**Puget Sound Comprehensive Chum Salmon Management Report (2023–2024):**

# A State of the Science, Population Trends, and Harvest Co-Management on Chum Salmon (*Oncorhynchus keta*) returning to the Puget Sound Region of Washington State

Joint Report Prepared by: Washington Department of Fish and Wildlife (WDFW), Puget Sound Treaty Indian Tribes, and Northwest Indian Fisheries Commission (NWIFC)


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## Executive Summary

- Puget Sound chum salmon populations have experienced considerable stochasticity in survival over the recent decades, driving declines and suppression of escapement for several systems.
- Conservation concerns for Puget Sound chum salmon range from basin-scale marine climate variability to predation, competition, harvest, and habitat changes in nearshore and freshwater environments.
- Tribal and Washington Department of Fish and Wildlife (WDFW) co-managers use a variety of tools pre-season and in-season to evaluate the status of Puget Sound chum returns; however, data collection gaps represent an ongoing challenge to advancements in modeling recruit-spawner rates, carrying capacity, escapement goals, harvest impacts, and forecasts.
- To address population-level conservation concerns, the co-managers have continued to discuss conservation-fishery tradeoffs, hatchery programs, and the development of sustainable and adaptive harvest management strategies.
- Puget Sound co-managers have identified potential additions to chum salmon management structure and tools that may improve or stabilize declining populations, primarily pre-season and in-season genetic stock identification and population-level impact evaluation modeling.
- Puget Sound co-managers have also identified a need to understand and quantify conservation-based data gaps (e.g., predation and climate effects) for various regions to develop sustainable mixed-stock fishery management plans.
- Next steps in the comprehensive chum salmon management process for Puget Sound include identifying conservation-based objectives for individual management units, in-season data collection needs, clearly defined fishery proposals by Tribes and WDFW, in-season catch accounting processes, and developing harvest controls for stocks of high conservation concern.
- Additionally, strategies need to be developed to address basin specific chum salmon habitat needs for improved resiliency to climate change, along with integrated hatchery production and population-level specific recovery planning.

# Introduction

Chum salmon (*Oncorhynchus keta*) is an ecologically, economically, and culturally important salmonid across their range in the North Pacific Ocean. In the Puget Sound region of Washington State, chum salmon support both Tribal and state commercial fisheries, state recreational fisheries, and Tribal ceremonial and subsistence fisheries. Puget Sound is home to three chum salmon ecotypes designated by their return migration timing: summer chum salmon, which return to spawn primarily in September and October, fall chum salmon, which return to spawn primarily in November and December, and winter chum salmon that spawn from January to March. Historically one of the most abundant salmonids in the Pacific, chum salmon in the Pacific Northwest have experienced declines in abundance over the recent few decades (Atlas et al., 2022; Litz et al., 2021; Malick and Cox, 2016). Most recently in 2019 and 2020, Puget Sound fall and winter chum salmon experienced two of the lowest documented returns in the past 40 years (WDFW reconstructed total Puget Sound chum run size). Farley Jr. et al., (2024) suggested that juvenile chum salmon in the Bering Sea were negatively impacted by warming sea surface temperatures, however, competition, habitat loss, marine mammal predation, and marine and freshwater harvest practices may also play a role (Agha et al., 2021; Litz et al., 2021; Ruggerone et al., 2021). To address stock-level conservation concerns, Puget Sound harvest managers have continued to discuss conservation and fishery tradeoffs, hatchery programs, and the development of a comprehensive chum management plan that provides sustainable harvest management strategies and a pathway to recovery for populations experiencing suppressed productivity and below-average returns over the recent few decades.

This document has been prepared to comply with the Puget Sound Salmon Management Plan and to support the development of a Comprehensive Management Plan for Puget Sound Chum that guides Puget Sound Treaty Indian Tribes and Washington Department of Fish and Wildlife (WDFW) - co-managers - in planning annual harvest regimes that balance conservation goals and harvest abundant stocks. Under the Puget Sound Salmon Management Plan, species and area-specific management structures have been employed to define equal sharing, Treaty Tribal reserved off-reservation rights to fish in Usual and Accustomed Places (U&A), and seasons and areas during which harvest control measures for a particular salmon species may be useful. Since the development of the Puget Sound Salmon Management Plan, co-managers have actively discussed how best to define the scale (i.e., stocks and management units) at which salmon populations should be managed to achieve conservation goals (i.e., escapement goals for population-level sustainability). In 2022 and 2023, during North of Falcon, the annual process where state, Tribal, and federal representatives cooperatively plan the commercial and recreational salmon fisheries, co-manager policy representatives agreed to a short-term goal of creating a framework to evaluate commercial harvest impacts by marine area and fishery on chum management units of conservation concern (i.e., genetically independent chum stocks or groupings of stocks that have experienced abundance declines over the recent 20-30 years). The term ‘conservation’ is hereafter defined as meeting and exceeding biologically based escapement goals for a defined population, to drive recovery and achieve long-term sustainability. In doing so, co-managers have set out to build an adaptive management conservation-grounded framework to plan and sustainably operate fisheries on chum salmon pre-season and in-season. To address this goal in 2022 and 2023, Puget Sound co-managers agreed to increase genetic sampling and evaluation in-season across fall test fisheries and directed chum fisheries in mixed stock areas to evaluate the stock composition of chum salmon intercepted en route to their terminal destination. In addition, Puget Sound co-manager technical staff met for a series of comprehensive chum salmon specific meetings during the summer and fall of 2023, several of which were held at the regional level (Strait of Juan de Fuca, Hood Canal, Nooksack-Samish basin, Skagit basin, Stillaguamish-Snohomish basin, and South Puget Sound) to identify and define for Puget Sound chum salmon: 1) stocks and management units, 2) genetic structure, 3) natural and hatchery harvest and escapement trends, 4) natural and hatchery chum salmon conservation concerns, and 5) overall data gaps and needs. Co-manager technical staff also discussed the chum salmon harvest management structure, as implemented by the Puget Sound Salmon Management Plan and improved upon each year during North of Falcon, and the desired chum salmon management unit resolution at which to achieve regional annual escapement and harvest goals. The purpose of this document is to summarize the status of chum salmon in Puget Sound, the results of the 2023 and 2024 chum salmon technical and policy discussions, and to provide a basic informational resource to describe chum salmon management components and population-level attributes that may be useful in defining sustainable harvest agreements both pre-terminal (marine) and terminal (freshwater) areas across Puget Sound.

# Run Reconstruction, Population Structure, and Management Units

## Run Reconstruction

Salmon "stocks" are defined in multiple ways. The predominant description of a salmon stock is generally summarized as fish spawning in a particular lake or stream(s) at a particular season, in which fish to a substantial degree do not interbreed with any other group spawning in a different place, or in the same place at a different season (Washington Department of Fisheries 1993). In some cases, independent spawning populations or spawning aggregates show a unique genetic signature that separates them from adjacent spawning populations in time and space. Additionally, salmon stocks can also be identified as management units with geographic boundaries, biological attributes, or based on different harvest management strategies. Specifically, salmon management units can include single stocks, groupings of independent and non-independent stocks, run timings (summer vs. fall vs. winter), marine and freshwater areas, and/or spawning origins (natural vs. hatchery). For chum salmon in Puget Sound, identification and delineation of spawning populations and subpopulations provides an avenue for higher resolution harvest management.

The current stock aggregation structure that has been defined for Puget Sound chum salmon includes five primary geographic regions – Strait of Juan de Fuca, Hood Canal, North Puget Sound, Stillaguamish-Snohomish basin (Table 1), South Puget Sound and 81 catch areas (Figure 1, Table 2). In addition to the geographic region delineation, chum salmon are classified as hatchery origin, natural origin, or both (i.e., populations that contain mixed natural and hatchery origin production); and based on their return spawn timing they are classified as summer-run, fall-run, or winter-run ecotypes. Within the five geographic regions, Tribal and WDFW staff annually survey rivers, creeks, and streams, contributing to escapement estimates for specific streams and regions (Table 1). Co-manager staff estimate total escapement abundances through various methods - predominantly Area Under the Curve (AUC) assessments, using live-dead counts by survey date, estimated live fish stream-life (i.e., generally 10 days for fall chum), and percent visibility. Additionally, co-manager staff annually account for fish returning to off-station sites (i.e., chum salmon taken from natural and hatchery origins for broodstock at Tribal and WDFW satellite facilities or CO-OP projects; Table 1), as well as the number of chum salmon returning to hatchery racks (Table 1). During the annual run reconstruction process, co-manager staff build a summary of spawning escapement estimates and hatchery numbers across Puget Sound.

Tribal and non-tribal commercial harvest, non-tribal recreational harvest, and Tribal ceremonial and subsistence harvest are accounted via fish tickets and estimated via catch record cards throughout the year from pre-terminal marine areas to terminal freshwater reaches, including 81 monitored Puget Sound catch areas (4B-83H), of which only around 40 have recorded summer, fall, and/or winter-run harvest in the recent 10 years (Table 2). Commercial harvest and ceremonial and subsistence harvest from fishers associated with the Treaty Tribes are recorded in an online database, the Tribal Online Catch Accounting System (TOCAS), administered by the Northwest Indian Fisheries Commission (NWIFC) and commercial harvest from non-tribal fishers are recorded in the Washington Fish Ticket (WAFT)

System managed by WDFW. These datasets are dynamic, where new data and error corrections are continually added.

Once natural spawning escapement, hatchery returns, and commercial and recreational harvest are accounted for in databases, WDFW and Tribal biologists work together to develop an annual run reconstruction for summer, fall, and winter-run chum salmon ecotypes across the Puget Sound.

Run reconstructions have been produced for data spanning from 1968 to present (hereinafter, the “traditional run reconstruction”). Escapement is documented and summarized annually by regional Tribal and state biologists. Terminal and pre-terminal mixed-stock catch is parsed using the ratio of relative terminal abundances for all management units that are deemed to have escaped each fishery (escapements plus any assigned catches in more extreme terminal fisheries), with assumed run migration pathways based on geography. In catch areas 4B–7A harvest is calculated using Pacific Salmon Commission (PSC) genetic stock identification (GSI) collections to distinguish US and Canada origin chum salmon.

In 2018, co-managers agreed to produce a run reconstruction incorporating GSI collections (hereinafter, the “GSI-corrected run reconstruction”). The GSI-corrected run reconstruction uses GSI summaries collected from the Apple Cove Point test fishery just north of the Marine Area 9 and 10 boundary, Fraser chum commercial fisheries in Marine Areas 7 and 7A, PSC test fisheries, and North Hood Canal commercial fisheries in Area 9 in Puget Sound to parse pre-terminal catch based on genetic reporting group and several assumptions related to geographic stock origin (Table 3). Furthermore, the GSI-corrected run reconstruction format currently identifies several stocks based on the geographic resolution of escapement and catch data. Similarly, pre-terminal harvest is apportioned to specific streams or populations by the relative proportion of escapement of the respective population. The GSI-corrected run reconstruction has been produced for data spanning from 1996–2022 (based on available GSI data collections). The GSI-corrected run reconstruction is currently reviewed during the annual forecasting process for Central and South Puget Sound stocks; however, it is still under evaluation by other regions for further implementation (for comparison of the traditional run reconstruction and the GSI-corrected run reconstruction refer to Figure S1, Figure S2).

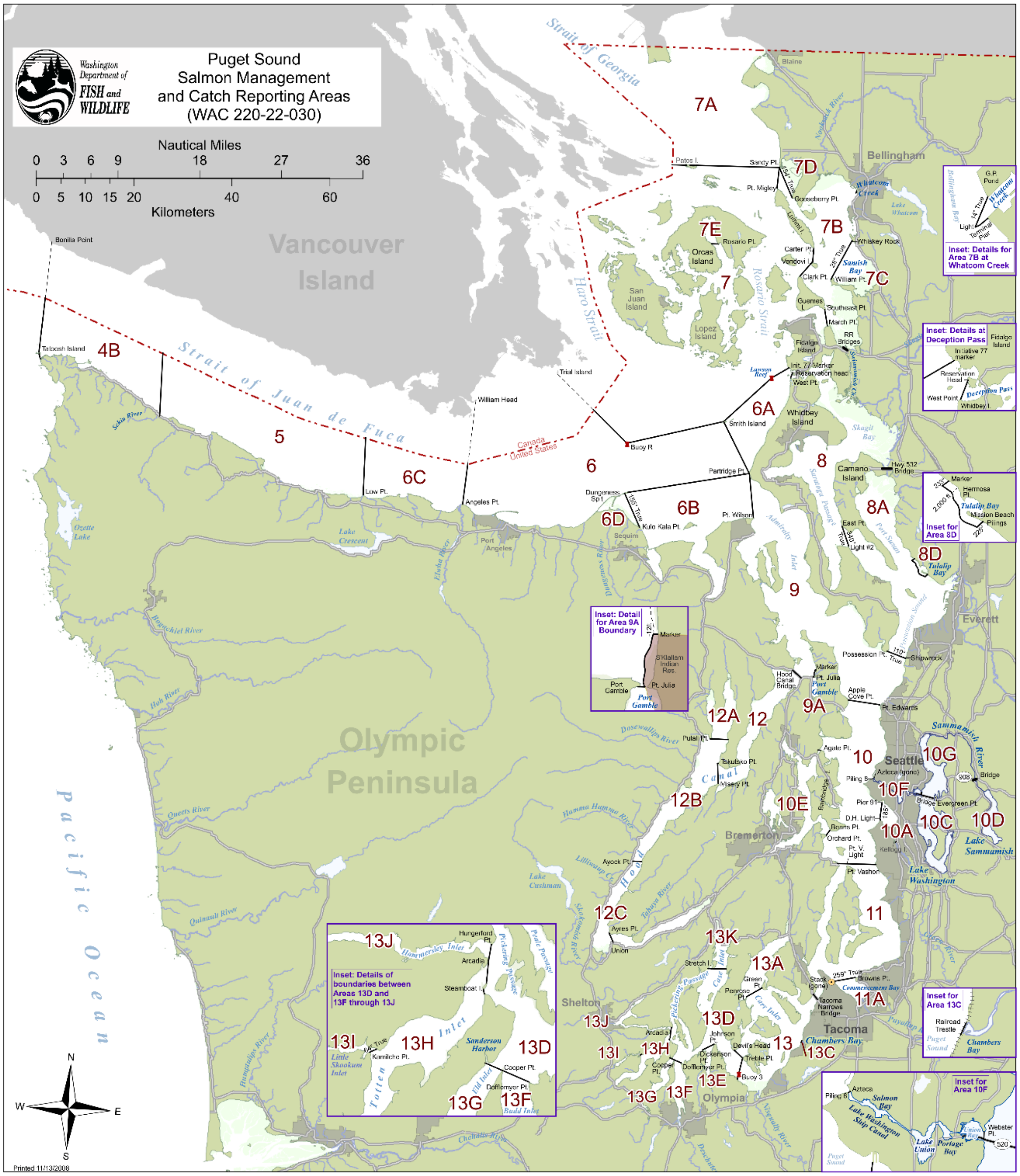


Figure 1. Map of Puget Sound, Washington, commercial salmon marine catch areas.

## Population Structure

To improve understanding of spatial and temporal population-level aggregation of chum salmon stocks, a Single Nucleotide Polymorphism (SNP) baseline was generated for Puget Sound chum salmon by WDFW, NWIFC, and Tribes using collections from spawning surveys and hatcheries across the Pacific Northwest (Table 1, Table 3, Figure 1, Figure 2). The current SNP baseline includes 11 reporting groups in

Puget Sound and southern British Columbia (Smith et al., 2023; Table 3). Collections were assigned to regional reporting groups with high probability, averaging 95%. However, self-assignments to individual stock collections or populations averaged 57% (6 - 99%). As there was variability in assignment probability and resolution, some populations may be better distinguished than others in mixed-stock sample collections (Table 3). Given the lack of alignment between the resolution of the SNP chum baseline and the current run reconstruction formats, further discussion is needed to determine the appropriate stock management unit resolution and needs for additional baseline development (see Data Gaps and Data Management section). In Table 3, we summarize the different formats under which extant spawning aggregations are currently aligned or grouped for run reconstruction and management.

Table 1. Puget Sound chum salmon escapement units by freshwater creek, stream, or river parsed by natural, hatchery, and off-station origin, and summer, fall, and winter run timing groups. “Active” with an “X” associated to the stream indicates that escapement has been recorded in the recent 10-years. Hatchery and off-station designations are recorded in historical escapement summary files and may not reflect current release or rearing practices. Please see attached Puget Sound Management Units spreadsheet for more detail.

| Origin | Geographic region | Stream | Active summer | Active fall | Active winter |
|---|---|---|---|---|---|
| Natural | Strait of Juan de Fuca | Dungeness R. | | X | |
| | | Elwha R. | | X | |
| | | Pysht R. | | X | |
| | | Misc. Straits streams (Lyre R, E.F. and W.F. Twin, Deep Cr., Hoko R.) | | X | |
| | | Area 6B streams (Snow Cr., Salmon Cr., Jimmy-Come-Lately) | X | | |
| | North Puget Sound | Nooksack R. | | X | |
| | | Samish R. | | X | |
| | | Misc. 7B, 7C streams (Whatcom Cr., Chuckanut Cr., Oyster Cr., Colony, Whitehall Cr.) | | X | |
| | | Skagit R. | | X | |
| | Hood Canal | Area 9 Chimacum Cr. | X | | |
| | | Area 12 Hood Canal (Little Anderson, Big Beef Cr., Seabeck Cr.) | X | X | |
| | | Area 12B Hood Canal (Stavis Cr., Anderson Cr., Jorstad Cr., Hamma Hamma R., Hamma Hamma Sl, John Cr., Piece Cr., Fulton Cr., Duckabush R., Dosewallips R., State Park Sl., Wolcott Sl., Jackson Cr., Spencer Cr.) | X | X | |
| | | Area 12A Hood Canal (Big Quilcene R., Little Quilcene R.) | X | X | |
| | | Area 12C Hood Canal (Dewatto Cr., White Cr., Shoe Cr., Rendsland Cr., Swift Cr., Hill Cr., Clark Cr., Miller Cr., Sound Cr., Little Lilliwaup Cr., Eagle Cr.) | X | X | |

| | | | | | |
|---|---|---|---|---|---|
| | | Skokomish R. Drainage (N.F. Skokomish R., Vance Cr., Mainstem Skokomish R., S.F. Skokomish R.) | | X | |
| | | Area 12D Hood Canal (Twanoh Cr., Alderbrook Cr., Caldervin Cr., Tahuya R., Stimson Cr., Little Mission, Big Mission, Union R.) | X | X | |
| | **Stillaguamish-Snohomish basin** | Snohomish R. | | X | |
| | | Stillaguamish R. | | X | |
| | **South Puget Sound** | Area 10 streams (Curly Cr.) | | X | |
| | | Green-Duwamish R. | | X | |
| | | Area 10E streams (Blackjack Cr., Gorst Cr., Chico-Wildcat Cr., Kitsap Cr., Dickerson Cr., Lost Cr., Celar Cr., Barker Cr., Steele Cr., Big Scandia Cr., Dogfish Cr.) | X | X | |
| | | Area 11 streams (North Cr., Crescent Cr., Ollala Cr.) | | X | |
| | | Area 11A Puyallup R. Drainage (Swan Cr., Clarks Cr., Fenel Cr., Canyon Falls Cr.) | | X | X |
| | | Area 13 streams (McAllister Cr., Mounts Cr., McAllister Springs) | | | X |
| | | Area 13A streams (Lackey Cr., Minter Cr., Burley Cr., Purdy Cr.) | | X | |
| | | Area 13B streams | | X | |
| | | Area 13C streams (Chambers Cr.) | | | X |
| | | Area 13E streams (Woodland Cr., Woodard Cr.) | | X | |
| | | Area 13G streams (McClane Cr., Swift Cr., Perkins Cr., Perry Cr.) | | X | |
| | | Area 13H streams (Kennedy Cr.) | | X | |
| | | Area 13I streams (Skookum Cr., Little Cr., Elson Cr.) | | X | |
| | | Area 13J streams (Johns Cr., Cranberry cr., Deer Cr.) | X | X | |
| | | Area 13K streams (Sherwood Cr., Coulter Cr., Rockey Cr.) | X | X | |
| | | Nisqually R. Drainage | | | X |
| **Hatchery** | **North Puget Sound** | Nooksack R. | | X | |
| | | Samish R. | | X | |
| | | Area 7B (Lummi Sea Ponds, Kendall/Nooksack) | | X | |
| | | Skagit R. | | X | |
| | **Hood Canal** | Walcott Sl. | | | |
| | | Quilcene R. | | | |
| | | Enetai (Skokomish Tribe) | | X | |
| | | Hoodsport Hatchery | | X | |
| | | George Adams | | X | |
| | | McKernan | | X | |
| | | Skokomish R. | | X | |
| | **Stillaguamish-Snohomish basin** | Tulalip Bay | | X | |
| | | Snohomish R. | | X | |
| | **South Puget Sound** | Grovers Creek Hatchery (Cowling Cr.) | | X | |
| | | Area 11A Puyallup (Diru) | | | X |
| | | Chambers Cr. | | | |

| | | | | | |
|---|---|---|---|---|---|
| | | Misc. 13A - Minter Cr. | | X | |
| | | Misc. 13B - Olympia | | | |
| | | Green (Keta) (Including Burns Cr. And Crisp Cr.) | | X | |
| Off-Station | **Strait of Juan de Fuca** | Elwha R. | | | |
| | **North Puget Sound** | Nooksack R. | | X | |
| | | Misc. 7B streams (Whatcom Cr.) | | X | |
| | | Skagit R. | | X | |
| | **Hood Canal** | Area 9A Port Gamble (little Boston) | | X | |
| | | N. Hood Canal (Big Beef Cr.) | | X | |
| | **Stillaguamish-Snohomish basin** | Snohomish R. | | | |
| | | Stillaguamish R. and Harvey Cr. | | X | |
| | **South Puget Sound** | Misc. 10 - Seattle | | | |
| | | Green (Keta) | | X | |
| | | Misc. 10E (Port Orchard) | | | |
| | | Misc. 11 (North Cr.) | | | |
| | | Diru Cr. (Clarks Cr.) | | | X |
| | | Misc. 13B (>=13D - Olympia) | | | |

Table 2. Puget Sound chum salmon harvest units by marine and freshwater areas, parsed by summer, fall, and winter periods. “Active” with an associated “X” indicates areas that have recorded catch in the recent 10-years. Please see attached Puget Sound Management Units excel file for more detail.

| Geographic region | Catch area | Location | Active summer | Active fall | Active winter |
|---|---|---|---|---|---|
| **Strait of Juan de Fuca** | 4B | Seiku | X | X | |
| | 5 | Sekiu-Pillar pt. | X | X | |
| | 6 | East SJF | X | X | |
| | 6A | East Whidbey (Salmon Banks) | | | |
| | 6B | Sequim/Discovery Bay | | | |
| | 6C | Angeles Pt (Elwha R)-Lyre R. | | X | |
| | 6D | Dungeness Bay | | X | |
| | 74B | Sail R. | | | |
| | 75A | Clallam R. | | | |
| | 75B | Deep Cr. | | | |
| | 75C | Hoko R. | | | |
| | 75D | Lyre R. | | | |
| | 75E | Pysht R. | | | |
| | 75F | Sekiu R. | | | |
| | 76A | Dungeness R. | | | |
| | 76B | Elwha R. | | | |
| | 76C | Morse Cr. | | | |
| | 76D | Salt Cr. | | | |
| **North Puget Sound** | 7 | San Juans | X | X | |
| | 7A | North Sound | X | X | |
| | 7B | Belling/Padilla Bay | | X | |
| | 7C | Samish Bay | | X | |
| | 7D | Lummi Bay | | X | |
| | 7E | East Sound/Orcas Island | | | |
| | 8 | Skagit Bay | | X | |
| | 77A | California Cr. | | | |

| | | | | | |
|---|---|---|---|---|---|
| | 77B | Nooksack (Lower) | | X | |
| | 77C | Nooksack (Upper) | | X | |
| | 77D | Samish R. | | | |
| | 78B | Sauk R. | | X | |
| | 78C | Skagit R. (Lower) | | X | |
| | 78D | Skagit R. (Upper) | | X | |
| **Stillaguamish-Snohomish basin** | 8A | Port Susan/Possession Sound | | X | |
| | 8D | Tulalip Bay | | X | |
| | 78F | Snohomish R. | | | |
| | 78G | Stillaguamish R. | | X | |
| **Hood Canal** | 9 | Admiralty Inlet | X | X | |
| | 9A | Port Gamble | | X | |
| | 12 | North Hood Canal | X | X | |
| | 12A | Quilcene Bay | X | X | |
| | 12B | Northcentral HC | X | X | |
| | 12C | Southcentral HC | X | X | |
| | 12H | Hoodsport Zone | X | X | |
| | 12D | South HC | X | X | |
| | 82B | Dewatto Cr. | | | |
| | 82C | Dosewallips R. | | | |
| | 82D | Duckabush R. | | | |
| | 82E | Hamma Hamma R. | | | |
| | 82F | Big Quilcene R. | X | | |
| | 82G | Skokomish R. | | X | |
| | 82H | Tahuya R. | | | |
| | 82I | Union R. | | | |
| | 82J | Purdy Cr. (Hood Canal) | | X | |
| **South Puget Sound** | 10 | Seattle | X | X | |
| | 10-on Res | Miller Bay + shoreline | | X | |
| | 10A | Elliot Bay | | X | |
| | 10B | Old North Lake Wash. | | | |
| | 10C | South Lake Wash. | | | |
| | 10D | Lake Sammamish | | | |
| | 10E | Kitsap | | X | |
| | 10F | Lake Union | | | |
| | 10G | North Lake Wash. | | | |
| | 11 | Tacoma | X | X | |
| | 11A | Commencement Bay | | | |
| | 13 | South PS | | X | |
| | 13A | Carr Inlet | | X | |
| | 13B | Old SS Mgt Unit | X | | |
| | 13C | Chambers Bay | | X | |
| | 13D | Squaxin/Peale passage | X | X | |
| | 13E | Henderson Inlet | | | |
| | 13F | Budd Inlet/Oly | | X | |
| | 13G | Eld Inlet | | X | |
| | 13H | Totten Inlet | | X | |
| | 13I | Skookum Inlet | | X | |
| | 13J | Hammersley/Oakland Inlet | | | |
| | 13K | North/Rocky Bay | | | |
| | 80B | Green R. (King Co.) | | X | |
| | 80C | Curley Cr. | | | |
| | 81A | Carbon R. | | | |
| | 81B | Puyallup R. | | X | |

| | | | | | |
|---|---|---|---|---|---|
| | 81C | White R. | | | |
| | 83A | Deschutes R | | | |
| | 83B | McClane Cr. | | | |
| | 83C | Minter Cr. | | | |
| | 83D | Nisqually R. | | | X |
| | 83F | McAllister Cr. | | | |
| | 83H | Chambers Cr. | | | |

New genetic baseline collections directed towards the development of the SNP genetic baseline (Smith et al., 2023) have increased the resolution and statistical reporting power for some Puget Sound chum salmon populations. Due to these improvements in the SNP baseline, the resolution and number of reporting groups have shifted. For example, in the historical GSI dataset, Nooksack River chum salmon were separated into a unique reporting group, where in the current baseline they cluster with North Puget Sound (85%, Table 3, Figure 3). On the other hand, recent collections from the Diru Creek Hatchery and corresponding additions to the SNP baseline has resulted in Diru Creek chum salmon reporting separately from Nisqually winter chum salmon with higher confidence (Preliminary estimates: Diru Creek = 83%, Nisqually winter = 89%), whereas they were previously grouped as “PS-Lates” (Table 3). Even with recent improvements to the SNP baseline, continued evaluation is needed to determine if additional collections can improve delineation of return timing ecotypes.

Throughout their range, chum salmon exhibit shifts in migration phenology that can influence both juvenile marine entry and adult freshwater return timing (Kovach et al., 2015; Wilson et al., 2021). While the timing (early or late) and span of migration varies over time and space, in South Puget Sound, fall and winter timed populations are returning as adults one to four and half weeks earlier than what has historically been documented (Agha et al., 2021). In some cases, winter timed adult returns now extensively overlap with fall timed returns, and earlier timed returns may overlap with summer timed returns. Where extensive overlap occurs, there may be challenges in accurately assigning populations as summer, fall, or winter run timing groups in both the traditional and GSI-corrected run reconstructions. These challenges can be addressed with escapement distribution evaluation and careful assumptions of spawning aggregations. For example, the GSI-corrected run reconstruction delineates fall and winter timed returns to the Puyallup River based on the relationship between river entry timing and timing of returns to the hatchery. Co-managers continue to discuss run timing and escapement classifications and their genetic associations (i.e., whether current genetic baseline collections suggest one ecotype classification over another). The SNP genetic baseline provides some clarity in distinguishing return timings, however, the most recent baseline information and reporting groups have yet to be incorporated in either run reconstruction. For example, the Cranberry Creek population in South Puget Sound is recorded as a summer-timed return, but genetically assigned to South Puget Sound fall. Similarly, the Curley Creek population is assigned to Central Puget Sound fall in the SNP genetic baseline (Smith et al., 2023), whereas previous allozyme-based GSI data suggested this was a summer timed population (WDFW 2003). Further evaluation will be needed to ensure the baseline includes collections with robust sample sizes and temporal spread to appropriately define the return timing ecotype of the spawning population. As genetic sampling, detection, and confidence in assignment improves or increases, co-managers have discussed the need for further evaluation of how pre-terminal interceptions are added to run reconstruction evaluations. Additionally, the chum salmon genetic stock composition summaries that are applied to run reconstructions need further review to assess temporal and spatial variability of hatchery and natural origin stocks (see Genetic Stock Identification under In-season Agreements and Assessments section).

