark status, release location and origin, number released, and brood year.

Method Carcass Survey (CS), Hatchery (HAT)	Decoded Tag No.	Number of tags recovered	Mark Status (ADP or Unmarked)	Release location and Origin	WRIA No.	Release No.	Brood year
CS	637377	5	ADP	Elwha R.	18.0272	246,534	2017
CS	637526	6	ADP	Elwha R.	18.0272	248,527	2018
CS	637777	1	Unmarked	Elwha R.	18.0272	95,206	2019
HAT	637243	10	Unmarked	Elwha R.	18.0272	193,663	2017
HAT	637372	2	Unmarked	Elwha R.	18.0272	182,324	2018
HAT	637377	18	ADP	Elwha R.	18.0272	246,534	2017
HAT	637526	14	ADP	Elwha R.	18.0272	248,527	2018
HAT	637751	3	Unmarked	Elwha R.	18.0272	246,500	2019
HAT	637778	3	Unmarked	Elwha R.	18.0272	93,737	2019
HAT	637777	1	Unmarked	Elwha R.	18.0272	95,260	2019

Hatchery-Origin Returns (HORs) are estimated by the percentage of carcasses sampled that had been identified by a combination of different marking techniques (adipose clip, thermal otolith mark, CWT) applied to them prior to release from the hatchery. For return years 2009-2020, the proportion of HOR Chinook salmon ranged from 90.29% to 97.99% and averaged 95.4% (Table 4-39).

Table 4-39. Percentage of Elwha Chinook returns that were identified as hatchery origin based on marks present (Marked fish in this table include adipose clip, thermal otolith, CWT) for RY 2009 to 2020.

Return Year	Marked	Unmarked	Total	Percent marked
2009	292	6	298	97.99%
2010	259	16	275	94.18%
2011	962	30	992	96.98%
2012	93	10	103	90.29%
2013	891	43	934	95.40%
2014	753	30	783	96.17%
2015	793	55	848	93.51%
2016	523	23	546	95.79%
2017	1039	40	1079	96.29%
2018	727	15	742	97.98%
2019	588	21	609	96.55%
2020	394	27	421	93.59%

4.13 Hoko

WDFW and Makah Fisheries Management staff conducted foot surveys to count live and dead Chinook and Chinook redds in the mainstem Hoko River between river miles 3.4 and 21.7 and in tributaries which represent 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. During the 2021 return, high flow and flooding events precluded the full suite of foot surveys from being conducted (Figure 4-1). WDFW conducted surveys from RM 3.4 to 10.1 during the 2021 return year and observed 123 redds (Table 4-40 and Table 4-41) and Makah Fisheries Management (MFM) counted 8 redds (Table 4-42).

Figure 4-1. USGS Hoko River flows (cfs) from October 1 to December 31, 2021.

