

Washington Department of Fish and Wildlife
Puget Sound Treaty Indian Tribes

Puget Sound Chinook Comprehensive Harvest Management Plan

Annual Report
The 2022-2023 Fishing Season

October 2023

Acknowledgements

The data contained in this report are the result of the widespread work of Tribal and WDFW staff throughout the Puget Sound Region. Staff members directly contributing to preparation of this report include:

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); Megan Hintz (Port Gamble S'Klallam Tribe); Aaron Brooks and Chris Burns (Jamestown S'Klallam Tribe); Samantha Rae and Matt Bierne (Lower Elwha Klallam Tribe); Cindy Gray (Skokomish Tribe); Diego Holmgren (Tulalip Tribes); Jon Oleyar (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, Joseph Short, Dave Low, Kwasi Addae, Maria Kaniewski, Derek Dapp, Ty Garber, Christina Iverson, and Chad Herring.

Table of Contents

Acknowledgements.....	i
Table of Contents.....	ii
List of Tables	iv
List of Figures	vii
Executive Summary	viii
1 Introduction.....	9
1.1 Management Objectives	9
2 Commercial Harvest	11
2.1 Strait of Juan de Fuca and San Juan Islands	12
2.2 Nooksack/Samish Terminal Area	13
2.3 Skagit Bay/Skagit River Terminal Areas	14
2.4 Stillaguamish/Snohomish Terminal Area	19
2.5 South Puget Sound Terminal Areas.....	20
2.6 Hood Canal	22
2.7 Strait of Juan de Fuca	23
2.8 Non-Treaty Commercial Monitoring and Total Mortality.....	23
3 Recreational Harvest	24
3.1 2021-2022 Recreational Chinook MSF and NS Catch	25
3.2 2022-2023 Recreational Chinook MSF Catch.....	27
3.2.1 Marine Area 5 Summer MSF	29
3.2.2 Marine Area 6 Summer MSF	29
3.2.3 Marine Area 7 Summer MSF	30
3.2.4 Marine Area 9 Summer MSF	31
3.2.5 Marine Area 10 Summer MSF	31
3.2.6 Marine Area 11 Summer MSF	32

3.2.7	North Fork Nooksack Spring Chinook MSF	33
4	Spawning escapement	33
4.1	Nooksack River Early Chinook	34
4.2	Skagit River	38
4.3	Stillaguamish River	44
4.4	Snohomish River	47
4.5	Cedar River	50
4.6	Green River	51
4.7	White River	55
4.8	Puyallup River	56
4.9	Nisqually River	58
4.10	Hood Canal	58
4.11	Dungeness	63
4.12	Elwha River	67
4.13	Hoko	76
5	Coded-wire Tag Sampling	77
6	Literature Cited	79
7	9-Year (2013-2021) Spawning Escapements	80

List of Tables

Table 1-1. 2022 Puget Sound Chinook Harvest Management Objectives..... 10

Table 1-2. Management guidelines implemented and projected exploitation rates and escapements for Puget Sound Chinook Management Units for 2022 – 2023 pre-season planning (FRAM Chin2522)..... 11

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 2022. 12

Table 2-2. Expected and observed Chinook catches in the Nooksack/Samish terminal area, 2022. 13

Table 2-3. Skagit terminal area projected and actual hatchery and wild Chinook catches for Skagit terminal area tribal fisheries in 2022. Weekly projections were made by plugging the FRAM Chin2522 run sizes into the Skagit weekly harvest rate model, so totals may differ slightly from FRAM. 16

Table 2-4. Projected (FRAM Chin2522) and actual Chinook net fishery harvest in the Stillaguamish - Snohomish terminal area in 2022..... 19

Table 2-5. Projected and actual Chinook catch in 2022 South Puget Sound net fisheries.20

Table 2-6. Pre-season projected and observed catch of Chinook in Hood Canal terminal area net fisheries in 2022.23

Table 2-7. Projected and actual catches of Chinook in Strait of Juan de Fuca terminal net fisheries in 2022.23

Table 2-8. Commercial fishery observation data for 2022 Puget Sound non-treaty salmon net fisheries.24

Table 2-9. Total pre-season projected and post-season estimated Chinook mortality (landed + released) in Puget Sound non-treaty commercial salmon fisheries in 2022...24

Table 3-1. Projected (FRAM 3721) and actual (preliminary, where available) Chinook catches in Puget Sound Chinook MSF and NS recreational fisheries during the 2021-2022 season.26

Table 3-2. Projected (FRAM 2522) and actual (preliminary, where available) Chinook MSF catches in Puget Sound recreational fisheries during the 2022-2023 season.28

Table 3-3. Comparison of modeled (FRAM 2522) and estimated total Chinook encounters for the 2022 Area 5 summer Chinook MSF.....29

Table 4-1. Preseason projections and estimates of Puget Sound Chinook natural spawning escapement in 2022.34

Table 4-2. Early timed Chinook spawning escapements for 2019 - 2021 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.	36
Table 4-3 Early timed Chinook spawning escapements for 2019 - 2021 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.....	37
Table 4-4. Early timed Chinook pre-spawn mortality (PSM) raw counts for 2019 - 2021 return years in the South Fork basin.....	38
Table 4-5. Suiattle River spring Chinook 2022 spawning ground survey redd counts. This table includes only observed redds.....	39
Table 4-6. 2022 Cascade River spring Chinook redd counts.....	40
Table 4-7. Upper Sauk River spring Chinook redd counts from 2022 spawning ground surveys.	41
Table 4-8. Skagit summer Chinook redd counts from 2022 spawning ground surveys.....	42
Table 4-9. Lower Sauk River summer Chinook redd counts from 2022.....	43
Table 4-10. Lower Skagit River fall Chinook redd counts from 2022 spawning ground surveys.	43
Table 4-11. North Fork Stillaguamish summer and fall Chinook redd counts in 2022.	45
Table 4-12. South Fork and Mainstem Stillaguamish summer and fall Chinook redd counts in 2021.	46
Table 4-13. Stillaguamish Chinook sample proportions and HOR:NOR composition in 2021.....	46
Table 4-14. Skykomish summer/fall Chinook redd counts and escapement, 2022.	48
Table 4-15. Snoqualmie fall Chinook redd counts and escapement by reach, 2022. ...	49
Table 4-16. Snohomish Chinook carcass sampling and escapement composition in 2022.	50
Table 4-17. Chinook redd counts from foot and boat surveys of the Green River in 2022.	53
Table 4-18. Aerial survey counts of Chinook redds in the Green River, 2022.	53
Table 4-19. 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 2022. Weekly discharges are 7-day averages of mean daily discharge beginning with the day listed.	54
Table 4-20. Summary of Chinook biological sampling in the Green River, 2022.....	54

Table 4-21. Coded wire tag sampling, thermal mark analysis of otoliths ¹ , and origin of natural Chinook spawners ² in the Green River, 2022.....	55
Table 4-22. Estimated number NOR and Acclimation Pond Chinook salmon hauled upstream of Mud Mountain Dam in 2022. Results are a combination of returns sampled White River Hatchery and sampled and un-sampled fish at the Buckley Trap and FPF.55	
Table 4-23. Chinook escapement estimates for Puyallup River tributaries, 2022.....	57
Table 4-24. Summary of Chinook escapement to Hood Canal streams during 2022. ...	60
Table 4-25. Chinook salmon spawner escapement origin based on carcasses sampled for marks and coded-wire tags (CWTs) in Hood Canal rivers, 2022.	62
Table 4-26. Chinook salmon spawner escapement origin based on carcasses sampled for marks and coded-wire tags (CWTs) in Hood Canal rivers, 2022.	63
Table 4-27. The number, density, distribution, and proportion of Chinook redds and estimated adults in the Dungeness and Gray Wolf rivers system in 2022.	64
Table 4-28. 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 2022.....	65
Table 4-29. Total number and percentages of adult, age-3, age-4, age-5, and age-6 HOR and NOR Chinook returns in 2022.....	66
Table 4-30. Total number of NOR and HOR natural spawners and broodstock collected in the mainstem Dungeness River for return years 2006-2022.....	66
Table 4-31. 2022 Elwha River Chinook salmon spawners from Upper Watershed Dam to the mouth (McHenry et al. 2022).....	68
Table 4-32. Chinook broodstock collection, SONAR estimate of total adult return, and estimated number of natural spawning fish Elwha River in 2022.....	69
Table 4-33. Number of DNA, otolith, and snouts sampled from Chinook carcasses in the Elwha River and broodstock collected for WDFW Hatchery facility in 2022.	70
Table 4-34. Total number of female and male Chinook sampled during spawning operations on September 6, 13, 20, and 27, 2022 at the WDFW Elwha Hatchery facility.	70
Table 4-35. Number of female and male Chinook carcasses sampled in the mainstem Elwha River and tributaries by survey reach and date in 2022.	71
Table 4-36. Number and ages of female and male Chinook broodstock and river carcasses sampled in the hatchery and mainstem Elwha River in 2022.	72
Table 4-37. Mark/Unmark status, tag presence/absence, and age of Elwha Chinook broodstock and river carcasses in 2022.	73
Table 4-38. Number of decoded tags recovered in 2022 from sampling carcasses in the Elwha River (CS) and the Elwha Hatchery (HAT), mark status, release location and origin, number released, and brood year.....	75

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 2014 to 2022..... 76

Table 5-1. Chinook coded-wire tag sampling rates for commercial fisheries in 2021 (calendar year). 77

Table 5-2. Chinook coded-wire tag sampling rates for marine recreational fisheries in 2021..... 78

List of Figures

Figure 4-1. Estimated Number of Chinook salmon returning to the Dungeness basin from 1986 to 2022. The adults are broken into hatchery and natural origin in years where this data is available..... 65

Figure 4-2. Percentages of NOR and HOR Dungeness River adult Chinook sampled from carcasses in broodstock collection and natural spawners in river for return years 2006-2022.67

Figure 4-3. 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 2014 to 2022..... 76

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, 2022 and April 31, 2023, and Chinook spawning escapement in 2022. It also includes harvest information relevant to the 2021-2022 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) 2021.

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 2021-2022 season was estimated at 47,390 compared to the pre-season projection of 40,229. Creel survey-based estimates of catch in 2022-2023 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 2022-23 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 and spring-run management units were generally greater than projected.

Coded-wire tag sampling rates for calendar year 2021 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.

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 2022 Harvest Biological Opinion (WCRO-2022-01000) by assessing the performance and effectiveness of treaty and non-treaty commercial fishery management actions adopted for the most recent management year, May 2022 through April 2023. Included in this report are:

- Management objectives for the 2022-2023 management year (May 1, 2022, through April 30, 2023)
- Projected and actual commercial landed catch in Puget Sound and descriptions of fisheries for the 2022-2023 management year
- Projected and actual landed catch for 2022 Puget Sound recreational fisheries where Chinook retention was allowed and creel surveys were conducted as well as for 2021 Puget Sound recreational sport fisheries where Chinook retention was allowed.
- Estimates of total encounters for 2022 summer Chinook mark-selective fisheries and non-landed mortality for commercial fisheries with Chinook non-retention where data are available.
- Projected and actual 2022 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 2021 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 2021 (January to December 2021).

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 2022 (Table 1-1). The final pre-season FRAM model run (Chin2522) highlighted the rates that were used as the ceilings for each Management Unit (MU) in 2022, and the projected exploitation rates and escapements for each unit (Table 1-2).

Pre-season fishery planning for 2022-2023 fisheries projected that natural spawning escapement would fall below the Low Abundance Thresholds (LAT) for the Nooksack early, Snohomish, 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. 2022 Puget Sound Chinook Harvest Management Objectives.

Management Unit	ER Ceiling	Critical ER Ceiling	Low Abundance Threshold
Nooksack			
North Fork		10.9% SUS	400 ^a
South Fork			200 ^a
Skagit summer / fall	52%	15% SUS	7,800 ^a
Upper Skagit summer			2,200 ^a
Sauk summer			400 ^a
Lower Skagit fall			900 ^a
Skagit spring	36%	10.7% SUS	1,024 ^a
Upper Sauk			130 ^a
Cascade			170 ^a
Suiattle			170 ^a
Stillaguamish	9% SUS UM /14% SUS M.	Co-manager discussion	900 ^b
Snohomish	9.3% SUS	8.3% SUS	3,250 ^a
Skykomish			2,015 ^a
Snoqualmie			1,132 ^a
Lake Washington	500	12% SUS	200
Cedar River	Escapement (14% PT SUS)		
	2,744		
Green	Escapement (14% PTSUS)	12% SUS	1,098
White River spring	22% SUS	15% SUS	400
	1,170		
Puyallup fall	Escapement (14% PT SUS)	15% SUS	468
Nisqually	47% + 2% Exp. Fishery	50% Reduction of SUS ER	6,300
Skokomish	50%	12% PTSUS	1,300 aggregate; 800 natural
Mid-Hood Canal ^c			200
Dungeness	10% SUS	6% SUS	500
Elwha	10% SUS	6% SUS	2,000
Western SJDF	10.6% SUS	6.3% SUS	500

^a Abundance Thresholds are NOR specific.

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

^c The exploitation rate for mid-Hood Canal Chinook in Puget Sound marine fisheries will be the exploitation rate associated with achieving the management objectives for the 14 other management units within the Puget Sound Chinook ESU. Mid-Hood Canal freshwater fisheries directed at Chinook salmon will be closed.

Table 1-2. Management guidelines implemented and projected exploitation rates and escapements for Puget Sound Chinook Management Units for 2022 – 2023 pre-season planning (FRAM Chin2522).

Management Unit	ERC or CERC implemented	Projected ER	Projected Escapement
Nooksack	10.9% SUS	10.7% SUS	481 ^a
Skagit summer fall	52% Total	41.2% Total	9,758 ^a
Skagit spring	36% Total	21.7% Total	2,192 ^a
Stillaguamish	9% UM SUS/14% M SUS	8.9%UM SUS/12.1% M SUS	983 ^b
Snohomish	<8.3% SUS	6.8% SUS	2,402 ^a
L. Washington (Cedar)	500 Escapement / 14% PT SUS	13% PT SUS	714
Green	2,744 Escapement / 14% PT SUS	13% PT SUS	3,865
White	22% SUS	17% SUS	2,541
Puyallup	1,170 Escapement / 14% PT SUS	13% PT SUS	2,439
Nisqually	47% + 2% Exp. Fishery	47.48%	9,460
Skokomish	50%	50%	3,284
Mid Hood Canal ^c			12
Dungeness	10% SUS	4.4% SUS	894
Elwha	10% SUS	4.5% SUS	4,021
Western SJDF	10.6% SUS	2.1% SUS	735

^a NOR specific escapement estimates.

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

^c The exploitation rate for mid-Hood Canal Chinook in Puget Sound marine fisheries will be the exploitation rate associated with achieving the management objectives for the 14 other management units within the Puget Sound Chinook ESU. Mid-Hood Canal freshwater fisheries directed at Chinook salmon will be closed.

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 2022–23 List of Agreed Fisheries (<https://nwifc-fisheriesservices.s3.amazonaws.com/wp/wp-content/uploads/20221104172707/2022-2023-Final-LOAF-w-signatures.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 Chin2522.

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 areas (Nooksack/Samish, Skagit, Stillaguamish/Snohomish, South Puget Sound, Hood Canal, and Strait of Juan de Fuca). General information is presented for the 2022–23 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 2022.

Fishery	Projected	Actual
Washington ocean non-treaty troll	27,000	25,978
Washington ocean recreational	27,000	24,828
Washington ocean treaty troll	40,000	34,365
Puget Sound pre-terminal net & troll total		
Strait of Juan de Fuca troll	3,831	3,965
Strait of Juan de Fuca net	797	3,952
PSC Test Fishery		142
San Juan Islands net ^a	7,855	5,386
San Juan Islands/Bell. Bay C&S		
Nooksack-Samish terminal net	19,629	19,820
Skagit terminal net	4,679	4,575
Stillaguamish-Snohomish net	7,820	4,322
South Puget Sound terminal net	33,787	31,867
Hood Canal terminal net	25,368	39,062
Strait Tributaries terminal net	0	0

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

2.1 Strait of Juan de Fuca and San Juan Islands

Treaty net fisheries in the Strait of Juan de Fuca and the San Juan Islands caught 3,952 and 4,715 Chinook, respectively. Catch in both regional areas primarily occurred during the Fraser sockeye salmon directed fishery in August, 2022.