Table 3. Population structure of Puget Sound chum salmon based on geographic region, geographic region/timing group, SNP genetic reporting group (probability of assignment), marine area, traditional run reconstruction, GSI-corrected run reconstruction, timing, and origin (hatchery, mixed production, or natural). Many of the populations represented in the run reconstructions have not been sampled and are thus not included in the genetic baseline data. Rather, designation to reporting groups assume that chum salmon in nearby streams are genetically similar. Collections after 2022 have been analyzed but have yet to be incorporated in the most recent SNP genetic baseline. Please see attached Puget Sound Management Units excel file for more detail.

| Geographic region | Region/timing group | Marine catch area | Traditional RR stock | GSI-corrected RR stock | Baseline collection | Genetic reporting group (probability) |
|---|---|---|---|---|---|---|
| Strait of JDF | Strait of JDF fall | 6C | Strait of JDF (HOR) | Elwha Tribe Hatchery (HOR) | 96_Elwha | Strait of JDF fall (0.22) |
| | | 4B,5,6C | Strait of JDF (NOR) | Strait of JDF - West (NOR) | 96Hoko | Strait of JDF fall (0.30) |
| | | | | | 18LyreCr | Strait of JDF fall (0.77) |
| | | | | | 05_20Pysht | Strait of JDF fall (0.80) |
| | | 6,6C,6D | | Strait of JDF - East (NOR) | 16_ElwhaR | Strait of JDF fall (0.17) |
| | | | | | 10DungenessF | Hood Canal Fall (0.51) |
| | Strait of JDF summer | 6B,9 | Strait of JDF (NOR) | Strait of JDF (NOR) | 16_18Salmon_S | Hood Canal summer (1.00) |
| Hood Canal | Hood Canal fall | 9A | Port Gamble (9A) (HOR) | Little Boston (Port Gamble Tribe) (HOR) | Collections Needed | |
| | | 12 | Area 12 Hood Canal (NOR) | Area 12 (NOR) | 10BigBeef_F | Hood Canal Fall (0.94) |
| | | 12A | Area 12A Hood Canal (NOR) | Area 12A (NOR) | Collections Needed | |
| | | 12B | Area 12B Hood Canal (NOR) | Area 12B (NOR) | 20SpenceJack | Hood Canal Fall (0.95) |
| | | | | | 11Anderson | Hood Canal Fall (0.98) |
| | | | | | 11_19Duckabush_F | Hood Canal Fall (0.96) |
| | | | | | 20SpenceJack | Hood Canal Fall (0.95) |
| | | 12C | Area 12C Hood Canal (Excl. Skok. R.) (NOR) | Area 12C (NOR) | 10Lilliwaup_F | Hood Canal Fall (0.96) |
| | | | | | 98_11Dewatto_F | Hood Canal Fall (0.95) |
| | | | | | 20VanceCr | Hood Canal Fall (0.93) |
| | | | Hoodsport Hatchery (HOR) | Hoodsport (WDFW) (HOR) | 10HoodH_F | Hood Canal Fall (0.98) |
| | | | Skokomish R. Drainage (HOR) | Enetai (Skokomish Tribe) (HOR) | Collections Needed | |
| | | | | George Adams (WDFW) (HOR) | Collections Needed | |
| | | | | McKernan (WDFW) (HOR) | Collections Needed | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | 12D | Area 12D Hood Canal (NOR) | Area 12D (NOR) | Collections Needed | |
| | Hood Canal summer | 12 | Area 12 Hood Canal (NOR) | Big Beef Creek (NOR) | Collections Needed | |
| | | 12A | Area 12A Hood Canal (NOR) | Area 12A (NOR) | Collections Needed | |
| | | 12B | Area 12B Hood Canal (NOR) | Area 12B (NOR) | 14Duck_S | Hood Canal summer (1.00) |
| | | | | | 12_14Hamma_S | Hood Canal summer (1.00) |
| | | | | | 03_14Dose_S | Hood Canal summer (1.00) |
| | | 12C | Area 12C Hood Canal (Excl. Skok. R.) (HOR) | Lilliwaup River (Long Live the Kings) (HOR) | Collections Needed | |
| | | | Area 12C Hood Canal (Excl. Skok. R.) (NOR) | Area 12C (NOR) | Collections Needed | |
| | | 12D | Area 12D Hood Canal (HOR) | Union River (HCSEG) (HOR) | Collections Needed | |
| | | | Area 12D Hood Canal (NOR) | Area 12D (NOR) | Collections Needed | |
| North Puget Sound | Nooksack, Samish, 7B & 7C Independents | 7B | Misc 7B streams (HOR) | Whatcom Creek (Bellingham Heritage) (HOR) | Collections Needed | |
| | | | Misc 7B streams (NOR) | Area 7B (NOR) | Collections Needed | |
| | | | Nooksack R. (HOR) | Kendall / Nooksack (WDFW) (HOR) | Collections Needed | |
| | | | Nooksack R. (NOR) | Nooksack River (NOR) | 98_20Nooksack | North Puget Sound fall (0.85) |
| | | 7C | Samish R. (NOR) | Area 7C (NOR) | 92Samish | North Puget Sound fall (0.63) |
| | Skagit | 8 | Sauk River (Sauk-Suiattle Tribe) (HOR) | Sauk-Suiattle Hatchery (HOR) | 14_19Lo_Sauk | North Puget Sound fall (0.94) |
| | | | Skagit R. (HOR) | Skagit River Hatchery (WDFW) (HOR) | 20Marblemount | North Puget Sound fall (0.96) |
| | | | | Upper Skagit Hatchery (HOR) | Collections Needed | |
| | | | Skagit R. (NOR) | Skagit River (NOR) | 98_14Skagit | North Puget Sound fall (0.86) |
| Stillaguamish-Snohomish basin | Stillaguamish & Snohomish | 8A | Snohomish R. (HOR) | Wallace River (WDFW - not active) (HOR) | 20WallaceH | North Puget Sound fall (0.91) |
| | | | Snohomish R. (NOR) | Snohomish River (NOR) | 10_21SkySno | North Puget Sound fall (0.88) |
| | | | Stillaguamish R. (HOR) | Harvey Creek (Stillaguamish Tribe) (HOR) | Collections Needed | |
| | | | Stillaguamish R. (NOR) | Stillaguamish River (NOR) | 10_21Stillaguamish | North Puget Sound fall (0.94) |
| | | 8D | Tulalip Bay (HOR) | Tulalip Bay-8D (Tulalip Tribes) (HOR) | 20TulalipBrood | Hood Canal Fall (0.97) |
| South Puget Sound | South Sound (summer and fall) | 10 | Area 10 streams (HOR fall) | Grovers Creek, Cowling Creek (Suquamish Tribe) (HOR fall) | 10_15Chico/Grovers | Central Puget Sound fall (0.60) |
| | | | Area 10 streams (NOR fall) | Area 10 (NOR fall) | 02CurleyCr | Central Puget Sound fall (0.75) |
| | | 10A | Green-Duwamish R. (HOR fall) | Green River (HOR fall) | 07GreenR_H | Central Puget Sound fall (0.57) |
| | | | | | 20KetaCrHat | Central Puget Sound fall (0.78) |
| | | 10E | Area 10E streams (NOR fall) | Area 10E (NOR fall) | Collections Needed | |
| | | | Area 10E streams (NOR summer) | Blackjack Creek (NOR summer) | Collections Needed | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | 11 | Area 11 streams (HOR fall) | North Creek (HOR fall) | Collections Needed | |
| | | | Area 11 streams (NOR fall) | Area 11 (NOR fall) | Collections Needed | |
| | | 11A | Puyallup R. Drainage (Area 11A) (NOR fall) | Puyallup River (NOR fall) | S_PrairieCr | (Still Being Evaluated) |
| | | 13A | Area 13A streams (HOR fall) | Minter Creek (WDFW) (HOR fall) | Collections Needed | |
| | | | Area 13A streams (NOR fall) | Area 13A (NOR fall) | 03MinterCr_H | South Puget Sound fall (0.91) |
| | | 13C | Area 13C streams (NOR fall) | Chambers Creek (NOR fall) | Collections Needed | |
| | | 13E | Area 13B streams (NOR fall) | Area 13E (NOR fall) | Collections Needed | |
| | | 13G | | Area 13G (NOR fall) | 21Perry | South Puget Sound fall (0.96) |
| | | | | | 21McLane | South Puget Sound fall (0.97) |
| | | 13H | | Area 13H (NOR fall) | 11Kennedy | South Puget Sound fall (0.85) |
| | | 13I | | Area 13I (NOR fall) | 10Skookum | South Puget Sound fall (0.89) |
| | | 13J | | Area 13J (NOR fall) | 11Mill/Johns Cr | South Puget Sound fall (0.86) |
| | | 13K | | Area 13K (NOR fall) | 94Sherwood | South Puget Sound fall (0.86) |
| | | 13J | Area 13B streams (NOR summer) | Area 13J (NOR summer) | 19_20_21Cranberry | South Puget Sound fall (0.94) |
| | | 13K | | Area 13K (NOR summer) | Collections Needed | |
| | South Sound winter | 11A | Puyallup R. Drainage (Area 11A) (HOR winter) | Clark's/Diru Creek (HOR winter) | 11DIRU_PuyH | South Puget Sound HOR winter (0.83) |
| | | 13 | Area 13 streams (NOR winter) | Area 13 (NOR winter) | Collections Needed | |
| | | | Nisqually R. Drainage (NOR winter) | Nisqually River (NOR winter) | 11_19Nisqually | South Puget Sound NOR winter (0.89) |
| | | 13C | Area 13C streams (NOR winter) | Chambers Creek (NOR winter) | Collections Needed | |

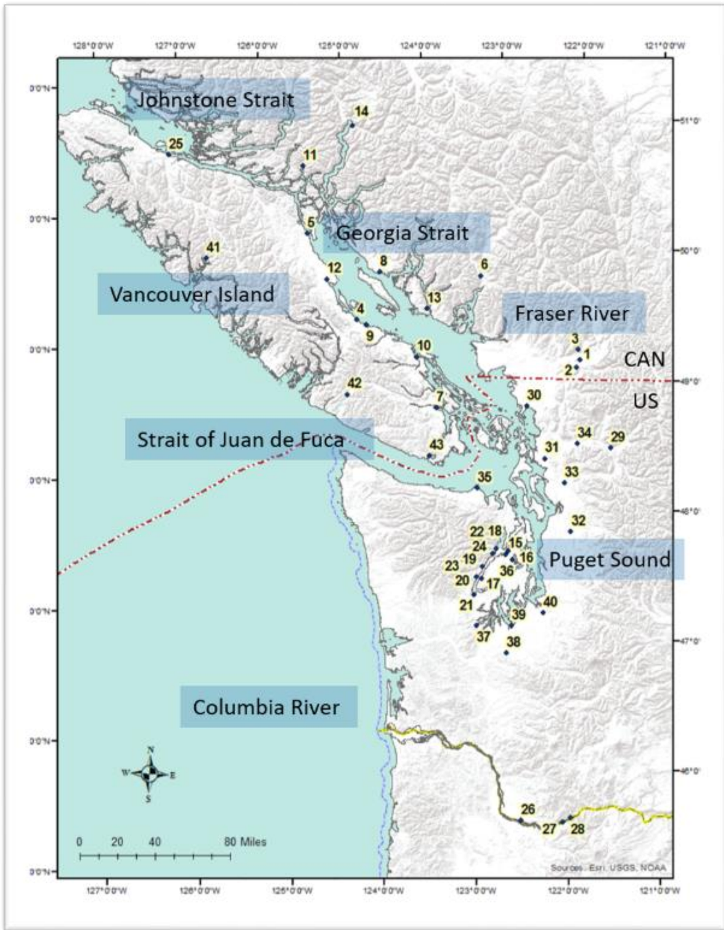


Figure 2. Map created by WDFW genetics lab showing the distribution of chum salmon populations in the Single Nucleotide Polymorphism (SNP) genetic baseline. Numbers correspond to some locations for chum salmon populations described in the genetics report, but new locations have been sampled since the map was constructed. Please see Table S1 for the map key.


Figure 3. Neighbor-joining tree created by WDFW genetics lab of Nei’s genetic distances among chum salmon SNP baseline collections. Bootstrap values at the nodes are the percentage of 1000 trees in which the collections beyond the node clustered together. Most recently added collections are highlighted in pink-type. Prairie Creek collection is highlighted in orange because it had been suspected to be winter-run but clustered independent of the winter-run collections and may include fall-run spawning chum salmon.

## Management Units

During the summer and fall of 2023, co-managers met at the regional level (South Puget Sound, Central Puget Sound, Hood Canal, and North Puget Sound) to identify and define Puget Sound chum salmon stocks and management units, trends, conservation challenges, management challenges, habitat issues, and data gaps. Through the process, co-managers defined a management structure that represented geographic units, typically by watershed or basin and in some cases origin type (Table 4).

Table 4. Management units identified by regional co-managers during 2023 chum salmon technical discussions. Management units have not been identified yet for Hood Canal, so stocks identified in the 1992 Salmon and Steelhead Stock Inventory (Washington Department of Fisheries 1993) are shown here. Please see attached Puget Sound Management Units spreadsheet for more detail. *Indicate where hatchery supplementation was discontinued, but classification and data are still maintained in the historical dataset.

| Geographic region | Sub-region and return timing | Management unit | Genetic reporting group | Catch area | Origin |
|---|---|---|---|---|---|
| Strait of JDF | Strait of JDF fall & Strait of JDF summer | Strait of JDF | Hood Canal summer | 4B, 5, 6, 6B, 6C, 6D, 7A, 9, 75A, 75B, 75C, 75D, 75E, 75F, 75G, 76A, 76B, 76C, 76D | natural |
| | Strait of JDF fall & Strait of JDF fall | Strait of JDF | Strait of JDF fall | 4B, 5, 6, 6B, 6C, 6D, 7A, 9, 75A, 75B, 75C, 75D, 75E, 75F, 75G, 76A, 76B, 76C, 76D | natural |
| North Puget Sound | Nooksack/Samish/7B & 7C independents | 7B & 7C Independents | Collections Needed | 7B, 7C | natural |
| | | Nooksack HOR | Collections Needed | 7B, 77B, 77C | hatchery |
| | | Nooksack NOR | North Puget Sound fall | 7B, 77B, 77C | natural |
| | | Samish River | North Puget Sound fall | 7C, 77D | natural |
| | | Whatcom Creek | Collections Needed | 7B, 77H | hatchery |
| | Skagit | Skagit River | North Puget Sound fall | 8, 78B, 78C, 78D, 78O, 78P | both |
| Stillaguamish-Snohomish basin | Stillaguamish/Snohomish | Snohomish River | North Puget Sound fall | 8A, 78A, 78E, 78F, 78H, 78N | natural |
| | | Stillaguamish River | North Puget Sound fall | 8A, 78G | natural |
| Hood Canal | Hood Canal fall | Lower Skokomish Fall Chum HOR | Collections Needed | 12C, 82G | hatchery |

| | | | | | |
|---|---|---|---|---|---|
| | | NE Hood Canal | Collections Needed | 12, 82A | natural |
| | | Port Gamble Bay | Collections Needed | 9A | hatchery |
| | | Quilcene | Collections Needed | 12A, 82F | natural |
| | | SE Hood Canal | Collections Needed | 12D, 82H, 82I | natural |
| | | West Hood Canal | Hood Canal fall | 12B, 12C, 82B, 82C | natural |
| | Hood Canal summer | Hamma Hamma | Hood Canal summer | 12B, 82E | both* |
| | | NE Hood Canal | Collections Needed | 12, 82A | natural |
| | | Quilcene | Collections Needed | 12A, 82F | natural |
| | | SE Hood Canal | Collections Needed | 12D, 82H, 82I | natural |
| | | West Hood Canal | Hood Canal summer | 12B, 12C, 82B, 82C | natural |
| South Puget Sound | South Sound (summer and fall) | Carr Inlet | South Puget Sound fall | 13A | both |
| | | Case Inlet | South Puget Sound fall | 13K | both* |
| | | East Kitsap (A10) | Central Puget Sound fall | 10 | both |
| | | East Kitsap (A10E) | Central Puget Sound fall | 10E | both* |
| | | East Kitsap (A11) | Collections Needed | 11 | both* |
| | | Eld Inlet | South Puget Sound fall | 13G, 83B | natural |
| | | Green River | Central Puget Sound fall | 10A, 80B | hatchery |
| | | Hammersley Inlet | South Puget Sound fall | 13J | natural |
| | | Henderson Inlet | South Puget Sound fall | 13E, 82J, 83C, 83E | natural |
| | | Puyallup NOR | Collections in evaluation | 11A, 81A, 81B, 81C | natural |
| | | Skookum Inlet | South Puget Sound fall | 13I | both* |
| | | Totten Inlet | South Puget Sound fall | 13H, 83I | both* |
| | South Sound winter | Nisqually | Nisqually winter | 13, 83D, 83F | natural |
| | | Puyallup HOR | Diru | 11A, 81B | hatchery |
| | | Misc 13 | Collections Needed | 13, 13C | natural |

While some of these management units may not be represented in the latest genetic baseline or in the GSI-corrected run reconstruction (Table 3), they represent important pieces to the future of mixed-stock chum salmon fishery management in Puget Sound. Specifically, smaller geographic or spatially defined units may require different fishery approaches and/or pre-terminal impact considerations in a comprehensive Puget Sound chum salmon management plan. Given the information provided in this report, co-managers may explore the resolution to which harvest management units may be described.

# Data Assessments

## Puget Sound Chum Salmon Escapement

Puget Sound chum salmon escapement trends tend to oscillate over the historical time series concurrent with basin-scale decadal marine climate regimes. While some populations have improved during years with favorable oceanic conditions for juvenile salmon (https://www.fisheries.noaa.gov/west-coast/science-data/ocean-conditions-indicators-trends), other populations remain depressed since the early 2000s. Except for a few natural and hatchery origin South Puget Sound and Hood Canal populations, including Endangered Species Act (ESA) listed summer chum, many fall and winter regional populations have struggled to meet escapement goals over multiple decades (Figure 4, Figure S3). Several factors may be correlated or driving these patterns, which we discuss in the following sections.

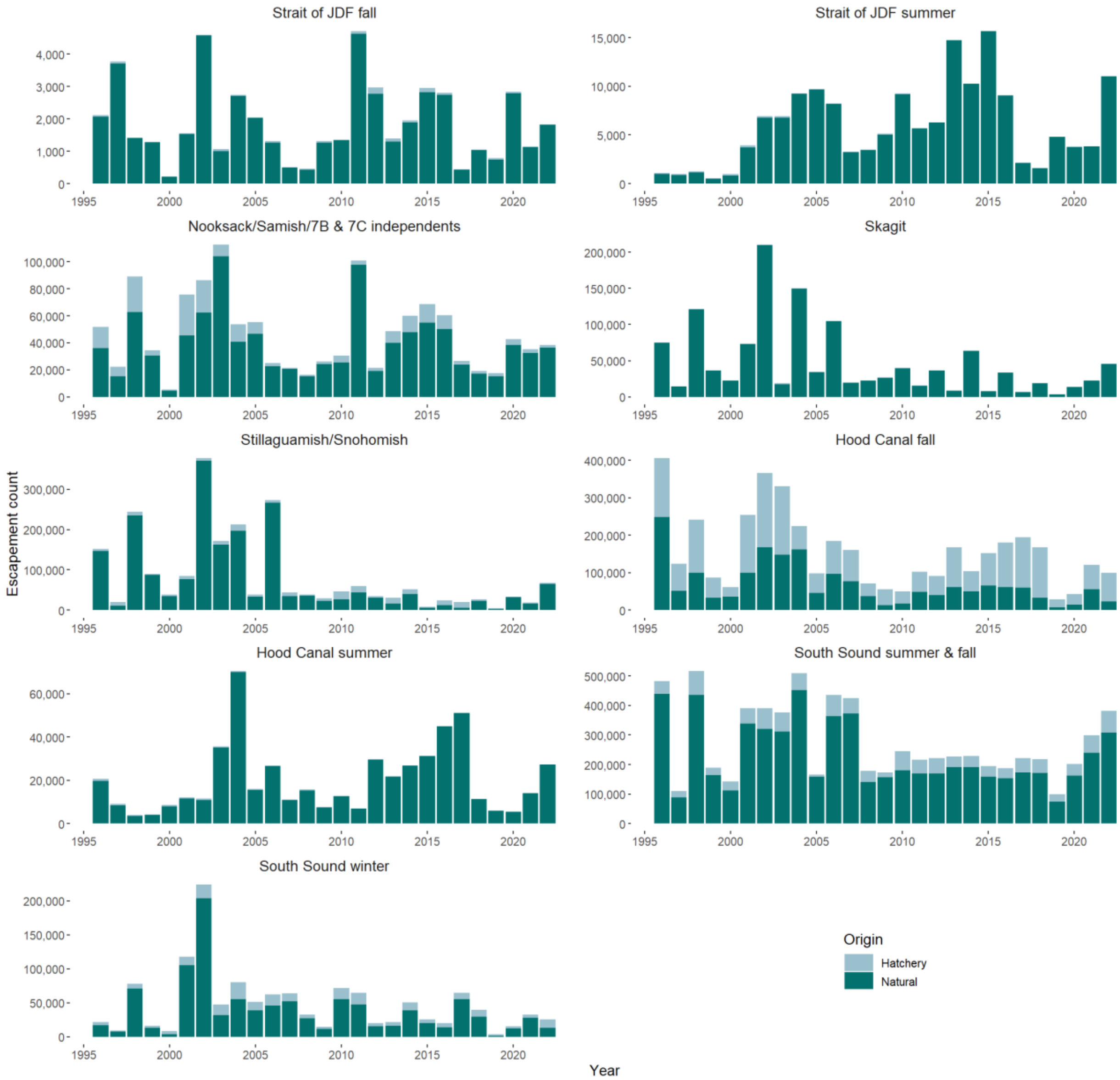


Figure 4. Puget Sound chum salmon escapement by year (1996-2022), origin, timing, and region. Note that the range of the y-axis varies between regions.

## Harvest

In Puget Sound, chum salmon returns are forecasted for regions in which harvest impacts are evaluated, specifically, North Puget Sound (Nooksack, Samish, and Skagit Rivers), the Stillaguamish-Snohomish basin, South Puget Sound (summers, falls, and winters), Hood Canal (summers and falls), and Strait of Juan de Fuca (summers and falls). Harvest data trends from these regions indicate that overall trends in catch have been similar for both Tribal and non-tribal fisheries across Puget Sound (Figure S4). While harvest between Tribal and non-tribal fisheries were similar, total harvest in mixed stock fisheries has generally declined in many regions since 2012 (Figure 5, Figure 6). Furthermore, North Puget Sound has experienced the steepest decline in total catch (Figure 6). Harvest management throughout Puget Sound is responsive to projected run size estimates, where harvest may be reduced at low abundances. This relationship is reflected when exploitation rate (catch divided by run size) trends are stable (e.g., Hood Canal, Figures 5). This trend may be due to a primary management focus of meeting the broodstock goals in Hood Canal, given its hatchery dominance in the region, and harvest managers attempting to maximize opportunity when goals are achieved to take advantage of the surplus.

Understanding pre-terminal and terminal harvest effects on Puget Sound chum salmon are critical to ensure the sustainability of stocks at the population level. Indeed, studies from across the Pacific Ocean have determined that selective harvest can cause evolutionary pressure within ten or fewer generations, primarily via selection intensity, genetic variability loss, and population-level response to selection (Hard et al., 2008). Exploitation rates of Puget Sound chum salmon have increased in some areas and decreased in others in the recent few decades (Figures 5, Figure 6, Figure S4). These exploitation rate trends are strongly associated with total abundance, however for some regions, there has been a decline in effort that has triggered lower than expected harvest rates (see Commercial Effort under Harvest Management section).

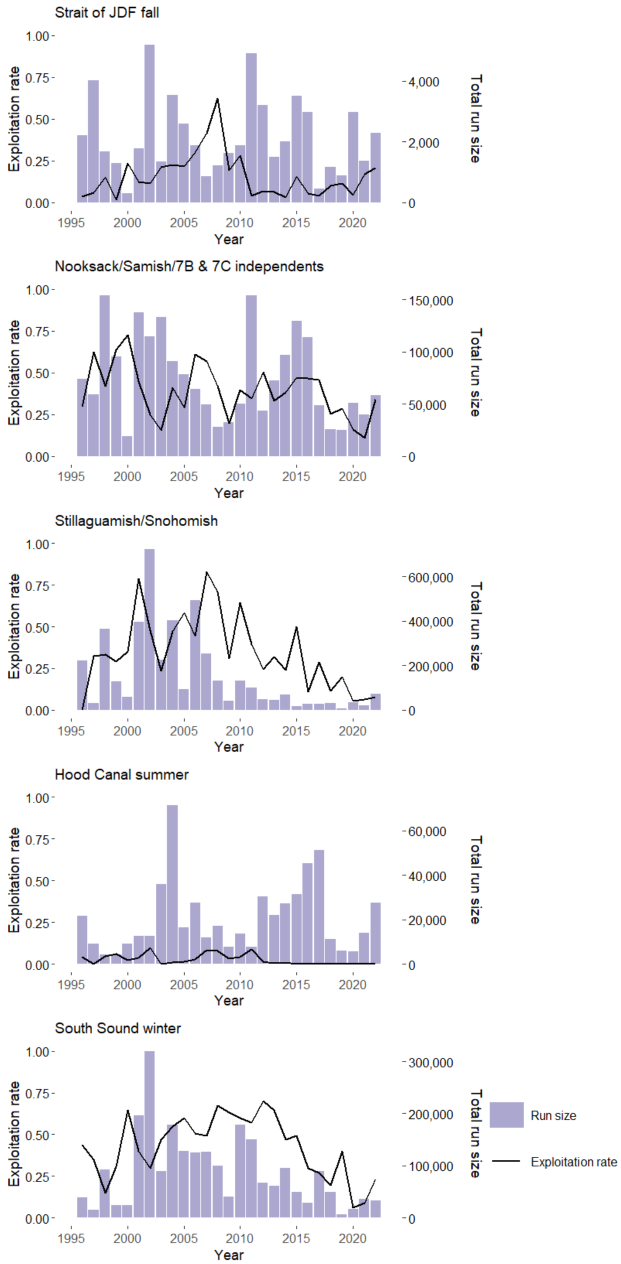


Figure 5. Exploitation rate and run size trends of chum salmon (including natural and hatchery origin) across the Puget Sound over recent decades (1996–2022) based on GSI-corrected run reconstruction data. Note that the range of the right y-axis varies between regions.


Figure 6. Chum salmon harvest in the Puget Sound by (a) commercial and (b) recreational fishers and geographic region of harvest from 2003–2022. Both natural and hatchery origin fish are included. Note that the range of the y-axis varies between regions and by harvest type. The commercial catch data were pulled from TOCAS (Apr. 12, 2024), including only catch from the "commercial fishery" disposition from both terminal and pre-terminal areas. The recreational catch data were pulled from the WDFW recreational catch database. The data are subject to change based on ongoing reconciliations.

## Productivity

Several populations of fall chum salmon have experienced reduced productivity (i.e., recruits per spawner) since 2001 (Figure 7). From 2000 onwards, approximately 70% of the brood year recruit per spawner ratios have fallen below the long-term median. Indeed, since 2000, all Puget Sound chum salmon runs except South Puget Sound falls and Hood Canal falls have experienced productivity that is frequently below the rate of replacement (Figure 7).

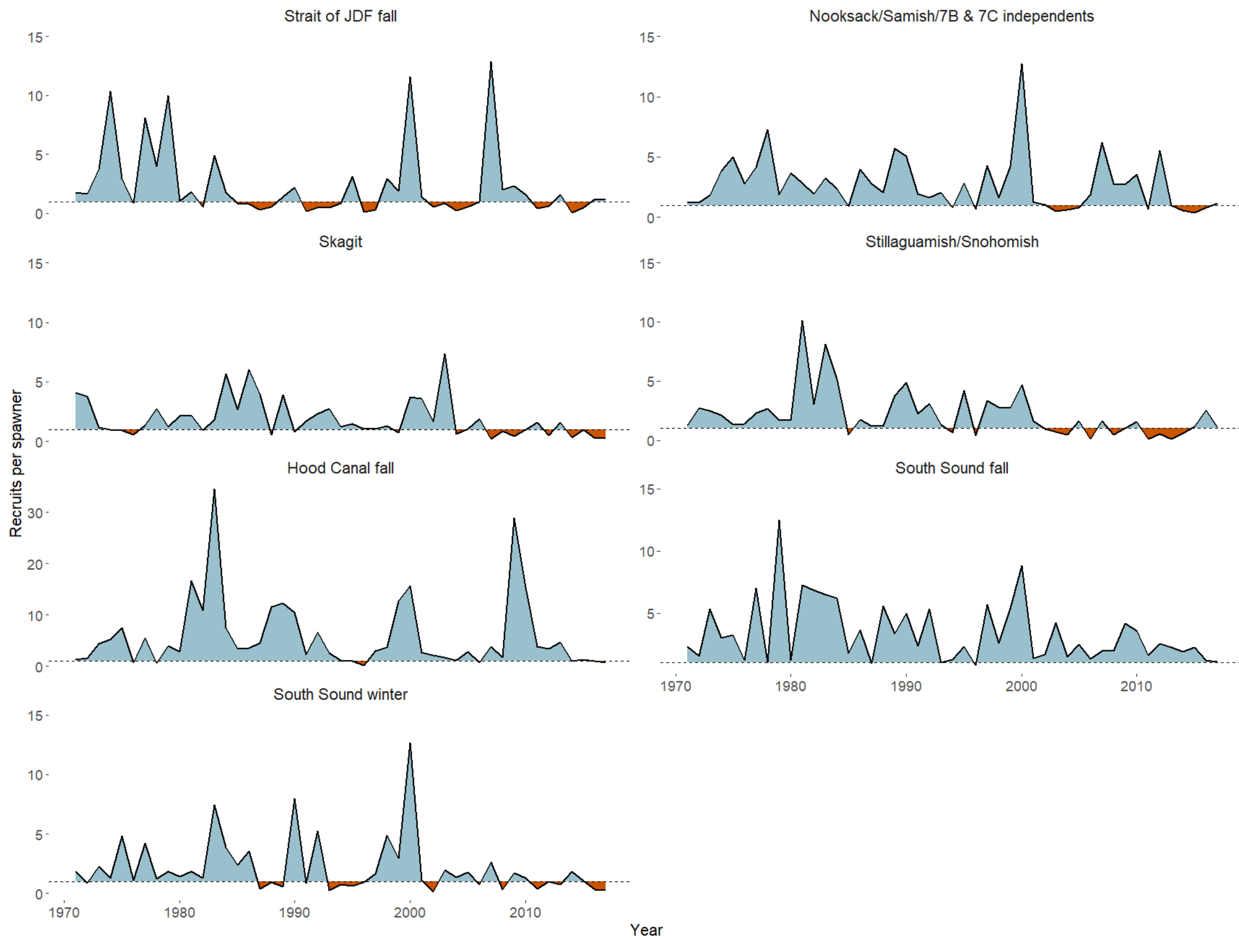


Figure 7. Natural origin chum salmon recruits per spawner by return region and timing for brood years 1971–2017 using WDFW's run reconstructions and age data where available. A recruits per spawner ratio of greater than 1 indicates a growing population (shaded in blue), whereas a ratio of less than 1 indicates a shrinking population (shaded in orange). Hood Canal fall chum salmon are represented on a larger scale than other regions to show values greater than 15.