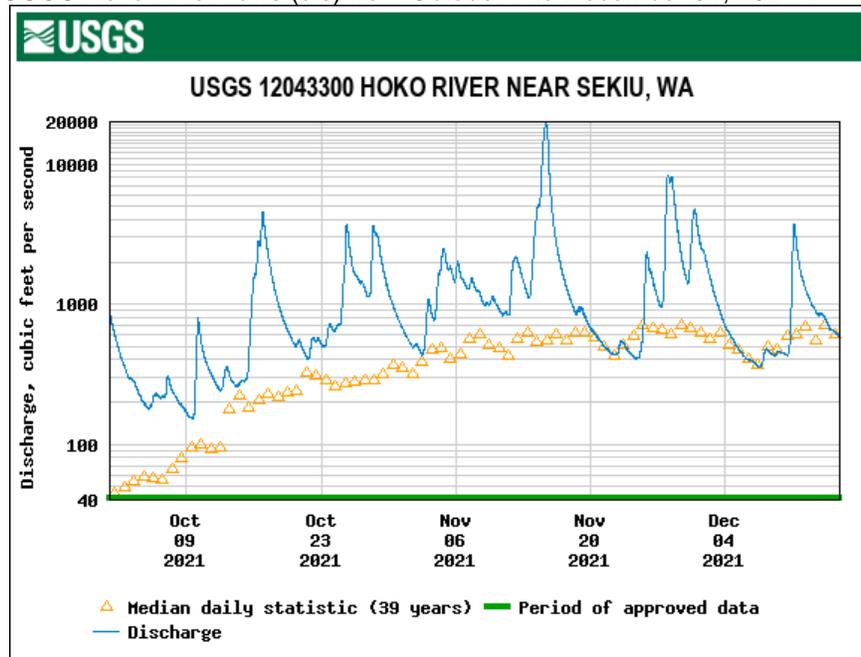


Table 4-40. Chinook redd surveys in mainstem Hoko River from RM 3.4 - RM 10. by WDFW 2021.

Stream Name	Survey Date	End River Mile	Start River Mile	Total Live	Total Dead	New Redds
Hoko R (19.0148)	2021-10-07	RM 9.80	RM 10.10	18	0	34
Hoko R (19.0148)	2021-10-07	RM 7.50	RM 8.70	7	0	17
Hoko R (19.0148)	2021-10-07	RM 5.60	RM 7.50	5	0	12
Hoko R (19.0148)	2021-10-07	RM 4.40	RM 5.60	1	0	3
Hoko R (19.0148)	2021-10-07	RM 3.40	RM 4.40	0	0	0
Weekly Redd Total						66
Hoko R (19.0148)	2021-10-14	RM 9.80	RM 10.10	91	0	57
Redd Grand Total from RM 3.4 - RM10.1						123

Visibility poor downstream of RM 9.8 on 10-14-2021 and for the remainder of the season.

Table 4-41. Observations of Chinook spawning activity during Coho redd surveys in upper mainstem Hoko River from RM 20.4 - RM 22.5, Bear Creek from RM 0.0-RM1.7, and Cub Creek RM 0.0-RM 1.1 by WDFW 2021.

Stream Name	Survey Dates	End River Mile	Start River Mile	Total Live	Total Dead	New Redds
Hoko R (19.0148)	1/	RM 20.4	RM 22.5	0	0	0
Bear Cr (19.0196)	1/	RM 0.0	RM 1.7	0	0	0
Cub Cr (19.0197)	1/	RM 0.0	RM 1.1	0	0	0
Redd Grand Total from RM 3.4 - RM10.1						123

1/ Coho surveys conducted on November 2 and 23 and December 13 and 21 in 2021. No live, dead, or Chinook redds observed.

Table 4-42. Summary of Hoko River Chinook surveys by Makah Fisheries Management staff in 2021.

Stream Name	Survey Date	End River Mile	Start River Mile	Total Live	Total Dead	New Redds
Browns Cr (19.0170)	2021-10-14	RM 0.00: Mouth	RM 0.59:	47	0	7
Browns Cr (19.0170)	2021-10-14	RM 0.00: Mouth	RM 0.70: Bridge	0	0	0
Little Hoko R (19.0149)	2021-10-20	RM 0.00 Mouth	RM 3.5	1	0	1
Redd Grand Total for Makah Surveys						8

Hoko Broodstock Collection

For the 2021 Hoko Chinook broodstock season, 269 females, 246 males, and 898 jacks returned to the Hoko Falls Hatchery pond facility. Of the 1,404 total fish that returned to the pond, 176 females, 121 males and 78 jacks were lethally spawned. The remaining 93 females, 125 males, and 811 jacks were released back to the river to spawn naturally (Table 4-43).

Table 4-43. Number of female, male, and jack Chinook that returned to the Hoko Falls Hatchery in 2021 that were spawned, released back to the river to spawn naturally, culled, surplused, or died before spawning.