Non-treaty fisheries targeting Fraser chum salmon in Areas 7 and 7A landed 23 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 358 Chinook release mortalities occurred during the chum directed non-tribal purse seine fishery in Area 7 and an additional 290 release mortalities occurred in fisheries 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 3,965 Chinook. Seven hundred eighty Chinook

were caught during the summer SJD troll fishery while 3,185 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 2022 season along with four limited community C&S openings. Total landed catch was 580 hatchery-origin Chinook and 14 (including one jack) natural-origin Chinook with an additional 42 natural-origin (including jacks) and 88 HOR Chinook salmon encountered and released. Applying the expected release mortality rate of 30% to the 42 early-run NOR encounters results in 13 NOR (including jacks) estimated mortalities. The total encounter of NORs (n=58, including released and retained, adults and jacks fish) was lower than the pre-season projection of 100 NOR adults. Genetic results for the released NORs are not currently available to determine population origin.

A commercial fishery for Lummi Sea Pond early Chinook hatchery returns was prosecuted in 2022. A total of 90 Chinook were harvested in that fishery in 2022. The pre-season projection was for 290 Chinook.

In 2022, the Nooksack Tribe conducted a permit only, subsistence fishery, with five openings between May 17 through June 27, 2022. A total of 222 Chinook were caught in the traditional C&S fisheries and all were sampled. Two hundred thirteen of the 222 chinook were determined to be hatchery-origin based on adipose-fin marks, CWT detections, or otolith results. Of the remaining nine NORs, six caught in May were determined to be NF/MF NOR origin and three caught in June were SF NOR origin.

The Tribes 2022 total NOR mortality is estimated to be 21 early-run NORs, pending additional analysis of remaining biological samples. The pre-season projection was 40 NOR mortalities.

Table 2-2. Expected and observed Chinook catches in the Nooksack/Samish terminal area, 2022.

Area	Management Period	Projected	Actual
7B, 7C, 7D, Treaty net ¹	Chinook, coho, chum	10,606	8,811
7B, 7C Non-treaty net	Chinook, coho, chum	4,960	9,446
Nooksack River Treaty net	Early Chinook, May-Jun ²	2,617	945
	Fall Chinook, Aug-Oct	1,446	1,337

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

² Includes Lummi Bay fishery targeting returns to Lummi Sea Ponds.

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 9th and in Samish Bay (7C) from August 1st through September 17th, with a catch of 8,309 Chinook. The coho fishery operated as planned from September 11th through October 29th, with an incidental harvest of 499 Chinook. During the 7A on-reservation Coho fishery from September 8th through October 2nd, three Chinook were incidentally harvested. No Chinook were harvested incidentally during the chum fishery. The total fall Chinook catch of 8,808 for Areas 7B, 7C, and 7D was less than the pre-season projection of 10,606 (Table 2-2).

The non-treaty fishery in Area 7B and 7C landed 9,446 Chinook from July through October, higher than the pre-season projection of 4,954. Eight Chinook were forecasted to be landed during the chum fishery, with zero landed.

Fisheries for fall Chinook, coho, and chum in the Nooksack River occurred as planned from August 1 – September 9, September 11 – October 22, and October 30 – December 14, respectively. The total Chinook catch was 1,337, less than the projected catch of 1,446 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

Spring Chinook Fisheries: Tribal commercial fisheries in the Skagit terminal area directed at hatchery spring Chinook were conducted in 2022 as scheduled preseason, although adjusted in timing and duration in response to ESA, tribal, and environmental needs. A total of 154 wild and 2,438 hatchery spring Chinook were encountered and retained in these directed spring Chinook fisheries. The final pre-season modeled projections in Chinook FRAM 2522 were 205 wild and 1,846 hatchery spring Chinook.

An additional 5 wild spring Chinook and 34 hatchery spring Chinook were harvested incidentally in directed sockeye fisheries, compared to 20 wild spring Chinook and 10 hatchery spring Chinook projected preseason.

There were no tribal ceremonial and subsistence (C&S) spring Chinook fisheries, so C&S harvest was zero compared to 17 wild and 36 hatchery expected pre-season.

Total wild spring Chinook mortalities across all of these tribal commercial and C&S fisheries were 159 wild and 2,472 hatchery fish, compared to the pre-season modeled 242 wild and 1,892 hatchery mortalities.

Summer/Fall Chinook Fisheries: No treaty commercial fisheries directed at summer/fall Chinook were scheduled in the Skagit terminal area for 2022. However, as anticipated, incidental harvest of summer/fall Chinook occurred in the sockeye and coho fisheries. The sockeye and coho fisheries were adjusted from the preseason schedule as noted in Table 2-3 due to in-season management needs and intertribal sharing agreements. Total summer/fall Chinook mortalities in these fisheries were 1,342 fish, compared to the pre-season expectation of 1,348 based on Chinook FRAM 2522.

There was no tribal ceremonial and subsistence (C&S) harvest of summer/fall Chinook in 2022, so C&S harvest was zero compared to 700 expected pre-season.

Total summer/fall Chinook mortalities across all of these tribal commercial and C&S fisheries were 1,342 in these fisheries, compared to the pre-season expectation of 2,048 based on Chinook FRAM 2522.

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 2022. 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 70 wild spring Chinook, 28 hatchery spring Chinook, and 504 summer/fall Chinook mortalities occurred in these fisheries. The pre-season expectation of mortalities in the test fisheries was 40 wild spring Chinook, 37 hatchery spring Chinook, and 418 summer/fall Chinook.

Summary: Overall, a total of 229 wild spring Chinook, 2,500 hatchery spring Chinook, and 1,846 summer/fall Chinook were harvested in treaty commercial, C&S, and test fisheries. The preseason expectation based on Chinook FRAM 2522 was 282 wild springs, 1,929 hatchery springs, and 2,466 summer/fall Chinook salmon.

Table 2-3. Skagit terminal area projected and actual hatchery and wild Chinook catches for Skagit terminal area tribal fisheries in 2022. Weekly projections were made by plugging the FRAM Chin2522 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 Fisheries:								
Chinook	1 site, wks 19-35	132	132	Wks 20-22,24,26,30-35	115	115	-17	-17
Sockeye	2 sites: Area 3 wks 23-30, Blakes wks 24-29	71	71	Area 3 wks 23-29; no Blakes	45	45	-26	-26
Coho	3 sites: Blakes wks 34 – 45, Area 3 wks 34-42, Spudhouse wks 35-44	288	288	Blakes wks 36-41 and 43; Area 3 wks 35-36,38-39,42-44 ; Spudhouse wks 34-42	407	407	119	119
Chum	3 sites, wks 44-45	0	0	None	0	0	0	0
Steelhead	2 sites, wks 8-18	5	5	Wks 8-17	35	35	30	30
Area 8/78C Spring Chinook Fishery Swinomish Tribe:								
Week 18	7 days	367	367	Same	397	397	30	30
Week 19	6 days	201	201	Same	537	537	336	336
Week 20	4 days	192	192	Same	258	258	66	66
Week 21	2 days	79	79	1 days	28	28	-51	-51
Area 78P Spring Chinook Fishery Sauk-Suiattle Tribes:								
Wk 21-29	Wk 21: 3 days, wk 22: 7 days; wks 23-29: 3 days/wk	500	500	Wk 21: 6.67 days; wk 22: 7 days; wk 23: 0.875 days	519	519	19	19
Area 78C/78D Spring Chinook Fishery Upper Skagit Tribe:								
Week 18	0.625 days	141	141	None	0	0	-141	-141
Week 19	0.750 days	169	169	None	0	0	-169	-169
Week 20	0.750 days	232	232	1.33 days	853	853	621	621
Week 21	0.625 days	172	172	None	0	0	-172	-172
Area 8/78C/78D/78P Chinook C&S Fishery Swinomish, Sauk-Suiattle, Upper Skagit Tribes:								
Sum/Fall-Spring Chin.	As needed	753	753	As needed	0	0	-753	-753
Areas 8/78C Sockeye Fishery Swinomish Tribe:								

Week 26	3.833 days	29	29	3 days	40	40	11	11
Week 27	5 days	47	47	5.25 days	98	98	51	51
Week 28	5 days	65	65	7 days	99	99	34	34
Week 29	4 days	82	82	0.229 days	1	1	-81	-81
Area 78D/78O Sockeye Fishery Swinomish Tribe:								
Week 28	1 day	5	5	None	0	0	-5	-5
Week 29	1 day	3	3	0.229 days	1	1	-2	-2
Week 30	None	0	0	0.5 days	1	1	1	1
Week 31	None	0	0	None	0	0	0	0
Week 32	None	0	0	0.5 days	0	0	0	0
Areas 78C/78D/78O Sockeye Fishery Upper Skagit Tribe:								
Week 27	1 day	41	41	1.417 days	54	54	13	13
Week 28	0.375 days	17	17	None	0	0	-17	-17
Week 29	None	0	0	0.792 days	60	60	60	60
Areas 8/78C Coho Fishery Swinomish Tribe:								
Week 38	2.375 days	127	127	Same	93	93	-34	-34
Week 39	3 days	62	62	1.792 days	13	13	-49	-49
Week 40	2 days	14	14	None	0	0	-14	-14
Week 41	1.5 days	2	2	None	0	0	-2	-2
Week 42	None	0	0	None	0	0	0	0
Areas 78P Coho Fishery Sauk-Suiattle Tribe:								
Wk 36-43	Wk 36: 3 days; wk 37: 7 days; wk 38: 5 days; wks 39-43: 3 days/wk	500	500	wk 37: 0.667 days; wk 38: 7 days; wk 39: 6 days; wk 40-42: 3 days; wk 43: 2.792 days	87	87	-413	-413
Areas 78B Coho Fishery Sauk-Suiattle Tribe:								
Wk 45-50	7 days/wk	0	0	wk 45: 0.458 days; wk 46: 7 days; wk 47: 1.75 days	0	0	0	0
Areas 78C/78D Coho Fishery Upper Skagit Tribe:								
Week 39	0.5 days	126	126	None	0	0	-126	-126
Week 40	1.125 days	174	174	2.417 days	580	580	406	406
Week 41	1.125 days	83	83	2.417 days	228	228	145	145

Week 42	None	0	0	1 days	26	26	26	26
All Terminal Area Chum Fishery Swinomish, Upper Skagit Sauk-Suiattle Tribes:								
None	None	0	0	None	0	0	0	0
Total Skagit Terminal Area:		4,679	4,679		4,575	4,575	-104	-104

2.4 Stillaguamish/Snohomish Terminal Area

The tribal net fishery in Area 8A was open for the 2022/2023 fishing season for Ceremonial Chinook and a five-week commercial coho fishery. Twenty Chinook salmon were taken during the Coho salmon directed fishery in September. Eighteen ceremonial Chinook were harvested in Area 8A during 2022 (Table 2-4). Non-treaty commercial fishing in Area 8A was closed for the 2022-2023 season.

Tribal Chinook catch in Area 8D occurred from May through September, with most of the catch occurring during June and July. Total 8D catch was 4,263, including 339 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 2022-2023 season.

The Stillaguamish Tribe harvested three chinook for ceremonial purposes from the Stillaguamish River in 2022 (Table 2-4). No chinook were harvested incidentally during the coho directed fishery.

Table 2-4. Projected (FRAM Chin2522) and actual Chinook net fishery harvest in the Stillaguamish – Snohomish terminal area in 2022.

Area		Projected	Actual
8A Commercial	Treaty	12	20
	Treaty C&S	Up to 100	18
	Ntrty	0	0
8A Test		N/A	--
8D Commercial	Treaty	7,686	3,924
	Treaty C&S		339
	Ntrty	3	0
Stillaguamish R. Net	C&S/Coho	19	3

2.5 South Puget Sound Terminal Areas

Table 2-5. Projected and actual Chinook catch in 2022 South Puget Sound net fisheries.

Area	Management Period	Projected	Actual
Area 9/10/11	Coho (A10 – Test)	0	0
	Chum (A9 – Test)	121	18
	A9 (Trty. C&S + chum)	11	0
	Trty Coho/Chum (A10/11)	12	0
	NT Chum (A10/11)	88 ^a	45 ^a
Area 10E	Treaty Chinook/coho/chum	4,593	7,888
Area 10A	Chinook (test/C&S/Comm)	1,546	582
	Coho/chum	40	64
Duwamish River	Chinook/Coho/Chum	7,983	8,917
	Coho (Test/C&S)		36
L Washington/Ship Canal	Sockeye/coho/ C&S	801	914
	Test/Research	N/A	--
Lake Sammamish	Chinook/Coho	1	0
Puyallup River	Spring/Fall C&S	594	34 ^b
	Chinook/Coho	6,080	6,040
White River	Spring/Fall C&S	-- ^c	148
	Coho	--	0
Areas 13, 13D-K	Chinook/Coho/Chum	3,101	1,593
Area 13A	Chinook/Coho/Chum	1,586	1,372
Areas 13C/Chambers	Chinook	1,095	1,408
Nisqually River	Chinook/coho	5,923	2,748 ^b
McCallister Cr.	Chinook	212	360

^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 594 fish.

Marine Areas 9, 10 & 11

The coho test fishery in area 10 was not implemented in 2022. The chum test fishery at Apple Cove Point (Area 9) incidentally caught a total of 18 Chinook (Table 2-5), well below the estimated 121.

An estimated 45 Chinook release mortalities occurred during the chum directed non-treaty purse seine fishery in area 10 and 11. The treaty coho and chum salmon fishery in Area 10 harvested zero chinook. Fisheries directed at Chinook and coho in Area 10E harvested 7,888 Chinook (Table 2-5). No Chinook were harvested during the chum fishery in area 10E.

No Chinook were harvested in Area 9 for C&S purposes or 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 2022 which harvested 190 Chinook. Incidental Chinook catch during the coho fishery in Lake Union, and the upper and lower Ship Canal harvested 178 Chinook. The Muckleshoot Tribe conducted a coho directed commercial fishery in North Lake Washington with a total by-catch of 546 Chinook. The coho directed fisheries in Lake Sammamish incidentally harvested zero Chinook salmon.

The Lake Washington ship canal abundance and diet study of piscivorous fish was conducted as planned by WDFW in 2022. The study was conducted between early-February and late-June. Five adult Chinook mortalities were projected to occur. Sampling work in 2022 encountered no adult and a total of one juvenile (sub-adult) Chinook.

The Lake Washington warm water test fishery, conducted by the Muckleshoot Tribe was prosecuted in spring (May-June) of 2022. Monthly reports were provided separately to NOAA for this research.

Elliott Bay/Duwamish River

The Chinook test fishery in Area 10A harvested 174 Chinook in 2022. A Chinook-directed commercial fishery occurred in Area 10A and the Duwamish River, with 408 and 7,517 Chinook salmon, respectively. In 10A, there were 64 Chinook caught in September during the coho directed fishery by Muckleshoot Indian Tribe. In the Duwamish River, 36 Chinook were caught during the coho test fishery to determine Chinook clearance. During the Coho directed fishery in the Duwamish River, 1,377 Chinook were caught incidentally as well as 23 Chinook caught during the chum directed fishery in late-October.

Puyallup River and White Rivers

Ceremonial and subsistence fisheries in the Puyallup River caught 33 adult spring Chinook salmon along with six estimated jacks during management weeks 22–29. Based on fisheries sampling data, an additional one adult presumed to be a fall-run Chinook, based on ad-clip marks, was taken during the spring C&S fishery. The Muckleshoot Tribe had an additional spring Chinook C&S fishery in the White River which caught 141 spring Chinook and 7 presumed fall Chinook based on ad-clip marks and GSI analysis. Besides the 8 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 2,361 during the Chinook directed fishery. The coho fishery in the Puyallup and White River occurred from management week 37 (September 5th) to management week 42 (October 10th) and incidentally harvested 3,679 Chinook salmon, mostly during early September (Table 2-5).

Marine area 13 & sub areas (Deep South Sound)

The Chinook fishery in Carr Inlet (13A) caught 1,283 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 89 Chinook, with a preseason expectation of 21.

The Chinook fishery at Chambers Bay (13C) occurred between July 26 through October 10 with 1,408 Chinook harvested (Table 2-5). The preseason catch projection was 633.

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 249 fish. Zero Chinook were caught during the Fox Island (Area 13) coho fishery. The total preseason catch projection for both areas was 3,101.

Nisqually River

The treaty commercial fishery in the Nisqually River harvested an estimated 2,478 Chinook, excluding jacks, but including fish for Ceremonial and Subsistence purposes, with a pre-season projected commercial catch, excluding jacks, of 5,923 (Table 2-5).

The short term release mortality study in the Nisqually River encountered and released 128 adult Chinook salmon during 2022. Given a sample size of 128 at 95% confidence interval the mortality estimate for 2022 is 1.6% plus or minus 8.67%. Three additional chinook were collected during the study but were 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 3,881. Two Chinook were landed in 12C during the Coho directed fishery in October. In marine catch area 12B, one Chinook was harvested while no Chinook were landed in 12 during the tribal Coho directed fishery.