## Age Data and Trends

Scale collection and age data processing have been ongoing priorities to understand chum population dynamics. Recruit-spawner dynamics for some systems sometimes rely on collections from mixed stock areas and act as a surrogate for forecast and escapement goal evaluation. Due to low sample size of collections from declining populations, co-managers have increased collection efforts across Puget

Sound over the recent decade (see Table S4 for list of Puget Sound chum salmon scale collection locations, also in attached supplementary files). However, there are still some populations from Central and North Puget Sound that may require increased collections to adequately evaluate age dynamics, such as brood year productivity and dominant age at return (Figure S5).

Chum salmon return to freshwater as adults predominantly at ages 3, 4, and 5, but can occasionally return at ages 2 and 6 (Figure 8). Although mean age and age composition of adults returning to Puget Sound varies regionally and temporally (Figures 8, Figure 9), there appears to be a significant downward trend of average age of adult chum salmon returning to Puget Sound ($p = 0.0025$; Figure 9), suggesting that for multiple populations the predominant age class of Puget Sound chum salmon annual returns is generally moving from a traditionally observed age 4 class to age 3 class. Research suggests marine climate, harvest management, and hatchery production can influence age dynamics in Pacific salmon

(Ohlberger et al., 2018; Cline et al., 2019). Further evaluation will be needed to investigate the parameters that affect the age of chum salmon returning to Puget Sound.

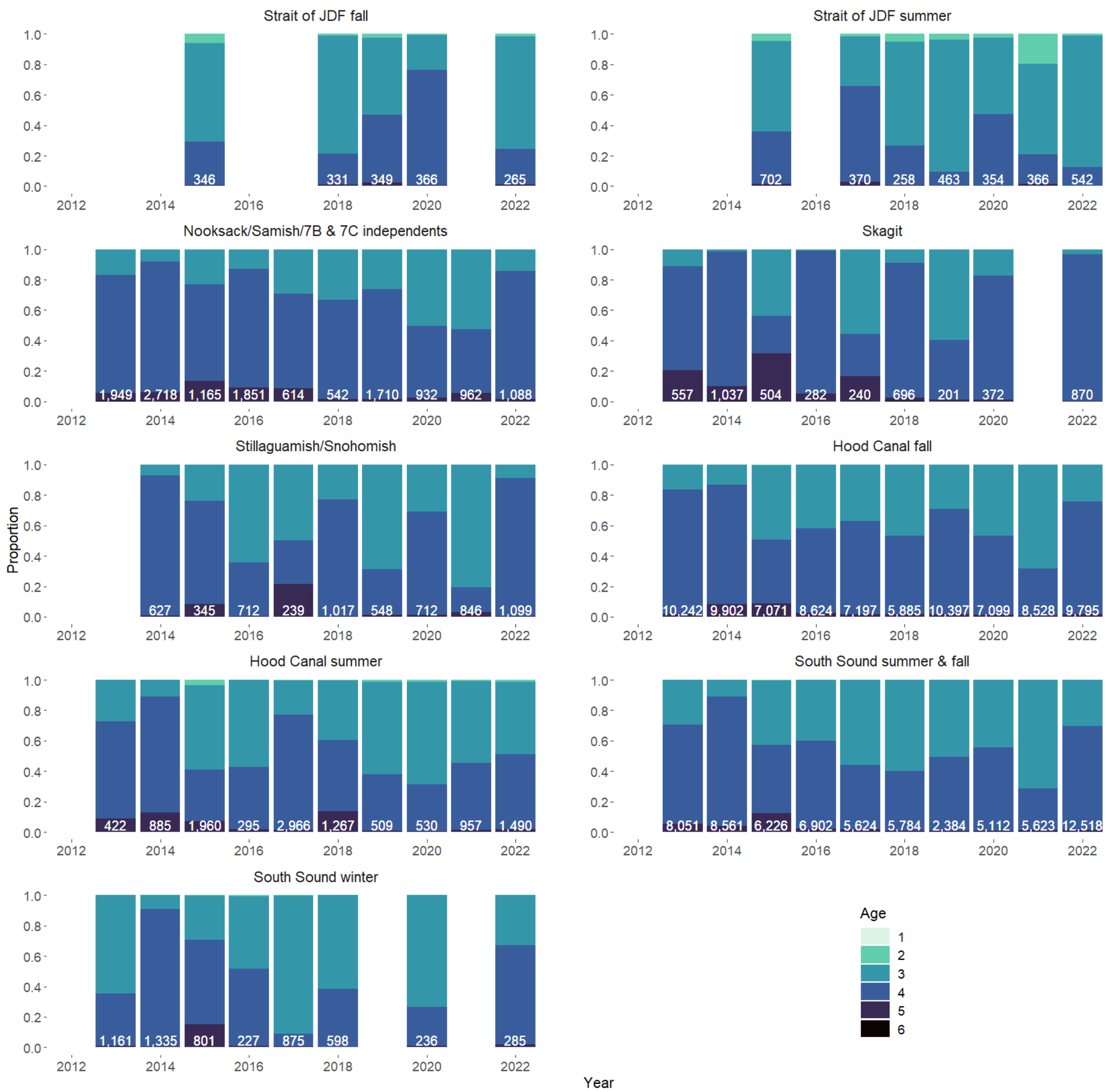


Figure 8. Age composition by year for each return region/timing group from years 2013−2022. The sample size for each year and region is noted at the bottom of each bar. Samples of less than 200 have been excluded.

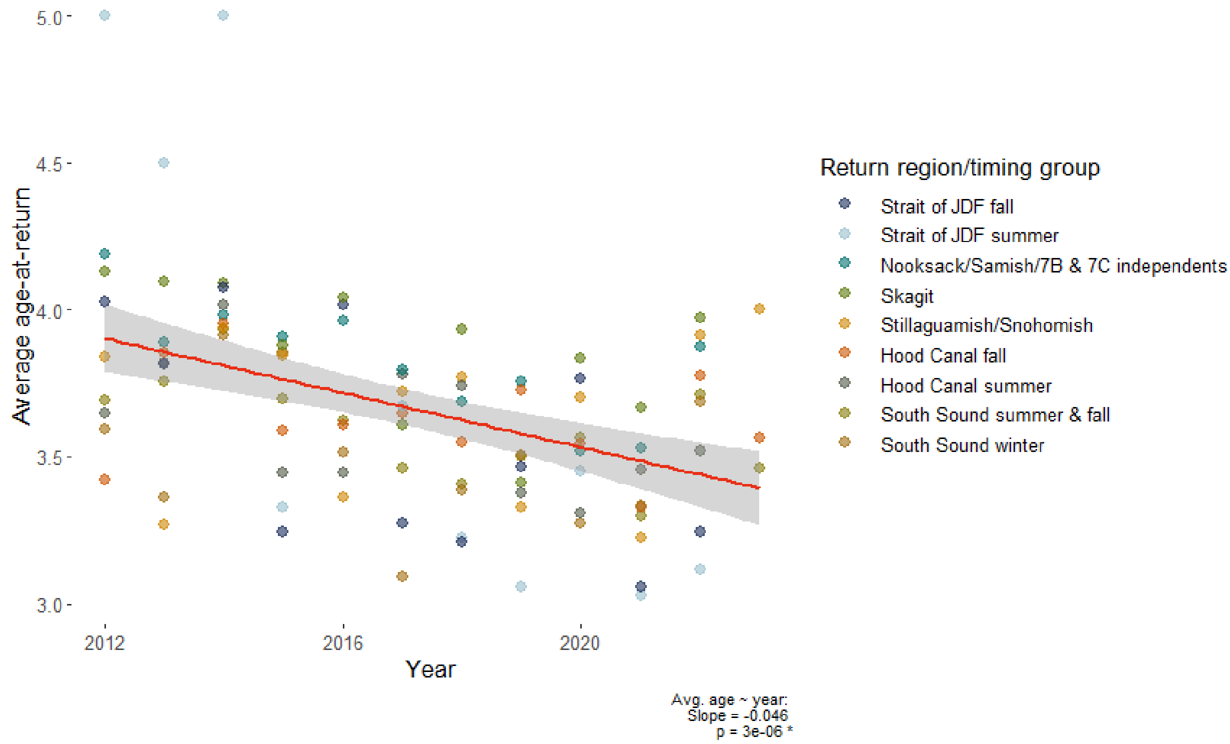


Figure 9. Average age of adult chum salmon from scales collected in Puget Sound test fisheries, commercial fisheries, hatcheries, and spawning grounds in years 2012−2023. Each point represents the average age of returning adult chum salmon in a single year in a single forecast return region/timing group. A simple linear regression was applied regressing average age against year, using an alpha of 0.05. Shading around the red line represents the 95% confidence interval.

# Conservation Concerns

## Co-manager Meetings and Data Assessments

Based on co-manager discussions held during 2023, marine conditions, marine mammal predation, harvest, and habitat appear to be the primary concerns related to declining stocks across Puget Sound. However, freshwater climate and competition also remain as potential obstacles to Puget Sound chum recovery. In the sections below, we reviewed published literature and available data related to these concepts as they pertain to chum salmon in Puget Sound.

## Habitat

Chum salmon complete their life cycle across freshwater, estuarine, and marine habitats. Understanding the availability and quality of these habitats is essential to evaluating the decline of chum salmon. Maintaining and, in some cases, rebuilding population productivity is important for planning sustainable harvest opportunities. Populations of chum salmon that spawn and rear within Puget Sound rely on a broad range of river systems, including small, independent creeks and streams as well as the lower reaches, side-channels, and tributaries of large rivers. During incubation, moderate flows of cold, clean water are critical to avoid physiological stress and physical scouring of redds (Quinn 2018). After hatching, chum salmon typically spend only a few days or weeks in freshwater rearing settings before transitioning to estuarine and nearshore marine environments.

Given these life history traits, Puget Sound chum salmon face various habitat-related threats across the watersheds they occupy. Altered freshwater quantity (e.g., artificially increased high flows or decreased low flows) and degraded river and estuarine water quality (e.g., excessive temperatures, inadequate dissolved oxygen concentrations, introduced pollutants and toxins) can impair adult return migration, egg incubation, and juvenile rearing success. These factors interact with physical barriers, such as road-crossing culverts and floodplain levees, that can impede adult and juvenile movements, thereby reducing access to suitable spawning grounds and refugia. Terrestrial land use modifications often drive these threats experienced by chum salmon within riverscapes and nearshore environments. This may be caused by loss of riparian tree canopy resulting in increased stream temperature and reduced riverbank stability, expansion of impervious surface area which concentrates runoff, and bank or shoreline armoring which promotes erosion (Beechie et al., 2012). Ongoing pressures from intensifying land and water use, in combination with increased air and water temperatures and altered precipitation patterns, are expected to heighten this suite of threats (Battin et al., 2007). Evaluation of potential physiological ramifications of these environmental challenges is needed, particularly regarding the critical thermal maximum for natural origin juvenile and adult chum salmon in Puget Sound.

Habitat protection measures and rehabilitation projects have been implemented in efforts to ameliorate some of these threats. However, the ongoing degradation of salmon habitats continues to outpace restoration efforts (Judge 2011). In addition to local jurisdiction, comprehensive planning and Critical Area Ordinances that must consider ‘anadromous fisheries’ under the Washington Growth Management Act, the community of Puget Sound salmon recovery practitioners has completed various acquisitions to preserve particularly high value locations, many used by chum salmon. Rehabilitation has taken many forms, involving culvert replacement or removal, armor and bulkhead removal, riparian planting, and invasive species control. Building on a foundation established by the Puget Sound Nearshore Ecosystem Restoration Project (PSNERP), the Estuary and Salmon Restoration Program (ESRP) has delivered key resources to a range of recovery organizations addressing salmon habitat threats. These programs, and the Habitat Strategic Initiative associated with the Puget Sound Partnership Action Agenda, have funded both on-the-ground interventions and research to increase the efficacy of these interventions. Many data gaps remain, particularly with respect to chum salmon, which have received less attention than Chinook and coho salmon. Nonetheless, these programs and projects highlight the collaborative efforts of Tribal and non-tribal governments, non-profit organizations, and local communities to rehabilitate habitats to the benefit of Puget Sound chum salmon responding to ongoing habitat loss and climate change.

*Estuarine and Nearshore Conditions*

Estuaries and nearshore habitat are critical for chum salmon growth and survival in Puget Sound due to their early emigration from freshwater at a small size (Simenstad et al., 1982; Urawa et al., 2018). Specifically, the stability of nearshore environmental conditions and forage productivity is integral for juvenile chum growth and survival (Anderson et al., 2021; Toft et al., 2007). Habitat features such as eelgrass are associated with nearshore chum abundance, prey availability, and provide a safe space for predator avoidance (Francis et al., 2022). Unfortunately, shoreline modifications such as armoring for tidal flux, in concert with altered water chemistry associated with human population growth and development in these reaches may affect the behavior, growth, and survival of juvenile chum salmon (Toft et al., 2007). Indeed, multiple studies have documented a pattern of ecosystem process degradation linked to human population and development-driven stressors across Puget Sound (Schlenger et al., 2011). In response to environmental degradation of the nearshore environment, aquatic and land use regulations along with ecosystem restoration projects linked to the Growth Management Act and the Shoreline Management Act have been implemented to mitigate negative effects to salmonids. However, further research is needed to document whether nearshore regulations and restoration are assisting in the recovery of suppressed chum salmon populations in Puget Sound (Bilby et al., 2024).

*Marine Conditions*

Over the recent 50 years, chum salmon have exhibited a complex relationship with the marine climate. Observed chum salmon population stochasticity and a non-stationary association with the marine climate may be attributed to variable life history strategies (Salo, 1991). Specifically, the ability for chum salmon to effectively shift the dominant age class of return and timing of return migrations. Despite the plasticity of chum, the recent decade of warming sea surface temperatures has been associated with declining recruit-per-spawner (i.e., productivity) trends for chum salmon stocks in Puget Sound, British Columbia, and Southeast Alaska (Atlas et al., 2022; Litz et al., 2021). Specifically, a mass of warm water in the North Pacific, termed ‘the blob,’ that amassed in late 2013 and continued to spread throughout 2014 and 2015 (Cavole et al., 2016), had a dramatic effect on marine salmon survival (Wilson et al., 2021). Sea surface temperature anomalies greater than 3 ℃ and low brood year survival resulted in 2019 and 2020 being the two lowest Puget Sound chum salmon returns documented since 1980. Additionally, it has been speculated that marine heatwaves decreased the availability of gelatinous and non-gelatinous chum salmon prey. Atlas et al. (2022) hypothesized these marine heat waves exacerbated the decline of chum salmon stocks throughout the north Pacific Ocean. Similar heat indexes in the North Pacific were detected in the following years but dissipated much faster than the blob. Nevertheless, marine heatwaves of varying spatial and temporal extents are becoming a frequent occurrence (Athanase et al., 2024). When heat waves align with outmigration timing and occur in nearshore environments, they may have damaging effects on marine growth, body condition, energy, and survival of chum salmon (Farley Jr. et al., 2024). Additionally, Pacific salmon may exhibit non-stationary spatial and temporal responses, to marine climate and patterns (i.e., the Pacific Decadal Oscillation and the North Pacific Gyre Oscillation; Litzow et al., 2018). A closer examination between sea surface temperature and Puget Sound chum productivity determined that the relationship may be non-linear and non-stationary, such that there is an optimum temperature for the highest observed productivity estimates, followed by a sudden and sustained drop in productivity over a particular thermal threshold (Figure 10).

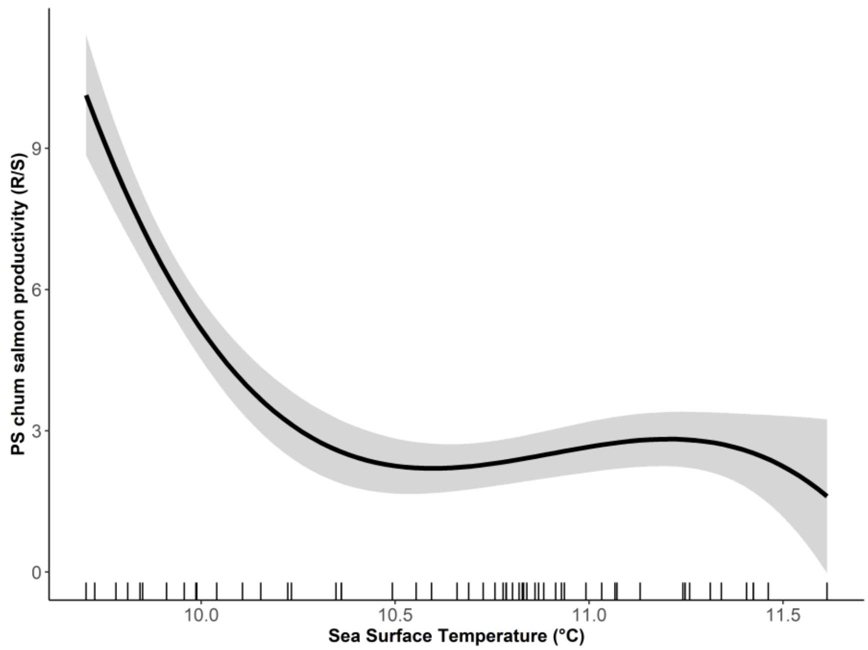


Figure 10. Modeled relationship between sea surface temperature (°C), measured at Race Rocks light station, and Puget Sound (PS) chum salmon recruits per spawner (R/S) for years 1968–2018. This relationship was fit using a generalized additive model, where parent escapement and sea surface temperature predicted R/S. The gray shaded region indicates 95% confidence intervals, and the inside ticks on the x-axis indicate data points.

In addition to non-linear and non-stationary relationships with sea surface temperature, simple linear correlations over the recent 20 years have revealed negative relationships between Puget Sound chum salmon productivity and the Aleutian Low Beaufort Sea Anticyclone (ALBSA), such that increasing Aleutian low pressure in the North Pacific may drive lower survival of Puget Sound chum (Figure 11). These results may suggest that within the first one to two years of their life cycle, Puget Sound chum salmon migrate quickly up the coast and are exposed to climate conditions driven by the Gulf of Alaska and the Bering Sea. We also see strong negative correlations across chum salmon stocks with sea surface salinity from the Strait of Juan de Fuca. Sea surface salinity variability in the Pacific is primarily driven by a reduction of surface precipitation (Li et al., 2019), which may be negatively affecting chum in nearshore environments as they out-migrate.

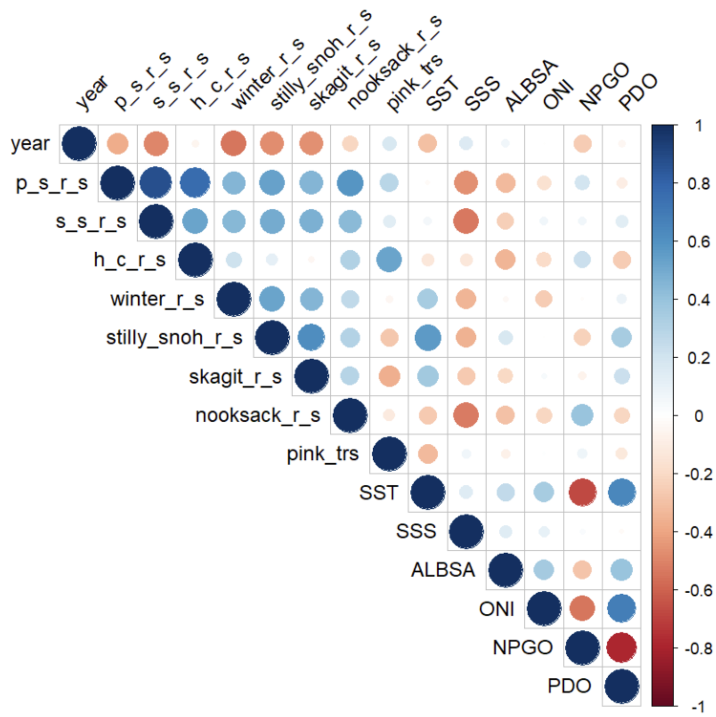


Figure 11. Recent 20-year linear correlation between natural origin Puget Sound recruits per spawner (p_s_r_s), South Puget Sound recruits per spawner (s_s_r_s), Hood Canal recruits per spawner (h_c_r_s), South Puget Sound winter recruits per spawner (winter_r_s), Stillaguamish and Snohomish recruits per spawner (stilly_snoh_r_s), Skagit recruits per spawner (skagit_r_s), Nooksack recruits per spawner (nooksack_r_s), Puget Sound Pink total run size (pink_trs), sea surface temperature (SST) measured at Race Rocks, sea surface salinity (SSS) measured at Race Rocks, Aleutian Low Beaufort Sea Anticyclone (ALBSA), Oceanic Niño Index (ONI), North Pacific Gyre Oscillation (NPGO), and Pacific Decadal Oscillation (PDO). Correlations were determined using Pearson's correlation coefficient, where blue shading indicates a positive correlation and red shading indicates a negative correlation. Size and degree of shading represent the strength of correlation, where darker shades and larger bubbles indicate a stronger relationship.

Other stressors, including competition, can also interact with marine climate to influence chum population dynamics. Unlike chum salmon, pink salmon populations have generally maintained high returns even during marine heatwaves (e.g., Ruggerone and Irvine, 2018, Ruggerone et al., 2023). Since prey availability decreases as sea surface temperature increases, interspecific competition for limited resources may increase, leading to decreased growth rates and survival for some populations of chum salmon (Anderson et al., 2021; see Competitive Interactions section). Growth and productivity are positively correlated, thus, maintaining growth rates in the first year is critical to sustaining productivity across generations. In the South Puget Sound, increasing returns documented in Green River fall chum may be related to the timing of release and the number of individuals released, as well as fish condition.

Conversely, declining returns observed in Nisqually River winter chum may be attributed to the later outmigration timing relative to summer and fall run populations which corresponds to higher observed marine temperatures, poor growth, and higher susceptibility to mortality.

### *Freshwater Conditions*

Like other salmon species, chum salmon emerge from redds in freshwater streams. However, unlike coho (*O. kisutch*), Chinook (*O. tshawytscha*), and sockeye (*O. nerka*) salmon, they do not reside in freshwater for an extended period. Upon emergence, they immediately migrate as fry to the lower estuarine reaches of rivers, and in some cases, to the nearshore marine environment (Salo 1991). Given this short residency in freshwater and their small body size, chum salmon outmigrants are often difficult to trap. In Puget Sound, co-managers have operated long-term juvenile trapping sites in the Dungeness, Duckabush, Skagit, Stillaguamish, Snohomish, Nooksack, Green, Nisqually, and Puyallup river basins. While some co-managers noted the poor outmigrant data quality in some years, others questioned the utility. As such, it may be a relevant discussion topic worth further review to determine the usefulness and application of outmigrant abundance estimation. From the sites with both hatchery and natural origin production, there remains a challenge in separating the origin of outmigrants due to lack of an external marking program for hatchery origin juvenile chum across Puget Sound. As such, it remains a challenge to parse the productivity between hatchery and natural broods based on juvenile production. For systems such as the Stillaguamish and Snohomish, in addition to the in-river traps, there are marine fry surveys conducted lower in the system, and when water levels are optimal, these surveys provide a useful indicator of productivity. The Skagit system also uses outmigrant trap data along with marine fry surveys to develop indices of production. In recent years, the estimated juvenile abundance has overestimated the system's observed productivity. Understanding outmigrant survival can provide critical information to estimate productivity. However, outmigrant estimates can be challenging for some systems and may be dependent on the stream and trap location.

Adult chum salmon return timing to freshwater has shifted over the recent few decades for both fall and winter Puget Sound chum populations. For some populations the general timing of river detection has shifted earlier in the year, initiated by rainfall events and lower marine sea surface salinity (Agha et al., 2021). Conversely, in other regions there have been consecutive years with delayed fall precipitation corresponding with later return timing. In drought years, some chum populations are not able to access their natal spawning grounds, experiencing a higher rate of prespawn mortality, as well as reduced spawning success. For instance, one hypothesis for age class shifts and declines in body size may be driven by a selection event occurring in freshwater where larger chum salmon are not able to successfully reach their natal spawning grounds during low flow and above average water temperature years. Without sufficient habitat connectivity, these larger fish are then subject to predation for longer periods of time while staging in marine terminal areas and/or unsuccessful spawning events lower in the same or adjacent tributaries.

## Predation

Predation of chum salmon by marine mammals, sea birds, and fish in Puget Sound estuarine and marine environments is an ongoing concern to the recovery of declining chum salmon stocks. Due to their small body size at marine entry, juvenile chum salmon are susceptible to avian and fish predation (Nelson et al. 2015; Duncan and Beaudreau 2019). In the Puget Sound, marine mammal predators of adult and juvenile chum salmon include California sea lions (*Zalophus californianus*), Steller sea lions (*Eumetopias jubatus*), harbor seals (*Phoca vitulina*), and killer whales (*Orcinus orca*). A negative relationship has been documented between pinniped density and the return abundance of anadromous salmonids in Puget Sound (Berejikian et al., 2016). Specifically, marine mammal predators are known to synchronize presence with adult salmon migrations and can efficiently select or target larger bodied individuals during certain periods of the year. Further assessments will be needed to test the relationships between marine mammal predation and Puget Sound chum salmon age structures.

Agha et al. (2021) indicated a negative relationship between coastal and Puget Sound seal densities and migratory run timing, particularly in winter run chum salmon. Late timed chum salmon are the largest salmonid available in marine waters to predators during the late fall and early winter periods of the year, and thus have been shown to be an important prey species for Southern Resident Killer Whales (SRKW) and pinnipeds (Ford and Ellis 2006; Hanson et al., 2021). Since the mid-20th century when multiple legal protections for marine mammals were enacted across the United States (Marine Mammal Protection Act) and Canada (Fisheries Act), pinnipeds in North America have experienced rapid population increases, including in the Puget Sound (Lotze et al., 2011). The recovery of pinnipeds in Puget Sound has coincided with the rise of other stressors on chum salmon, including habitat degradation and loss and climate change effects, including increased frequency and magnitude of peak flows and reduced survival during marine heat waves. These factors make accurate assessments of the effect of pinniped predation on chum salmon difficult.

Pinnipeds such as California and Steller sea lions represent an unquantified threat to the recovery of chum salmon in Central and South Puget Sound. Our review of predator observations with co-managers indicated that the year-round abundance and wintering migrations of pinnipeds in Central and South Puget Sound are increasing or stable despite recent stochasticity in salmon abundance. Traditional knowledge suggests that California and especially Steller sea lions were not regularly seen in Deep South Puget Sound and would be a target of traditional harvest and used when present. During the late fall and early winter, California sea lions, Steller sea lions, and harbor seals are observed throughout Puget Sound predating on chum salmon. Additionally, they are often observed in and around Elliot Bay and further south to the Green River and Puyallup. In South Puget Sound, California and Steller sea lions are frequently observed and documented entering the Nisqually River with the onset of the winter chum return. There are several observations from the region of pinniped predation events and scars on chum salmon as they attempt to spawn. Preliminary findings from South Puget Sound California sea lion scat data indicate that chum salmon are a component of their diet (Casey Clark, WDFW Communication). Upcoming work by the co-managers and NOAA will focus on the year-round diet of harbor seals in the Nisqually River delta and Hood Canal, with the goal of estimating their consumption of salmon in these systems. Much remains to be learned about the consumption of chum salmon by California and Steller sea lions and potential demographic responses.

## Hatchery Production

Hatchery production has been applied across Puget Sound for several decades to facilitate recovery of natural chum salmon stocks, to sustain both Tribal and non-tribal directed fisheries, and most recently to also support recovery of SRKW. WDFW hatchery facilities throughout Puget Sound currently have a total release goal of 40.5 million juveniles, which reflects a recent increase of 6 million to benefit SRKW, as prescribed in the State of Washington Executive Order 18-02. The current level of production is near 40% of the production levels that occurred in the 1980s (Figure 12). Multiple hatchery programs, Tribal and WDFW, in Central Puget Sound, North Puget Sound, and Hood Canal continue to use supplementation efforts to support recovery and buffer demographic variability, with Hood Canal hatcheries comprising the largest component in Puget Sound (Figure 12). Of the total, 28 million juvenile releases support Hood Canal harvest programs. These programs produce hatchery origin fish that provide important and meaningful Tribal (as affirmed in *U.S. v. Washington*, 1974 and subsequent proceedings) and non-tribal fishing opportunities and remain valuable to numerous directed and incidental fisheries across the North Pacific. Hatchery origin chum salmon also help meet Pacific Salmon Treaty harvest sharing agreements with Canada.