Sex	Rack count	Pond Mortality	Surplused	Lethal spawned (Viable)	Non-Viable Spawned	Returned to stream
Female	269	0	0	176	0	93
Male	246	0	0	121	N/A	125
Total adults	515	0	0	297	0	218
Jack	898	0	0	78	N/A	811
Total fish	1404	0	0	375	0	1,029

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

The 2021 adult escapement estimate for Hoko Chinook is 852 spawning in the river (natural origin and hatchery origin combined) and 297 returning to and remaining at the hatchery, plus an additional 218 adults released back into the river for a total terminal runs size (TRS) of 1,367. The following methods were used to calculate the final TRS:

- 1) Hoko Falls Hatchery return retained for broodstock purposes (includes jacks, pond mortalities and non-viable females) 375 (176 females, 121 males and 78 jacks). There were no pond mortalities nor were there any non-viable females in 2021.
- 2) 218 adults captured at the hatchery were released back to the river. Fish were released back into the river on October 7th, 11th, 14th and November 1st. Most adults were tagged with pink floy tags prior to release to the river.
- 3) In 2021, high river flows precluded foot surveys during the peak spawning season. A predictive model was developed for 2021, in lieu of actual spawning survey data. In this model, we predict natural spawning escapement from the total hatchery rack returns (excluding jacks) at Hoko Falls Hatchery using linear regression. The time series utilized in this model is truncated due to the availability of total rack return counts, counts of total hatchery rack returns for years prior to 2010 were not available. Jacks were excluded from this model to ensure an equitable

comparison between estimates, as historic estimates of natural spawners do not include jacks. The model results in a highly statistically significant relationship ($P=0.004$) and produces a reasonable estimate for the natural spawning chinook population in the Hoko River in the absence of adequate spawning ground survey data. The model predicted a natural spawner estimate of 852 (excluding jacks).

- 4) During the 2021 spawning season, WDFW staff counted 123 redds (123 redds x 2.5 adults per redd = 308 fish). The 2.5 adults per redd is equal to one female and 1.5 males per redd. Makah staff counted 8 redds (8 redds x 2.5 adults per redd = 20 fish). However, these survey results were incomplete and the comanagers opted to use the model results rather than a redd based calculation for escapement in 2021.
- 5) The Terminal Run Size (TRS) is estimated at 1,367 adults. 297 adult broodstock spawned at the hatchery, 852 in-river spawners predicted from the model, and 218 released from the hatchery back into the river.
- 6) The estimated age and number of hatchery origin (HOR) and natural origin (NOR) Chinook which returned to the Makah Hoko Falls Hatchery and the Hoko River equals 939 HOR adults and 428 NOR adults (Table 4-44). The age composition of HOR total spawners consisted of 144 age-3 (15.3%), 637 age-4 (67.9%), and 158 age-5 (16.8%). The age composition of NOR total spawners consisted of 25 age 3 (5.8%), 303 age 4 (70.9%), and 100 age 5 (23.3%). The proportion of HOR spawners by age group were: age 3 (85%), age 4 (68%) and age 5 (61%).

Table 4-44. Age and origin of broodstock and natural Chinook spawners in the Hoko River in 2021.

Hatchery Brood				In-River Spawners				Total Spawners			
By Origin				By Origin				By Origin			
Age	NOR	HOR	Totals	Age	NOR	HOR	Total	Age	NOR	HOR	Total
3	5	31	37	3	19	113	132	3	25	144	169
4	66	138	204	4	238	499	736	4	303	637	941
5	22	34	56	5	78	124	201	5	100	158	257
6	0	0	0	6	0	0	0	6	0	0	0
7	0	0	0	7	0	0	0	7	0	0	0
Totals	93	204	297	Totals	316	622	1070	Totals	428	939	1367

Data Source: Expanded CWT tag recoveries from hatchery broodstock

Data source: Hap Leon and Tiffany Petersen, 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) 2020 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 2020 generally exceeded the 20% sampling objective although North Hood Canal (9A, 12, 12A, 12B), 12C, 13D-F, and Strait of Juan de Fuca Troll were below 20% (Table 5-1). Marine area recreational fisheries were sampled at rates between 5.9% and 31.1% 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 2020 (calendar year).