Tribal Chinook harvest in the Hoodspout Hatchery Zone (12H) was 22,358 and occurred as planned from July 12 through September 12. Catch was greater than the preseason expectation of 9,645.

Tribal chinook troll fishery in areas 12/12B had zero effort so no Chinook were landed in 2022.

Chinook harvest in the Skokomish River occurred as planned from August 3 (wb 8/2) through August 27 (wb 8/23) landing 3,124 fish. One Chinook was harvested during the Coho directed fishery in October. 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 late July 23 through August 16 landing 403 fish.

In Port Gamble (Area 9A), 231 Chinook were harvested, primarily in mid-August to mid-September during Coho fisheries.

Non-treaty commercial fisheries in the Hoodspout Zone (12C) harvested 9,446 Chinook salmon (Table 2-6). There were no Chinook landed in other non-treaty fisheries in Hood Canal in 2022 but 18 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 2022.

Area	Target Species	Projected	Actual
(12, 12B-12D, 9A) (T)	chin, coho, chum	2,970	4,115
(12-12C, 9A) (NT)	chum, coho	11	18 ^a
(12, 12B) Troll (T)	chinook, coho	200	0
12A Net (T)	coho	54	0
12H Net (T)	chinook, chum	9,645	22,358
12C Hoodsport Zone Net (NT)	chinook, chum	5,000 ^b	9,446
Skokomish River (82G) (T)	chin, coho, chum	7,488	3,125
(82J) (T)	<i>chinook</i>		403
Total		25,368	39,060 ^c

^a Values reported are release mortalities.

^b The co-managers pre-season agreement was for 5,000 and increased by in-season in the NT Hoodsport Zone net catch, but 10,000 was modeled in CHIN2522.

^c 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 2022.

Table 2-7. Projected and actual catches of Chinook in Strait of Juan de Fuca terminal net fisheries in 2022.

Terminal Area	Projected	Actual
Area 6D & Dungeness River Treaty	0	0
Area 6D Non-Treaty	0	0
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 2022 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 2022 Puget Sound non-treaty salmon net fisheries.

Area	Gear type	# sets observed	Chinook	Coho	Sockeye	Pink	Chum	Steelhead
7	PS	19	90	120	1,287	0	498	0
7A	PS	28	72	443	400	7	2,083	0
8A	PS	Closed						
10	PS	89	27	182	0	0	15,377	1
11	PS	40	3	87	0	0	6,835	0
12	PS	49	0	95	0	0	6,844	0
12B	PS	77	7	100	0	0	9,566	0
7	GN	6	0	1	5	0	4	0
7A	GN	2	0	3	0	0	0	0
10	GN	49	8	11	0	0	6,663	0
11	GN	9	0	1	0	0	960	0
12	GN	16	0	3	0	0	629	0
12B	GN	4	0	0	0	0	233	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 2022.

Area	Total Mortality	
	Projected	Actual
6D	0	0
7/7A	3,185	648
7B/7C	4,960	9,446
8	N/A	Closed
8A	N/A	Closed
8D	3	Closed
10/11	88	45
12-12C/9A	11	18
12C Hoodsport	5,000	8,281

3 Recreational Harvest

This chapter summarizes expected recreational catch in Puget Sound marine waters and freshwater tributaries for the 2022-2023 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 2021-2022 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, 2022.

3.1 2021-2022 Recreational Chinook MSF and NS Catch

Mark-selective and non-selective Recreational Chinook harvest in 2021-2022, estimated from preliminary Catch Record Card (CRC) data through March 31, 2022, and creel estimates where available, was 47,390, compared to a preseason projection of 40,229. 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 3721) and actual (preliminary, where available) Chinook catches in Puget Sound Chinook MSF and NS 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	3,842*
Area 6 Summer MSF	4,769	5,098
Area 6 Winter MSF	Closed	
Other		
Strait Tributaries		
Area 7		
Summer (July MSF)	1,382	2,504
Winter MSF	Closed	
Nooksack/Samish FW	4,668	9,932
NF Nooksack Spring Chinook	801	174
Area 8-1 & 8-2		
Winter MSF	Closed	
Skagit River		
Spring MSF	475	112
Area 8D SAF	495	441
Stillaguamish River	1	0
Snohomish River		
Skykomish MSF	551	942
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	271
Lake Sammamish	1	0
Area 10A SAF	146	464
Green River	526	857
Puyallup River		
Carbon R MSF	706	796
Puyallup R MSF	1,256	2,360
Area 13		
Summer MSF	2,064	2,418
Winter MSF	179	486*
Chambers Cr	34	0
Nisqually	1,504	2,140
Deschutes	7	8
Area 12		
Summer MSF	2,309	1,587
Winter MSF	Closed	
Skokomish River	Closed	

* All CRC estimates of catch through 3/31/2022

3.2 2022-2023 Recreational Chinook MSF Catch

Projected Chinook catches for 2022-2023 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 and 11, 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 2022-2023 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 2023 annual report.

Table 3-2. Projected (FRAM 2522) and actual (preliminary, where available) Chinook MSF catches in Puget Sound recreational fisheries during the 2022-2023 season.

Area/Fishery	Projected	Actual
Area 5-6		
Area 5 Summer MSF	3,891	3,945
Area 5 Winter MSF	1,726	
Area 6 Summer MSF	6,050	4,791
Area 6 Winter MSF	Closed	
Other		
Strait Tributaries		
Area 7		
Summer MSF	1,800	1,766
Winter MSF	Closed	
Nooksack/Samish FW	8,021	
NF Nooksack Spring Chinook	1,296	105
Area 8-1 & 8-2		
Winter MSF	Closed	
Skagit River		
Spring MSF	613	
Area 8D SAF	0	
Stillaguamish River	2	
Snohomish River		
Skykomish MSF	655	
Area 9		
Summer MSF	4,700	4,697
Winter MSF	Closed	
Area 10		
Summer MSF	3,966	4,261
Winter MSF	836	1,048
Area 11		
Summer MSF	3,396	3,396
Winter MSF	237	171
Area 10E SAF	253	
Lake Sammamish	1	
Area 10A SAF	278	
Green River	484	
Puyallup River		
Carbon R MSF	702	
Puyallup R MSF	1,164	
Area 13		
Summer MSF	2,852	
Winter MSF	473	
Chambers Cr	26	
Nisqually	2,698	
Deschutes	8	
Area 12		
Summer MSF	1,822	
Winter MSF	Closed	
Skokomish River	Closed	

3.2.1 Marine Area 5 Summer MSF

2022 was the 20th 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 open July 1 through 4, then switched to open every other day starting July 6 through 23. It then reopened seven days a week July 24 through August 15. The adjustment in schedule was needed to preserve season length due to accumulation of impacts at a rate in-season higher than that was predicted preseason (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 (2023).

For Area 5, WDFW estimates that 3,891 Chinook were landed, compared to preseason projections of 3,945 (Table 3 3).

Table 3-3. Comparison of modeled (FRAM 2522) and estimated total Chinook encounters for the 2022 Area 5 summer Chinook MSF.

Data Source	Group	Total Encounters	Legal	Sublegal	Landed Only
FRAM Encounters	UM	9,727	2,904	6,823	29
	AD	13,146	4,439	8,707	3,862
	Total	22,873	7,343	15,530	3,891
	% Marked	57	60	56	99
Estimated (Creel) Encounters	UM	9,956	3,930	6,026	9
	AD	30,655	4,192	26,463	3,936
	Total	40,611	8,122	32,489	3,945
	% Marked	75	52	81	100

3.2.2 Marine Area 6 Summer MSF

2022 was the 20th 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 implemented from July 1 through July 23, then again from July 27 through July 30. The fishery was closed by emergency regulation on July 24 through July 26, then again on July 31, 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 (2023).

For Area 6, WDFW estimates that 6,050 Chinook were landed, compared to preseason projections of 4,791 (Table 3 4).

Table 3-4. Comparison of modeled (FRAM 2522) and estimated total Chinook encounters for the 2022 Area 6 sub-area summer Chinook MSF.

Data Source	Group	Total Encounters	Legal	Sublegal	Landed Only
FRAM Encounters	UM	3,899	2,474	1,425	25
	AD	10,887	6,926	3,961	6,025
	Total	14,786	9,400	5,386	6,050
	% Marked	74	74	74	100
Estimated (Creel) Encounters	UM	16,941	8,916	8,024	2
	AD	31,503	5,350	26,154	4,790
	Total	48,444	14,266	34,178	4,791
	% Marked	65	38	77	100

3.2.3 Marine Area 7 Summer MSF

2022 was the 7th year of summer mark-selective Chinook fishing in Marine Area 7. In 2022, Area 7 was planned to be open for a three-day period beginning on July 14, then closed to assess catch and encounter totals versus management controls. Subsequent three-day openings were scheduled on July 21 and July 28 based on remaining available catch and encounters. In 2022, the fishery in Area 7 was open in July for a total of 9 days.

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 (2023).

For Area 7, WDFW estimates that 1,800 Chinook were landed, compared to preseason projections of 1,766 (Table 3 5).

Table 3-5. Comparison of modeled (FRAM 2522) and estimated total Chinook encounters for the 2022 Area 7 summer Chinook MSF.

Data Source	Group	Total Encounters	Legal	Sublegal	Landed Only
FRAM Encounters	UM	3,991	2,769	1,222	28
	AD	3,387	2,037	1,350	1,772
	Total	7,378	4,806	2,572	1,800
	% Marked	46	42	52	98
Estimated (Creel) Encounters	UM	1,347	1,122	224	3
	AD	2,469	2,020	449	1,763
	Total	3,816	3,143	673	1,766
	% Marked	65	64	67	100

3.2.4 Marine Area 9 Summer MSF

In 2022, a recreational MSF occurred for the 16th consecutive summer in Marine Area 9. Similar to the management paradigm in Area 7, Area 9 was planned to be open for a three-day period beginning on July 14, then closed to assess catch and encounter totals versus management controls. The fishery would then open again on August 1 and run continuous through August 15, 2022. Subsequent three-day openings were scheduled on July 21 and July 28 based on remaining available catch and encounters. In 2022, the fishery in Area 9 was open in July for a total of 9 days. The fishery was closed on August 4 when estimates of catch and encounters neared management controls.

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 (2023).

An estimated 4,697 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 2522) and estimated Chinook encounters for the 2022 Area 9 summer Chinook MSF.

Data Source	Group	Total Encounters	Legal	Sublegal	Landed Only
FRAM Encounters	UM	3,099	1,382	1,717	14
	AD	14,058	5,386	8,672	4,686
	Total	17,157	6,768	10,389	4,700
	% Marked	82	80	83	100
Estimated (Creel) Encounters	UM	4,846	3,392	1,454	3
	AD	13,568	5,330	8,237	4,694
	Total	18,413	8,722	9,691	4,697
	% Marked	74	61	85	100

3.2.5 Marine Area 10 Summer MSF

In 2022, a recreational MSF occurred for the 15th consecutive summer in Marine Area 10. The summer recreational MSF was planned and implemented in Area 10 from July 14 through August 31, 2022. 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. Detailed descriptions of the sampling program and results are available in WDFW (2023).

An estimated total of 4,261 Chinook were landed during this fishery, compared to the pre-season projection of 3,966 (Table 3 7).

Table 3-7. Comparison of modeled (FRAM 2522) and estimated Chinook encounters for the 2022 Area 10 summer Chinook MSF.

Data Source	Group	Total Encounters	Legal	Sublegal	Landed Only
FRAM Encounters	UM	4,240	1,345	2,895	13
	AD	10,401	4,543	5,858	3,953
	Total	14,641	5,888	8,753	3,966
	% Marked	71	77	67	100
Estimated (Creel) Encounters	UM	3,655	1,058	2,597	21
	AD	7,791	4,713	3,078	4,240
	Total	11,446	5,771	5,675	4,261
	% Marked	68	82	54	100

3.2.6 Marine Area 11 Summer MSF

In 2022, a recreational MSF occurred for the 16th consecutive summer in Marine Area 11. The fishery was planned to occur from June 1 through September 30, 2022. The fishery was open from June 1 through 3, July 1 through 2, July 6 through 9, August 3 through 6, and then again from August 10 through August 13, 2022. In total the fishery was open for 17 days in 2022. These in season management actions were implemented as estimates of catch and encounters were accumulating at a rate which would have drastically shortened the planned fishery.

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. Detailed descriptions of the sampling program and results are available in WDFW (2023).

An estimated total of 3,290 Chinook were landed during this fishery, compared to the pre-season projection of 3,084 (In 2022, a recreational MSF occurred for the 15th consecutive summer in Marine Area 10. The summer recreational MSF was planned and implemented in Area 10 from July 14 through August 31, 2022. 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. Detailed descriptions of the sampling program and results are available in WDFW (2023).

An estimated total of 4,261 Chinook were landed during this fishery, compared to the pre-season projection of 3,966 (Table 3 7).

8).

Table 3-8. Comparison of modeled (FRAM 2522) and estimated Chinook encounters for the 2022 Area 11 summer Chinook MSF.

Data Source	Group	Total Encounters	Legal	Sublegal	Landed Only
FRAM Encounters	UM	2,091	1,051	1,040	21
	AD	6,965	3,880	3,085	3,375
	Total	9,056	4,931	4,125	3,396
	% Marked	77	79	75	99
Estimated (Creel) Encounters	UM	2,355	1,275	1,079	14
	AD	5,396	3,826	1,570	3,382
	Total	7,750	5,102	2,649	3,396
	% Marked	70	75	59	100

3.2.7 North Fork Nooksack Spring Chinook MSF

In 2022, a recreational spring Chinook MSF was prosecuted in the North Fork Nooksack River from May 28th through July 10th. An estimated 105 ad-clipped adult chinook were harvested during the fishery of a projected 1,296 (Table 3-99).

Table 3-9. Comparison of modeled (FRAM 3721) and estimated Chinook encounters for the 2022 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	1,296	1,296
	Total	1,319	1,319
	% Marked	98	100
Estimated (Creel) Adult Encounters	UM	12	0
	AD	105	105
	Total	117	105
	% Marked	90	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 Dungeness River spring/summer-run Chinook salmon.

For summer/fall populations, escapements were greater than projected for all management units, except the Nisqually River and Mid-Hood Canal fall-runs and Elwha River summer-run Chinook escapements were less than forecasted abundance.

Table 4-1. Preseason projections and estimates of Puget Sound Chinook natural spawning escapement in 2022.

Management Unit		NOR	HOR	Total	Projected (FRAM 2522)
Nooksack	NF			N/A	123 ¹
	SF			N/A	358 ¹
Skagit spring	Suiattle			535	655 ¹
	Cascade			410	203 ¹
	Sauk			2,542	1,333 ¹
	Total spring			3,487	1,442 ¹
Skagit summer/fall	Sauk summer			733	401 ¹
	Upper Skagit summer			12,005	7,945 ¹
	Lower Skagit fall			4,585	1,462 ¹
	Total summer/fall			17,323	9,758 ²
Stillaguamish	Total	780	915	1,831 ³	866
Snohomish	Skykomish	2,789	1,565	4,354	1,601 ¹
	Snoqualmie	861	420	1,281	801 ¹
	Total	3,650	1,985	5,635	2,402 ¹
Lake Washington	Cedar	662	233	895	714
Green				5,587	3,865
Puyallup		1,175	2,532	3,707	2,439
White		2,611	1,118	3,279 ⁴	2,541 ⁴
Nisqually		513	2,907	8,890 ⁵	9,460
Skokomish		930	4,465	5,395	3,284
Mid Hood Canal	Dosewallips	1	3	4	
	Duckabush	1	0	1	
	Hamma Hamma	1	5	6	
	Total	3	8	11	12
Dungeness		256	369	737 ⁶	894
Elwha				3,998 ⁷	4,021
Hoko				N/A	735

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=136) from the North Fork which are part of the FRAM Projection.

4. Includes NORs, HORs, and 981 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 700(526 NOR and 174 HOR) volitional spawners, as well as 8,367 hatchery rack return of which 1,457 adults were trucked upstream to spawn naturally for a total natural spawning estimate of 2,157.

6. Includes 112 fish removed from the river for use as broodstock.

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

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 account 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 basins). Escapement estimates are carcass-based for the NF/MF population and redd-based for the SF population. Population assignments are made for each individual carcass observed by using a combination of genetic, external mark, CWT, and otolith biological data collected during surveys. For unmarked, or putative wild fish, genetic stock assignments are the primary means to assign probable population for each individual.

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 -2021 escapement estimates are presented here. The 2022 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 used 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 2021, visibility was lower in the Middle Fork which limited redd detection efficiency 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; 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 2013-2021, Peat Bog Creek and Bear Creek (tributaries to the Middle Fork) also began showing higher carcass counts than prior to 2013. Therefore, during this period, carcass counts from all tributaries to the Middle Fork that are surveyed were enumerated but not expanded. Surveys were frequent and the unexpanded tributary carcass counts were considered to reflect total Chinook more accurately, given consistent low flow and clear water conditions.