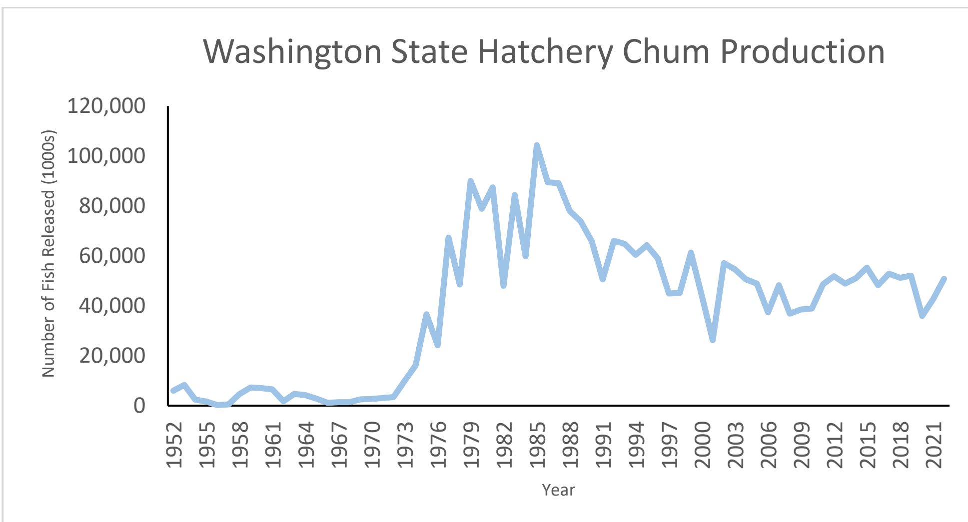


Figure 12. Total Washington State hatchery chum release numbers (1000s) by year, includes Puget Sound, Coast, and Columbia output from 1952 through 2021.

Hatchery management and goals, specific to each watershed, are described in Hatchery and Genetic Management Plans (HGMPs), which are submitted to the National Marine Fisheries Service (NMFS) for evaluation. While HGMPs for several programs are awaiting review, NMFS evaluates whether proposed actions meet criteria in the ESA, limiting adverse impacts to species listed under the ESA. For example, the Summer Chum Salmon Conservation Initiative acknowledged possible interactions between Hood Canal summer chum salmon and hatchery production of fall chum salmon, which were subsequently addressed in HGMPs (SCSCI 2000; NMFS 2022a). Several strategies are used to mitigate adverse interactions between hatchery origin fall chum salmon and ESA listed populations, including: 1) relying on local broodstock, 2) reducing straying by rearing at release sites, 3) minimizing marine ecological interactions by releasing fish as smolts, and 4) delaying release timing to avoid freshwater and marine interactions. For Hood Canal summer chum salmon, supplementation programs, temporally adjusted harvest regimes on fall chum, and recommendations documented in the listing process have been successful at guiding recovery, given increased returns observed in recent years (SCSCI 2000; NMFS 2022a; Lestelle et al., 2018; Lestelle 2020). Similar strategies are implemented in other watersheds where interactions between hatchery origin chum salmon and species listed under the ESA are possible (e.g., NMFS 2022b; NMFS 2022c).

### Competitive Interactions

During the 2023 review, some co-managers recognized the potential relationship between chum salmon productivity and increasing abundances of pink salmon. Previous studies indicated the magnitude and potential response of chum salmon to competitive interactions vary spatially and temporally, throughout their geographic range (Sturdevant et al., 2012; Hasegawa et al., 2014; Litz et al., 2021). Currently, potential interactions with pink salmon and chum salmon are incorporated in chum salmon management in several regions in Puget Sound, where populations have alternating escapement goals in years when pink salmon are present. Additionally, the presence and abundance of pink salmon are tested in annual chum salmon preseason forecasts in many regions in Puget Sound. The mechanisms and potential of interspecific competition leading to a demographic shift are poorly understood in Puget Sound, thus, further research and data collection will be needed.

### Harvest

Chum salmon provide critical cultural and economic harvest opportunities throughout Puget Sound. However, in some circumstances, harvest can impact size and age structure, run timing, and demographic vital rates (Hard et al., 2008; Morita 2019). The co-managers in all regions highlighted specific examples where harvest had been curtailed to address reduced productivity. While the implications of these management actions on chum salmon abundances vary across regions, we present harvest and exploitation trends in the Data Assessments and Harvest Management sections of this document.

### Co-manager Conservation Concerns by Region

To determine the relative conservation concern, co-managers were asked to review escapement trends over the recent 20 to 30 years, survival concerns in freshwater and marine environments, predation concerns, and habitat concerns specific to their region, and potential fishery impacts on the identified management units (Table 5). Each of the conservation concerns were then ranked and provided a score from high to low concern. Additionally, given the prioritization of conservation concern around natural origin management units, natural and mixed origin stocks were given the highest prioritization over hatchery origin stocks. Based on the ranking process, natural origin Nisqually winters (including Chambers Creek and Misc. Area 13 winters) were ranked as a management unit with the highest level of conservation concern across Puget Sound. Other management units that fell into the 75$^{th}$ percentile and above for conservation concern included: natural North Puget Sound 7B/7C fall independents, hatchery origin Whatcom Creek falls, hatchery origin Puyallup winters, natural origin Stillaguamish and Snohomish falls, mixed origin Nooksack falls, and mixed origin Skagit River falls. In that top group of management units, escapement showed a strong declining trend in the recent 20 years, and marine survival, freshwater predation, and habitat issues were all high or unknown concern based on the scores provided in the co-manager review (Table 5). For natural Nisqually winters, adult predation and potential fishery impacts are of the highest concern as compared to all other management units.

Table 5. Management units with scoring based on level of conservation concern. Table excludes Hood Canal and SJDF stocks as they were not reviewed for conservation concerns during the 2023 co-manager technical process.

**Stock of Concern Evaluation**

| Geographic Region | Management Unit | Origin | Escapement trends | Freshwater survival (climate) | Marine survival (climate) | Freshwater predation | Marine predation | Habitat | Fishery impacts |
|---|---|---|---|---|---|---|---|---|---|
| South Puget Sound | Nisqually Winter (and Misc 13 and Chambers Cr.) | NOR | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | Carr Inlet | Both | 2 | 0 | 0 | 3 | 0 | 0 | 2 |
| | Case Inlet (fall and summer) | NOR | 1 | 0 | 0 | 3 | 0 | 0 | 2 |
| | Totten Inlet | NOR | 1 | 0 | 0 | 3 | 0 | 0 | 2 |
| | Skookum Inlet | NOR | 1 | 0 | 0 | 3 | 0 | 0 | 2 |
| | Eld Inlet | NOR | 1 | 0 | 0 | 3 | 0 | 0 | 2 |
| | Hammersly Inlet (fall and summer) | NOR | 1 | 0 | 0 | 3 | 0 | 1 | 2 |
| | Henderson Inlet | NOR | 3 | 0 | 0 | 3 | 0 | 0 | 2 |
| | Puyallup Fall | NOR | 1 | 0 | 1 | 0 | 0 | 1 | 2 |
| | Puyallup Winter (HOR) | HOR | 1 | 0 | 1 | 1 | 1 | 1 | 2 |
| | East Kitsap (10 E Fall) | NOR | 1 | 0 | 0 | 3 | 0 | 0 | 2 |
| | Green River | HOR | 3 | 2 | 0 | 0 | 1 | 1 | 2 |
| Stillaguamish - Snohomish basin | Snohomish River | NOR | 1 | 1 | 0 | 0 | 0 | 1 | 2 |
| | Stillaguamish River | NOR | 1 | 1 | 1 | 3 | 0 | 1 | 2 |
| North Puget Sound | Skagit River | Both | 1 | 1 | 1 | 0 | 0 | 1 | 2 |
| | Samish River | Both | 2 | 0 | 1 | 0 | 0 | 1 | 2 |
| | 7B&7C Independents | NOR | 2 | 0 | 1 | 1 | 1 | 1 | 2 |
| | Whatcom Creek | HOR | 1 | 0 | 1 | 1 | 1 | 1 | 2 |
| | Lummi Bay | HOR | 3 | 0 | 1 | 1 | 1 | 1 | 2 |
| | Nooksack NOR | NOR | 3 | 0 | 1 | 1 | 1 | 1 | 2 |
| | Nooksack HOR | HOR | 3 | 0 | 1 | 1 | 1 | 1 | 2 |
| Hood Canal Strait of Juan de Fuca | | | | | | | | | |

**Legend**

| | |
|---|---|
| 0 | Unknown level of concern - data gap |
| 1 | High concern and further evaluation needed |
| 2 | Some concern, being evaluated |
| 3 | Low and concern, no need for evaualtion |

## *South Puget Sound*

South Puget Sound co-managers expressed high concern for escapement trends, followed by predation, and habitat. Regarding escapement trends, natural population trends remained a priority to co-managers. Specifically, co-managers highlighted that natural Nisqually winter (including Chambers Creek and Misc. Area 13 winters) chum salmon and hatchery Puyallup fall and winter chum populations have not responded to significant reductions in pre-terminal and extreme terminal harvest(i.e., in years where there are limited or no pre-terminal chum directed commercial fisheries or fisheries limited to earlier management weeks, well below average winter chum salmon returns are still observed and zero extreme terminal harvest). However, recent adjustments to pre-terminal fishery management structure such as an abundance trigger (i.e., in-season South Puget Sound chum salmon abundance estimate of 460,000 that limits pre-terminal fisheries) have allowed fall-timed chum salmon to meet most escapement goals in South Puget Sound during years with return abundance below the long-term average. Additionally, an exploitation rate and impact quota ceiling for natural origin winter chum was implemented in 2023 for Tribal and state commercial fisheries, yet it still needs to be reviewed over multiple years for how it may be successful in adjusting for potential fishery-related conservation concerns. Independent of fisheries, there was a resounding concern regarding the effect of pinnipeds and interspecific piscivory (e.g., Duffy and Beauchamp 2008) on natural populations occurring in marine and freshwater environments. Co-managers suggested a need for further evaluation of predator diet and monitoring, specifically in South Puget Sound. The effect of predators was noted in both pre-terminal marine waters and terminal freshwater reaches. While habitat issues remain a large data gap across South Puget Sound, several co-managers noted that low flows have affected the ability of chum to reach spawning grounds and that late winter flooding has caused large scouring events. Additionally, aligning the outmigration timing of deep South Puget Sound natural winter and fall juveniles with nearshore and ocean environmental conditions remains an ongoing investigation, and it remains a concern for South Puget Sound co-managers where populations are predominantly of natural origin.

*Central Puget Sound*

In Central Puget Sound, including the Green River and streams associated to Area 10 and 10E, co-managers noted a concern of declining escapement trends, followed by freshwater survival, marine survival, and habitat. Regarding escapement trends, some populations continue to be depressed despite efforts to supplement and reduce fishing pressure. For example, co-managers in the Stillaguamish-Snohomish River system made significant efforts over the recent decade to recover chum, however, returns continue to be limited. Given changing climate conditions in freshwater and nearshore marine environments, outmigrant survival is of high concern. Continued and improved estimation of juvenile survival in the nearshore environment may provide important insight to juvenile survival trends. Additionally, the condition of outmigrant fry was also suggested as a possible factor in survival and productivity from the system. Finally, habitat came up as another important factor for chum salmon in Central Puget Sound, and in some cases the lack of connectivity in some reaches, and lack of a functioning estuary in others could be a limitation to juvenile survival and adult spawning success.

*North Puget Sound*

North Puget Sound co-managers noted a variety of concerns including marine survival, freshwater predation, marine predation, and habitat. Although chum salmon directed fisheries have been reduced throughout North Puget Sound, several co-managers cited concerns related to offshore and preterminal fishery impacts to these stocks. There is ongoing concern in the Skagit River related to loss of off-channel habitats and floodplain connectivity. Furthermore, there is growing concern in the Skagit River basin around warmwater piscivores that may be decreasing juvenile survival. Throughout North Puget Sound, there is suspected adult predation by pinnipeds, however, understanding the predator-prey dynamics in nearshore areas remains a data gap. In the Samish system, co-managers noted loss of marine shoreline habitats, slough, side channel availability, and connectivity may be factors that drive lower survival of juveniles and possibly poor spawning success. In the Nooksack system, co-managers noted freshwater habitat concerns, however survival relationships with freshwater conditions still needed to be examined. The challenge of not being able to distinguish natural from hatchery origin outmigrant and adult chum salmon through an external mark adds complexity to management and recovery as hatchery production increases. While fry released from Kendall Creek Hatchery have thermal marked otoliths, collected otoliths have yet to be analyzed and evaluated for integration into hatchery and natural origin population productivity estimate. Furthermore, a retrospective review of escapement evaluation and methodology was suggested by co-managers for the Nooksack. Ultimately, for all North Puget Sound systems, further evaluation of conservation concerns, data gaps, and their association with adult returns is needed to determine if these factors play an important role in population-level sustainability.

# Harvest Management

## Pre-season Agreements and Assessments

The Puget Sound Salmon Management Plan along with the annual North of Falcon management process define forecasts, harvest agreements for pre-terminal and terminal fisheries, and time and space bounds for prosecuted fisheries. Here, we describe annual forecasts and performance, and management structures that are applied to the major mixed stock chum salmon directed fisheries in Puget Sound, with particular attention to the well-documented South Puget Sound management process.

### *Annual Forecasting Process and Performance*

Commercial harvest management relies on effective pre-season and in-season abundance estimation. Pre-season chum salmon forecasts play a pivotal role in determining harvest opportunity tradeoffs with conservation priorities. However, diminishing chum salmon returns in recent decades have amplified the need for accurate forecasts where the margins of reaching conservation and harvest objectives are increasingly thin. Moreover, recent declines in productivity have increased annual forecast performance error (Figure 14, Figure 15). Forecasts are developed annually by co-managers for the following geographic regions: Nooksack/Samish/7B & 7C independents, Skagit, Stillaguamish/Snohomish, South Puget Sound, Hood Canal, and Strait of Juan de Fuca. Annual chum salmon forecasts are produced separately for each ecotype (summer, fall, and winter-run returns), as well as by production type (natural or hatchery origin). Once forecasts are agreed to by technical and policy co-manager staff, they are used in the North of Falcon management process to determine sustainability concern, available harvest, and pre-season shares.

Historically, pre-season natural chum salmon forecasts in Puget Sound used multi-year mean return abundances and simple linear regression to predict recruits per spawner. However, these methods have often failed to capture the current chum salmon productivity regime documented in declining stocks over the recent decade. In response to these challenges, several regional co-managers have developed flexible forecasting approaches that account for nonlinear and nonstationary relationships between productivity and the environment. In South Puget Sound, the inclusion of sea surface temperature, Oceanic Niño index, and parent escapement reduced the overall forecast mean absolute percent error (MAPE) for the recent 10 years by 7.1% using one-year-ahead evaluation. Nevertheless, given the uncertainty in pre-season forecasts, co-managers have typically relied on in-season assessments (in-season update models based on test fishery or commercial fishery catch-per-effort) to re-evaluate the strength of the return and adjust harvest management structures. Climate-driven forecast uncertainty has further forced co-managers to consider even more adaptive management harvest regimes that are sustainable in low-abundance return years. Restrictions on commercial fishery effort and harvest implemented in recent years have, in turn, compromised the time series of data that had been used to develop in-season update models based on catch-per-effort in those fisheries.

Hatchery chum salmon forecasts are typically developed by multiplying pounds released from each facility by long-term even/odd brood year specific average return rates for that facility. For example, 3-year-old returns were forecast by multiplying pounds released in the 2021 brood year by the long-term, even-year brood Age 3 return rate for that hatchery. The age 4 and 5 returns were forecast by the same method. Off-station release (volunteer/cooperative projects) return rates were based on rates for a corresponding hatchery, which in some instances were reduced by a factor of 4 to compensate for smaller size at release and whether the fry were fed prior to release. Similar to natural origin chum salmon forecasts, long term averages have failed to capture recent declines in return rates and nonstationary responses to environmental conditions, leading to a MAPE of over 80% for some hatchery forecasts. Hatchery chum salmon forecasts will need further development to explore ecological relationships and to reduce uncertainty.

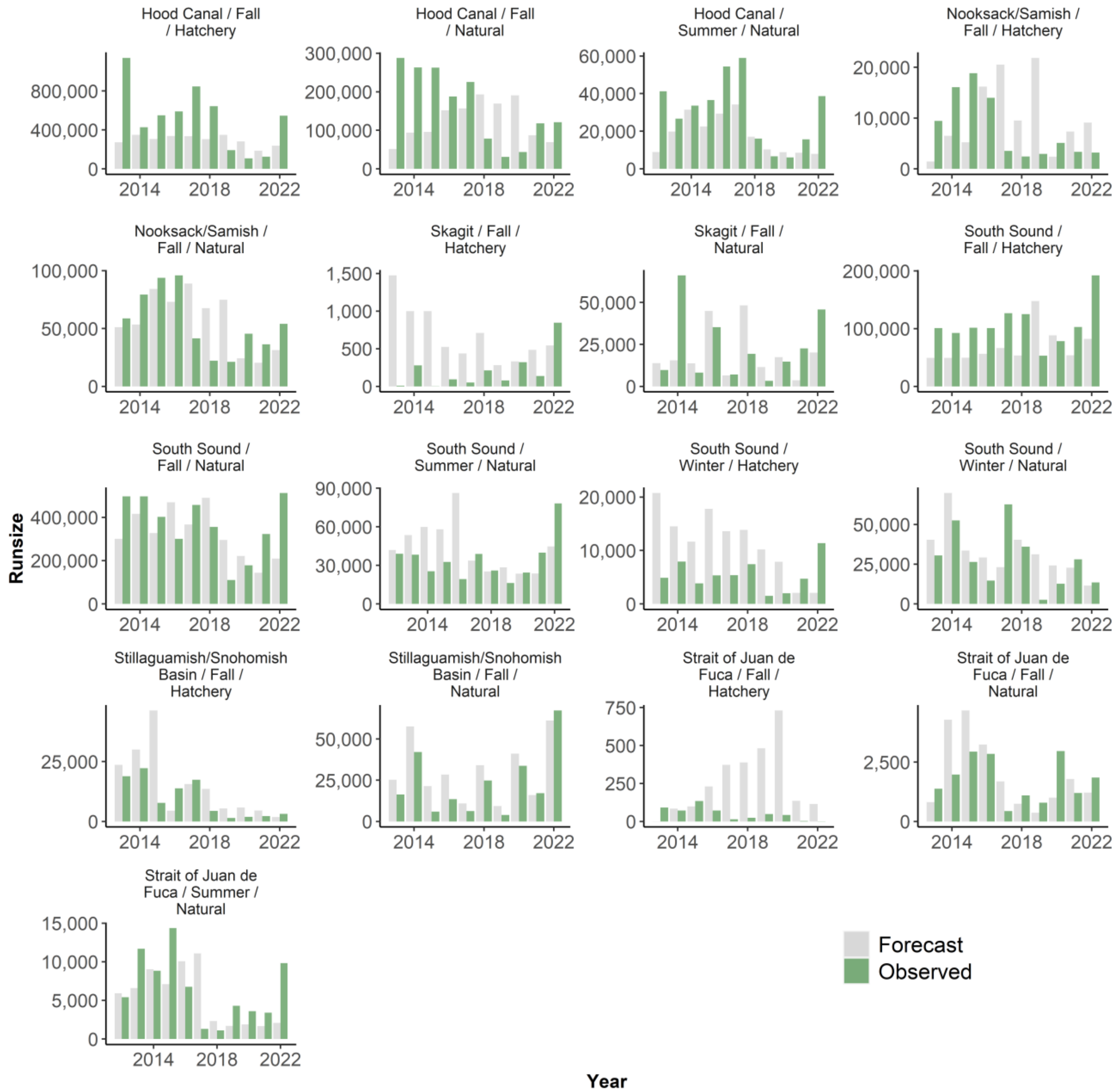


Figure 13. Predicted return abundance with agreed-to co-manager forecasts and observed traditional run reconstruction abundance from 2012–2022. Note that the range of the y-axis varies between panels.

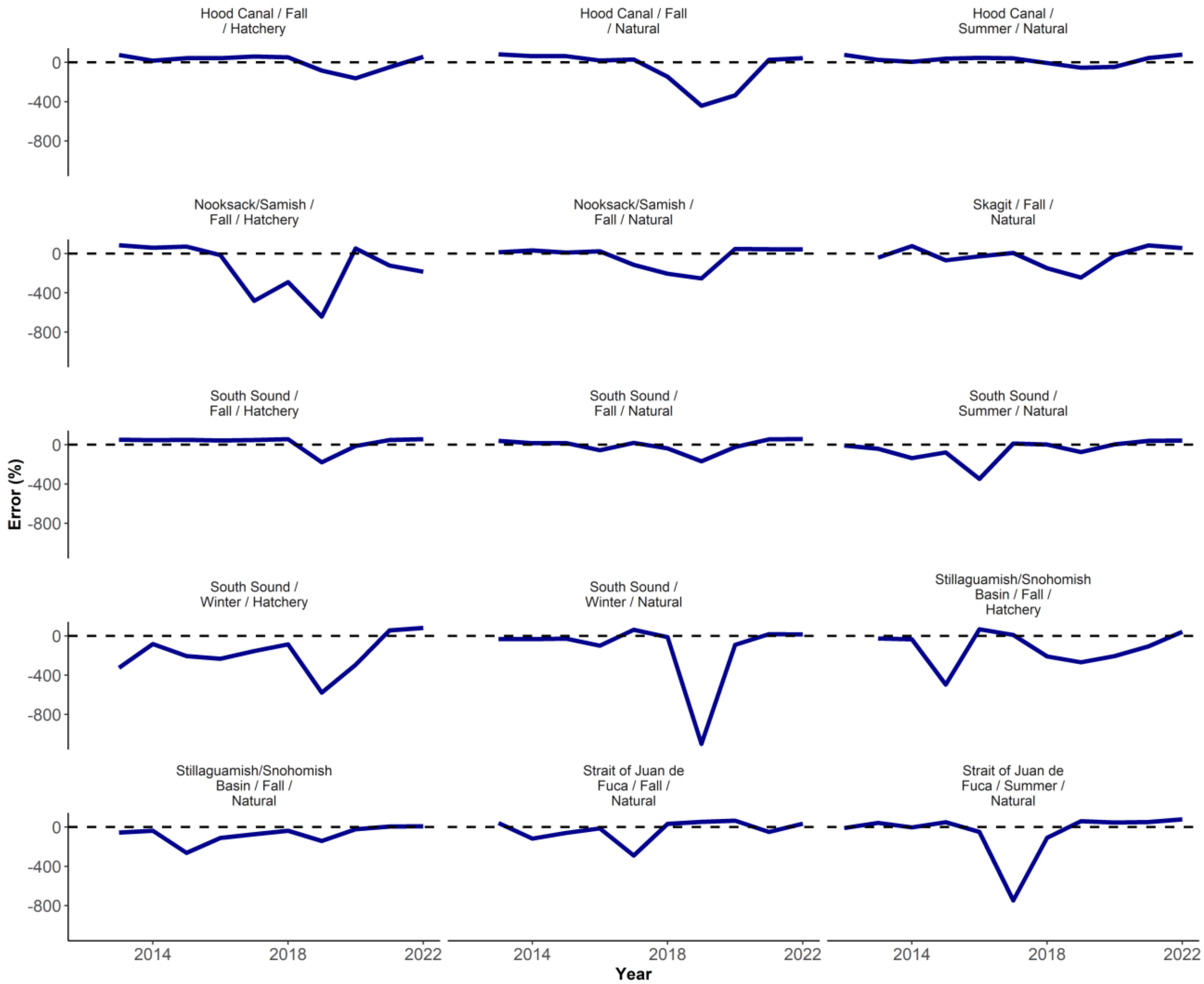


Figure 14. Percent error calculated from agreed-to forecasts compared to observed run size broken down by region and run timing from 2013–2022. The solid blue line indicates calculated percent error for each season and the dashed line indicates the intercept at 0.0% error. Forecasts that underpredict result in positive percent error, whereas over predictions result in negative percent error.

*Pre-season and In-season Sharing and Allocation Agreements*

Pre-season fishery planning and in-season co-management of Puget Sound chum salmon are primarily focused on managing the substantial pre-terminal marine fisheries that target the fall chum runs returning to 1) Hood Canal and 2) South and Central Puget Sound (managed together as "South Puget Sound"), with these two regional aggregates being managed independently. When co-managers determine that either aggregate has sufficient surplus chum salmon available to allow for harvest opportunities, preterminal commercial fisheries directed on these aggregates typically occur in Hood Canal (in Marine Areas 9, 12, 12B, 12C) or in South Puget Sound (Marine Areas 10 and 11).

In addition to these two fisheries, a significant commercial fishery on chum can also occur in North Puget Sound (Marine Areas 6, 7 and 7A) directed towards Canadian chum salmon (Figure 24) transiting

US waters as they return to the Fraser River and other systems in Southern British Columbia. Management of this North Puget Sound fishery is prescribed by the provisions of the Pacific Salmon Treaty chapter on chum salmon and rely on in-season assessments of Canadian chum abundances provided by the Department of Fisheries and Oceans Canada.

Each of these regional aggregates is co-managed with the intent of dividing the harvest opportunity equally between the Treaty Tribes and the all-citizens non-tribal fleet. WDFW prioritizes commercial fisheries for chum salmon over recreational and balances non-tribal fishery structures as such. The non-tribal commercial purse seine and gillnet fleet harvests its allocation pre-terminally in marine waters exclusively. The Treaty Tribes divide their allocation between pre-terminal and terminal fisheries among the regional Tribes' Usual & Accustomed Areas according to various established sharing agreements, which are designed to deliver sufficient fish past the pre-terminal fisheries to achieve escapement objectives and allow for the equitable allocation of harvest opportunities to terminal Tribes. Terminal Tribal fisheries are managed to ensure that escapement objectives are met.

Tribal chum fisheries also may occur pre-terminally in the Strait of Juan de Fuca (Marine Areas 4B, 5 and 6C), although in recent years, effort there has declined, and catches have been small. These pre-terminal catches, and those in the Tribal commercial fishery that occur in the north end of Hood Canal (Marine Area 9, north of the Hood Canal bridge and south of a line connecting Olele Point and Foulweather Bluff) may not be consistently accounted for in regional allocation calculations. Interceptions of South Puget Sound fall chum salmon are estimated based on assumptions of stock composition derived from recent-year GSI analyses in Area 9, north of the Hood Canal Bridge. Central and South Puget Sound Tribal allocation agreements dictate that estimated pre-terminal interceptions of South and Central Puget Sound origin chum salmon are deducted from the South and Central Puget Sound Treaty share of harvestable chum salmon entering Area 10. Stock compositions are estimated from GSI collections taken from 2011 and 2013 - 2023 and an average composition is reviewed in the pre-season during North of Falcon.

The remainder of Marine Area 9 (excluding the north Hood Canal fishery location described above) represents an ongoing challenge to allocate shares and in-season catch based on the diversity of Puget Sound stocks that pass through en route to various regional terminal areas. Additional proposed fisheries in areas such as Marine Area 9 may require updates to sharing plans, as well as to pre-season and in-season allocation calculations, which would necessitate additional assumptions regarding the stock composition of proposed mixed-stock catches, which, for some locations, has proven difficult to measure with independent sampling efforts.

*South Puget Sound Fishery Triggers*

A South Puget Sound data-driven break-point analysis was produced to assist co-managers with identifying a conservation-relevant, in-season threshold or trigger at which to open chum salmon fisheries. For this analysis, escapement data were collected for ten South Puget Sound sub-regions (Puyallup, East Kitsap, Chambers Creek, and Carr, Henderson, Eld, Totten, Skookum, Hammersley, and Case Inlet) from 1968 to 2021. Escapement estimates for some populations such as Chambers are currently under review, but for the purpose of this analysis, inclusion or exclusion does not change the result. These sub-regions represent independent chum salmon populations for which co-managers have identified and agreed to even- and odd-year escapement goals. Despite these even- and odd-year escapement goals South Puget Sound in-season chum salmon have been managed to an aggregate average of even- and odd-year goals from 2018 to 2020. Subsequently, each independent escapement value in the dataset was given a binomial classification: one (if the population met or exceeded the escapement goal), or zero (if the population failed to reach its escapement goal). Using the binomial classification, a percent-goals-met value was calculated for each year to summarize the total percentage of independent South Puget Sound escapement goals met for each of the 54 years in the dataset. Using the percent-goals-met value as a response variable, we examined the effect of total South Puget Sound return abundance. From the data, it was readily apparent that there is a non-linear association and plateau of South Puget Sound return abundances at which escapement goals are met. To identify the approximate abundance at which the plateau formed, a segmented regression model was conducted. The segmented regression identifies a significant change in slope of a linear regression (i.e., a maximum likelihood point estimate) and a standard error interval that accounts for variation in the estimate. The benefit of this model is that it uses reconstructed run size data to account for uncertainties driven by population decline and various fisheries management strategies, pressures, and impacts that have been observed during the past 54 years. While these estimates include non-locals (chum salmon returning to regions other than South Puget Sound), the South Puget Sound-specific estimate can be calculated with the same post-hoc adjustment that is applied to the in-season update model.

The break-point model estimated a slope change with a mean estimate of approximately 426,000, and a standard error interval of 326,000–525,000 (Figure 16). From the model, the change in slope at the mean estimate of 426,000 supports an important turning point for reaching up to 80% of South Puget Sound goals, given that percent goals met above 80% occur infrequently across the dataset. To put that in perspective, only in eight of the past 54 years have we met 80% or more of our escapement goals in South Puget Sound (~14.8% of the time series). From the data, it was also apparent that much variation in percent goals met exists around the lower bound of 326,000 (i.e., black data points in Figure 16), where the mean percent-goals-met at that value is approximately 70% but ranges anywhere from 30% to 80%. However, as the South Puget Sound abundance increases past the mean estimate of 426K, projected confidence in meeting >70% of South Puget Sound escapement goals also increases.