Catch Area/River	Catch	# Sampled	Sample Rate
7-7A	127	114	90%
7B-7C-7D-Nooksack River	7,769	3,256	42%
Skagit River/Bay	4,875	1,335	27%
8A	26	16	62%
8D	9,371	1,986	21%
Stillaguamish River	51	26	51%
10	19	0	0%
10E	4,650	2,666	57%
10F	19	0	0%
10G	96	0	0%
10A	616	13	2%
Duwamish River	7,552	0	0%
Puyallup/White rivers	4,954	2,519	51%
Nisqually River	2,009	1,247	70%
McAllister Cr.	165	120	70%
13A	1,164	15	1%
13C	227	0	0%
13D-F	753	120	16%
9	18	0	0%
9A-12-12A-12B	57	5	9%
12C	10,841	4,505	41%
12H	6,989	2,837	22%
Skokomish River	1,435	730	51%
Purdy Creek	163	120	74%
Strait of JDF 4B-5-6 (Net)	73	0	0%
Strait of JDF 4B-5-6C (Troll)	197	0	0%

Table 5-2. Chinook coded-wire tag sampling rates for marine recreational fisheries in 2020.

Catch Area	Catch	# Sampled	Sample Rate
MARINE SPORT AREA 5	6,732	1,312	19.5%
MARINE SPORT AREA 6	2,847	886	31.1%
MARINE SPORT AREA 7	4,606	764	16.6%
MARINE SPORT PCA 8.1	111	28	25.2%
MARINE SPORT PCA 8.2	770	190	24.7%
MARINE SPORT AREA 9	4,950	772	15.6%
MARINE SPORT AREA 10	2,455	660	26.9%
MARINE SPORT AREA 11	3,181	500	15.7%
MARINE SPORT AREA 13	1,162	138	11.9%
MARINE SPORT AREA 12	2,376	140	5.9%

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7 9-Year (2012-2020) Spawning Escapements

Nooksack Early Management Unit.

Early timed Chinook spawning escapements for 2012 through 2020 return years within the North Fork and Middle Fork Basins. South Fork early NOR and HOR spawning escapement in the North/Middle Fork basins are additional to those within the South Fork basin.

Year	North./Middle Fork					
	NF NORs	Kendall HORs	SF NORs	SF HORs	Fall NORs	Fall HORs
2012	281	477	N/A	N/A	N/A	N/A
2013	100	1,247	N/A	N/A	N/A	N/A
2014	91	1,307	N/A	N/A	N/A	N/A
2015	401	1,316	N/A	N/A	N/A	N/A
2016	187	735	15	7	5	15
2017	88	1,811	41	39	6	23
2018	53	1,622	39	24	0	6
2019	32	831	10	79	11	1
2020	38	198	7	100	15	15

Early timed Chinook spawning escapements for 2012 through 2020 return years in the South Fork basin. North Fork early NOR and Kendall Creek HOR spawning escapement in the South Fork basin are in addition to those spawning within the North/Middle Fork basins.

Year	South Fork					
	SF Native NOR	SF HOR	N. Fk Early NOR	Kendall Cr. HOR	Fall NOR	Fall/other HOR
2012	116 (1)	0	172 (1)	79 (17)	93 (2)	42 (0)
2013	10 (1)	0	39 (0)	162 (39)	16 (2)	15 (2)
2014	22 (1)	10 (0)	56 (1)	99 (2)	11 (0)	10 (0)
2015	7 (0)	11 (0)	39 (0)	9 (0)	32 (0)	37 (0)
2016	319 (4)	302 (7)	179 (3)	32 (5)	86 (1)	39 (0)
2017	145 (4)	697 (55)	43 (4)	62 (8)	100 (4)	65 (4)
2018	369 (5)	896 (8)	49 (0)	65 (2)	50 (1)	97 (1)
2019	61 (2)	369 (30)	6 (0)	9 (1)	8 (0)	27 (0)
2020	243 (1)	1,085 (34)	45 (0)	67 (1)	30 (0)	10 (4)

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

Skagit Springs Management Unit.