Beginning in 2010 and continuing through 2021, another significant change in early Chinook escapement estimate methodology was applied in Kendall Creek, 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 to be 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.

The 2021 NF/MF Chinook escapement estimate is 1,040 in the North Fork basin (55 NORs and 985 HORs; Table 4-2), plus an additional 111 in the South Fork basin (4 NORs and 107 HORs; Table 4-3). There were an additional 84 pre-spawn mortalities (PSMs) in the South Fork (2 NORs and 82 HORs; Table 4-4). NF/MF NOR escapement was slightly higher than 2019 and 2020, and HOR escapement was much higher than 2020. The number of SF Chinook that spawned in the NF/MF basin also greatly increased in 2021 relative to 2019 and 2020.

Table 4-2. Early timed Chinook spawning escapements for 2019 - 2021 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
2021	55	985	59	313	24	23

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.

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 Chinook, North/Middle Fork early 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. Furthermore, 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 2021, 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. Starting with return year 2022, all returning HORs are otolith marked and we no longer assess stock assignments based on only on genetic parentage-based assignments for natural escapement purposes. As such, the South Fork Chinook escapement estimates are the number of naturally spawning NOR early-timed South Fork chinook and Skookum Creek HOR Chinook in the Nooksack basin, including those within the North/Middle Forks (see previous section and Table 1).

The 2021 South Fork population escapement estimate is 809 in the South Fork basin (92 NORs and 717 HORs; Table 4-3) and 372 in the North Fork basin (59 NORs and 313 HORs; Table 4-2). Pre-spawn mortalities are not included in South Fork basin escapement estimates and are separately summarized for 2021 below.

Table 4-3 Early timed Chinook spawning escapements for 2019 - 2021 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 Basin					
	SF NOR	SF HOR	NF/MF NOR	NF/MF HOR	Fall NOR	Fall HOR
2019	61	369	6	9	8	27
2020	243	1,085	45	67	30	10
2021	92	717	4	107	26	19

In 2021, the Nooksack co-managers observed an unprecedented pre-spawn mortality event where 2,432 Chinook died before they had the chance to spawn. This was a raw count of Chinook carcasses that did not show any evidence of spawning, and was likely an underestimate, given that it wasn't logistically feasible to sample every carcass before they deteriorated or were carried downstream. Total counts of all PSM Chinook are summarized in Table 3 and include observations from 2019 and 2020 for comparison.

It was not feasible to fully sample every carcass during the PSM event, so Lummi staff employed a subsampling scheme to determine which carcasses would be fully sampled. All data collected would be the same for both sampled and subsampled groups, except fully sampled fish would include additional biological data such as: fin clip for genetics, CWT extraction (if present), otolith, and scales. Fork length and sex were collected for many subsampled fish but not all. All unmarked fish were fully sampled and not subject to the subsampling scheme. On the first day of the event that saw several hundred carcasses in a small area, Lummi staff subsampled 1 in 5 from each group based on mark status (Groups were: ad-clipped only, ad-clipped + CWT, and CWT only). After the first day, Lummi staff changed to a 1 in 10 subsampling scheme to be able to better handle the PSM event and still be able to gather representative data from each group. This 1 in 10 scheme was generally used during any survey where staff estimated there were >100 carcasses present. Notes on PSM observations and subsampling scheme used were included in survey data sheets.

There were environmental variables that likely played a role in the PSM event including a “heat dome” event in late June that saw local temperatures above 100°F over several days and consistent low-flow, high water temperature conditions throughout the South Fork basin. These cumulative stressors led to the proliferation of several pathogens (*Flavobacterium columnare*, *Ichthyophthirius multifiliis*, and freshwater diatoms) that were confirmed by a WDFW senior veterinarian who performed necropsies on carcasses of 4 PSM Chinook.

The escapement estimate is an expanded value based on the number of redds and the PSM carcasses are raw counts, and thus not directly comparable. However, it is important to note that we observed 364 spawned or partially-spawned carcasses throughout the survey season. Therefore, PSM carcasses accounted for over 86.7% of all carcasses observed (2,796) in the SF basin in 2021. This die-off has clear short-term consequences for the spawning success of this cohort and may have long-term negative impacts on population productivity in the SF basin.

Table 4-4. Early timed Chinook pre-spawn mortality (PSM) raw counts for 2019 - 2021 return years in the South Fork basin.

Year	South Fork Basin					
	SF NOR	SF HOR	NF/MF NOR	NF/MF HOR	Fall NOR	Fall HOR
2019	2	30	0	1	0	0
2020	1	34	0	1	0	4
2021	41	2,292	2	82	4	11

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), Sauk-Suiattle Indian Tribe, and Seattle City Light, performed work and contributed data necessary to complete the escapement estimates and predictions for the Skagit River Basin Chinook salmon stocks.

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 August 3 through October 6. 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 2022. The logjam continues to be a total passage barrier with no live Chinook or Chinook redds observed upstream of the logjam. A total of 214 redds were observed in 2022.

A total of 53 Suiattle spring Chinook carcasses were observed, and 33 were collected and sampled; 2 carcasses were adipose clipped but not tagged, and 31 were wild unmarked fish. The season total redd count was 214 (Table 4-5).

Table 4-5. Suiattle River spring Chinook 2022 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	11
Tenas Creek	3.0761	Foot	0.0-0.5	9.6	27
Straight Creek	3.0797	Foot	0.0-0.1	15.1	18
Buck Creek	3.0813	Foot	0.0-1.7	18.1	12
Circle Creek	3.0892	Foot	0.0-0.2	18.4	0
Lime Creek	3.0897	Foot	0.0-0.5	20.8	5
Downey Creek	3.0919	Foot	0.0-2.1	24.4	127
Sulfur Creek	3.0973	Foot	0.0-0.9	26.3	8
Milk Creek	3.1022	Foot	0.0-0.1	28.6	6
Total redds					214

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

The preliminary 2022 Suiattle River Spring Chinook escapement estimate was 535 fish (rounded). All data and estimates of escapement were preliminary at the time of reporting.

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 varying distances (less than one river mile) dependent upon stream flow and available spawning habitat.

Surveys of all known spawning habitat occurred from August 8 through October 11. Mainstem surveys were conducted by foot or pontoon boat depending on the stream features of the index. Historically this survey interval for this population was one pass every 10-14 days, but to find and sample more carcasses, surveys of these reaches occurred up to twice per week in 2022. One pass would focus on redds and carcasses, the next pass would focus only on carcasses.

A total of 48 carcasses were observed and 45 were able to be collected and sampled in the upper Cascade spring Chinook area in 2022. 41 of the carcasses were unmarked and untagged wild Chinook, 1 carcass was adipose clipped and untagged, and 3 of the carcasses were unknown origin due to compromised adipose and or head tissue due to scavengers or decomposition.

Surveyors located 164 redds in 2022 (Table 4-6). The 2022 upper Cascade River spring Chinook spawning escapement estimate was 410 fish. All data and estimates of escapement were preliminary at the time of reporting.

Table 4-6. 2022 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	12
Marble Creek	3.1451	Foot	0.0-0.3	8.6	1
Cascade River	3.1411	Foot/Raft	9.0-12.4	9.0	57
Cascade River	3.1411	Foot	12.4-15.8	12.4	56
Cascade River	3.1411	Foot	15.8-18.6	15.8	38
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:					164

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 39.7. 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 22 through October 13. 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 648 Sauk River spring Chinook carcasses were observed and 202 were recovered and sampled. 197 carcasses sampled were wild unmarked and untagged fish, 3 were adipose clipped and untagged, 1 was coded wire tagged and not clipped, and 1 carcass was unknown due to compromised tissue. There were 1,003 redds located upstream of the White Chuck River by ground based surveys, and 13 (rounded) AUC estimated redds downstream of the White Chuck River in the section surveyed by helicopter (Table 4-7).

The 2022 upper Sauk River spring Chinook preliminary escapement estimate was 2,542 fish. All data and estimates of escapement were preliminary at the time of reporting.

Table 4-7. Upper Sauk River spring Chinook redd counts from 2022 spawning ground surveys.

Stream	WRIA	Survey method	Reach (RM)	Location ^{*1}	Redds
Sauk River	3.0673	Flight	31.0-31.9	31.0	13
Sauk River	3.0673	Foot/Float	31.9-34.5	31.9	401
Sauk River	3.0673	Foot/Float	34.5-37.8	34.5	362
Falls Creek	3.1182	Foot	0.0-0.2	34.9	0
Sauk River	3.0673	Foot/Float	37.8-39.7	37.8	29
South Fork Sauk River	3.1204	Foot	0.0-2.9	0.0	148
North Fork Sauk River	3.0673	Foot	39.7-40.1	39.7	32
North Fork Sauk River	3.0673	Foot	40.1-41.3	40.1	31
Total redds (rounded):					1,016

*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 6 through November 3 (Table 4-8).

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 405 Skagit summer Chinook carcasses were observed, and 388 carcasses were recoverable and sampled; 312 carcasses were unmarked and untagged wild Skagit summer Chinook, 3 carcasses were adipose clipped only (no cwt), 2 were adipose clipped but unknown tag status due to compromised head tissue, 18 were adipose clipped and CWT present, 2 were CWT only, and 51 were adipose present but unknown tag status due to compromised head tissue.

We observed 220 Skagit summer Chinook redds in the tributaries and estimated 4,582 redds in the mainstem reaches.

The 2022 expected escapement of Skagit River summer Chinook was 12,005 fish (rounded). All data and estimates of escapement were preliminary at the time of reporting.

Table 4-8. Skagit summer Chinook redd counts from 2022 spawning ground surveys.

Stream	WRIA	Survey method	Reach (RM)	Location ¹	Redds
Goodell Creek	3.1867	Foot	0.0-1.3	92.9	1
Falls Creek ³	3.1780	Foot	0.0-0.4	4.0	0
Bacon Creek	3.1774	Foot	0.0-4.2	82.9	73
Diobsud Creek	3.1750	Foot	0.0-1.3	80.7	25
Cascade River	3.1411	Foot/Float	0.0-4.2	78.1	95
Illabot Creek	3.1346	Foot	0.0-2.6	71.6	26
Total redds:					220

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 September 29 and continued through November 3 but no Sauk summer Chinook redds or carcasses were observed (Table 4-9).

Weather and stream conditions were generally favorable for aerial surveys of the mainstem Sauk summer Chinook indexes. An estimated total of 293 redds were built in the mainstem throughout spawning. The 2022 escapement estimate was 733 Sauk summer Chinook (rounded). Carcass sampling data was not yet available at the time of reporting. All data and estimates of escapement were preliminary at the time of reporting.

Table 4-9. Lower Sauk River summer Chinook redd counts from 2022.

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	0	N/A	N/A
Hilt Creek	3.0678	Foot	0.0-0.5	0.6	0	293	N/A
Grand total redds from all methods (rounded):					0	293	0

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 September 29 and continued through November 3 (Table 4-10). A total of 17 carcasses were observed but only 12 were able to be collected and sampled. 8 carcasses were from wild unmarked and untagged fish, and 3 were from adipose clipped and untagged fish. One carcass was not tagged, but adipose 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 34 redds, and these were summed with 1,800 AUC estimated mainstem redds from the four aerial surveys. Redd counts were multiplied by 2.5 fish per redd to calculate escapement.

The 2022 escapement estimate of Skagit River fall Chinook was 4,585 fish (rounded). All data and estimates of escapement were preliminary at the time of reporting.

Table 4-10. Lower Skagit River fall Chinook redd counts from 2022 spawning ground surveys.

Stream	WRIA	Survey method	Reach (RM)	Redds
Skagit River	3.0176	Flight	24.5-56.5	851
Skagit River	3.0176	Flight	56.5-67.2	949
Hansen Creek	3.0265	Foot	3.0-4.5	0
Day Creek	3.0299	Foot	0.0-2.2	0
Jones Creek	3.0332	Foot	0.0-1.3	0
Grandy Creek	3.0337	Foot	0.0-1.4	16
Alder Creek	3.0359	Foot	0.0-1.6	3
O'Toole Creek	3.0365	Foot	0.0-0.2	0
Mill Creek	3.0375	Foot	0.0-0.2	0
Pressentin Creek	3.0385	Foot	0.0-0.4	2
Finney Creek	3.0392	Foot	0.0-7.0	13
Jackman Creek	3.0626	Foot	0.0-0.7	0
EF Nookachamps Creek	3.0230	Foot	3.5-5.1	0
Total Redds				1,834

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. Prior 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 to excellent throughout the spawning period. However, streamflows in 2022 were very low until the end of October, when fall rains finally came. The first redds were detected on August 29th in the North Fork, and last one was detected October 24 in the South Fork. A total of 463 Chinook redds were counted on the North Fork of the Stillaguamish in 2022 (Table 4-11). The redd-based escapement estimate was 1,159 fish (Table 4-11). The GMR-adjusted provisional escapement estimate is 1,396 fish (652 NOR, 744 HOR). An additional 136 fish (69 NOR, 67 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.

Table 4-11. North Fork Stillaguamish summer and fall Chinook redd counts in 2022.

Stream	WRIA	Method	Reach (RM)	Redds	Escapement
North Fork	5.0135	Foot/Float	0.0-14.3	52	130
North Fork	5.0135	Foot/Float	14.3-30.0	329	823
North Fork	5.0135	Foot/Float	30.0-34.4	51	128
Grant Creek	5.0156	Foot	0.0-0.4	0	0
Deer Creek	5.0173	Foot	0.0-6.0	0	0
Brooks Creek	5.0215	Foot	0.0-0.1	0	0
Boulder River	5.0229	Foot	0.0-2.9	8	20
French Creek	5.0246	Foot	0.0-3.0	0	0
Squire Creek	5.026	Foot	0.0-4.0	23	58
Brown Creek	5.0265	Foot	0.0-1.0	0	0
Total Redds				463	
Redd-based Escapement Estimate					1,159
GMR adjusted EE (provisional)					1,396

South Fork and Mainstem Stillaguamish summer and fall Chinook

South Fork and Mainstem Stillaguamish summer and fall Chinook escapement in 2022 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. No Chinook redds were observed in the upper SF in 2022. The mainstem aerial index reach, from mouth (RM 0.0) to the forks (RM 17.8), was flown three times in 2022, September 16, October 4, and October 18.

A total of 99 Chinook redds were found in the Mainstem Stillaguamish and South Fork Stillaguamish River and tributaries in 2022 (Table 4-12). The redd-based escapement estimate

was 248 adult fish, which expanded to 299 adult fish with the application of the GMR correction factor (Table 4-12).

Table 4-12. 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	18	45
South Fork	5.0001	Foot/Float	17.8-34.7	72	180
South Fork (upper)	5.0001	Foot	34.7-65.0	0	0
Pilchuck Creek	5.0062	Foot/Float	0.0-6.2	0	0
Jim Creek	5.0322	Foot/Float	0.0-4.1	3	8
Siberia Creek	5.0324	Foot	0.0-0.4	0	0
Canyon Creek	5.0359	Foot	0.0-0.5	6	15
Total Redds				99	
Redd-based Escapement Estimate					248
GMR adjusted EE (provisional)					299

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, 588 complete carcasses (status of both adipose fin and CWT was determined) were sampled in the Stillaguamish River; 136 in broodstock collection, 452 combined in the North Fork and South Fork reaches (Table 4-13). The sampling rates of Chinook carcasses, not including those with unknown mark dispositions, were 26.7% 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 2022, 244 of 452 samples were determined to be of hatchery origin, which estimates 54% of the provisional GMR adjusted escapement is 915 adults. Then the number of hatchery origin adults known in the broodstock (67) are added to the estimated spawning ground hatchery adults (915), for a watershed escapement hatchery proportion of 52.9%. 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 4-13).

Table 4-13. Stillaguamish Chinook sample proportions and HOR:NOR composition in 2021.

	Sampled	Sampled Hatchery	Sampled Natural	% Hatchery	% Natural	GMR Esc EST	% Sampled
GMR Adjusted EE1	452	244	208	54.0%	46.0%	1,695	26.7%
Broodstock (NF)	136	67	69	49.3%	50.7%	136	100.0%
Stillaguamish Totals				52.9%	47.1%	1,831	

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 and were plotted against survey date for the area-under-curve (AUC) method yielding total redds. 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, less Sunset Falls. The live count of Chinook passed above the trap at Sunset Falls on the South Fork of the Skykomish was added to redd-based total for the total escapement estimate. Carcasses encountered were sampled for scales, DNA, CWT, adipose fin mark status, and otoliths. Hatchery and natural fractions determined from these samples are applied to the redd-based escapement estimates for each subwatershed and summed to estimate total hatchery- and natural-origin Chinook escapements for each population and the basin total.