Given that meeting 70% of goals represented the plateau bound, and meeting 80% of goals occurs only 14.8% of the time across the 54-year time series given all available data of escapement in South Puget Sound, we regressed percent-goals-met by year. The analysis suggested that we never reach 100% of our individual South Puget Sound sub-unit goals across the 54-year dataset, even when the South Puget Sound run size exceeds one million chum salmon. In 2007, a year in which the run size surpassed one million chum salmon, we reached 90% of our South Puget Sound goals except for Chambers Creek. However, in 2004, the only other year the run surpassed one million chum, we reached 70% of our South Puget Sound goals. In the last three decades, we characteristically meet or exceed 70–75% of our goals when the run size is above average (~415,000), thereby providing more support for a threshold of 426,000 and above. In the recent decade, some populations in particular – Puyallup, Chambers, Henderson, and Hammersley – have exhibited poor trends despite high variability in returning South Puget Sound run size.  Additionally, this analysis demonstrates over the past decade our percent-goals-met has declined, which correlates with the decline in return abundance observed during the same period. This suggests that as the total returning run size has declined, we have increasingly missed our escapement goals. To address whether this decline in meeting escapement was associated with harvest, we conducted a non-linear regression of percent goals met with harvest percent (i.e., percent of the total run size harvested). This regression suggested that while harvest percent is negatively associated with percent-goals-met only when approximately 70% of the total returning run size or greater is harvested. However, a simple linear regression suggested that the strength of that relationship is rather poor, which means that other factors affecting survival (i.e., environmental) are likely more important than harvest impact when determining whether South Puget Sound goals are met or failed to be met. It also suggests that escapement goals for some South Puget Sound populations may not be reasonable or biologically based. Using the break-point analysis to identify a trigger, we inherently account for the uncertainty in these real impacts.

Following the late August 2021 co-manager meeting at which the break-point model was discussed, it was suggested that Nisqually winter chum should be included. As such, we conducted a separate break-point analysis including the effect of Nisqually winter chum. The model also identified a mean estimate of approximately 426,000, but with a larger standard error bound of 308,000–544,000. Inclusion of Nisqually winter chum increases the mean estimate and dramatically increases the uncertainty of the threshold trigger point (i.e., variation identified by the standard error bounds). Given that the mean estimate of 426,000 remains relatively consistent with the South Puget Sound fall only analysis, the large confidence range demonstrates high uncertainty. However, using data from 1968–2021, Nisqually winter chum (NWC) abundance shows a 59% correlation with South Puget Sound fall chum abundance; and in the recent decade a 71% correlation is observed between fall and NWC abundance. Overall, much of the uncertainty is reduced as the run size approaches 500,000. As such, the mean estimate of 426,000 to an upper bound of 500,000 represents a reasonable possible range at which to trigger a Treaty and non-treaty fishery. For reference, for 2021-2023 fishing seasons, co-managers agreed to a trigger of 460,000 that was derived in the original 2021 analysis.

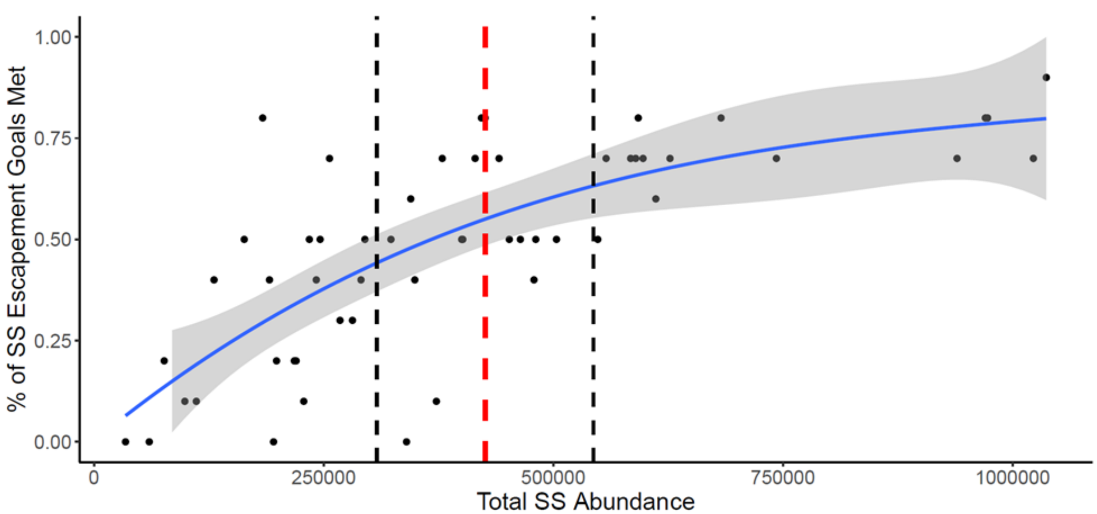


Figure 15. Break-point analysis to identify South Puget Sound (SS) fisheries trigger using data from 10 sub-populations of fall chum from 1968–2022. The blue line represents the mean relationship between

percent goals met and total returning South Puget Sound run size, the gray band represents the 95% confidence bound of that relationship, the red dotted line represents the mean break-point estimate, the black dotted lines represent the standard error bounds of the mean estimate, and the black dots represent actual data points applied in the regression.

In 2022 and 2023, co-managers implemented a separate trigger to prosecute limited fisheries when the run size is below 460,000. Specifically, when the in-season predicted run size, or in-season update (ISU)is between 350,000 and 460,000, the state and Tribes have implemented limited effort quota-based fisheries. These limited pre-terminal fisheries have often resulted in lower-than-expected catch, below the quota targets, and have had minimal effect on stocks of concern based on genetic sampling collection.

### *Commercial Effort*

Chum salmon are harvested at different rates by Tribal and non-tribal fishers, primarily a result of the different gear types used, and whether the fisheries occur predominantly in pre-terminal mixed-stock marine areas, in terminal marine areas, and in freshwater. Non-tribal fisheries use both gillnet and purse seine gears, and WDFW allocates commercial salmon harvest opportunities for each gear group based on time spent on the water. Once WDFW has a designated catch share based on co-manager agreement, WDFW manages fisheries to achieve escapement and broodstock goal objectives, minimize by-catch of non-target species, and abides Revised Code of Washington 77.04.012 - to maintain the economic well-being and stability of the fishing industry, and Revised Code of Washington 77.50.120 - to allow a sustainable level of harvest sufficient to provide opportunity for each gear type. Non-tribal fisheries primarily use commercial gear in marine areas of Puget Sound and recreational gear in freshwater, while the Tribes use commercial gear in both pre-terminal and terminal marine areas and in terminal freshwater areas, as are their legal rights, as reserved in the Stevens' Treaties (1855) reaffirmed by the 1974 Boldt Decision in *US v. Washington*. These area-specific fisheries are also designed based on inter-Tribal sharing agreements, as there are certain Treaty Tribes that have U&A in pre-terminal marine areas. Most of the chum salmon harvest in Puget Sound is attributed to commercial fisheries occurring in Hood Canal and South Puget Sound (Figure 17, Figure 25, Table S2, Table S3). Commercial fishing effort has notably decreased in the recent decade (Figure 17), primarily due to declining returns and a conservation-based management approach, including measures such as limited participation effort and quota-based management agreements at low in-season run sizes (Table 6). Given the reduced effort in recent years, the co-managers continue to review improvements to pre-season and in-season catch estimation processes that support sustainable harvest management.

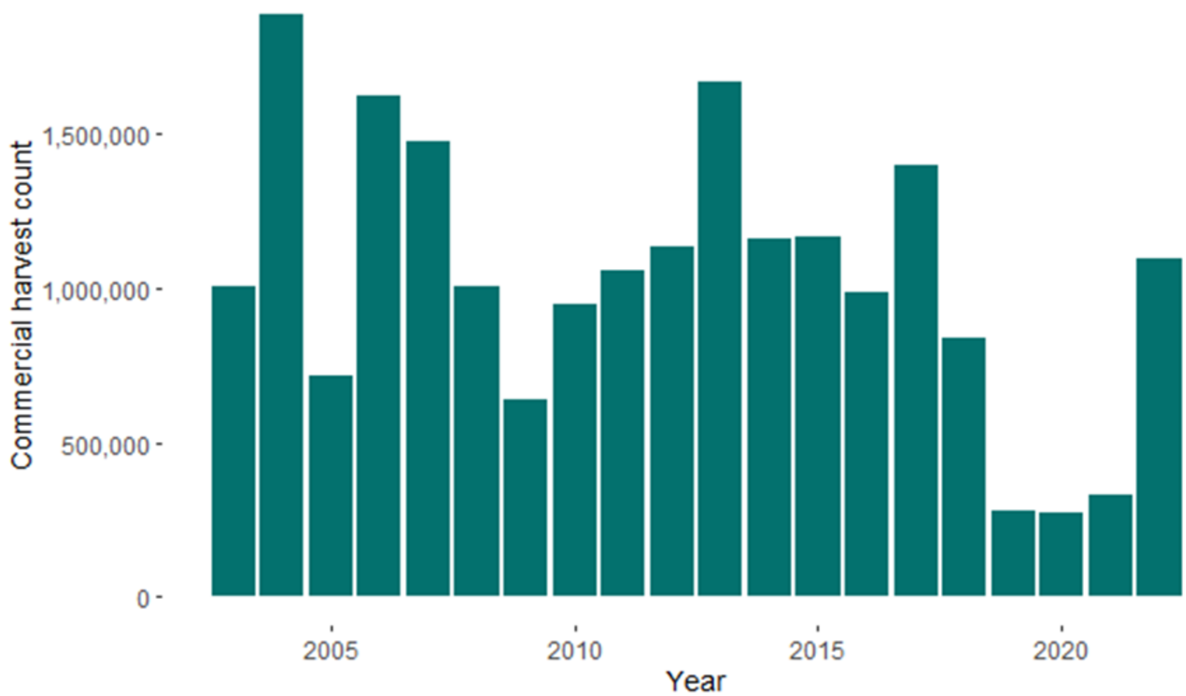


Figure 16. Chum salmon harvest in Puget Sound by commercial fishers from 2003–2022. Both natural and hatchery origin fish, and Tribal and non-tribal fishers, are included here. These data were pulled from TOCAS (Apr. 12, 2024), filtering to only the “commercial fishery” disposition from both terminal and pre-terminal areas. The data are subject to change based on ongoing reconciliations.

Table 6. Number of active non-tribal commercial chum fishers in Puget Sound using a gillnet or purse seine over the past 10 years (2014–2023).

| Year | Count of active purse seine net licenses | Count of active gillnet licenses |
|---|---|---|
| **2014** | 74 | 101 |
| **2015** | 74 | 103 |
| **2016** | 71 | 96 |
| **2017** | 72 | 100 |
| **2018** | 72 | 110 |
| **2019** | 67 | 74 |
| **2020** | 53 | 70 |
| **2021** | 42 | 40 |
| **2022** | 53 | 52 |
| **2023** | 30 | 30 |

### *Fishery Management Tools for Stocks of Concern*

When stocks are forecasted to not reach escapement objectives (i.e., stocks of concern), fishery managers have considered conservative management approaches to reduce fishery related impacts. For example, in 2023, natural origin Nisqually winter chum salmon were forecasted below the escapement goal of 25,000. In response, Areas 10 and 11 fall chum Tribal and non-tribal fisheries planned to reduce impacts to NWC to 8% or less of the preseason forecast in 2023. The proposed 8% impact rate was developed via the Statewide Steelhead Management Plan (WDFW 2008), which supports evaluation of potential impacts to Puget Sound steelhead listed as threatened under the ESA. This risk assessment was subsequently applied within the 2004-2010 Chinook Resource Management Plan, to ensure that fishery impacts to Puget Sound steelhead would not impede recovery (WDFW and PSTIT 2010). NWC impacts are estimated in-season based on GSI data from South Puget Sound commercial and test fisheries.

## In-season Agreements and Assessments

### *Test and Data Sampling Fisheries*

To inform co-managers on the status of chum salmon returns, marine test fisheries are operated in-season across Puget Sound. Since 1981, a test fishery known as the Apple Cove Point (ACP) test fishery has occurred to assess chum salmon catch-per-unit-effort (CPUE) near Kingston, along the west end of the Marine Area 9 and 10 boundary. This test fishery employs a single purse seine vessel that conducts between six to seven sets during one day per week from management weeks 41–46 or 47. The ACP test fishery also collects 200 fin clips and scale samples each week, along with biological data such as fork lengths and the ratio of females to males. Starting in 2022, a single purse seine in West Pass (West of Vashon Island) and a single purse seine in East Pass (East of Vashon Island), both in Marine Catch Area 11, conducted six to seven sets one day per week from management weeks 42 to 46. On each of these vessels, 200 fin clips and scale samples are collected each week, as well as biological data. Finally, a single purse seine in Area 9, north of Hood Canal bridge, conducts sets until a sample size of 200 chum are fin clipped and scales sampled, and all fish are released at that site.

Table 7. A list of Puget Sound pre-terminal chum salmon test fisheries, hydroacoustic sampling, and associated dates and goals that occurred in 2023–2024.

| Collection name | Marine Area | Duration | Data collected | Commissioner | Use |
|---|---|---|---|---|---|
| Purse seine test (Single vessel) | 9/10 boundary | 6 Weeks (41–46) | South Puget Sound census, stock composition, and age | NWIFC | ISU, and stock composition for in-season management and run reconstruction. |
| Purse seine GSI (Single vessel, 200 samples/week) | 9/10 boundary | 2 Weeks (47–48) | South Puget Sound stock composition and age | NWIFC | Identify pre-terminal winter chum timing. |
| Hydroacoustic sampling boat | 9/10 boundary | 7 Weeks (41–47) | South Puget Sound chum detection and abundance | WDFW | Detect chum in test fishing area, and, in the postseason, evaluate abundance by space and time. |
| Purse seine GSI (Single vessel, 200 samples/week) | 9 (above Hood Canal Bridge) | 5 Weeks (42–46) | Stock composition and age | WDFW, NOAA | Stock composition for in-season management and RR. Collect spatially and temporally consistent weekly GSI applicable to Hood Canal and other areas (North, Central and South Puget Sound, and Canada). |
| Commercial GSI sampling (tender collection point, 200 samples/area/week)) | 10, 11 | 5 Weeks (42–46) | Stock composition and age | WDFW | Commercial fishery stock composition GSI for run reconstruction. |
| Purse seine Test (Two vessels + GSI) | 11 | 5 Weeks (42–46) | Stock composition, census, and age | WDFW | Stock composition for in-season management and run reconstruction. |

NWIFC and WDFW both commission test fishery and fishery-independent data sampling across marine areas of Puget Sound to determine the abundance and age of adult chum salmon returning to Puget Sound and their associated stock compositions.

From 2016 through 2023, the Pacific Salmon Commission Chum Technical Committee also conducted a research fishery for chum salmon on both the Canadian and US sides of the Strait of Juan de Fuca (Marine Catch Area 5 on the US side), targeting 200 scales and genetic samples from each side each week starting in late September and running through early November. This project was completed in 2023.

### *Genetic Stock Identification*

Genetic stock identification (GSI) provides a valuable tool in estimating stock-specific harvest impacts. Historically, we have processed chum genetic data postseason from the ACP test fishery and from various state and Tribal commercial fisheries (Figures 18 - 24), which can in turn be utilized in run reconstructions. In 2023, the co-managers initiated a process to analyze and evaluate genetic collections in-season with the goal of assessing stock specific impacts, thereby reducing impacts on stocks of concern. For example, in South Puget Sound, co-managers agreed to use historical data, along with in-season GSI results, to predict the composition of Puget Sound winter chum salmon and account for fishery impacts.

In 2023, sampling of chum salmon genetic tissues occurred onboard four test fishing vessels (ACP, North of Hood Canal Bridge, and two vessels in Area 11 East and West pass), as well as during commercial fisheries. A sample size of 200 tissues was targeted from each test fishing vessel in each week, as well as 200 from each gear type in each area in each week from commercial fisheries. Please see the detailed protocols distributed to chum co-managers September 14, 2023. A subset of up to 600 tissues collected from test fisheries are analyzed in-season each week, with results available at co-manager meetings in the following week. Remaining samples from test fisheries and samples collected in commercial fisheries are processed postseason.

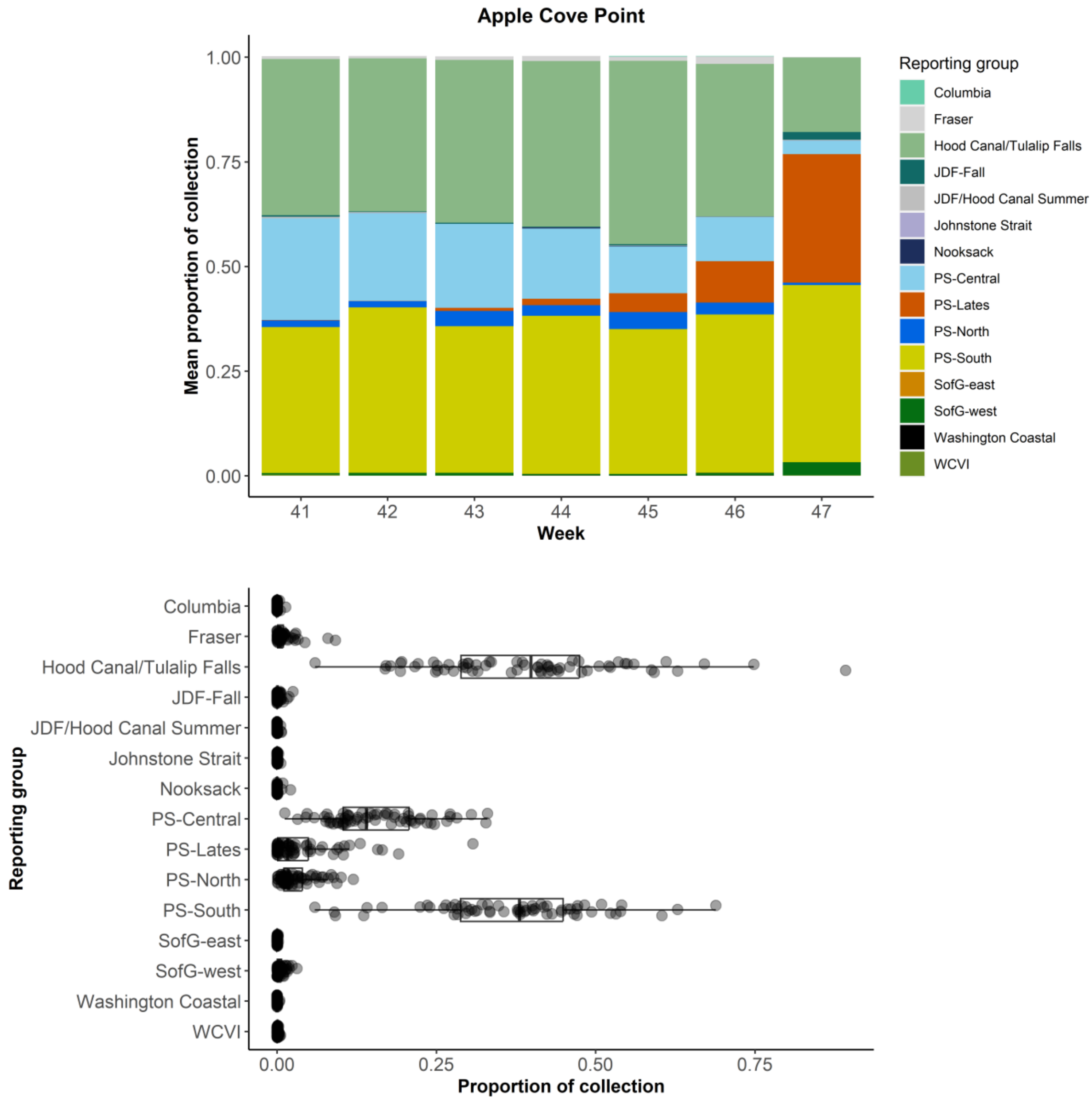


Figure 17. Mean weekly proportion (top panel) and distribution of proportion (bottom panel) of genetic reporting groups collected in the Apple Cove Point (ACP) test fishery from 1996–2023 (n = 10,043). Reporting groups represented include Columbia River, Fraser River, Hood Canal summer (JDF/Hood Canal Summer), Johnstone Strait, Nooksack River, Central Puget Sound fall (PS-Central), South Puget Sound winter (PS-Lates), North Puget Sound (PS-North), South Puget Sound fall (PS-South), East Strait of Georgia (SofG-east), West Strait of Georgia (SofG-west), Hood Canal and Tulalip fall (Hood Canal/Tulalip Falls), Washington Coastal, and West Coast Vancouver Island (WCVI).

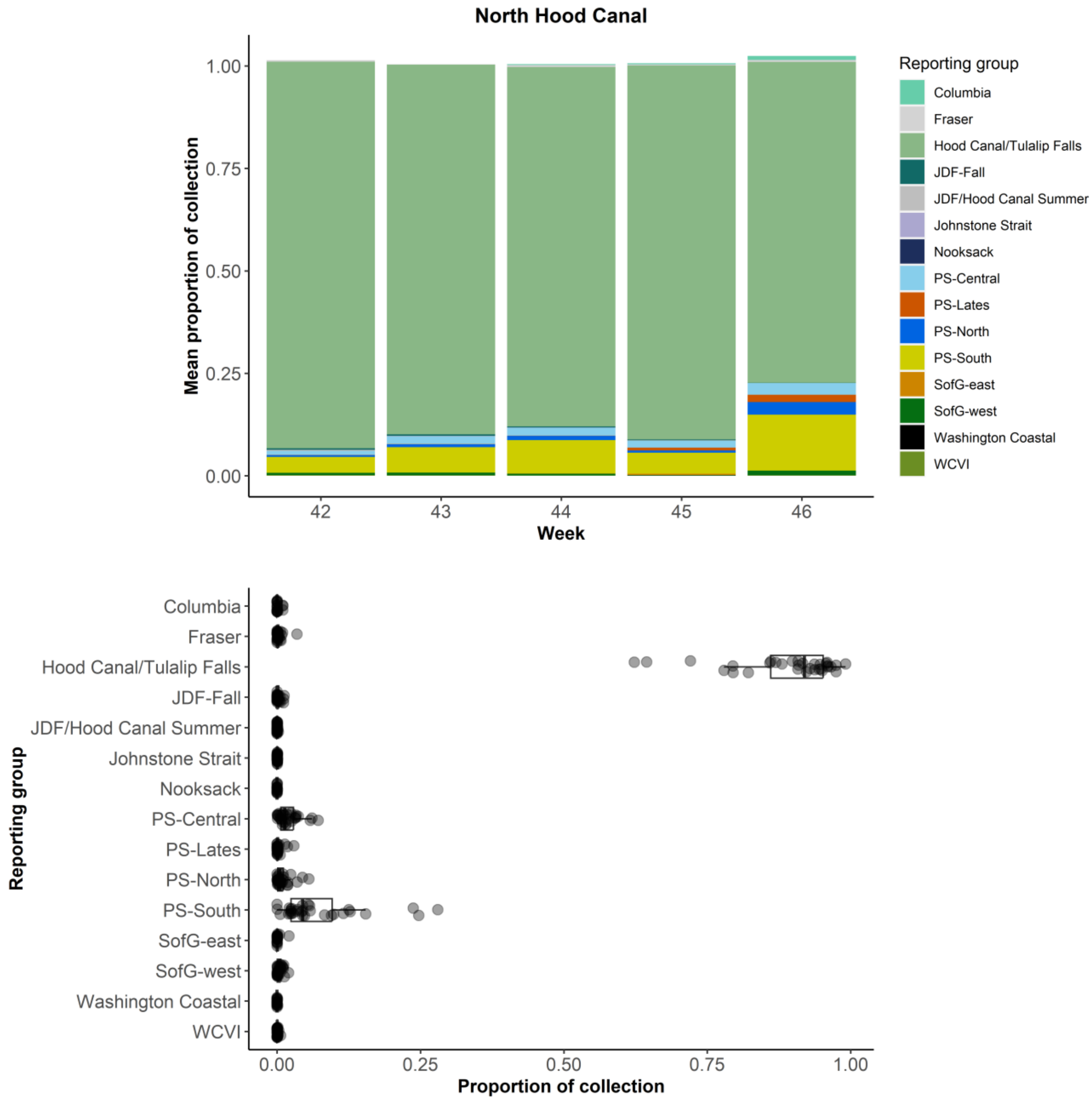


Figure 18. Mean weekly proportion (top panel) and distribution of proportion (bottom panel) of genetic reporting groups collected in North Hood Canal Tribal commercial fisheries from 2011–2021, and from test fisheries in 2022–2023 (n = 5,399). Reporting groups represented include Columbia River, Fraser River, Hood Canal summer (JDF/Hood Canal Summer), Johnstone Strait, Nooksack River, Central Puget Sound fall (PS-Central), South Puget Sound winter (PS-Lates), North Puget Sound (PS-North), South Puget Sound fall (PS-South), East Strait of Georgia (SofG-east), West Strait of Georgia (SofG-west), Hood Canal and Tulalip fall (Hood Canal/Tulalip Falls), Washington Coastal, and West Coast Vancouver Island (WCVI).

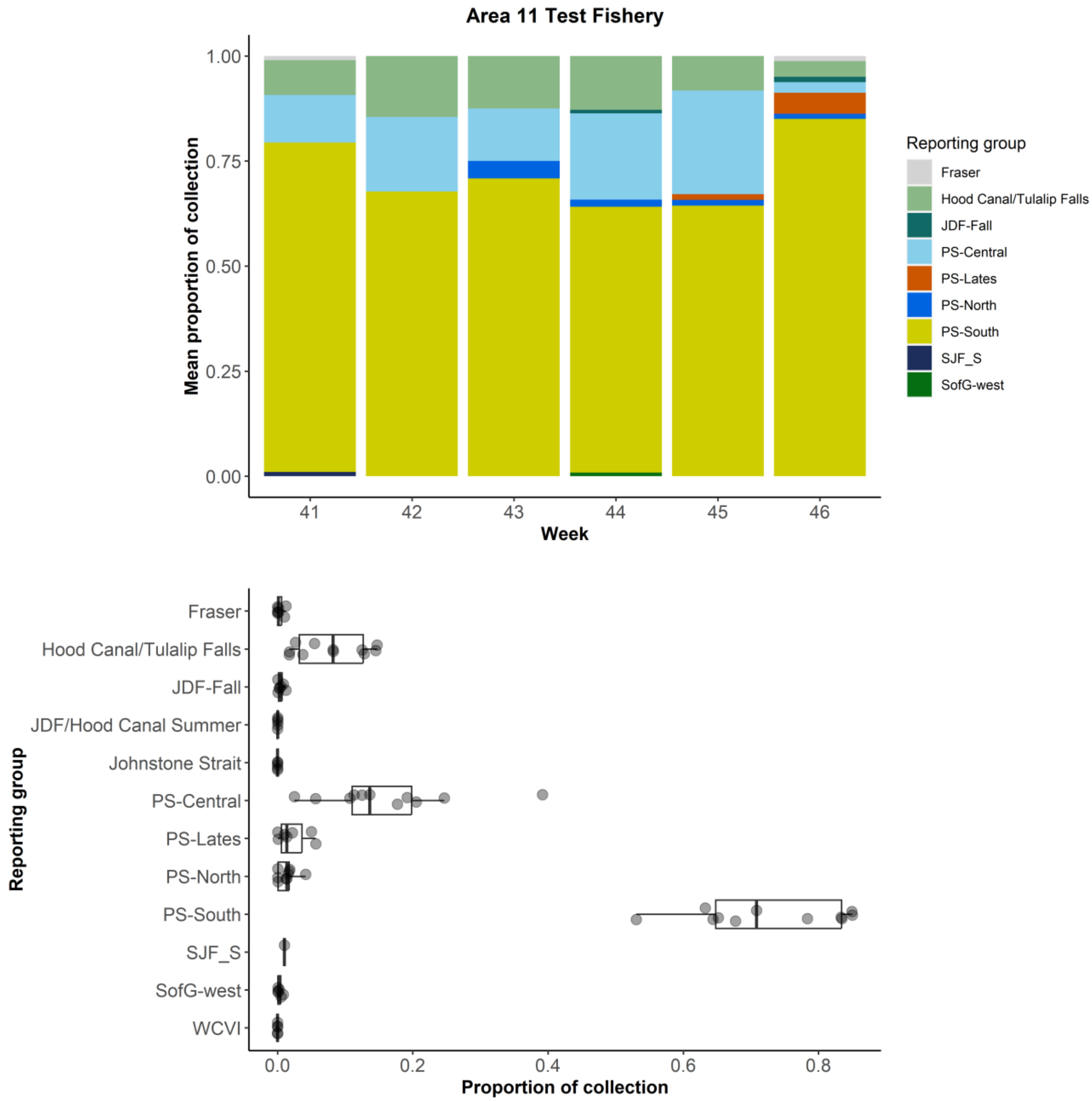


Figure 19. Mean weekly proportion (top panel) and distribution of proportion (bottom panel) of genetic reporting groups collected from Area 11 test fisheries from 2022–2023 (n = 2,025). Collections in 2023 were pooled from two test vessels due to low sample sizes in some weeks. Reporting groups represented include Columbia River, Fraser River, Hood Canal summer (JDF/Hood Canal Summer), Johnstone Strait, Nooksack River, Central Puget Sound fall (PS-Central), South Puget Sound winter (PS-Lates), North Puget Sound (PS-North), South Puget Sound fall (PS-South), East Strait of Georgia (SofG-east), West Strait of Georgia (SofG-west), Strait of Juan de Fuca summer (SJF_S), Hood Canal and Tulalip fall (Hood Canal/Tulalip Falls), Washington Coastal, and West Coast Vancouver Island (WCVI).