Year	Upper Sauk	Suiattle	Upper Cascade
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	323
2018	1,603	645	128
2019	551	400	180
2020	938	396	115

Skagit Summer/Falls Management Unit.

Year	Upper Skagit	Lower Sauk	Lower Skagit
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
2018	8,602	378	1,923
2019	10,155	319	1,336
2020	9,599	341	869

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

Year	MU Total	
	NOR (BS)	HOR (BS)
2012	934 (109)	853 (70)
2013	620 (73)	377 (59)
2014	140 (57)	279 (87)
2015	482 (61)	227 (68)
2016	702 (76)	351 (65)
2017	548 (76)	522 (65)
2018	199 (44)	767 (102)
2019	196 (28)	748 (103)
2020	333 (49)	517 (88)

Snohomish Management Unit.

Year	Skykomish		Snoqualmie	
	NOR	HOR	NOR	HOR
2012	2,462	1,283	891	488
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	2,790	1,584	1,409	336
2018	2,259	789	823	339
2019	569	397	443	233
2020	1,975	747	804	407

Lake Washington Management Unit.

Year	Cedar River		Sammamish River	
	NOR	HOR	NOR	HOR
2012	899	184	60	1,974
2013	1,590	260	96	2,237
2014	303	277	20	462
2015	1,177	631	52	936
2016	609	436	102	1,145
2017	1,557	491	153	1,371
2018	671	142	84	575
2019	599	256	101	264
2020	277	236		

Green River Management Unit.

Year	NOR	HOR
2012	1,638	1,452
2013	524	1,517
2014	756	1,974
2015	864	3,223
2016	2,566	7,497
2017	2,031	6,326
2018	2,177	4,714
2019	1,360	1,616
2020	1,967	2,333

Puyallup River Fall Management Unit.

Year	NOR	HOR
2012	642	395
2013	203	406
2014	468	793
2015	831	729
2016	713	1,822
2017	637	849
2018	486	1,833
2019	291	1,397
2020	542	1,208

White River Spring Management Unit.

Year	NOR	HOR	APP
2012	825	204	1,120
2013	803	873	2,734
2014	221	105	637
2015	360	472	736
2016	657	501	2,851
2017	686	2,953	2,749
2018	326	1,520	1,837
2019	344	588	2,013
2020	633	103	1,173

Nisqually River Management Unit. HOR's on the spawning grounds include trucked fish in 2017, 2018, and 2019.

Year	NOR	HOR
2012	617	1,850
2013	738	933
2014	528	512
2015	715	790
2016	796	168
2017	1,445	2,039
2018	435	1,850
2019	343	1,957
2020	481	104

Skokomish River Management Unit.

Year	NOR	HOR	Total
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
2018	103	2,356	2,459
2019	260	2,005	2,265
2020	69	2,052	2,061

Mid-Hood Canal Management Unit.

Year	Hamma Hamma	Duckabush	Dosewallips
2012	425	6	7
2013	707	7	4
2014	117	13	11
2015	236	20	3
2016	268	15	8
2017	365	2	7
2018	58	4	1
2019	18	3	0
2020	3	2	0

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
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	515
2017	149	456	605	26	74	100	175	530	705
2018	127	661	788	20	97	117	147	758	905
2019	173	665	838	19	73	92	192	738	930
2020	297	436	733	26	74	100	323	510	833

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
2012	2,638
2013	4,243
2014	4,360
2015	4,112
2016	2,628
2017	3,100
2018	7,107
2019	7,500
2020	3,250

Hoko River Management Unit.

Year	HOR/NOR
2012	663
2013	1,406
2014	1,760
2015	2,877
2016	1,324
2017	1,225
2018	1,943
2019	1,815
2020	2,122