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. The Bolt Creek fire created hazardous air quality conditions, delaying some surveys and normal fall rains came at the end of October that interrupted survey coverage, but overall 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 1,698 Chinook redds were found in the Skykomish River, its tributaries, and in the Pilchuck River in 2022 (Table 4-14). The spawning escapement estimate for the Skykomish population (including Sunset Falls trap counts) was 4,354 adult fish (2,789 NOR, 1,565 HOR; Table 4-16). An additional 5,870 adult hatchery-origin fish (including 119 jacks) and 211 adult and 12 jack natural-origin fish recruited to Wallace River Hatchery and were included in the

hatchery escapement and not this natural escapement estimate. Total adult NOR Skykomish escapement (natural spawning + broodstock collection) was 2,990 Chinook.

Table 4-14. Skykomish summer/fall Chinook redd counts and escapement, 2022.

Stream Reach	WRIA	Method	Reach (RM)	Redds	Escapement
Snoh-Sky (Mainstems)	7.0012	Float/Flight	13.2-51.5	987	2,468
NF Skykomish	7.0982	Foot/Flight	0.0-13.5	246	615
SF Sky (Sunset Falls)	7.0012	Trap/Haul	51.5-up		106
Pilchuck River	7.0125	Foot/Float	2.0-26.5	77	193
Woods Creek	7.0826	Foot/Float	0.0-3.5	5	13
Elwell Creek	7.0865	Foot	0.0-1.0	0	0
Sultan River	7.0881	Foot/Float	0.0-9.7	256	641
Wallace River (lower)	7.094	Foot/Float	0.0-4.4	104	260
Wallace River(upper)	7.094	Foot/Float	4.4-7.3	11	28
Olney Creek	7.0946	Foot	0.0-0.6	0	0
Proctor Creek	7.097	Foot	0.0-0.4	0	0
Bridal Veil Creek	7.1248	Foot	0.0-0.4	12	30
Total Redds				1,698	
Escapement					4,354

Snoqualmie summer/fall Chinook

The escapement estimates for Snoqualmie 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 2022, 1,281 Chinook were estimated to have escaped to the Snoqualmie Basin based on a total count of 511.5 redds (Table 4-15). Based on carcass sampling results, the escapement estimate is composed of 861 NORs and 420 HORs (Table 4-16).

Table 4-15. Snoqualmie fall Chinook redd counts and escapement by reach, 2022.

Stream Reach	WRIA	Method	Reach (RM)	Redds	Escapement
Snoqualmie River (Lower)	7.0219	Float	20.5-24.9	129	323
Snoqualmie River (Upper)	7.0219	Float	32.9-39.6	164	410
Cherry Creek	7.0240	Foot	1.8-3.5	1	3
Tolt River (Lower)	7.0291	Foot/Float	0.0-6.0	110	275
Tolt River (Upper)	7.0291	Foot/Float	6.0-8.9	27	68
NF Tolt River	7.0291	Foot	8.9-11.3	22	55
SF Tolt River	7.0302	Foot	0.0-2.3	14	35
Raging River	7.0384	Foot	0.0-4.6	5	13
Raging River (Upper)	7.0384	Foot	4.6-13.2	4.5	11
Tokul Creek (Lower)	7.044	Foot	0.0-0.3	32	80
Tokul Creek (Upper)	7.044	Foot	0.3-0.6	3	8
Total Redds				511.5	
Escapement Estimate					1,281

Sampling and HOR:NOR summary

Field staff sampled 706 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 39 live Chinook passed at Sunset Falls. In total, the Chinook carcass sampling rate on the spawning grounds and at Sunset Falls was 12.5% (Table 4-16). 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/ tagged carcasses and unmarked carcasses to the escapement estimate by reach groupings and to live fish sampled at Sunset Falls) (Table 4-16). Hatchery contribution estimates were stratified by subbasin or aggregated subbasins to derive the annual estimates of natural- and hatchery- origin escapement and strata totals were added together as described in Rawson, Kramer and Volk (2001). 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 4-16. Snohomish Chinook carcass sampling and escapement composition in 2022.

Stratum	Escapement	No. Hatchery	No. Natural	% Hatchery	% Natural	Number Sampled	Percent Sampled
Skykomish	2,481	737	1,744	29.72%	70.28%	212	8.5%
Bridal Veil	645	336	309	52.03%	47.97%	123	19.1%
SF Sky *	106	8	98	7.69%	92.31%	39	36.8%
Pilchuck River	193	28	165	14.29%	85.71%	7	3.6%
Sultan River	641	194	447	30.30%	69.70%	66	10.3%
Wallace River	288	272	16	94.44%	5.56%	54	18.8%
Skykomish Population	4,354	1,575	2,779	36.16%	63.84%	501	11.5%
Snoqualmie	1,193	370	823	31.01%	68.99%	129	10.8%
Tokul	88	50	38	56.58%	43.42%	76	86.4%
Snoqualmie Population	1,281	420	861	32.79%	67.21%	205	16.0%
Snohomish Total	5,635	1,955	3,640	35.40%	64.60%	706	12.5%

*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 2022, a total of 358 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, 356 were observed in the Cedar River mainstem (347 below Landsburg Dam and 9 above), and 2 were observed in the small tributaries to the Cedar River. Expansion by 2.5 Chinook per redd resulted in the estimated escapement of 895 (Table 4-1). Carcass surveys in the Cedar River indicated that 74% of the naturally spawning adult Chinook were natural origin (unclipped) and 26% were hatchery origin (clipped).

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 2022 was estimated at 3,196.

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 Chinook counts, and a 10-day stream life estimate are used to calculate escapement.

The Bear Creek/Cottage Creek area was surveyed weekly during the 2022 spawning season. The escapement estimate was 227 Chinook. Of these, 99 were estimated in the Bear Creek mainstem, and 128 were estimated in Upper and Lower Cottage Creek. Carcass surveys in the Big Bear/Cottage Lake system indicated that 20% of the naturally spawning adult Chinook were natural origin and 80% were hatchery origin.

Issaquah Creek System

Issaquah Creek is surveyed weekly from the Issaquah Hatchery (located at river mile 3.0), downstream to SE 56th st.(located at river mile 1) 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 2022 spawning season, and total escapement was estimated at 2,969 Chinook. This estimate includes 2,847 in the mainstem below the hatchery, and 122 from the East Fork. Carcass surveys in the Issaquah Creek system indicated that 7% of the naturally spawning adult Chinook were natural origin and 93% were hatchery origin.

Chinook escapement to Issaquah Hatchery in 2022 was 5,217 (4,815 adults and 402 jacks); of which 135 adults and 0 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 7 and continued through November 3; although visibility was limited during the last week, no surveys were suspended because of high flows. Redd counts from Metzler Side Channel were conducted on September 30, October 12, and October 26. 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 5 and 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 (113 redds) and Hwy 167 to Transfer Shack (19 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 132 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, but was generally highest during the first week of October (Table 4-17 and Table 4-18). By the end of surveys, the week of October 16, 95.6% of the redds (1,926 of 2,014) observed during boat and foot spawning ground surveys were complete.

Table 4-17. Chinook redd counts from foot and boat surveys of the Green River in 2022.

Section	Week ¹									Total
	4-Sep	11-Sep	18-Sep	25-Sep	2-Oct	9-Oct	16-Oct	23-Oct	30-Oct	
Headworks	3	8	55	247	284	125	64	12	2	800
Lower Gorge	-	1	2	17	53	31	29	10	0	143
Middle River	-	1	21	109	236	198	119	57	0	741
Lower River ¹	-	1	-	55	-	50	-	7	-	113
Newaukum Creek	0	0	21	88	86	21	1	0	-	217
Total	3	11	99	516	659	425	213	86	2	2,014

¹An aerial survey on October 5 was used to estimate 19 redds for the survey season in the Hwy 167 to transfer shack reach.

Table 4-18. Aerial survey counts of Chinook redds in the Green River, 2022.

Section	Week ¹									Total
	4-Sep	11-Sep	18-Sep	25-Sep	2-Oct	9-Oct	16-Oct	23-Oct	30-Oct	
Headworks	-	-	-	-	262	-	150	-	-	412
Gorge	-	-	-	-	110	-	70	-	-	180
Lower Gorge	-	-	-	-	78	-	86	-	-	164
Middle River	-	-	-	-	361	-	213	-	-	574
Lower River	-	-	-	-	130	-	36	-	-	166
Hwy 167- Transfer Shack	-	-	-	-	17	-	3	-	-	20
Total	-	-	-	-	958	-	558	-	-	1,516

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

²Although more difficult to discern from the air, it is possible some coho redds were mixed in with the aerial count for the lower river.

The season total redds from the Middle River was 716 redds plus 25 from MSC, 143 from the Lower Gorge, 800 from the Headworks, and 113 in the Lower River plus 19 in the Hwy 167-Transfer Shack reach. The G/A ratio for the Lower Gorge was 1.83 (143/78) resulting in a calculated 202 redds for the "Gorge". A total of 2,018 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 60 and for the section "Whitney Hill Bridge" to mouth" was 157, totaling 217 redds in Newaukum Creek.

Applying the constant 2.5 Chinook/redd (1.5 males:1.0 female), an estimate of 5,587 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 2022, 116 adults and 2 jacks that returned to the Keta Creek Hatchery were ventral fin-clipped 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 2022 Chinook spawning season were low until the final week of the season and no surveys had to be suspended because of high flows (Table 4-19).

Table 4-19. 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 2022. Weekly discharges are 7-day averages of mean daily discharge beginning with the day listed.

USGS Gauge	Week								
	4-Sep	11-Sep	18-Sep	25-Sep	2-Oct	9-Oct	16-Oct	23-Oct	30-Oct
Palmer	194	267	312	317	317	231	162	214	1679
Auburn	354	416	474	470	469	389	298	366	1663
Newaukum Creek	16	16	15	15	12	10	9	14	24

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 802 carcasses were sampled for standard biological data by Green River crews in 2022; 492 (11 DIT+ 24 CWT&AD + 362 AD (no CWT) + 95 thermal marked with no adipose fin and no CWT) or 62.1% were of hatchery origin as indicated by the presence of an adipose fin, CWT tag, or hatchery thermal mark (Table 4-20).

Table 4-20. Summary of Chinook biological sampling in the Green River, 2022.

Section	Biological Samples	Adipose Clipped	Thermal Marks	MIT Tags ¹	CWT ² & Ad-Clipped	DIT ²
Headworks	406	181	73	0	4	2
Lower Gorge	41	9	0	0	12	0
Middle River	195	50	12	0	4	2
Lower River	14	9	1	0	0	2
Metzler Side Channel	0	0	0	0	0	0
SubTotal: River	656	249	86	0	20	6
Newaukum: 400th to Whitney Hill Br	37	32	0	1	1	1
Newaukum: Whitney Hill Br to Mouth	109	81	9	0	3	4
SubTotal: Newaukum	146	113	9	1	4	5
Grand Total:	802	362	95	1	24	11

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 4-21. Coded wire tag sampling, thermal mark analysis of otoliths¹, and origin of natural Chinook spawners² in the Green River, 2022.

	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	656	285	361	10	26	630	6	285	20	335	0	10
Newaukum Creek	146	15	131	0	9	137	5	15	4	122	0	0
Green River Basin Total	802	300	492	10	35	767	11	300	24	457	0	10

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, 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 once sampling wraps up are uncertain. Records of trap and haul operations conducted in the absence of state or tribal fisheries managers are a subject of ongoing concern.

The number of adult fish sampled at the WRH and at the Buckley Trap prior to the termination of sampling was 3,776. Of these, 1,436 were natural-origin (NORs) and 841 were 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 38% and APs made up 22% 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, 153 of the adult NORs were collected at, or taken to, the White River Hatchery for use as broodstock.

Table 4-22. Estimated number NOR and Acclimation Pond Chinook salmon hauled upstream of Mud Mountain Dam in 2022. 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)	1,629	717	2,346
Acclimation Pond	981	1,557	2,539
Totals	2,611	2,274	4,885

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 2022, escapement to the Minter Creek/Hupp Springs hatchery was 961 adults and 95 jacks. Escapement to the White River Hatchery in 2022 was 957 adults and 6 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 1,118 adults and 2,112 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 WDFW staff used a redd count based methodology to estimate Chinook escapement in the Puyallup River basin during even 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

Survey coverage of the South Prairie system was very good in 2022. The cumulative redd count of 605 in South Prairie Creek, expanded by 2.5, yielded an escapement estimate of 1,513 spawners (615 NORs and 898 HORs). In Wilkeson Creek, the cumulative redd count of 68, expanded by 2.5, yielded an escapement estimate of 170 spawners (55 NORs and 115 HORs). The South Prairie Creek (SPC) sub-basin total spawning escapement estimate for 2022 is 1,683 spawners. This escapement is made up of 671 NORs and 1,012 HORs.

Carbon River

Because conditions in the Carbon River seldom allow accurate Chinook escapement surveys, estimates are based on the relationship between SPC and Carbon River escapement in 1999, when there was an accurate redd count for the Carbon River. Carbon River reaches with complete data tracked the SPC spawn timing remarkably well. Therefore, reaches with incomplete data were expanded using the SPC spawn timing curve with a high degree of confidence. The 2022 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 (1994-2022) ratio of redd-based escapement and live fish AUC estimate exclusively in SPC multiplied by the 2022 AUC live fish estimate for SPC sub-basin.

Survey conditions were not suitable on the Carbon River during the 2022 spawning period. Consistent with the last ten years, the 2022/1999 SPC AUC escapement ratio ($3,216 / 1,422 = 2.2613$) was applied to the 1999 Carbon River escapement (250) to estimate the 2022 value. This method estimated 565 Chinook spawning in the Carbon during 2022 ($250 * 2.2613 = 565$). Based on mark sampling ratios observed in South Prairie Creek, the escapement was made up of 230 NORs and 335 HORs.

Puyallup River Tributaries

Aggregate escapement to Puyallup River tributaries in 2022 was estimated at 521 (Table 4-23). Based on mark sampling in these tributaries, 28 of these fish are NORs and 493 HORs.

Table 4-23. Chinook escapement estimates for Puyallup River tributaries, 2022.

Tributary	Escapement
Fennel Creek (WRIA 10.0406)	8
Canyon Falls Creek (10.0410)	60
Kapowsin Creek (10.0600)	130
Clear Creek (10.0022)	158
Clarks Creek (10.0027)	165
Tributary total	521

Mainstem Puyallup River

Chinook spawning escapement to the mainstem Puyallup River was estimated to be 91. This escapement comprised 17 NOR and 74 HOR Chinook, based on mark sampling ratios observed in mainstem tributaries.

As with the Carbon River, surveys of Puyallup River were not possible in 2022. 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 2022/1999 Puyallup tributary AUC ratio ($53/113 = 0.4681$) was applied to the estimated 1999 Puyallup mainstem escapement (195) to estimate 2022 escapement of 91 Chinook ($195 * 0.4681 = 91$). The same even year (1994-2022) average AUC adjustment used for the Carbon River was applied to the Puyallup tributary AUC live-fish estimate to develop the 2022 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 2022 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 2022 was estimated to be 847 fish. This escapement is made up of 229 NORs and 618 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 2022 was 3,707. Based on carcass sampling, we estimated that 1,175 were NORs, and 2,532 were HORs.

4.9 Nisqually River

Natural escapement to the Nisqually River in 2022 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 8,890 adult Chinook salmon (Table 4-1) with a preliminary natural spawning escapement of 3,420. The spawning escapement was composed of 513 natural-origin and 554 hatchery-origin adult fish voluntarily escaping to the spawning grounds and an additional 2,353 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 2022 were 5,395 and 11, respectively (Table 4-24).

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 11 adults; four, one, and six Chinook in Dosewallips, Duckabush, and Hamma Hamma rivers, respectively (Table 4-24). During 2022, 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 four live fish were observed in the Dosewallips River during 2022. 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 estimate of one individual live adult 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 six 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. The FRAM preseason escapement projection was 12 for the Mid-Hood Canal (FRAM 2522) while the estimated escapement is 11 Chinook. Escapements to the Dosewallips, Duckabush and Hamma Hamma rivers 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) and redd accounting hybrid 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 can lead to redd superimposition and difficulties in individual redd detection.

Live and dead adults, along with visible redds, were counted in Skokomish River index areas during foot and raft surveys (e.g., see Smith and Castle 1994). Surveys are conducted every seven to ten days. Historically, the fall Chinook survey season extended from 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 when weather and river 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 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 2022, Chinook had limited access to the South Fork Skokomish as the channel remained dry from October 5 through October 14 when increased flow again allowed passage.