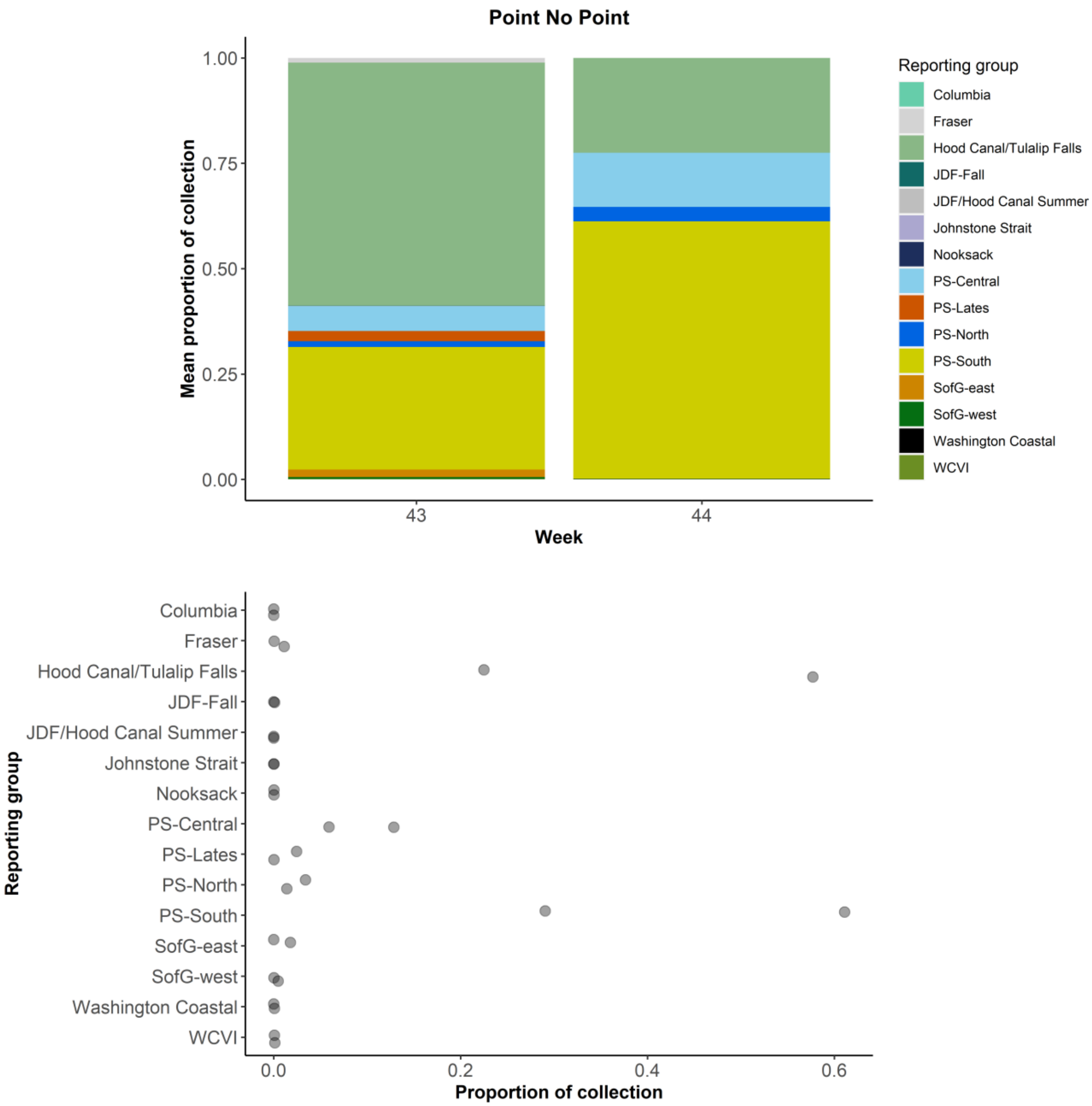


Figure 20. Mean weekly proportion (top panel) and distribution of proportion (bottom panel) of genetic reporting groups collected at Point No Point in 2018 (n = 313). Reporting groups represented include Columbia River, Fraser River, Hood Canal summer (JDF/Hood Canal Summer), Johnstone Strait, Nooksack River, Central Puget Sound fall (PS-Central), South Puget Sound winter (PS-Lates), North Puget Sound (PS-North), South Puget Sound fall (PS-South), East Strait of Georgia (SofG-east), West Strait of Georgia (SofG-west), Hood Canal and Tulalip fall (Hood Canal/Tulalip Falls), Washington Coastal, and West Coast Vancouver Island (WCVI).

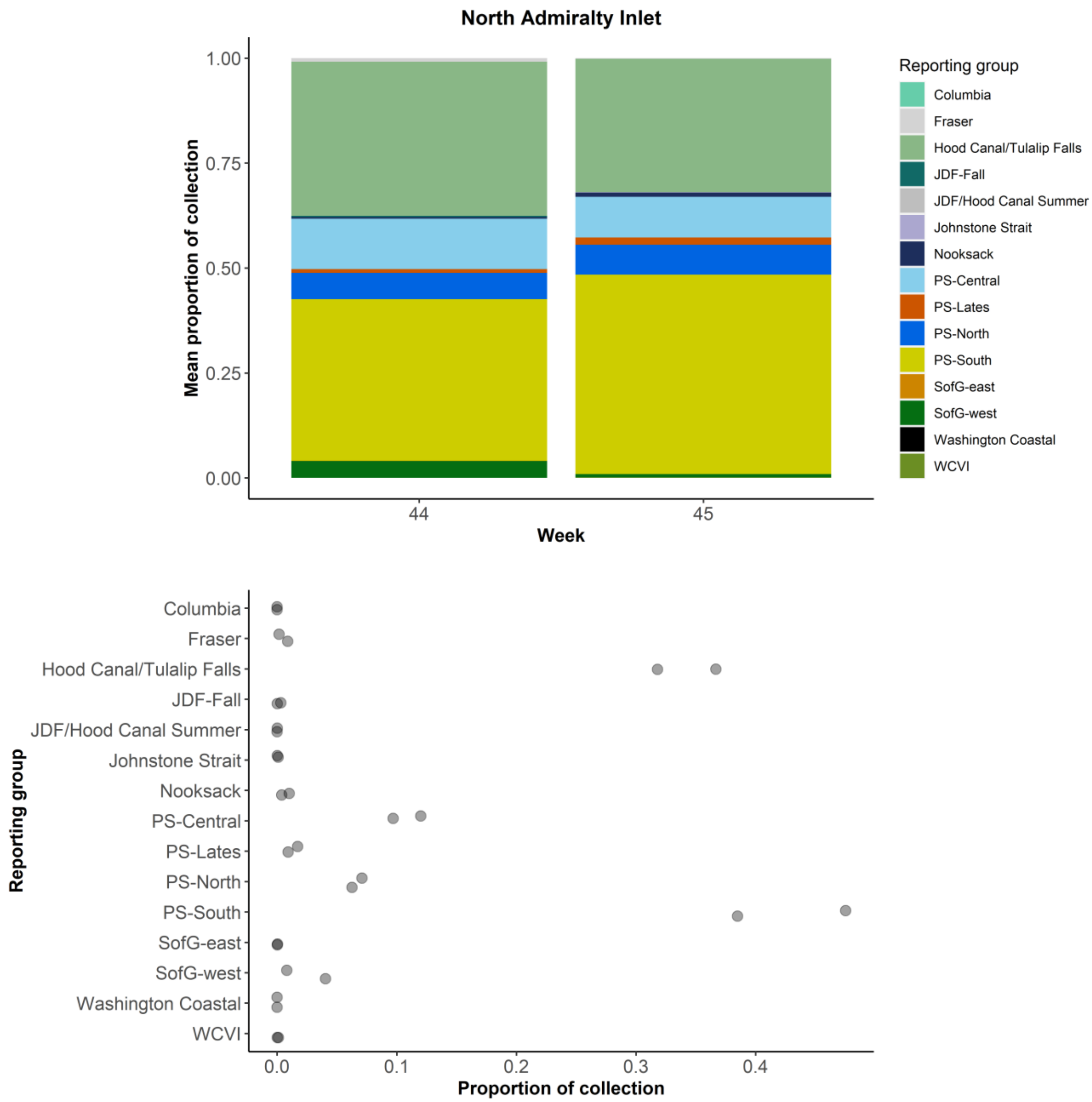


Figure 21. Mean weekly proportion (top panel) and distribution of proportion (bottom panel) of genetic reporting groups collected at North Admiralty Inlet in 2018 (n = 382). Reporting groups represented include Columbia River, Fraser River, Hood Canal summer (JDF/Hood Canal Summer), Johnstone Strait, Nooksack River, Central Puget Sound fall (PS-Central), South Puget Sound winter (PS-Lates), North Puget Sound (PS-North), South Puget Sound fall (PS-South), East Strait of Georgia (SofG-east), West Strait of

Georgia (SofG-west), Hood Canal and Tulalip fall (Hood Canal/Tulalip Falls), Washington Coastal, and West Coast Vancouver Island (WCVI).

*Commercial Fisheries Stock Composition Evaluation*

In response to the decline of chum salmon, co-managers have implemented harvest management actions, which have proven effective at ensuring escapement goals are met for some stocks (See Harvest Management Section). However, some stocks continue to decline. As such, co-managers have agreed to pre-season and in-season stock composition evaluations that provide a valuable tool to ensure the sustainability of pre-terminal fisheries.

Pre-terminal fisheries occurring in marine areas are considered mixed-stock fisheries because chum salmon often mill or stray from a direct migration route once entering the Puget Sound and before entering the freshwater to spawn. Since natural origin chum salmon abundances have declined in most basins, Tribal and WDFW hatchery production has helped support Tribal and non-tribal fishing opportunities. Because chum salmon from most hatcheries are not fin clipped, pre-terminal fisheries are conducted without information on the contributions of specific stocks or hatchery programs. Some hatcheries, such as Kendall Creek Hatchery and Marblemount Hatchery, have implemented tools to identify hatchery released fry (i.e., otolith thermal marks and parentage-based genetic tagging). At this time hatchery and natural origin identification tools have not been integrated into pre-terminal fishery management. As such, WDFW and the Tribes have implemented tissue collection programs of chum salmon caught in Puget Sound chum salmon directed fisheries and test fisheries and apply genetic stock identification to assess which chum salmon stocks are in a particular marine area by management week. To best identify components of mixed-stock fisheries and test fisheries, WDFW and the Tribes use the SNP baseline as described in the population structure section of this review.

Recent evaluation of stock composition – via the SNP baseline – in mixed stock chum salmon directed fisheries in Puget Sound has determined that Hood Canal hatchery production and South Puget Sound natural origin chum are the major contributors to pre-terminal fisheries (Figure 25).

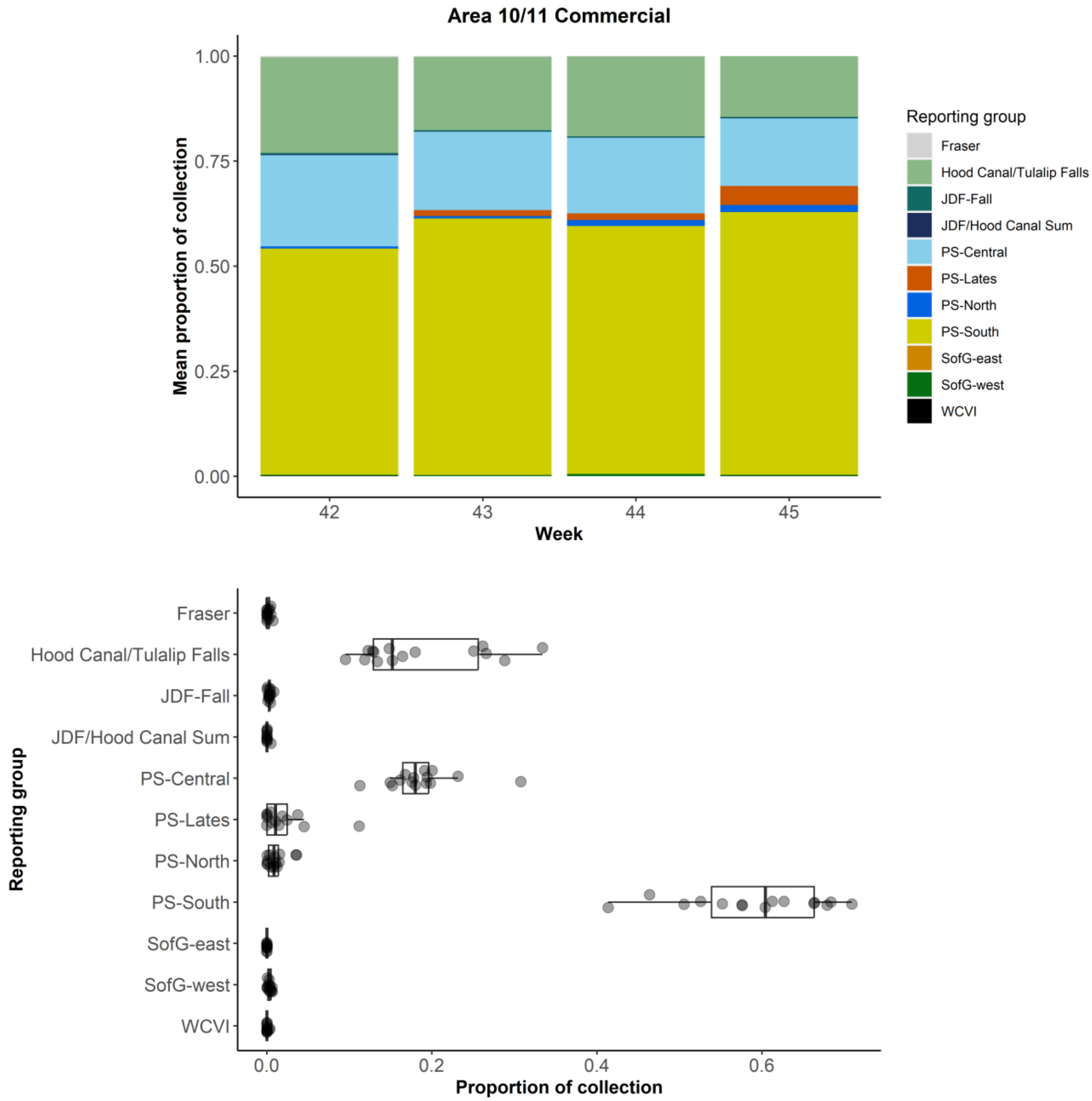


Figure 22. Mean weekly proportion (top panel) and distribution of proportion (bottom panel) of genetic reporting groups collected in Area 10 and 11 non-tribal and Tribal commercial purse seine and gillnet fisheries (n = 4,975). Reporting groups represented include Columbia River, Fraser River, Hood Canal summer (JDF/Hood Canal Summer), Johnstone Strait, Nooksack River, Central Puget Sound fall (PS-Central), South Puget Sound winter (PS-Lates), North Puget Sound (PS-North), South Puget Sound fall (PS-South), East Strait of Georgia (SofG-east), West Strait of Georgia (SofG-west), Hood Canal and Tulalip fall (Tulalip/Hood Canal Falls), Washington Coastal, and West Coast Vancouver Island (WCVI).

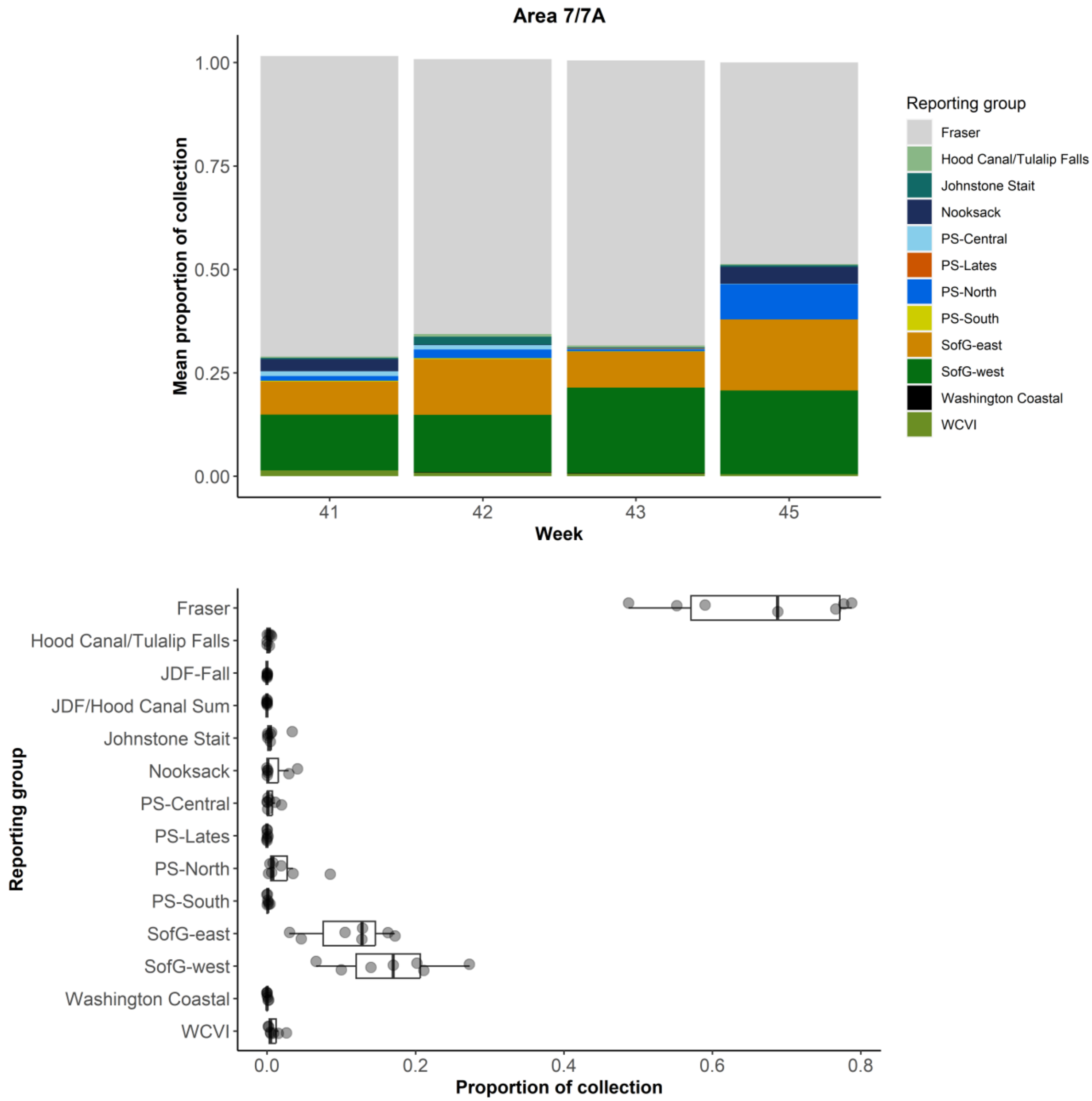


Figure 23. Mean weekly proportion (top panel) and distribution of proportion (bottom panel) of genetic reporting groups collected in Area 7/7A commercial fisheries (n = 1,779). Reporting groups represented include Columbia River, Fraser River, Hood Canal summer (JDF/Hood Canal Summer), Johnstone Strait, Nooksack River, Central Puget Sound fall (PS-Central), South Puget Sound winter (PS-Lates), North Puget Sound (PS-North), South Puget Sound fall (PS-South), East Strait of Georgia (SofG-east), West Strait of Georgia (SofG-west), Hood Canal and Tulalip fall (Tulalip/Hood Canal Falls), Washington Coastal, and West Coast Vancouver Island (WCVI).

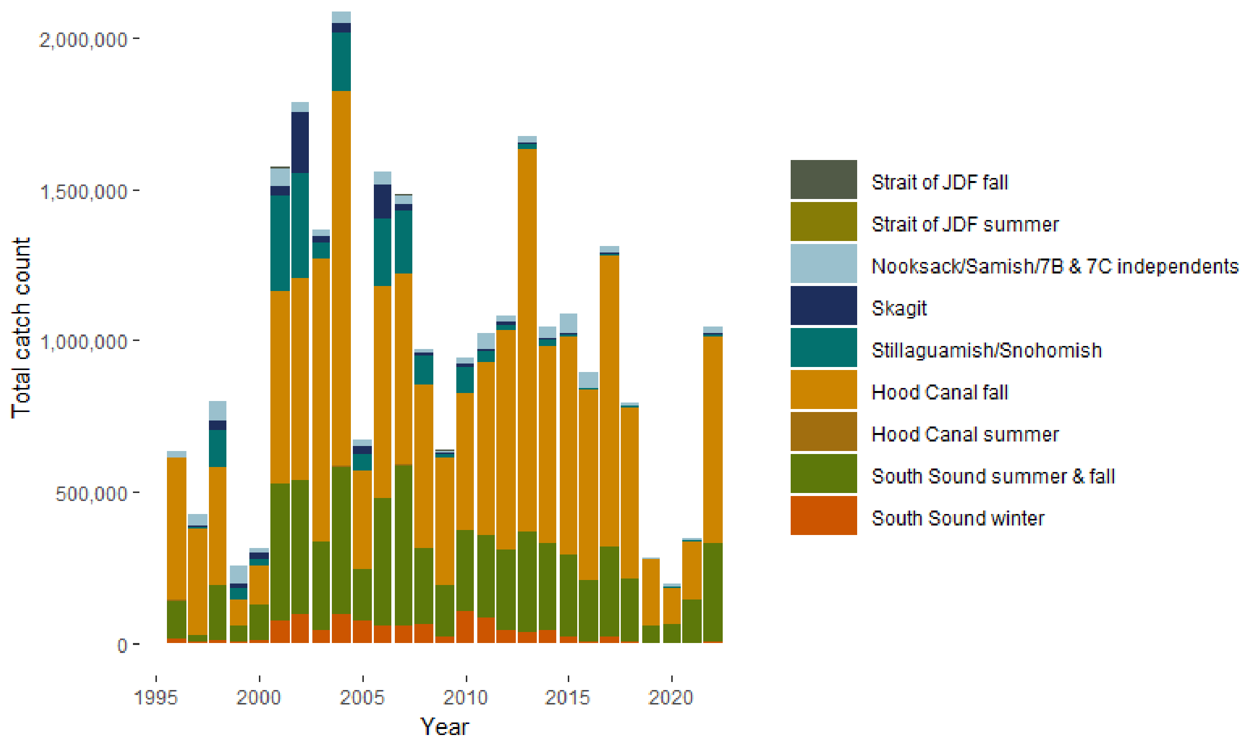


Figure 24. GSI reconstructed total chum salmon catch by year, timing, and geographic region of fish origin for Puget Sound from 1996 to 2021. This data includes commercial, recreational, Tribal, preterminal, and terminal catches and does not differentiate between hatchery and natural origin fish.

*Hydroacoustics*

A hydroacoustic monitoring program was initiated in 2022 and carried into 2023. Chum salmon are detected via a dual-frequency split-beam hydroacoustic array in the general area of Kingston, Washington in Marine Areas 9 and 10 (Figure 1) from management weeks 41 to 47.  The survey area is identified as the historical extent of the ACP test fishery (Figure 26) and includes eleven transect lines, equally spaced, approximately 250 m apart. Hydroacoustic survey transects are conducted to determine the relative spatial and temporal strength of the Central and South Puget Sound chum return. Hydroacoustic detection of chum salmon in Puget Sound are used to supplement net data from the traditional ACP test fishery and provide co-managers with more spatial resolution on where chum salmon are migrating or milling.

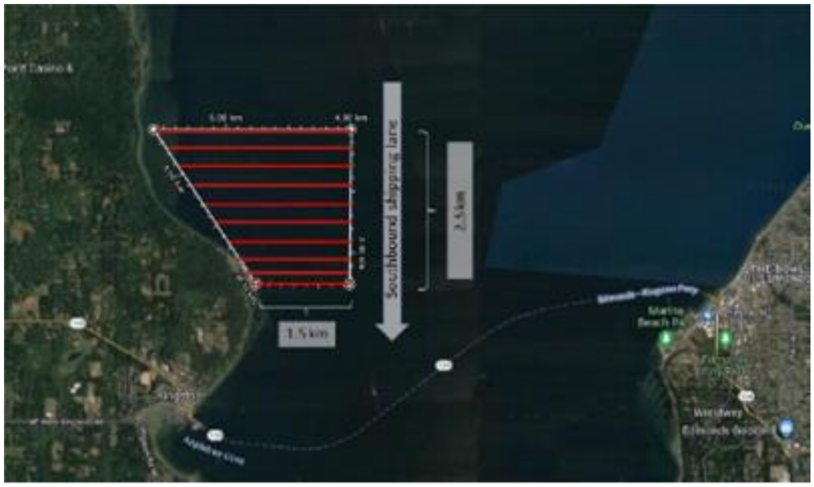


Figure 25. Map of Apple Cove Point test fishing area near Kingston, Washington. White outline indicates the largest extent of the test fishing area. Red lines indicate approximate locations of survey transect lines. The southbound shipping lane represents the eastern extent of the sampling area. The southern extent is a straight line from the Apple Cove marker (47.81, -122.48) out to 1.5km offshore, and 2.5km to the north. The western extent follows the shallowest possible depth contour to safely navigate.

Potential chum targets were identified from the upper 50 m of the survey area, as previous studies have indicated most chum salmon travel in the upper 50 m of the water column (Urawa et al., 2018) in marine and estuarine waters. Single target detection was applied to the upper 50 m region of the 38 kHz data to identify potential chum targets. A target strength threshold of -55 dB was used to identify potential chum targets, based on previous literature (Minami et al., 2022).

To define the sample area for analysis, acoustic data was binned into 10 m depth bins by 25 m transect distance bins, examining spatial patterns of chum salmon distribution in the survey area. Single targets were combined over the entire survey because the ACP test fishery total catch is combined over the entire survey day, making the scales more comparable by day. The proportion of chum caught in the test fishery was used to assign proportion of single targets detected in the acoustic survey as chum (Table 8).

Table 8. Total catch and total chum by week and year collected during the Apple Cove Point test fishery in 2022 and 2023. Proportion chum is applied to acoustic detections to approximate the number of chum acoustic detections. Total acoustic detections and estimated chum detections are also shown. N/A indicates sampling was not done that week.

| Year | Week | Total chum | Total fish | Proportion chum | Total acoustic detections | Estimated chum detections |
|---|---|---|---|---|---|---|
| **2022** | 41 | 414 | 527 | 0.79 | 7,585 | 5,959 |
| | 42 | 819 | 917 | 0.89 | 5,681 | 5,074 |
| | 43 | 3,242 | 3,335 | 0.97 | 3,525 | 3,427 |
| | 44 | 5,526 | 5,590 | 0.99 | 4,444 | 4,393 |
| | 45 | 3,046 | 3,098 | 0.98 | N/A | N/A |
| | 46 | 330 | 334 | 0.99 | 2,254 | 2,227 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | 41 | 407 | 470 | 0.87 | 1,396 | 1,209 |
| | 42 | 736 | 784 | 0.94 | 2,969 | 2,787 |
| | 43 | 376 | 412 | 0.91 | 989 | 903 |
| **2023** | 44 | 1,851 | 1,922 | 0.96 | 2,558 | 2,464 |
| | 45 | 560 | 596 | 0.94 | 1,456 | 1,368 |
| | 46 | 162 | 187 | 0.87 | 795 | 689 |
| | 47 | 50 | 67 | 0.75 | 1,542 | 1,151 |

Preliminary results from 2022 and 2023 indicated a strong relationship between total estimate chum detections and test catch produced by the ACP purse seine vessel. Chum detections varied by year, week, and depth in the water column (Figure 27). Total detections were higher in 2022 than 2023, which was consistent with test fishing data during these years. In 2023, highest acoustic detections were observed in weeks 41 and 42 with detections generally found deeper in the water column (Figure 27). Depth distribution was more consistent in later weeks in 2022. In 2023, there was not a strong pattern in depth distribution by week.

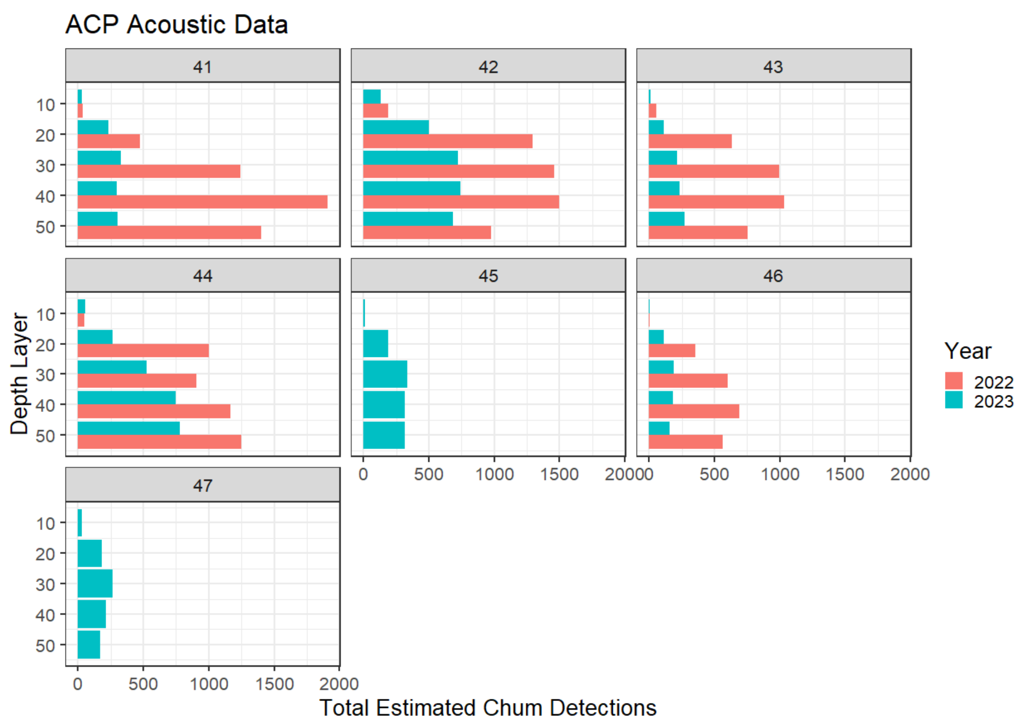


Figure 26. Total estimated acoustic detections of chum salmon (years 2022–2023) in the water column from depths of 0 to 50 meters, parsed by management week and sampling year. The last weeks of the Apple Cove Point (ACP) test fishery (week 45 in 2022 and week 47 in 2023) were only used to collect genetic samples instead of the full number of sets, so the correlation between ACP test fishery catch and acoustic chum detections is not as strong.