The total estimated spawner escapement to the Skokomish River is 5,395 (Table 4-24). This total includes 2,815 in the mainstem Skokomish, 2,510 Chinook in the North Fork, and 70 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 3,284 (FRAM 2522).

Table 4-24. Summary of Chinook escapement to Hood Canal streams during 2022.

Area	Stream	Escapement	Comments
82 G/J	Skokomish R.	2,815	AUC based on live fish (MS3+MS4), plus redd expansion for MS2
	Hunter Cr.	na	Not included, cwt sampling only
	N.F. Skokomish R.	2,510	redd expansion
	S.F. Skokomish R.	70	redd expansion
Total		5,395	
12A	Little Quilcene R.	0	No Chinook observed
	Big Quilcene R.	0	No Chinook observed
Total		0	
12B	Dosewallips R.	4	Peak live/dead
	Duckabush R.	1	Peak live/dead
	Hamma Hamma R. a/	6	Peak live/dead
Total		11	
12C	Dewatto R.	85	AUC
	Eagle Cr.	1	Peak live/dead
	Lilliwaup Cr.	2	AUC
Total		88	
12D	Tahuya R.	2	Observed counts
	Union R.	83	Trap
Total		85	
Hood Canal total		5,579	

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. 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 335 Chinook sampled in Hood Canal rivers during 2022, 178 Chinook were adipose-clipped and, of these, 28 had CWTs. 15 unmarked Chinook were coded-wire tagged. We sampled 4.6% of the Chinook spawning escapement in the Skokomish River. In the Mid-Hood Canal rivers Chinook escapement, zero fish were sampled in the Hamma Hamma River, one carcass was sampled in the Duckabush and two were sampled in the Dosewallips Rivers. Overall, the sampling rate was 27.3% for all Hood Canal rivers combined (Table 4-25).

Jacks are not included in Chinook spawning escapement nor pHOS estimates in Hood Canal, they are sampled when encountered on the spawning grounds.

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). 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 2017 (age-5), BY 2018 (age-4), and BY 2019 (age-3).

In 2022 there was close agreement in the two aforementioned methods, with mark sampling-based pHOS weighted estimated as 83% and expanded clip pHOS of 78.8% in the Skokomish River system (Table 4-25 and Table 4-26). Neither estimate includes Purdy Creek or Hunter samples because of the likely bias associated with hatchery mortality. A total of 249 adult Chinook sampled, 177 were adipose-marked (71%). Spawning escapement in the Skokomish River was comprised of about 83% hatchery-origin Chinook and 17% natural-origin Chinook, with a higher proportion of NOR returns to the North Fork where they accounted for 28% (Table 4-25). Also, the commercial sampling of the tribal gillnet fishery in the mainstem was similar in composition with 99.13% hatchery-origin Chinook and 0.86% natural-origin Chinook. These estimates may be further refined as CWT data becomes available next fall. The substantial carcass recovery sample size along with the strong escapement, likely reflect robust estimates of HOR/NOR estimates for the Skokomish River in 2022.

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 combined with scavenging and predation. Thus, snorkeling is now being also 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 (17%) was applied to the 2022 escapements (Table 4-25). Of the 11 fish estimated to have spawned in the MHC tributaries, we estimate 8 were NOR. However, the low carcass recovery sample size along with the extremely low escapement, highlight the uncertainty in the 2022 Mid Hood Canal HOR/NOR estimates.

Table 4-25. Chinook salmon spawner escapement origin based on carcasses sampled for marks and coded-wire tags (CWTs) in Hood Canal rivers, 2022.

Mgmt Unit and River	Spawner escapement	Chinook sampled		Tagged 1/			Untagged 1/			Unk. tagged 2/			Totals			pHOS (weighted)		
		Number	%	AD	NM	Unk	AD	NM	Unk	AD	NM	Unk	CWTs recovered	AD-clips observed	Rate 5/		HOR	NOR
Skokomish																		
Mainstem	2,815	90	3.2%	8	11	0	61	6	3	1	0	0	19	70	0.93	2621	194	
North Fk	2,510	156	6.2%	3	4	2	101	44	1	1	0	0	9	105	0.72	1797	713	
South Fk	70	3	4.3%	0	0	0	2	1	0	0	0	0	0	2	0.67	47	23	
Skokomish River total	5,395	249	4.6%	11	15	2	164	51	4	2	0	0	28	177	0.79	4,465	930	0.83
Skokomish Total w/o Hunter	5,395	249	4.6%	11	15	2	164	51	4	2	0	0	28	177	0.79	4465	930	0.83
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/	6	0	0.0%	0	0	0	0	0	0	0	0	0	0	0	0.17	1	5	
Duckabush R. 4/	1	1	100.0%	0	0	0	1	0	0	0	0	0	0	1	0.17	1	0	
Dosewallips R. 4/	4	2	50.0%	0	0	0	0	2	0	0	0	0	0	0	0.17	1	3	
Mid-Hood Canal total	11	3	27.3%	0	0	0	1	2	0	0	0	0	0	1	0.24	3	8	
12C																		
Dewatto R.	11	0	0.0%	0	0	0	0	0	0	0	0	0	0	0	0.00	0	11	
Eagle Creek	85	0	0.0%	0	0	0	0	0	0	0	0	1	0	0	0.00	0	85	
Lilliwaup R.	2	0	0.0%	0	0	0	0	0	0	0	0	0	0	0	0.00	0	2	
12D																		
Tahuya R.	2	0	0.0%	0	0	0	0	0	0	0	0	0	0	0	0.00	0	2	
Union R. 2/	83	83	100.0%	0	0	0	0	0	0	0	0	0	0	0	0.00	0	83	
Hood Canal total	5,589	335	6.0%	11	15	2	165	53	4	2	0	1	28	178	0.81	4,468	1,023	

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, provisionary estimates

natural escapement = 1023

hatchery escapement = 4468

Table 4-26. Chinook salmon spawner escapement origin based on carcasses sampled for marks and coded-wire tags (CWTs) in Hood Canal rivers, 2022.

	Age				Total
	21	31	41	51	
Mark rate	0.864	0.862	0.871	0.868	
ADB	1	4	4	0	
ADNB	5	45	54	1	
ADUkn	0	0	0	0	
ADNH	0	0	1	0	
Total ad-clipped	6	49	59	1	109
expanded	7	57	68	1	126
UMB	4	10	2	0	
UMNB	0	20	18	1	
UMNH	0	0	0	0	
Total no clip	4	30	20	1	
Adjusted	3	22	11	1	
Total mark status known	10	79	79	2	160
Proportion Hatchery Origin Spawners (pHOS)					0.788

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

4.11 Dungeness

Escapement Estimation:

Since 1986, surveys have been conducted by ground surveys throughout the spawning season from RM 0.5 to 18.7 in the mainstem Dungeness, and from RM 0.0 to 5.1 in the Gray Wolf mainstem, to generate cumulative redd counts for the season. Surveys begin in mid-August and end mid to late-October. Chinook temporal and spatial spawning distribution are documented by recording GPS waypoints for each redd observed by WDFW and JSKT fisheries staff. Files are shared between the agencies and maps are created by GIS specialists to show redd locations throughout the basin, with downloading shapefiles into ArcGIS and Google Earth Pro kmz file.

The total Chinook redd count in the Dungeness basin for return year (RY) 2022 was 250. The lower basin (defined as RM 0.5- RM 10.8) count was 199 (79.6%), the upper basin (defined as RM 10.8- RM 18.7) count was 39 (15.6%), and the Gray Wolf River (RM 0.0-6.1) count was 12 (4.8%) (Table 4-27).

The total number of new redds observed is multiplied by 2.5 (1 female plus 1.5 males per redd) to estimate total number of spawning adults (Smith and Castle 1991, Orrell, 1977). In 2022, 238 Chinook redds were counted in the Dungeness (an estimated 595 adults) and 12

redds (an estimated 30 adults) were counted in the Gray Wolf for a total of 625 adults (also Table 4-26, note there are rounding 'up' issues, bringing the Chinook adult estimates "total" values to (498+98+30) for a sum of 626, rather than the more accurate 625 value shown). There were an additional 112 adults trapped and netted from the river for the hatchery broodstock program. The broodstock collection value of 112 includes pre-spawn mortalities at Hurd Creek. The total estimated Chinook adult return to the river was 737.

Table 4-27. The number, density, distribution, and proportion of Chinook redds and estimated adults in the Dungeness and Gray Wolf rivers system in 2022.

Stream and section	Survey Reaches (miles)			2022	2022	2022	2022	Redd	1998-2022 Average
	Lower RM	Upper RM	Total length (mi)	Redds	redds/mi.	adult est.	adults/mi.	Proportion	redds/mi
Lower Dungeness River (RM 0.5-RM 10.8)									
Mouth to Woodcock Bridge	0.5	3.3	2.80	42	15.00	105	37.50	0.167	11.83
Woodcock Bridge to Hwy 101	3.3	6.4	3.10	67	21.61	168	54.03	0.229	14.81
Hwy 101 to Taylor Cut-Off - May	6.4	9.2	2.80	68	24.29	170	60.71	0.198	14.33
Taylor Cut-Off - May to Canyon Ck.	9.2	10.8	1.60	22	13.75	55	34.38	0.145	17.63
Total			10.30	199	19.32	498	48.30	0.740	14.31
Upper Dungeness River (RM 10.8-RM 18.7)									
Canyon Creek to Clink Bridge	10.8	13.8	3.00	13	4.33	33	10.83	0.092	5.97
Clink Bridge to Forks Campground	13.8	15.8	2.00	13	6.50	33	16.25	0.059	5.78
Forks Campground to East Crossing	15.8	17.5	1.70	11	6.47	28	16.18	0.046	5.39
East Crossing to Gold Creek	17.5	18.7	1.20	2	1.67	5	4.17	0.010	1.70
Total			7.90	39	4.94	98	12.34	0.208	5.15
Gray Wolf River (RM 0.0-RM 6.1)									
Mouth to RM 1.0 Bridge	0.0	1.0	1.00	10	10.00	25	25.00	0.027	5.56
RM 1.0 Bridge to Above 2 Mile Camp	1.0	2.5	1.50	2	1.33	5	3.33	0.022	2.85
Above 2 Mile Camp to Cliff Camp	2.5	4.0	1.50	NS				0.002	0.27
Cliff Camp to Slab Camp -Suppl. Surveys	4.0	5.1	1.10	NS				0.001	0.21
Slab Camp and upstream 1 mile -Suppl. Surveys	5.1	6.1	1.00	NS				0.000	0.00
Total			6.10	12	1.97	30	4.92	0.053	1.70
Dungeness Basin Grand Total			24.30	250	10.29	625	25.72	1.000	

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.

Since 1986, the Dungeness River Chinook total returns (HOR+NOR) have ranged from 50 in 1997, to 1,543 in 2006, and has averaged 449. The recent 5-year average total return is 813 and the recent 10-year average is 618. The 17-year average for NOR and HOR returns (years for which NOR and HOR returns were discerned) were 182 (30.1%) and 423 (69.9%), respectively. The recent 5-year average of NOR and HOR total returns were 261 (32.2%) and 550 (67.8%), respectively. The Chinook returns from 1986 to 2005 that could not be identified by origin and were labeled as "Unknown" (Figure 4-1).

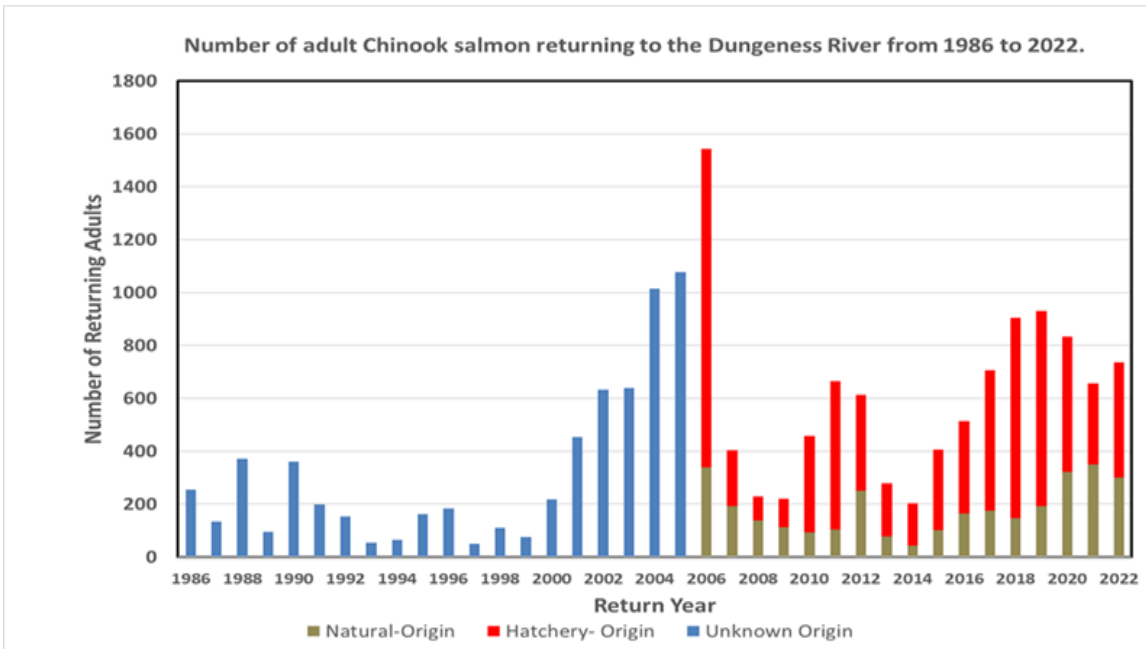


Figure 4-1. Estimated Number of Chinook salmon returning to the Dungeness basin from 1986 to 2022. The adults are broken into hatchery and natural origin in years where this data is available.

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 216 carcasses (112 broodstock collection and mortalities and 104 from natural spawners in the river). Of the total number of carcasses sampled, 124 of 216 (57.1%) were tagged (Table 4-28).

Table 4-28. 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 2022.

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	112	63	0.5625	48	0.4286
Spawning Ground Surveys (SGS)	104	61	0.5865	43	0.4135
Total sample size	216	124	0.5741	91	0.4213

Based on the CWT results and scale samples analyzed, the preliminary NOR/HOR composition for Return Year (RY) 2022 is 300 (40.7%) NOR and 437 (59.3%) HOR. The ages of the NOR Chinook for RY2022 consisted of, 23.0% age-3, 73.0% age-4, 4.0% age-5, and 0.0% age-6. The ages of the HOR Chinook for RY2022 consisted of, 56.8% age-3, 38.7% age-4, 4.5% age-5, and 0.0% age-6. The ages of all Chinook for RY2022 combined were, 43.00% age-3, 52.6% age-4, 4.3% age-5, and 0.0% age-6 (Table 4-29).

Table 4-29. Total number and percentages of adult, age-3, age-4, age-5, and age-6 HOR and NOR Chinook returns in 2022.

	NOR	Percentage	HOR	Percentage	Total	Percentage
Age-3	69	23.0%	248	56.8%	317	43.0%
Age-4	219	73.0%	169	38.7%	388	52.6%
Age-5	12	4.0%	20	4.5%	32	4.3%
Age-6	0	0.0%	0	0.0%	0	0.0%
Total	300	100.0%	437	100.0%	737	100.0%

From 2006 to 2022, the total Dungeness River Chinook NOR plus HOR returns ranged from 204 to 1,543 (Table 4-30). The number of NOR Chinook returns ranged from 43 to 349 and the number of HOR returns ranged from 90 to 1,204. The 17-year average is 182.5 (32.88%) NOR and 423.4 (67.12%) HOR, respectively. The percentages of HOR and NOR in the broodstock collection and natural spawners and for RY 2006-2022 are documented in Figure 4-2.

Table 4-30. Total number of NOR and HOR natural spawners and broodstock collected in the mainstem Dungeness River for return years 2006-2022.

Return year	Natural spawners 1/ NOR	Natural spawners 1/ HOR	Natural spawners 1/ NOR+HOR	Broodstock collection 2/ NOR	Broodstock collection 2/ HOR	Broodstock collection 2/ NOR+HOR	Natural Spawners + Broodstock NOR	Percentage NOR Spawners + Broodstock	Natural Spawners + Broodstock HOR	Percentage HOR Spawners + Broodstock	Total returns NOR+HOR
2006	293	1,112	1,405	46	92	138	339	21.97%	1,204	78.03%	1,543
2007	146	159	305	47	51	98	193	47.89%	210	52.11%	403
2008	86	54	140	53	36	89	139	60.70%	90	39.30%	229
2009	71	57	128	42	50	92	113	51.36%	107	48.64%	220
2010	76	269	345	18	94	112	94	20.57%	363	79.43%	457
2011	83	452	535	21	109	130	104	15.64%	561	84.36%	665
2012	212	296	508	38	68	106	250	40.72%	364	59.28%	614
2013	46	122	168	31	79	110	77	27.70%	201	72.30%	278
2014	21	87	108	22	74	96	43	21.08%	161	78.92%	204
2015	65	200	265	37	105	142	102	25.06%	305	74.94%	407
2016	135	273	408	30	77	107	165	32.04%	350	67.96%	515 4/
2017	149	456	605	26	74	100	175	24.82%	530	75.18%	705
2018	127	661	788	20	97	117	147	16.24%	758	83.76%	905
2019	173	665	838	19	73	92	192	20.65%	738	79.35%	930
2020	294	439	733	27	70 + 3unk	100	321	38.54%	512	61.46%	833
2021	312	246	558	37	61	98	349	53.20%	307	46.80%	656
2022	256	369	625	44	68	112	300	40.71%	437	59.29%	737
Mean	149.7	348.1	497.8	32.8	75.5	108.2	182.5	32.88%	423.4	67.12%	611.6

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

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

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

4/ Excludes 8 jacks

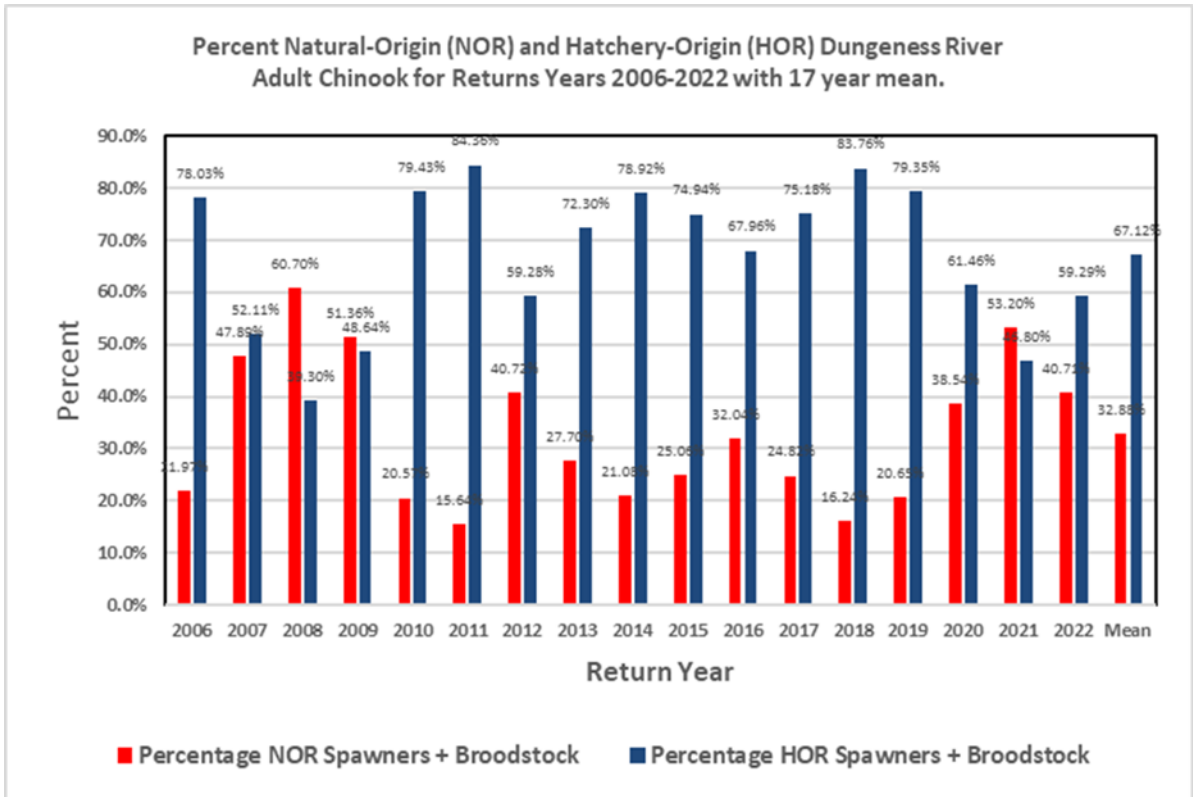


Figure 4-2. Percentages of NOR and HOR Dungeness River adult Chinook sampled from carcasses in broodstock collection and natural spawners in river for return years 2006-2022.

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 2022 Chinook estimate of total adult return to the river is 3,998 (95% CI ,3813-4,183) Denton et al., 2022.

Chinook Spawning Distribution:

To determine the 2022 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 21) in the upper, middle, and lower watersheds. The Upper Elwha section is from Mills at rkm 21.5 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 987 redds observed, 85 (8.6%) redds were in the Upper Elwha, 624 (63.2%) in the Middle Elwha, and 278 (28.1%) in the Lower Elwha. In addition to recording the number of redds, surveyors recorded the number of live and dead Chinook (Table 4-31, McHenry et al., 2022).

Table 4-31. 2022 Elwha River Chinook salmon spawners from Upper Watershed Dam to the mouth (McHenry et al. 2022).

Survey Reach	Rkm midpoint	No. Redds	Redds/km	Live Chinook	Dead Chinook	Jacks
Upper Elwha						
Upper Watershed	49.9	0	0	0	0	0
Geyser Valley	30	0	0	0	0	0
Cat Creek	0.7	12	36.6	0	2	0
Boulder Creek	0.2	0	0.0	0	0	0
Mills	21.5	66	18.6	87	41	0
Rica	23.9	7	8.7	13	2	5
UE Subtotal		85		100	43	5
		(8.6%)				
Middle Elwha						
Glines Powerhouse	19.1	44	55.0	19	21	0
Altaire Bridge	18.1	39	32.5	38	9	1
Elwha Ranger Stat.	17.8	92	153.3	74	23	0
Fisherman's Corner	16.1	79	71.8	44	18	0
ONP Boundary	14.9	26	15.2	29	13	0
McDonald Bridge	11.9	61	40.6	70	23	0
Little River	12.2	0	0.0	0	0	0
Indian Creek	12.1	91	47.9	135	49	10
Aldwell South	11.0	122	53.0	100	90	0
Aldwell North	8.8	70	29.1	89	35	0
ME Subtotal		624		598	281	11
		(63.2%)				
Lower Elwha						
Elwha Dam	6.1	9	5.0	333	51	0
Hwy 112 Bridge	4.9	99	20.6	0	0	0
County Bridge	3.2	97	14.7	0	0	0
East Channel	1.1	73	7.4	38	32	0
Hunt Road Channel	1.5	0	0	0	0	0
LE Subtotal		278		371	83	0
		(28.1%)				
Total		987		1,069	407	16

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 1,190 Chinook (489 males, 632 females, 69 jacks) as volunteers to the state and tribal hatcheries and fish netted from the river. An additional 4 fish were gaffed and spawned on the river (43 males, 155 females, including 143 non-viable females). Of the total broodstock collected, 31 adult males and 5 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 3,998 adult Chinook. Excluding jacks, the total number of adult Chinook that spawned naturally in the Elwha River and

its tributaries was 2,904. This number was calculated by subtracting the number of adult Chinook that were collected for broodstock (1,090), including the 143 non-viable females, and subtracting 4 adults for the LEKT C&S fishery from the SONAR estimate of 3,998 (Table 4-32).

Table 4-32. Chinook broodstock collection, SONAR estimate of total adult return, and estimated number of natural spawning fish Elwha River in 2022.

Capture method	No. Males	No. Females^{1/}	Total adults	No. Jacks	Total adults plus jacks
Gaff-Hook and line	43	298	341	0	341
Seining-Gill netting	194	157	351	2	353
Elwha Hatchery Trap Volunteers	178	106	284	52	336
Lower Elwha Hatchery transfers	74	71	145	15	160
Total broodstock collection	489	632	1,121	69	1,190
<u>Minus</u> Elwha Hatchery Trap Volunteers Returned back to the river to spawn naturally	-31	-0	-31	-5	-36
Total broodstock collection	458	632	1,090	64	1,154
Mortalities in raceways	21	6	27	4	31
SONAR adult estimate			3,998		
Estimated adult natural spawners in river 1/			2,904		

^{1/} Includes 143 females gaffed but were determined to be non-viable.

Natural spawners = SONAR estimate of 3,998 minus adult broodstock collection of 1,090 = 2,904 natural escapement.

Data source: 2022 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. Table 4-32). For the 2022 season, a total of 262 Chinook broodstock were sampled at the WDFW Elwha adult raceways and 283 carcasses were sampled in the river for a total of 545 All 545 Chinook were sampled for DNA, otoliths, scales, checked for marks (adipose clips), and tag (CWT) presence or absence (Table 4-33, Table 4-34).

Table 4-33. Number of DNA, otolith, and snouts sampled from Chinook carcasses in the Elwha River and broodstock collected for WDFW Hatchery facility in 2022.

Sample Type/ Sex ID	Natural River Spawners-Carcass Surveys (CS)	Broodstock Collection-LEKT Hatchery	Broodstock Collection-Netted-River Hatchery	Broodstock Collection-RP (Floy Tags) WDFW -Netted Hatchery	Broodstock Collection-Volunteer Hatchery	Grand Total Chinook Sampled
No. Chinook Sampled						
Female	141	18	105	7	5	276
Male	142	24	95	7	1	269
Total	283	42	200	14	6	545

Broodstock Collection:

Biologists and technicians sampled broodstock (BS) carcasses on three different spawning days. The following dates, September 6, 13, 20, and 27, provided an excellent opportunity for to collect scale, otolith, DNA, and to check for marked and tagged fish during the prime spawning period (Table 4-34). For the four spawning days, 262 of 384 (68.2%) of the fish were sampled.

Table 4-34. Total number of female and male Chinook sampled during spawning operations on September 6, 13, 20, and 27, 2022 at the WDFW Elwha Hatchery facility.

Broodstock Collection Method	Female	Male	Total (Male + Female)
Lower Elwha Klallam Hatchery	18	24	42
September 20, 2022	16	23	39
September 27, 2022	2	1	3
WDFW -Netting River	105	95	200
September 6, 2022	13	12	25
September 13, 2022	26	26	52
September 20, 2022	25	28	53
September 27, 2022	41	29	70
WDFW Netted River-RP Fish	7	7	14
September 6, 2022	2	2	4
September 13, 2022	5	5	10
Volunteer	5	1	6
September 27, 2022	5	1	6
Grand Total	135	127	262
Percentage Female and Male	51.5%	48.4%	100.0%

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 13 and October 5, 2022. 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 283 carcasses, (60 females,105 males),84.1% were sampled in the mainstem river and 15.9% were sampled in tributaries (Indian Creek and Little River combined; Table 4-35). The female (141) to male (142) sex ratio for sampled fish was 0.993:1.000.

Table 4-35. Number of female and male Chinook carcasses sampled in the mainstem Elwha River and tributaries by survey reach and date in 2022.

Method River Carcass Survey (CS)	Female	Male	Total (Male + Female)	Proportion Sampled in Reach
Elwha Dam to Mouth	1	3	4	0.0141
September 13, 2022	1	3	4	
Altaire Br. to Fisherman's Corner	19	32	51	0.1802
September 14, 2022	5	8	13	
September 21, 2022	14	24	38	
Glines to Altaire	6	10	16	0.0566
September 21, 2022	6	10	16	
Fisherman's Corner to US Hwy 101	39	44	83	0.2933
September 21, 2022	39	44	83	
Rica to Glines	26	25	51	0.1802
September 22, 2022	10	11	21	
September 28, 2022	16	14	30	
US Hwy 101 to Elwha Dam	2	4	6	0.0212
September 27, 2022	2	3	5	
October 5, 2022	0	1	1	
Indian Creek	28	17	45	0.1590
September 23, 2022	28	17	45	
US Hwy 101 to Gooseneck	14	6	20	0.0707
September 29, 2022	14	6	20	
Gooseneck to Elwha Dam	6	1	7	0.0247
September 29 2022	6	1	7	
Grand Total	141	142	283	1.0000
Percentage Female and Male	49.8%	50.2%	100.0%	

Broodstock and River Carcass Samples by Age and Sex

Of the 234 carcass samples (CS) from the river, that had readable scales, 119 were females and 115 were males. Female age classes consisted of 2.52% age 3, 88.24% age 4, and 9.24% age 5. Males age classes consisted of 2.61% age 2, 30.43% age 3, 66.09% age 4, and 0.87% age 5 (Table 4-36).

Of the 220 broodstock carcasses that had readable scales, 118 were females and 102 were males. Female age classes consisted of 2.54% age 3, 88.98% age 4, and 8.48% age 5. Males age classes consisted of 0.98% age 2, 23.53% age 3, 75.49% age 4, 0.0% age 5 (Table 4-36).

Combining all of the 454 readable scales for both sexes, the age classes consisted of 0.88 % age 2, 14.32% age 3, 79.95% age 4, and 4.85% age 5. (Table 4-36).

Table 4-36. Number and ages of female and male Chinook broodstock and river carcasses sampled in the hatchery and mainstem Elwha River in 2022.

Collection Method and Scale Age	Female Total	Female Prop.	Male Total	Male Prop.	Female + Male Total	Female + Male Prop. By Age
River Carcass Survey (CS)						
Age 2 ₁	0	0.0000	3	0.0261	3	0.0128
Age 2 ₂	0	0.0000	0	0.0000	0	0.0000
Age 3 ₁	3	0.0252	35	0.3043	38	0.1624
Age 3 ₂	0	0.0000	0	0.0000	0	0.0000
Age 4 ₁	101	0.8487	72	0.6261	173	0.7393
Age 4 ₂	4	0.0336	4	0.0348	8	0.0342
Age 5 ₁	9	0.0756	0	0.0000	9	0.0385
Age 5 ₂	2	0.0168	1	0.0087	3	0.0128
Age 6 ₁	0	0.0000	0	0.0000	0	0.0000
Age 6 ₂	0	0.0000	0	0.0000	0	0.0000
Readable Scales	119	1.0000	115	1.0000	234	1.0000
Total (CS) Scales Sampled	141		142		283	
Broodstock Collection-Hatchery	Female Total	Female Prop.	Male Total	Male Prop.	Female + Male Total	Female + Male Prop. By Age
Age 2 ₁	0	0.0000	1	0.0098	1	0.0045
Age 2 ₂	0	0.0000	0	0.0000	0	0.0000
Age 3 ₁	3	0.0254	24	0.2353	27	0.1227
Age 3 ₂	0	0.0000	0	0.0000	0	0.0000
Age 4 ₁	88	0.7458	71	0.6961	159	0.7227
Age 4 ₂	17	0.1441	6	0.0588	27	0.1045
Age 5 ₁	8	0.0678	0	0.0000	8	0.0364
Age 5 ₂	2	0.0169	0	0.0000	2	0.0091
Age 6 ₁	0	0.0000	0	0.0000	0	0.0000
Age 6 ₂	0	0.0000	0	0.0000	0	0.0000
Readable Scales	118	1.0000	102	1.0000	220	1.0000
Total Hatchery Scales Sampled	135		127		262	

Carcass + Broodstock Collection	Female Total	Female Prop.	Male Total	Male Prop.	Female + Male Total	Female + Male Prop. By Age
Age 2₁	0	0.0000	4	0.0184	4	0.0088
Age 2₂	0	0.0000	0	0.0000	0	0.0000
Age 3₁	6	0.0253	59	0.2719	65	0.1432
Age 3₂	0	0.0000	0	0.0000	0	0.0000
Age 4₁	189	0.7975	143	0.6590	332	0.7313
Age 4₂	21	0.0886	10	0.0461	35	0.0683
Age 5₁	17	0.0717	0	0.0000	17	0.0374
Age 5₂	4	0.0169	1	0.0046	5	0.0110
Age 6₁	0	0.0000	0	0.0000	0	0.0000
Age 6₂	0	0.0000	0	0.0000	0	0.0000
Readable Scales	237	1.0000	217	1.0000	454	1.0000
Total Scales Sampled	276		269		545	

Of the 269 river carcasses (CS) that had readable otoliths, 36 were unmarked (no otolith mark present). Of the 220 broodstock carcasses that had readable scales, 118 were females and 102 were males (Table 4-37) .

Female age classes consisted of 2.52% age 3, 88.24% age 4, and 9.24% age 5. Males age classes consisted of 2.61% age 2, 30.43% age 3, 66.09% age 4, and 0.87% age 5.

Female age classes consisted of 2.54% age 3, 88.98% age 4, and 8.48% age 5. Males age classes consisted of 0.98% age 2, 23.53% age 3, 75.49% age 4, 0.0% age 5.