Chum detections were further combined into overall depth bins by survey year and week to directly compare to ACP test fishery catch (Figure 28). Overall, we observed a relationship between the total ACP test fishery catch and the number of estimated chum detections in the ACP survey area (Figure 28).

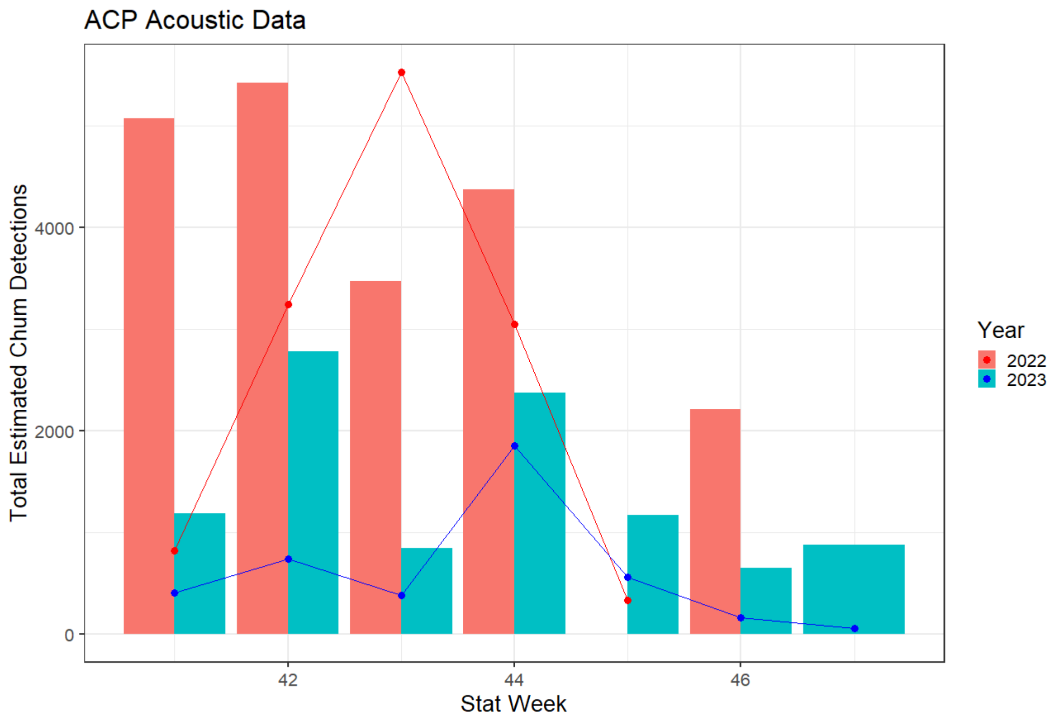


Figure 27. Total estimated chum detections over the entire survey area and all depth bins by survey week and year (bars) as compared to total chum catch during the ACP test fishery (line) in years 2022 and 2023.

### *Central and South Puget Sound Stream Assessments*

In-season, regional biologists from Central and South Puget Sound provide weekly dead/live counts from their surveyed streams. These survey estimates are placed into projection models to determine if the stock is on track to meet escapement goals. South Puget Sound streams that are evaluated and modeled in-season include Sherwood Creek, Coulter Creek, Johns Creek, and Kennedy Creek. In Central Puget Sound, in-season assessments include Chico Creek watershed, Yukon-Harbor watershed (Curley Creek), and Blackjack Creek watershed. Live counts from tributaries that have associated escapement goals are evaluated weekly to predict whether escapement goals will be met. Terminal inlet fishing schedules are typically dependent on inlet specific tributaries meeting escapement goals. Hood Canal Hatchery Assessments

In-season, regional hatchery biologists from Hood Canal provide weekly updates on brood stock take and percentage of goal achieved at both Hoodsport and McKernan hatcheries. These progress reports are provided weekly during co-manager fishery management meetings.

### *In-Season Update (ISU) Models*

For each of the two regions where returning chum salmon are predominantly harvested in Puget Sound – South Puget Sound and Hood Canal – co-managers employ ISU models for chum salmon abundance that are both fishery dependent and fishery independent. In South Puget Sound, ISUs primarily rely on test fishing at ACP along the Marine Areas 9 and 10 line that is conducted weekly by a single purse seine vessel. In Hood Canal, ISUs primarily rely on the non-tribal commercial purse seine fishery that operates weekly in Marine Catch Areas 12 and 12B.

*Traditional Central and South Puget Sound ISU*

The ACP purse seine test fishery CPUE data series that informs these South Puget Sound ISU models extends from 1981 to 2023. These data consist of 250 total Julian day-specific measurements of chum salmon catch per set from 43 different return years. Each week during in-season management for South Puget Sound fall chum, a simple linear regression model is produced relating the mean CPUE observed through the current week (the independent variable) with the observed postseason South Puget South fall chum salmon run sizes (the dependent variable) (Figure 29). This simple linear regression is then used to predict the in-season abundance of chum salmon. A 2017 analysis of the available ISU models identified the specific regression models (i.e., appropriate test fishing date ranges) that perform best in predicting this abundance each week. The best performing model and alternatives are presented in weekly in-season co-manager meetings.

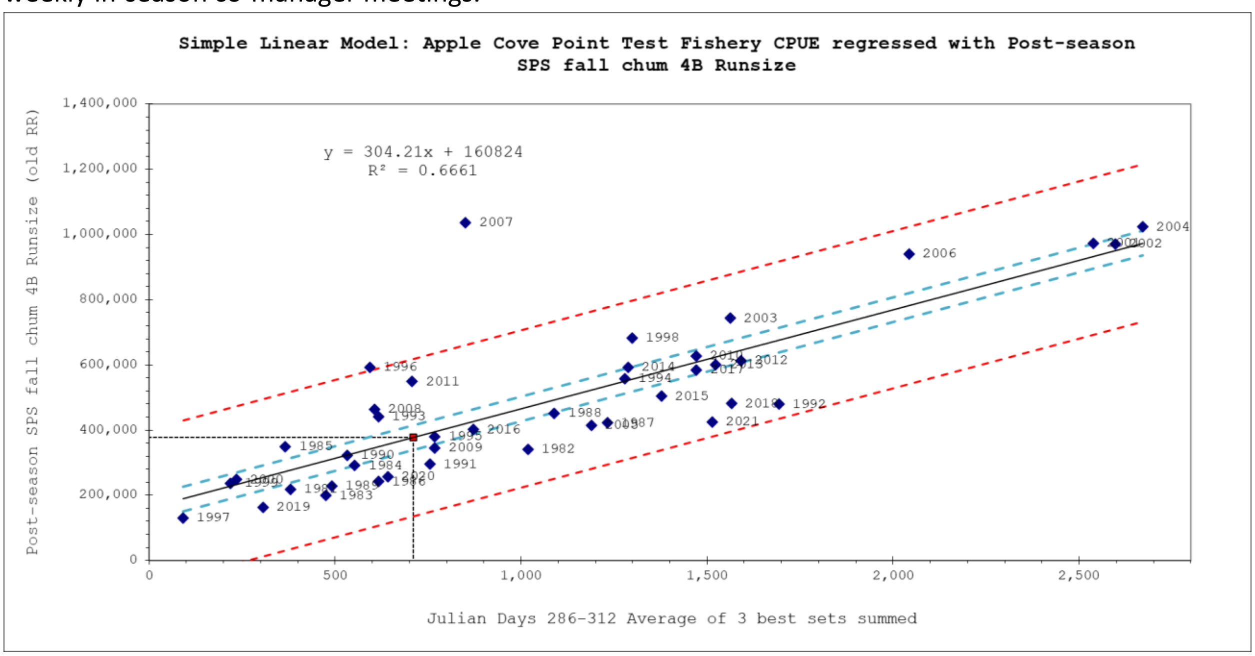


Figure 28. Example of a simple linear regression ISU model of the relationship between the observed CPUE in the Apple Cove Point purse seine test fishery and postseason estimates of total South Puget Sound (SPS) fall chum salmon abundance derived from the traditional run reconstruction.

Co-managers recognize (from prior GSI analyses) that the ACP test fishery occurs in a pre-terminal location where a significant number of non-local chum stocks (not destined for South Puget Sound terminal areas) contribute to the test fishery catch. These non-local chum salmon originate mainly from

Hood Canal (Figure 18). The test fishery CPUE therefore is a measure of the chum entering the mixed-stock area where pre-terminal fisheries occur. For this reason, the postseason run size estimates that are used as the dependent variable in these regressions are derived from the traditional (non-GSI) fall chum run reconstruction methodology, in which all fish harvested in Marine Areas 10 and 11 are automatically included in the overall South Puget Sound postseason run size. The ACP test fishery ISU model thus produces an estimate of the total abundance of chum present at ACP rather than only South Puget Sound chum salmon abundance, and, as such, further interpretation and assumptions are required to separate the South Puget Sound portion of the run from this aggregate mixture. This parsing has typically involved applying a historical mean non-local proportion to the ACP test fishery ISU abundance estimate, although with the advent of real-time in-season GSI analysis, it may become possible to correct for this influence directly in the model.

The performance of this traditional ACP ISU model was evaluated for its ability to accurately predict the postseason run sizes that were observed during 2013-2022, using one step ahead cross validation. This means that each year's run size (2013–2022) was "predicted" using naïve data (i.e., no run size data directly from the year being estimated). This provides a reasonable approximation of the model's performance, measured as the percent error, or the difference between each predicted and observed postseason run size, expressed as a proportion of the observed run size (note that in this analysis, negative percent error represents the overestimation of abundance). The mean percent error can then be used as a correction factor to make a post-hoc adjustment to the raw ISU model output. This evaluation was done for each management week's best ISU model for weeks 42–46, and the mean percent error was calculated for the recent 10 years. When graphed as a scatterplot with observed South Puget Sound run size on the x-axis and mean weekly percent error on the y-axis, a pattern is revealed. At ISU model predictions below approximately 450,000, a large error in the estimates is observed, with a tendency to overestimate the South Puget Sound fall chum run size (Figure 30). ISU predictions above 450,000 appear to be generally more accurate, although there continues to be a tendency to overestimate the run at ISU run size predictions at this higher end of the range. In general, the model's performance tends to improve with each added week of test fishery CPUE observations. The first week for which an ISU model is available is management week 42, and the fit of the models improve each week through week 46. However, even though the model tends to improve in later weeks, average error indicates the model continues to overestimate the South Puget Sound chum run size, at least in recent years.

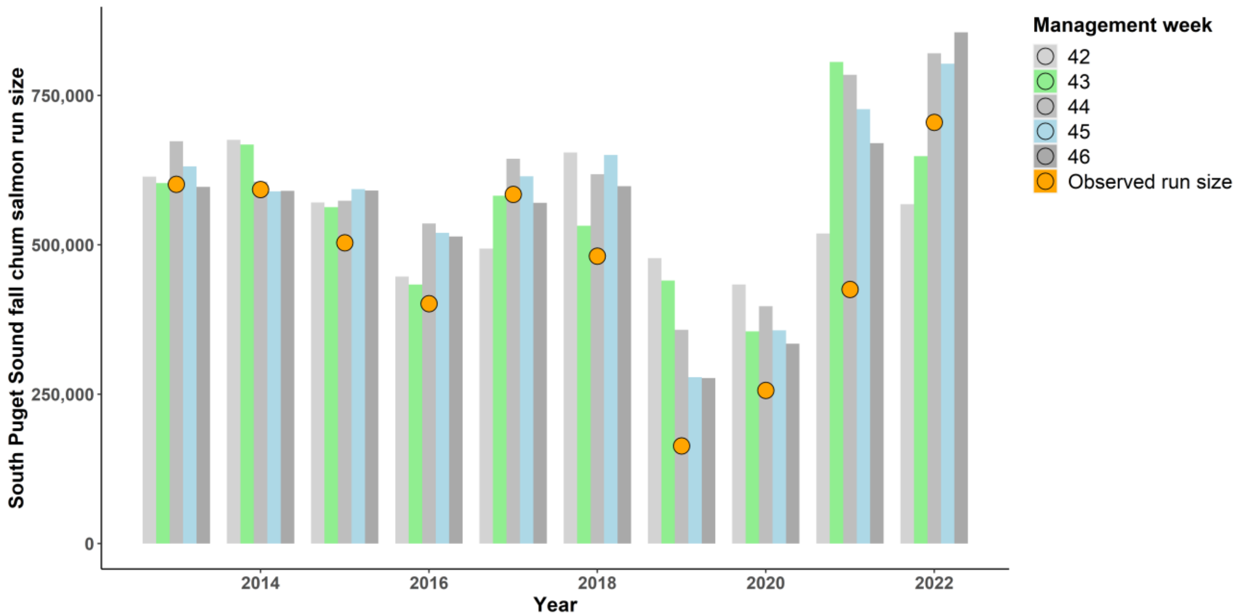


Figure 29. Weekly South Puget Sound fall chum estimates from traditional ISU models with postseason observed run sizes in years 2013–2022.

*Alternative South Puget Sound ISUs*

To provide evidence in support of an ISU to South Puget Sound fall chum, the co-managers suggested alternative ISU models should be considered pre-season, prior to October. While alternative model estimates may be presented in-season, the workgroup recommended providing performance metrics for each model to inform the weight of evidence in updating the run size. Using leave-future-out or one step ahead cross validation evaluation and performance metrics provides a more realistic understanding of forecast model performance with a naïve dataset (Burkner et al., 2019). Previously, WDFW provided abundance estimates derived from commercial purse seine CPUE. In recent years, restricted fleet sizes and fewer commercial openings have altered the utility of this model. WDFW will continue to evaluate the performance of the purse seine CPUE model as data becomes available. In 2022 and 2023, WDFW provided a weighted ensemble forecast approach. The ensemble approach is based on a generalized additive model and set of ARIMA models with and without environmental covariates, and it uses MAPE and one step ahead performance metrics to weight a "best model." Estimates are derived using a geometric mean of the best three sets at the ACP test fishery for a given date range, with or without biotic and abiotic covariates. This model uses a similar approach adopted by Skagit River co-managers for in-season abundance updates for Baker sockeye. Further documentation of the methodology and performance metrics are provided in an RMarkdown (Matt Bogaard, WDFW). When compared with the traditional ISU, the weighted ensemble forecast reduced performance error across all management weeks (10-year MAPE = 20%; Figure 15). While 10-year MAPE is reduced in the weighted ensemble model, this model tends to overpredict at run sizes less than 400k. As such, the workgroup recommends exercising caution and gathering additional evidence when traditional ISU models are predicting lower run sizes and test catch used for model training is below the long-term averages in the historic dataset. For example, below average test catches in 2023 drove an overestimate of abundance using the alternative ISU approach, and thus co-managers decided to use the traditional model with a performance adjustment for lower run sizes.

*South Puget Sound Fall Chum Salmon Management:*

The general procedure for South Puget Sound fall chum management has grown complex in recent years as a result of a better understanding of the complicated influence that non-local chum stocks have on in-season assessments. The current process is shown in Figure 31 and described in the following sections.

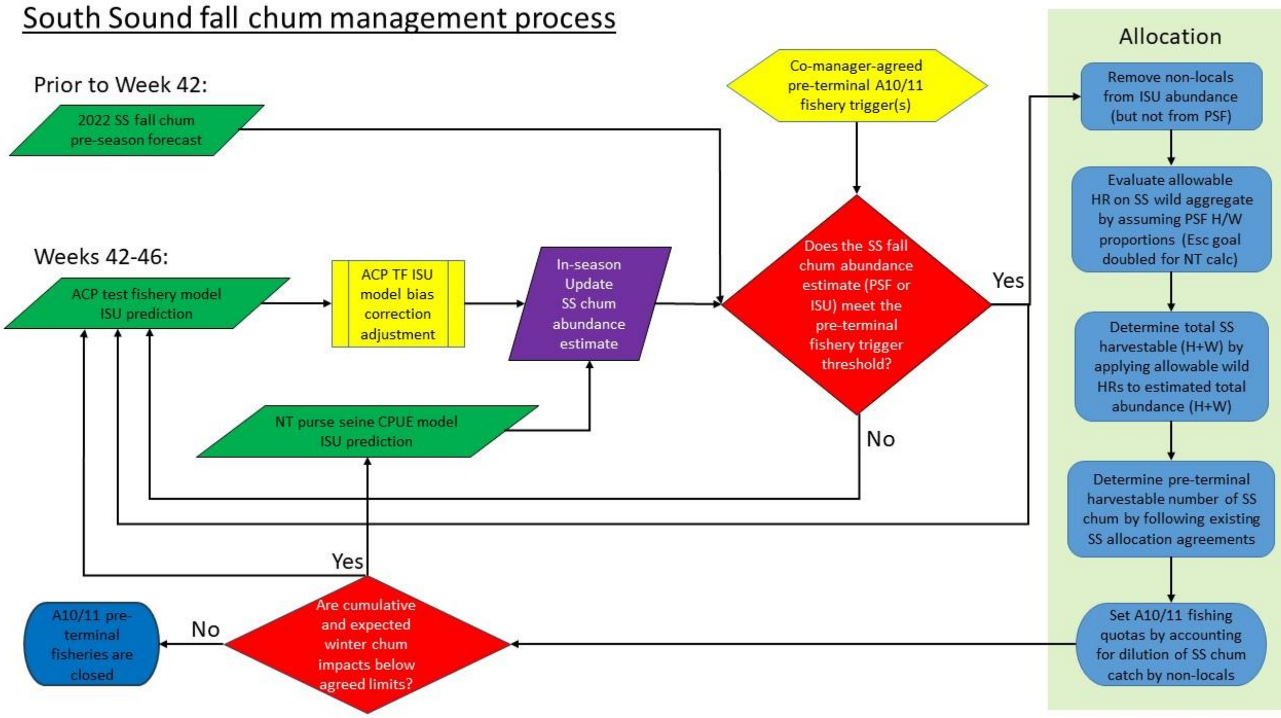


Figure 30. Schematic of the current South Puget Sound (SS) in-season management process. The abundance estimate is based on the pre-season forecast (PSF) prior to week 42, and, during weeks 42 through 46, the in-season update (ISU) resulting from the Apple Cove Point (ACP) test fishery (TF) in Marine Areas 10 and 11 (A10/11) and, if available, a model based on the non-treaty (NT) purse seine catch per unit effort (CPUE). The allowable harvest rate (HR) calculation (calc) is agreed upon based on PSF hatchery (H) and wild (W; i.e., natural) origin proportions and escapement (Esc) goals.

Prior to running the first in-season update (ISU) model in Week 42, the assumed South and Central Puget Sound run size is based on the pre-season agreed forecasts of natural and hatchery South and Central Puget Sound fall chum. Reasonably useful ISU models based on test fishing at ACP become available in Week 42. These models regress test fishery catch-per-effort metrics against the historical time series of reconstructed South and Central Puget Sound run sizes derived from the traditional (non-GSI) run reconstruction. Those run sizes therefore *include* non-local chum that were intercepted in Areas 10 and 11 as South Puget Sound fall chum. The test fishery thus measures the total abundance of chum present at Apple Cove Point, rather than only the fall chum run actually migrating to South and Central Puget Sound.

Due to a tendency for the test fishery-based models to overpredict this total abundance, a performance correction factor (described above) has been used to adjust these predictions since 2020, updated each year. This performance adjustment corrects for biases in the model predictions of total chum abundance at Apple Cove Point but does not address the contribution of non-local stocks to that total abundance, which is subsequently considered within the allocation calculations of harvestable South and Central Puget Sound fall chum.

Prior to calculating allocations, the performance-adjusted ISU model prediction is compared against the co-manager agreed fishery threshold triggers for the year. These thresholds, and their resulting fishery allocation limits, are adopted during the North of Falcon process and take precedence over the traditional South Puget Sound fall chum allocation calculations when low ISU abundances are predicted. However, if adjusted ISU abundances trend above the “upper threshold”, then full Area 10/11 fishery allocations are expected, although any agreed constraints on pre-terminal impacts to South Sound winter chum remain in effect.

The first step in determining preterminal catch shares is to estimate how much of the estimated chum abundance measured at ACP are South and Central Puget Sound fall chum stocks by subtracting the estimated non-local chum from the performance-adjusted ISU total chum abundance. This is done by applying an estimate of the non-local proportion of the total South Puget Sound “terminal” abundance. The assumed proportion used in recent years has been 15%. This proportion was derived as the mean (2005–2021) difference between the traditional run reconstruction postseason South Puget Sound run size, which includes preterminal non-local interceptions, and the GSI-based run reconstruction postseason South Puget Sound run size, which extrapolates ACP GSI results into Areas 10 and 11 to exclude the preterminal non-local interceptions there (Table 9). The South Puget Sound run component of the total South Puget Sound “terminal” abundance mixture is therefore calculated as 85% (1 minus 0.15) of the performance-adjusted ISU abundance estimate. As these pre-terminal catches in Areas 10 and 11 have declined in recent years, this discrepancy between the two run reconstructions methodologies has reduced since the non-local chum present in Areas 10 and 11, when not harvested there, presumably then return to their systems of origin, and therefore do not contribute the traditional South Sound postseason abundance estimate. If this approach to removing non-local chum for allocation purposes is to be continued, it may therefore be necessary to omit from this average any years with low pre-terminal area catches to capture the full influence of non-local stocks on the ACP abundance estimate. Alternatively, real time in-season GSI results from the ACP catches may allow for a more direct method of excluding non-local chum from the ACP ISU model estimates.

Table 9. Estimated proportion of non-locals based on the mean difference between the traditional reconstruction (old RR) (which includes non-locals harvested in Areas 10/11 as South Puget Sound, or SS, fall chum) and the new GSI-corrected (GSI RR) run reconstruction which does not. The data are from 2005 through 2021.

| Year | SS fall chum runsize (old RR) | SS fall chum runsize (GSI RR) | non-local proportion |
|---|---|---|---|
| 2005 | 414,939 | 309,641 | 25% |
| 2006 | 939,638 | 790,964 | 16% |
| 2007 | 1,036,774 | 900,841 | 13% |
| 2008 | 464,193 | 404,888 | 13% |
| 2009 | 344,854 | 319,136 | 7% |
| 2010 | 627,131 | 467,631 | 25% |
| 2011 | 548,386 | 449,817 | 18% |
| 2012 | 613,564 | 459,730 | 25% |
| 2013 | 601,124 | 518,971 | 14% |
| 2014 | 592,399 | 495,036 | 16% |
| 2015 | 503,531 | 429,590 | 15% |
| 2016 | 401,487 | 366,579 | 9% |
| 2017 | 584,420 | 485,148 | 17% |
| 2018 | 480,953 | 399,398 | 17% |
| 2019 | 163,566 | 142,289 | 13% |
| 2020 | 256,466 | 241,404 | 6% |
| 2021 | 425,184 | 402,523 | 5% |
| | | **Mean** | **15%** |

Also, as more years of GSI data become available, and particularly available directly from the harvest in Marine Areas 10 and 11, then the assumed proportion of non-local stocks contributing to the traditional run reconstruction run size estimates should be reevaluated.

The estimated South and Central Puget Sound fall chum abundance (with non-local chum removed) is then apportioned into natural and hatchery components based on the pre-season forecast ratio of natural and hatchery components. The maximum allowable harvest rate on South and Central Puget Sound natural fall chum is then evaluated by subtracting the South and Central Puget Sound aggregate natural escapement goal from the predicted South and Central Puget Sound natural fall chum run size. In recent years, the escapement goal used for this purpose has been an average (72,275) of the long-existing even-year and odd-year aggregate South Puget Sound fall chum escapement goals (80,200 and 64,350, respectively). Additionally, as a buffer against potential pre-terminal overallocation in-season, with acknowledgment that achieving the region's aggregate escapement goal does not ensure that the objective of every component population will be met, and awareness of the all-citizens fleet's disproportionate ability to quickly harvest its full pre-terminal allocation before a need for ISU adjustment might be recognized, co-managers have, in recent years, doubled the natural escapement goal (to 144,550) for the purpose of calculating the non-tribal maximum allowable harvest rate on South Puget Sound natural fall chum.

Applying the allowable harvest rate on South and Central Puget Sound natural fall chum to the total combined natural and hatchery run size estimate (adjusted for performance and with non-locals removed) thereby provides the surplus catchable shares of South and Central Puget Sound chum stocks. However, the expected interceptions of non-local chum associated with accessing pre-terminal catch shares still need to be estimated and added back into the Area 10/11 target catch quotas. Based on GSI-based stock composition assumptions that were developed for the new run reconstruction, the mean proportion (2005–2021) of non-local chum in Area 10/11 catches was estimated to be 32% (Table 10). The Area 10/11 catch shares of South and Central Puget Sound fall chum are therefore expanded (by dividing by 1 minus 0.32) in order to set the total Area 10/11 catch quotas. This “dilution factor” adjustment accounts for the dilution of the allocated South and Central Puget Sound fall chum shares to be harvested in the pre-terminal locations where non-local stocks are also present and intercepted.

Table 10. Estimated proportions of non-local chum salmon in catch Areas 10 and 11 from the GSI-corrected chum run reconstruction based on GSI sampling at Apple Cove Point (ACP) and extrapolated into Areas 10 and 11 using previously derived assumptions relating non-local proportions observed concurrently at ACP in Area 10 and 11 and based on commercial catch data reported for those areas. Data are summarized from 2005–2021.

| Year | Area 10 total chum catch | Area 11 total chum catch | Area 10+11 total chum catch | Area 10 estimated South Sound fall chum catch | Area 11 estimated South Sound fall chum catch | Area 10+11 estimated South Sound fall chum catch | Estimated non-local % in total Area 10/11 catch |
|---|---|---|---|---|---|---|---|
| 2005 | 116,986 | 122,993 | 239,979 | 56,551 | 76,772 | 133,323 | 44% |
| 2006 | 249,459 | 175,285 | 424,744 | 151,240 | 129,220 | 280,460 | 34% |
| 2007 | 251,067 | 140,723 | 391,790 | 162,634 | 110,643 | 273,277 | 30% |
| 2008 | 115,961 | 75,684 | 191,645 | 71,203 | 56,542 | 127,745 | 33% |
| 2009 | 84,241 | 63,753 | 147,994 | 62,993 | 53,611 | 116,604 | 21% |
| 2010 | 175,916 | 110,805 | 286,721 | 83,141 | 64,444 | 147,585 | 49% |
| 2011 | 182,966 | 65,813 | 248,779 | 125,199 | 52,720 | 177,919 | 28% |
| 2012 | 210,113 | 107,489 | 317,602 | 93,699 | 67,644 | 161,343 | 49% |
| 2013 | 171,573 | 109,576 | 281,149 | 116,781 | 87,149 | 203,930 | 27% |
| 2014 | 155,940 | 92,770 | 248,710 | 95,512 | 69,381 | 164,893 | 34% |
| 2015 | 215,422 | 69,306 | 284,728 | 154,161 | 55,577 | 209,738 | 26% |
| 2016 | 118,940 | 50,569 | 169,509 | 95,996 | 44,576 | 140,572 | 17% |
| 2017 | 212,841 | 96,209 | 309,050 | 145,928 | 76,192 | 222,120 | 28% |
| 2018 | 162,115 | 49,941 | 212,056 | 104,441 | 39,019 | 143,460 | 32% |
| 2019 | 50,491 | 8,637 | 59,128 | 33,442 | 6,756 | 40,198 | 32% |
| 2020 | 28,974 | 0 | 28,974 | 19,191 | 0 | 19,191 | 34% |
| 2021 | 64,319 | 29,805 | 94,124 | 42,599 | 23,313 | 65,912 | 30% |
| | | | | | | Mean | 32% |

The maximum allowable harvest rates on South and Central Puget Sound natural fall chum are re-assessed weekly in-season each time the pre-terminal ISU abundance is updated, and the shares and catch quotas are reset based on that rate, or if the upper threshold is not met, then at the lower restricted levels agreed to during pre-season North of Falcon meetings.

In South Puget Sound and Hood Canal mixed-stock fisheries, co-managers also implement early season closures to reduce impacts on summer chum (Base Conservation Regime). Additionally, co-managers often agree to late season closures in to reduce impacts of late run and winter chum salmon (winter chum impacts MOU; Hood Canal allocation agreement).

Each week, prior to fisheries, NWC impacts are estimated for each fishery using the historic rate of impact in our Puget Sound GSI collection, to ensure any future proposed fishery will not exceed the agreed-to impact for the year. Impacts are predicted from a model that incorporates the historical test fishing GSI dataset from ACP with the most recent data. The model predicts the proportion of Puget Sound late chum intercepted at ACP. The average proportion of NWC to total Puget Sound late chum, 17.5%, will be applied to project the proportion of NWC at ACP (Addendum to SEF Chum GSI Puget Sound Baseline 2020). Impacts are also estimated after fisheries have taken place, using historic rate of impact and/or real-time GSI data when available. A "nearest neighbor" approach will be used in estimating in-season catch of NWC, where the proportion caught in the nearest test fishery in time and place will be applied to the catch of the fishery in the corresponding area. For example, a proportion sampled in Area 11 test fisheries in Week 43 would be applied to commercial fishery catch in Area 11 in Week 43. ACP proportions will be applied to commercial chum catch in Area 10. Once an impact on NWC has been estimated for the week using historical and real-time GSI, it is subtracted from the available impacts and future fisheries will be constrained or limited to ensure the total impact is not exceeded. This data is reviewed weekly by co-managers every management week for fall chum in South Puget Sound.

*Traditional Hood Canal ISU*

Since 2018, Hood Canal Tribes and WDFW agreed to implement a single "early" ISU model (October 20–31) and an "extended window" ISU model (October 20–November 7) using non-tribal purse seine Cumulative Catch Per Unit Effort (CCPUE) as a predictor variable. Specifically, a simple linear regression of CCPUE (total catch / number of vessel-days) for the early and late windows to predict total Hood Canal run size.