Combining all the 454 readable scales for both sexes, the age classes consisted of 0.88 % age 2, 14.32% age 3, 79.95% age 4, and 4.85% age 5.

Table 4-37. Mark/Unmark status, tag presence/absence, and age of Elwha Chinook broodstock and river carcasses in 2022.

Collection Method- Brood Year (BY)	Otolith Mark Status a/ Absent Code 0	Otolith Mark Status a/ Present Code 1	Otolith Mark Status a/ Present Code 2	Otolith Mark Status a/ Not Readable	Grand Total
Carcass Survey (CS)					
BY 2017		16	3		
BY 2018		187	15		
BY 2019		7			
BY 2020		3			
NA	38				
Total	38	213	18	14	283
Collection Method- Brood Year (BY)	Otolith Mark Status a/ Absent Code 0	Otolith Mark Status a/ Present Code 1	Otolith Mark Status a/ Present Code 2	Otolith Mark Status a/ Not Readable	Grand Total
LEKT Hatchery					
BY 2018		32	3		
BY 2019		4			
BY 2020		1			

NA	2				
Total	2	37	3	0	42
NET Hatchery					
BY 2017		15	2		
BY 2018		157	5		
BY 2019		4	2		
NA	4				
Total	4	176	9	11	200
RP Fish NET Hatchery					
BY 2018		8	1		
BY 2019		2	1		
NA	1				
Total	1	10	2	1	14
Volunteer Hatchery					
BY 2018		5			
BY 2020		1			
Total	0	6	0	0	6
Grand Total					
BY 2017		31	5		
BY 2018		389	24		
BY 2019		17	3		
BY 2020		5	0		
NA	45				
Total	45	442	32	26	545

a/ Otolith Mark reference codes:

Code 0= No thermal mark; Code 1 = Thermal mark detected; Code 2 = marked, ambiguous pattern

Code 3 = Marked; no reference voucher; Code Sample damaged/broken-no alternate

The percentage of snouts with decoded tags recovered from 283 river carcasses sampled (CS) was 13.12% (37) and 86.88% (245) snouts did not have CWTs present. The percentages for ages 2, 3, 4, and 5 for the CWT recoveries were as follows: age 2 (2.70%), age 3 (13.51%), age 4 (72.98%) and age 5 (10.81%), respectively (Table 4-38).

The percentage of snouts with decoded tags recovered from 262 hatchery broodstock carcasses sampled at Elwha Hatchery (HAT) was 24.81% (65) and 75.19% (197) snouts did not have CWTs present. The percentages for ages 2, 3, 4, and 5 for the hatchery broodstock CWT recoveries were as follows: age 2 (3.08%), age 3 (12.31%), age 4 (76.92%) and age 5 (7.69%), respectively.

All but four of the sampled fish were from Elwha River releases. One tag was recovered from a fish released from the Dungeness River, one from the Gray Wolf River, one from Friday Creek in the Samish River watershed, and one from Cascade River in the Skagit watershed.

Table 4-38. Number of decoded tags recovered in 2022 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 (CWT) Recovered and Not Present	Mark Status (ADP or Unmarked)	Release location and Origin	WRIA No.	Release No.	Brood year	Release Age
CS	211305	1	Unmarked	Gray Wolf	18.0048	51,593	2019	Sub-yrlyg
CS	211308	1	Unmarked	Dungeness	18.0018	51,696	2019	Sub-yrlyg
CS	637243	3	Unmarked+OTO	Elwha	18.0272	193,663	2017	Yearling
CS	637377	1	ADP+OTO	Elwha	18.0272	246,534	2017	Sub-yrlyg
CS	637372	9	Unmarked+OTO	Elwha	18.0272	182,324	2018	Yearling
CS	637526	3	Unmarked+OTO	Elwha	18.0272		2018	Sub-yrlyg
CS	637526	15	ADP+OTO	Elwha	18.0272	248,527	2018	Sub-yrlyg
CS	637751	3	ADP+OTO	Elwha	18.0272	246,500	2019	Sub-yrlyg
CS	637924	1	ADP+OTO	Elwha	18.0272	242,679	2020	Sub-yrlyg
CS	No CWT	7	ADP					
CS	No CWT	237	Unmarked					
CS	No CWT	1	Unknown					
Total CS-		283						
HAT	637243	4	Unmarked+OTO	Elwha	18.0272	193,663	2017	Yearling
HAT	637377	1	ADP+OTO	Elwha	18.0272	246,534	2017	Sub-yrlyg
HAT	637372	23	Unmarked+OTO	Elwha	18.0272	182,324	2018	Yearling
HAT	637372	3	ADP+OTO	Elwha	18.0272		2018	Yearling
HAT	637526	1	Unmarked+OTO	Elwha	18.0272		2018	Sub-yrlyg
HAT	637526	21	ADP+OTO	Elwha	18.0272	248,527	2018	Sub-yrlyg
HAT	637751	7	ADP+OTO	Elwha	18.0272	246,500	2019	Sub-yrlyg
HAT	637924	2	ADP+OTO	Elwha	18.0272	242,679	2020	Sub-yrlyg
HAT	637352	1	ADP	Friday Cr.	03.0017	204,311	2018	Suby-rlg
HAT	637511	1	ADP+OTO	Cascade R.	03.1411		2018	Yearling
HAT	637778	1	ADP+OTO	Elwha	18.0272	93,737	2019	Sub-yrlyg
HAT	No CWT	3	ADP					
HAT	No CWT	194	Unmarked					
Total HAT		262						

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.

Hatchery mark rate assumptions

- 1) Hatchery marks examined include thermal otolith marks, adipose clip, coded wire tags and growth patterns from scales.
- 2) All samples included in mark rate calculations evaluated at otoliths, adipose and CWT (all three marks)
- 3) For 2009 – 2013 use hatchery mark rate data collected from both broodstock and naturally spawning fish in aggregate, same rate applied to both groups of fish.
- 4) Beginning in 2014, use separate hatchery mark rates applied to broodstock and naturally spawning fish. Beginning in 2014, increased carcass survey effort to cover known spawning locations, including areas above Elwha Dam and eventually Glines Canyon Dam.

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 2014 to 2022.

Return Year (RY)	Broodstock Marked	Broodstock Unmarked	Broodstock Total	Broodstock Mark Percentage	Natural River Spawners Marked	Natural River Spawners Unmarked	Natural River Spawners Total	Natural River Spawners Marked Percentage	Total Sample Size
2014	476	17	493	96.55%	198	10	208	95.19%	701
2015	475	27	502	94.62%	317	21	338	93.79%	840
2016	300	9	309	97.09%	213	14	227	93.83%	536
2017	551	11	562	98.04%	457	29	486	94.03%	1048
2018	306	3	309	99.03%	347	12	359	96.66%	668
2019	232	1	233	99.57%	282	19	301	93.69%	534
2020	231	2	233	99.14%	139	25	164	84.76%	397
2021	176	7	183	96.17%	87	11	98	88.78%	281
2022	248	5	253	98.02%	235	36	271	86.72%	524
Mean	332.8	9.1	341.9	97.58%	252.8	19.7	272.4	91.94%	614.3

Source: Joseph Anderson, Josh Weinheimer WDFW.

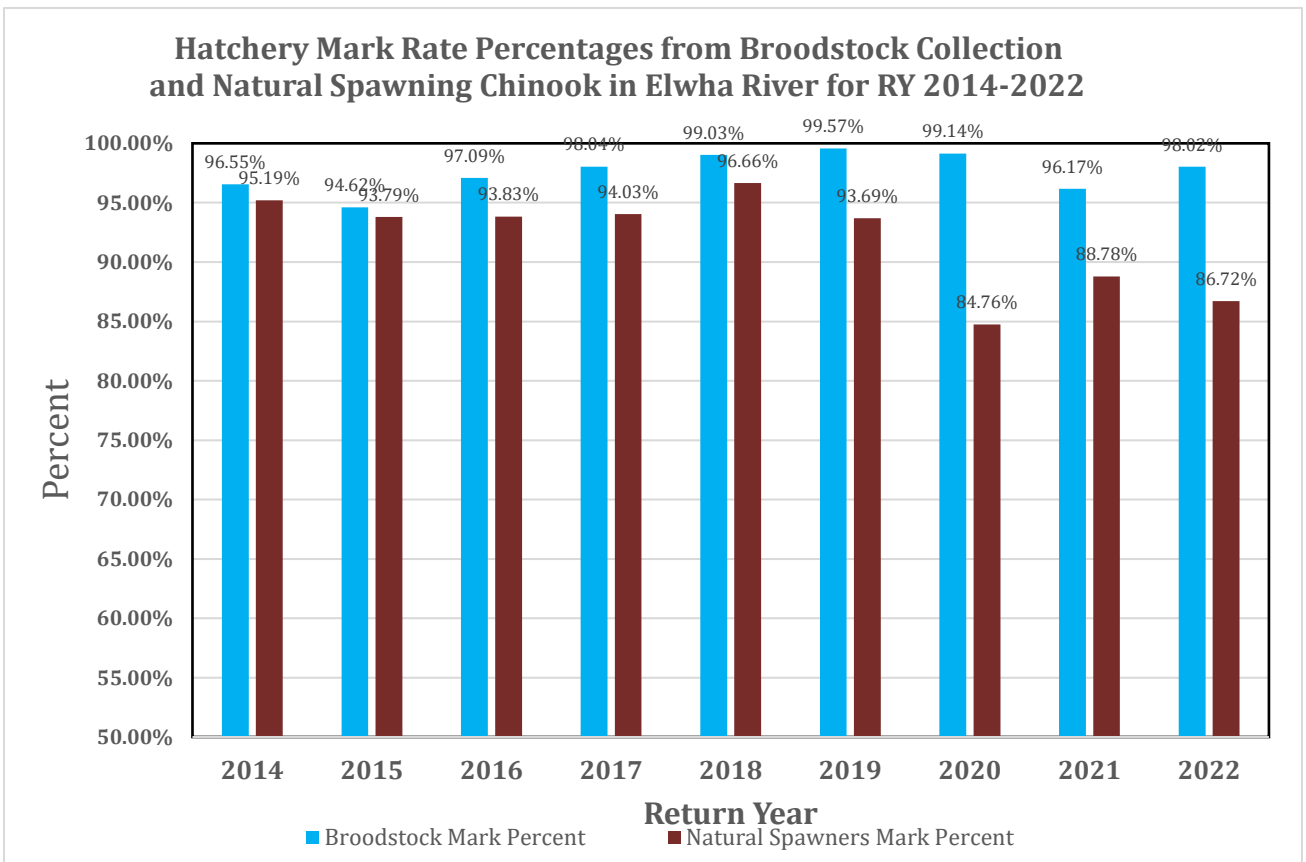


Figure 4-3. Percentage of Elwha Chinook returns that were identified as hatchery origin based on marks present (marked fish in this table include adipose clip, thermal otolith, CWT) for RY 2014 to 2022.

4.13 Hoko

No description available at the time this report was submitted.

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) 2021 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 2021 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 2021 (calendar year).

Catch Area/River	Catch	# Sampled	Sample Rate
7-7A	1,987	944	47%
7B-7C-7D-Nooksack River	9,938	5,059	51%
Skagit River/Bay	2,856	1,108	39%
8A	12	12	100%
8D	1,659	713	43%
Stillaguamish River	2	1	50%
10			--
10E	9,049	5,041	56%
10F	168	2	1%
10G	49	0	0%
10A	1,068	95	9%
Duwamish River	7,616	0	0%
Puyallup/White rivers	4,485	2,337	26%
Nisqually River	4,866	2,511	52%
McAllister Cr.	207	206	99%
13A	2,080	162	8%
13C	1,295	45	3%
13D-F	1,847	878	46%
9	60	60	100%
9A-12-12A-12B	65	6	9%
12C	8,159	2,987	37%
12H	17,066	3,688	22%
Skokomish River	7,284	2,087	29%
Purdy Creek	198	172	87%
Strait of JDF 4B-5-6 (Net)	31	0	0%
Strait of JDF 4B-5-6C (Troll)	123	0	0%

Table 5-2. Chinook coded-wire tag sampling rates for marine recreational fisheries in 2021.

Catch Area	Catch	# Sampled	Sample Rate
MARINE SPORT AREA 5	11,924	2,295	19.2%
MARINE SPORT AREA 6	6,490	1,852	28.5%
MARINE SPORT AREA 7	3,272	442	13.5%
MARINE SPORT PCA 8.1	11	0	0.0%
MARINE SPORT PCA 8.2	907	106	11.7%
MARINE SPORT AREA 9	9,146	1,513	16.5%
MARINE SPORT AREA 10	8,171	1,760	21.5%
MARINE SPORT AREA 11	6,782	1,086	16.0%
MARINE SPORT AREA 13	2,601	260	10.0%
MARINE SPORT AREA 12	1,587	365	23.0%

6 Literature Cited

- Denton, K.P., M. McHenry, R. Moses, E. Ward, M. Liermann, O. Stefankiv, W. Wells, and G. Pess. 2019. 2019 Elwha River Chinook Escapement Estimate Based on DIDSON/ARIS Multi-Beam SONAR Data. 35 pps
- Ford, M.J., T. Lundrigan, and M. Baird. 2004. Population Structure of White River Chinook Salmon Draft Report. Watershed Northwest Fisheries Science Center, Conservation Biology Division, Seattle, WA.
- McHenry, M., G. Pess, R. Moses, S. Brenkman, P. Crain, H. Hugunin, and J. Anderson. 2019. Spawning Distribution of Chinook Salmon (*Onchoryhnchus tshawytscha*) in the Elwha river, Washington State During Dam removal and early stages of recolonization (2012-2019). Final 44 pp.
- Nisqually Chinook Work Group, 2011. Nisqually Chinook Stock Management Plan 2011. Report January 2011.
- Puget Sound Indian Tribes and Washington Department of Fish and Wildlife. 2010. Comprehensive management plan for Puget Sound Chinook: Harvest management component. Northwest Indian Fisheries Commission, Olympia, WA. 230 pages.
- Seber, G. A. F. 1982. The estimation of animal abundance and related parameters. New York: McMillan Publishing Company
- Smith, C. and P. Castle. 1994. Puget Sound Chinook Salmon (*Oncorhynchus tshawytscha*) Escapement Estimates and Methods. Northwest Fishery Resource Bulletin. Project Report Series No. 1.
- WDFW. 2023. 2022 Summer Mark-Selective Recreational Chinook Fisheries in Marine Areas 5,6,7,9,10,11,12 and 13, Post-season report. January 23, 2020. Olympia, WA. 99 pages.
- Weinheimer, J., J. Anderson, R. Cooper, S. Williams, M. McHenry, P. Crain, and H. Hugunin. 2016. Age Structure and Hatchery Fraction of Elwha River Chinook Salmon: 2015 Carcass Survey Report. 27 pp.

7 9-Year (2013-2021) 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
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
2021	55	985	59	313	24	23

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
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)
2021	92 (41)	717 (2,292)	4 (2)	107 (82)	26 (4)	19 (11)

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

Skagit Springs Management Unit.

Year	Upper Sauk	Suiattle	Upper Cascade
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
2021	1,024	433	145

Skagit Summer/Falls Management Unit.

Year	Upper Skagit	Lower Sauk	Lower Skagit
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
2021	6,410	233	664

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)
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)
2021	425 (61)	307 (45)

Snohomish Management Unit.

Year	Skykomish		Snoqualmie	
	NOR	HOR	NOR	HOR
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
2021	1,414	607	611	367

Lake Washington Management Unit.

Year	Cedar River		Sammamish River	
	NOR	HOR	NOR	HOR
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		
2021	607	356		

Green River Management Unit.

Year	NOR	HOR
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
2021	1,200	1,800

Puyallup River Fall Management Unit.

Year	NOR	HOR
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
2021	1,513	3,947

White River Spring Management Unit.

Year	NOR	HOR	APP
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
2021	706	2,090	1,552

Nisqually River Management Unit. HOR's on the spawning grounds include trucked fish in 2017, 2018, 2019, and 2021.

Year	NOR	HOR
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
2021	417	1,595

Skokomish River Management Unit.

Year	NOR	HOR	Total
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
2021	208	785	993

Mid-Hood Canal Management Unit.

Year	Hamma Hamma	Duckabush	Dosewallips
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
2021	3	2	3

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
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
2021	313	251	564	36	56	92	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.

Elwha River Management Unit.

Year	HOR/NOR
2013	4,243
2014	4,360
2015	4,112
2016	2,628
2017	3,100
2018	7,107
2019	7,500
2020	3,250
2021	2,630

Hoko River Management Unit.

Year	HOR/NOR
2013	1,406
2014	1,760
2015	2,877
2016	1,324
2017	1,225
2018	1,943
2019	1,815
2020	2,122
2021	1,070