ISU model agreement was based on work by technical staff of Hood Canal Tribes, Point No Point Treaty Council (PNPTC), NWIFC, and WDFW. Co-managers agreed that the CCPUE from purse seine fisheries occurring during the second extended window model should be evaluated and/or discussed in assessing the run size, regardless of whether a sufficient catch share is available. Additionally, co-managers often evaluate the effort of the purse seine fleet and where it fits in comparison to the historical range to determine the validity and strength of the CCPUE value. During recent low abundance returns, the traditional ISUs have been over-predicting terminal run size (e.g., when the run size is close to the intercept of the linear regressions). In addition to fishery dependent information, fishery managers also consider fishery independent information along with the ISU models during the planning and prosecution of fisheries. For instance, managers review information on progress in achieving broodstock collection and hatchery egg-take goals at each of the WDFW and Tribal hatcheries, hatchery surpluses, sex ratio, and natural spawning ground surveys.

*Alternative Hood Canal ISUs*

Segmented and non-linear regression model approaches have been examined as alternatives for the linear Hood Canal ISU. In particular, broken-stick and local polynomial regression ISU models were evaluated. These approaches may be better suited to estimating terminal run size at lower abundance returns to the Hood Canal system. However, further evaluation is needed to identify their performance compared to the traditional model.

*Hood Canal Fall Chum Salmon Management*

Here, we summarize Hood Canal fall chum salmon fishery management below the Hood Canal Bridge, encompassing Central and South Hood Canal (Marines Areas 12, 12B, 12C, as well as all freshwater catch areas where Tribal fishing traditionally occurs). For Hood Canal fall chum, comanagers enter the season with harvestable share and allocation based on the pre-season Hood Canal aggregate forecast and an estimated proportion of late-timed chum salmon. The Treaty Tribes and state manage their respective chum salmon fisheries with updates to harvestable shares based on the non-tribal purse seine ISU, considering their pre-season schedules and fishery inputs. Co-managers meet weekly through the season to discuss the ISU, evaluate broodstock goals and status from hatcheries at Hoodsport and McKernan hatcheries, and discuss overall strength of the return before updating the in-season terminal run size and proposing fisheries (see Hood Canal ISU section for further detail).

*North Hood Canal (Area 9) Fall Chum Salmon Management*

This section summarizes fisheries occurring in North Hood Canal (Area 9), specifically bounded to the north by a line from White Rock due east to landfall (Foulweather Bluff) on the Kitsap Peninsula. Tribes with adjudicated U&A in the open section of Area 9 - North Hood Canal - may choose to participate and prosecute fisheries. The state does not operate chum directed fisheries in this area. Chum salmon directed fisheries in North Hood Canal generally occur from management week 43 through 45. If the fishery reaches a catch threshold of 30,000 chum salmon before October 30th, there is a discussion among co-managers on further fishery actions.

*North Puget Sound Chum Salmon Management*

Chum salmon fisheries directed at southern British Columbia chum salmon (i.e., Inside Southern chum salmon or Fraser River chum salmon) passing through Marine Areas 7 and 7A are regulated to comply with a base harvest ceiling of 125,000, based on the Pacific Salmon Treaty. Inside Southern chum salmon abundance (i.e., predominantly Fraser River Chum Salmon; Figure 24) is estimated by the Department of Fisheries and Oceans Canada, and if run sizes are estimated below 1.05 million, U.S. fisheries are limited to 20,000 chum salmon (limited to ceremonial and subsistence Tribal fisheries and by-catch from other limited fisheries). When run sizes are estimated above 1.6 million, the U.S. share is 160,000. Catches taken for the purpose of GSI sampling do not count towards the 20,000 fish catch limit when critical thresholds are not being met.

# Data Gaps and Data Management

During the 2023 chum salmon technical review, co-managers identified critical data gaps that may present challenges to population sustainability now and into the future (Table 11). Data needs were evaluated under seven categories (run reconstruction, genetic detectability, escapement estimation, age data, outmigrant data, pre-terminal fishery impacts, and forecasting). In addition to these seven major categories, co-managers discussed a need for more information on predator-prey dynamics, hatchery and production, and discerning hatchery origin fish from natural origin fish at pre-terminal and terminal scales.

Table 11. Data evaluation from 2023 chum salmon technical review, outlining level of data availability and quality by region and management unit.

| Geographic Region | Management Unit | Origin | Data Evaluation: Run Reconstruction | Genetic Dectectability | Escapement Estimation | Age data | Outmigrant abundance data | Pre-terminal fishery impacts | Forecasting | Genetic Reporting Group |
|---|---|---|---|---|---|---|---|---|---|---|
| South Puget Sound | Nisqually Winter (and Misc 13 and Chambers Cr.) | NOR | 2 | 2 | 3 | 3 | 1 | 2 | 3 | Nisqually |
| | Carr Inlet | Both | 2 | 2 | 1 | 2 | 1 | 2 | 1 | South, Fall |
| | Case Inlet (fall and summer) | NOR | 2 | 2 | 3 | 2 | 1 | 2 | 1 | South, Fall |
| | Totten Inlet | NOR | 2 | 2 | 3 | 2 | 1 | 2 | 1 | South, Fall |
| | Skookum Inlet | NOR | 2 | 2 | 3 | 2 | 1 | 2 | 1 | South, Fall |
| | Eld Inlet | NOR | 2 | 2 | 3 | 3 | 1 | 2 | 1 | South, Fall |
| | Hammersley Inlet (fall and summer) | NOR | 2 | 2 | 3 | 2 | 2 | 2 | 1 | South, Fall |
| | Henderson Inlet | NOR | 2 | 2 | 2 | 2 | 1 | 2 | 1 | South, Fall |
| | Puyallup Fall | NOR | 3 | 2 | 2 | 2 | 3 | 2 | 1 | Baseline additions needed |
| | Puyallup Winter | HOR | 3 | 2 | 2 | 3 | 3 | 2 | 1 | Diru |
| | East Kitsap (10 E Fall) | NOR | 3 | 2 | 3 | 2 | 2 | 2 | 1 | Central, Fall |
| | Green River | HOR | 3 | 2 | 3 | 3 | 2 | 2 | 1 | Central, Fall |
| Stillaguamish - Snohomish basin | Snohomish River | NOR | 3 | 2 | 2 | 2 | 3 | 2 | 2 | North, Fall |
| | Stillaguamish River | NOR | 3 | 2 | 2 | 2 | 3 | 2 | 1 | North, Fall |
| North Puget Sound | Skagit River | Both | 3 | 2 | 3 | 3 | 3 | 2 | 1 | North, Fall |
| | Samish River | Both | 3 | 2 | 2 | 1 | 1 | 2 | 1 | North, Fall |
| | 7B&7C Independents | NOR | 2 | 2 | 2 | 1 | 1 | 2 | 1 | Baseline additions needed |
| | Whatcom Creek | HOR | 2 | 2 | 3 | 1 | 1 | 2 | 1 | Baseline additions needed |
| | Lummi Bay | HOR | 3 | 2 | 3 | 1 | 3 | 2 | 1 | Baseline additions needed |
| | Nooksack NOR | NOR | 3 | 2 | 2 | 3 | 2 | 2 | 1 | North, Fall |
| | Nooksack HOR | HOR | 3 | 2 | 3 | 3 | 2 | 2 | 1 | North, Fall |
| Hood Canal | | | | | | | | | | |
| Strait of Juan de Fuca | | | | | | | | | | |

| Legend | |
|---|---|
| 1 | Lack of data, improvement needed |
| 2 | Being evaluated, some improvement made |
| 3 | Robust data, no concern |

## Genetic Resolution

Genetic evaluations have improved since 2014 with Pacific Salmon Treaty Southern Endowment funding, as well as legislative funding contributing to additional collections and evaluation towards the SNP genetic baseline. However, genetic leads from WDFW and NWIFC have suggested that detectability is an ongoing process of evaluation, and that baseline data will need to be collected at appropriate temporal and spatial scales to ensure individual stocks or populations are adequately represented. WDFW and NWIFC staff have also suggested that some stocks can be further evaluated with increased sample size collections to determine an improved confidence in distinguishing them in marine samples. As such, a consistent biennial review of the current baseline including regionally where collections need to be planned should be a future mainstay to assist with effective pre-terminal detectability.

## Escapement Estimation

With regards to escapement estimation, regional biologists have suggested additional river miles to be added or subtracted from various stocks for adequate and representative surveying, which may play a role in the escapement estimation by unit. A review of suggested changes to chum salmon escapement estimation across Puget Sound represents another important data gap in determining run timing classification of hatchery and natural origin returns. Additionally, some regional biologists have suggested evaluating live and dead count stream-life that varies over time and space, linked to climate variability in freshwater environments. Shifting stream life for chum can drive dramatic shifts in escapement estimation, especially with area under the curve assessments. Additionally, otolith marking and understanding hatchery versus natural origin dynamics may also play an important role in some systems, and its use may need to be further evaluated and prioritized. Finally, sampling and staff support, and possible integration of new freshwater monitoring technologies (i.e., hydroacoustic deployment) may be avenues for the future.

## Scale and Age Dynamics

Age data is a primary factor in building effective forecasts as well as development of new escapement goals. In the recent few years, co-managers made progress to improve scale collections across spawning reaches and in freshwater and marine fisheries. Chum salmon age dynamics are cyclical in nature and quite complex, as they have variable life history strategies that allow them to return and spawn at a range of ages. In Puget Sound, we have documented trends in some populations of the dominant age shifting towards younger age classes (Figure 9). We have also documented different age dynamics between chum salmon management units throughout Puget Sound (Figure 8). From our review of scale collection needs, parts of Central and North Puget Sound seemed to be lacking in age data for various hatchery and natural stocks, and further collection efforts may need to be discussed among co-managers. Specifically, age data collection may be occurring in fisheries rather than on spawning grounds, and vice-versa, and in some areas scale collections have been discontinued. The age data in fisheries may represent aggregations of stocks from larger geographic extents, rather than specific populations of concern, which influences productivity estimation at finer geographic scales. Moreover, there is a known bias of some sampling gear types towards larger-bodied, and thus older, fish. Not all historical scale collection data is associated with its sample gear type, which makes it difficult to parse this bias. With regards to forecasting and escapement goal evaluation, regional biologists have noted that age data collections need to be robust and continuous for multiple generations. For instance, regional biologists have limited biological inference when producing recruit-spawner estimates for certain populations without appropriate age data collection, and thus must make assumptions or use surrogate datasets that represent adjacent populations or larger geographic extents. These challenges have led to potential forecasting error for declining populations across Puget Sound. Ultimately, determining escapement goals with different levels of age data are necessary to understand sensitivity of surrogate age datasets.

## Outmigrant Monitoring

Outmigrant data represented another data gap for some regions of Puget Sound based on our review of data needs. Co-managers noted a need for further evaluation of juvenile chum salmon outmigrant survival estimates as they migrate from the fresh to marine environments and a review outmigrant trapping effort across Puget Sound. While outmigrant data are collected from the Dungeness, Duckabush, Snohomish, Skagit, Nooksack, Green, Nisqually, and Puyallup river basins, there remain challenges with understanding trapping success and appropriate trap location for chum salmon fry. Trapping success may be limited due to the small body size of juvenile chum salmon or trap timing and placement amidst changing freshwater dynamics. Limited trapping success has been a particular challenge for Deep South Puget Sound, especially the Nisqually River, where outmigrant information could be useful in understanding variability in productivity. As such, co-managers have recommended further review of outmigration trapping data and implementation of new technology (i.e., hydroacoustic) to understand survival dynamics of chum salmon.

## Pre-terminal Fishery Impacts Using GSI

With the advancement of the chum SNP baseline, co-managers can develop impact assessment tools for proposed fisheries, where genetic assignments are distinguishable between stocks or populations (Table 3). However, to have effective modeling outputs, fisheries need to be consistently sampled to understand temporal and spatial variation in stock composition. In the case of fisheries where stock composition data is lacking, surrogate data from nearby test fisheries has been a promising avenue. Nevertheless, Puget Sound co-managers have suggested that fin clips should be collected from all marine fisheries, as chum salmon have a strong ability to stray geographically far from the natal spawning areas and into different reaches of Puget Sound prior to completing their spawning migration. Marine areas identified by co-managers that need improved fishery fin clip collections include areas 4, 5, 6, 7, 7A, 9, 10A, 10E and 13A-K. Evaluating the stock composition in these areas may improve our run reconstruction evaluations and our understanding of where stocks of concern may be milling in time and space throughout the season and before they reach the spawning grounds.

## Forecasting Evolution

Forecasting chum salmon in Puget Sound remains an ongoing challenge due to the shifting productivity regimes observed, predation events occurring on spawning populations, improvement or lack thereof to escapement estimation, and the non-stationary relationships observed between survival in the marine environment. In terms of useful explanatory variables that account for conservation challenges, once a watershed has a robust enough dataset that matches the time series of spawner-recruit data, it generally becomes useful to train predictive models. For newly acquired data, such as predation events or predator diet via scat collection, further discussion is needed to determine the best possible integration of those variables into population predictive models. In addition to the conservation challenges, insufficient data availability and variability (i.e., escapement estimation and spawning age composition), data submission timelines (post-spawning or harvest), and updated run reconstructions are other factors that play a role in effective forecasting. Co-managers from across Puget Sound emphasized the need to continue to improve our forecasting process for Puget Sound Chum.

## Predator-Prey Dynamics

As noted in the conservation section regarding predator effects on chum salmon, multiple regions have noted predation challenges that juvenile and adult chum salmon face in Puget Sound. There remains a very strong concern among Puget Sound co-managers that increased and year-round pinniped residence is driving the decline of natural and hatchery stocks. There is also a growing concern that SRKWs are predating chum at higher rates, given they are moving through Puget Sound at later periods of the year that align with the end of the fall run and start of the winter run. As such, further evaluation is needed across Puget Sound to determine areas with the highest rates of mortality attributed to marine mammal predators, and how managers may adequately respond to those challenges.

## Integrated Hatchery Programs

The decline of natural salmon populations in Washington State has driven salmon co-managers to consider using integrated hatchery supplementation programs in many areas to increase overall chum salmon abundance. As mentioned earlier in the document, Puget Sound has a history of out-of-basin fish transfers, however the long-term ramifications have been sparsely documented. Historically in Puget Sound, co-managers have previously explored employing natural origin fish as brood stock and releasing their offspring into natural spawning areas. In Washington State, the first supplementation efforts started in the late-1970s for populations of summer-run chum. Because of their low cost and amount of effort to rear and release and size of returning adults, chum salmon may be the most suitable Pacific salmon to produce from hatcheries. In Puget Sound, chum salmon have a short juvenile freshwater residence time, typically spawn close to marine waters, and have strong response to hatchery propagation. From 1991–1996, two South Puget Sound summer chum salmon stocks (Hammersley Inlet and Case Inlet) were supplemented with hatchery origin fish. Since the supplementation has stopped, it remains to be evaluated whether these programs contributed towards long-term population viability. In Hood Canal, summer chum supplementation using within basin natural stocks started in 1992. Productivity estimates suggested supplementation resulted in stabilized Hood Canal summer chum populations (Lestelle et al., 2018; Lestelle et al., 2020). Additionally, these natural stock summer chum supplementation programs followed a metapopulation pattern of isolation by distance, and minimally impacted the population structure of the ESA listed populations (Small et al., 2009).

In North Puget Sound, integrated chum salmon supplementation has occurred since 2018 in the Snohomish River basin, initially collecting natural origin broodstock from the Skykomish River for rearing and release from Wallace River Hatchery, located on a tributary to the Skykomish. Additionally, in 2021 broodstock efforts expanded to the Skagit River, where chum salmon are collected and sent to Marblemount Hatchery. An integrated program restarted on the Nooksack River in 2012, expanding to collecting 5.2 million chum salmon eggs in 2023. In other regions of Puget Sound, there is a long history of Puget Sound chum salmon hatcheries rearing out-of-basin stocks. As described hatchery specific Hatchery Genetic Management Plan of these segregated programs have included extensive monitoring demonstrating genetic isolation while providing important harvest opportunity that would not otherwise exist (NMFS 2022a; NMFS 2022b). In addition to natural and hatchery stocks being sent to other hatcheries, hatchery stocks are sometimes provided to natural spawning grounds. For example, Grovers Creek Hatchery chum salmon on the western side of Puget Sound have been shared with Pipers

Creek and its tributaries on the eastern side of Puget Sound, and some success in natural spawning populations was noted in 2014 through 2016.

Hatchery programs have generally achieved the goal of increasing chum salmon abundance in some regions. However, negative impacts may arise when hatchery fish have interacted with natural spawners, bringing in out-of-basin traits (e.g., Lynch and O'Hely, 2001). While spawning protocols for some newer programs minimize out-of-basin origin, negative impacts can occur from unequal sex ratios and unintended selection of age classes (Small et al., 2009). Ultimately, in the early 2000s, co-managers discussed the potential effects of hatchery origin fish on natural populations, genetic effects, and potential density-dependent effects that may drive down productivity of natural populations. As such, further evaluation is needed to understand effects of hatchery and natural supplementation on natural populations across Puget Sound, and an overall evaluation of supplementation increases and whether they have led to increased or sustained returns of suppressed chum populations.

## Distinguishing Hatchery and Natural Origin Chum Salmon

An ongoing challenge in pre-terminal fisheries and terminal spawning ground assessments is determining interception of natural versus hatchery origin stocks. The advance of genetic stock identification has improved the process, however, the lack of identification in hatchery populations represents an ongoing challenge in most systems. Co-managers have noted these challenges in fisheries and spawning ground assessments with overlapping timing between natural and hatchery origin returns. To address these concerns, co-managers have proposed expanding otolith thermal marking programs and analyzing collections from spawning grounds as well as pre-terminal and terminal area fisheries throughout Puget Sound. Some regions have already implemented otolith collections and parent-based tagging evaluation; however, funding and staffing for sample processing remains a challenge. For integrated programs in North Puget Sound, there is a desire for gene flow between hatchery origin and natural origin components of the population.

## Catch Accounting in TOCAS and WAFT

Fish ticket data is being constantly added and edited in TOCAS and WAFT. Catch accounting reconciliation is the process of comparing data from the same fish tickets that has been separately entered into these two databases. These comparisons and edits are made throughout the year as Tribal, WDFW, and NWIFC staff receive and review fish ticket information. A revision of historical run reconstructions may be needed every few years to ensure regional biologists are using the best available data to review recruit-spawner trends and accurately determine if a chum salmon stock is declining, stable, or recovering.

## Cultural Importance

Chum salmon are a culturally important species and a staple to Tribes of the Pacific Northwest. As such, it is critical that the indigenous knowledge, practices, and beliefs developed by Tribes are protected and acknowledged by fishery managers. For some Tribes, chum salmon are the only fresh fish returning at a time when other salmon runs have completed their life cycle. Chum salmon preserve better than other species due to their low-fat content and are often smoked for long-term sustenance. In Puget Sound, chum salmon are a large bodied and historically abundant food resource. Their spawning abundance represents one of the larger marine-derived nutrient flows to freshwater ecosystems in Puget Sound, providing nourishment to many living life forms. The cultural importance of this species has been shared through oral tradition, writings, and depicted in art and carvings over many generations.

## Next Steps

Working towards a comprehensive management plan for Puget Sound chum salmon is critical for the sustainability of populations that have shown considerable stochasticity in the recent decade. Previous studies have noted that harvest management actions in Bristol Bay and the Fraser River have proven effective at restoring salmon in the presence of suitable habitat (Mundy, 1997). As such, a harvest management paradigm that is suitable for sustainable use of chum salmon in Puget Sound is recommended given the known interactions between harvest and salmon productivity. Based on the information provided in this report, Puget Sound co-manager technical staff have developed a series of recommendations for next steps, which we have summarized below in no order:

- Evaluate and define conservation-based objectives that ensure the future sustainability of declining management units (i.e., improving escapement estimation and escapement goals).
- Build a comprehensive data needs and prioritization plan revolving around conservation challenges identifying level of support needed (i.e., monetary and personnel) for each management unit.
- Develop recovery plans for declining stocks including habitat improvements and integrated hatchery production.
- Develop a harvest management plan that protects Treaty rights of all Tribes, reserved in the Stevens' Treaties (1855) and reaffirmed by the 1974 Boldt Decision in *US v. Washington*, and shares the conservation burden equally across all co-managers.
- Ensure catch accounting, historic run reconstructions, and escapement estimation methodologies are reviewed and updated annually as needed.
- Ensure pre-season (i.e., forecast) and in-season (i.e., ISU) abundance estimation methodologies and documentation are reviewed and updated annually as needed.
- Define current and future fishery management proposals by Tribes and state by marine area.
- Determine fishery effort and catch inputs by marine area based on forecasts to ensure impacts to stocks of concern are appropriately evaluated pre-season.
- Develop a standardized Puget Sound wide in-season and postseason catch accounting process that incorporates stock composition of all marine fisheries.

- Develop harvest management adjustments and exploitation rate ceilings that can be agreed to pre-season and in-season to address population status of management units of concern.
- Develop a strategy to identify and address basin specific chum salmon habitat needs and to improve resiliency to climate change effects such as flood and marine heat wave induced reductions in survival.

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# Supplemental

## Figures

a. Figures S1 and S2 below demonstrate the differences in percent natural origin and total natural run size over year in South Puget Sound from traditional to GSI-corrected run reconstructions. From these figures, it is readily apparent that each reconstruction provides a slightly different interpretation of the trends and composition of return.

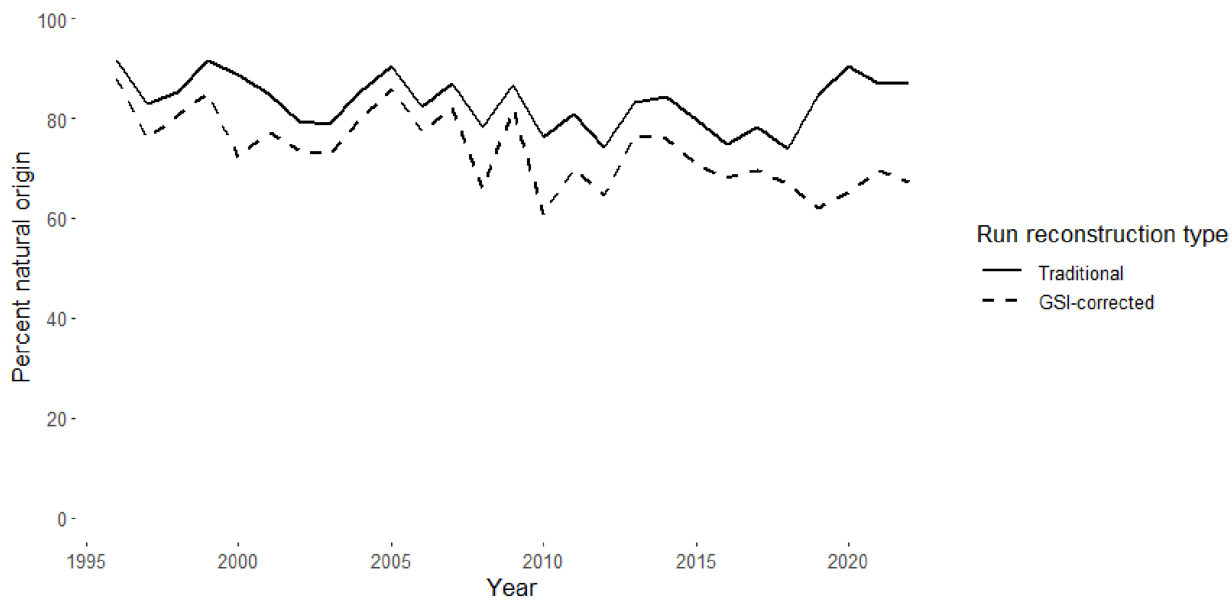



Figure S1. Percent natural origin of South Puget Sound chum salmon by year (1996–2022) and run reconstruction type.

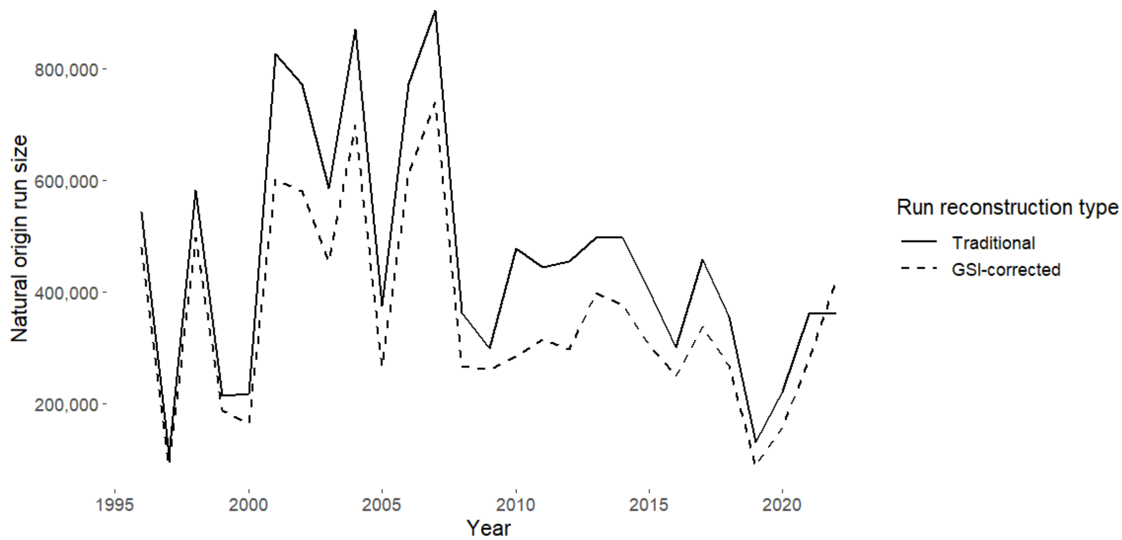
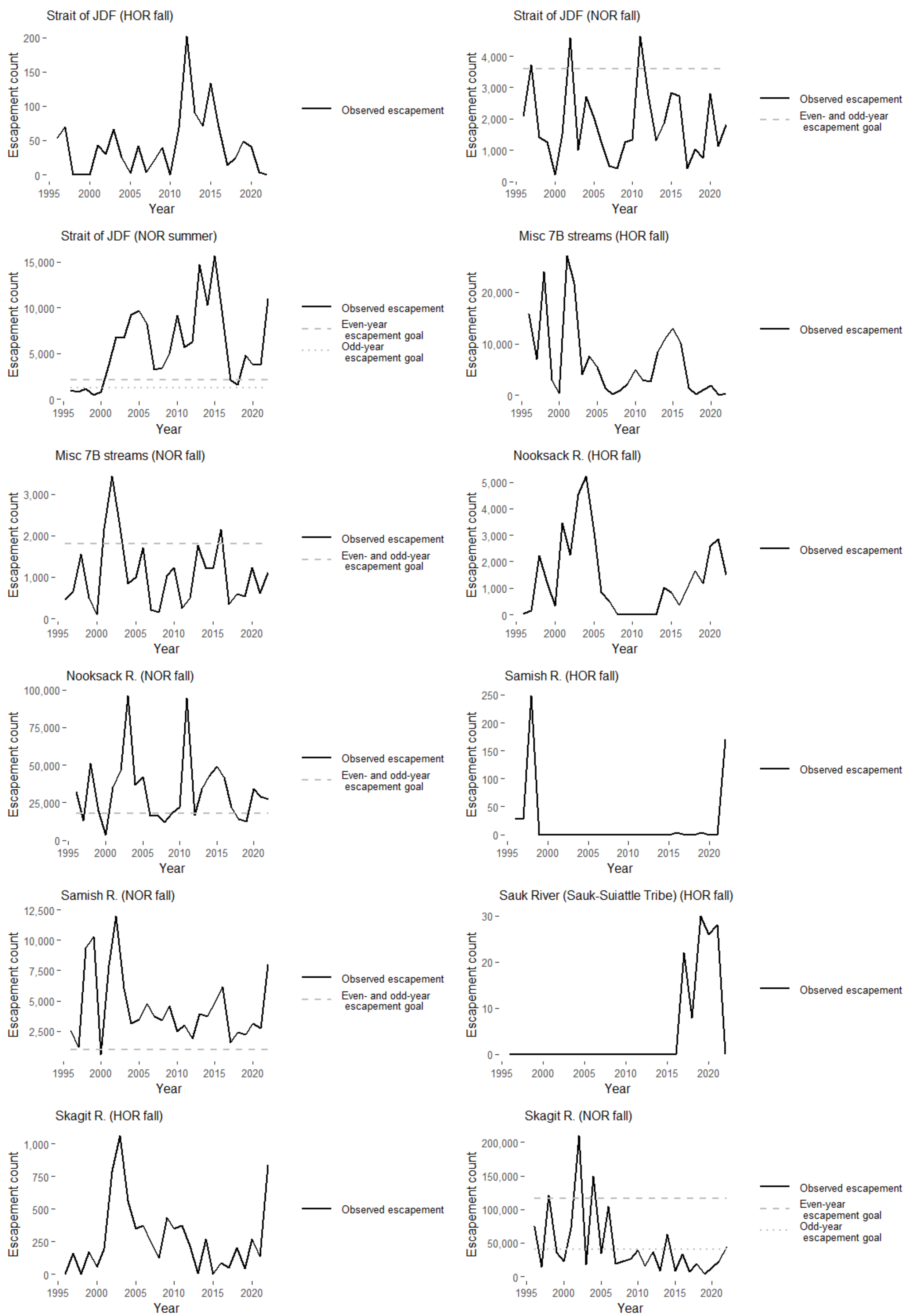
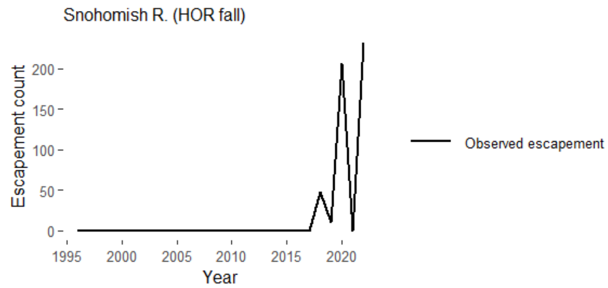
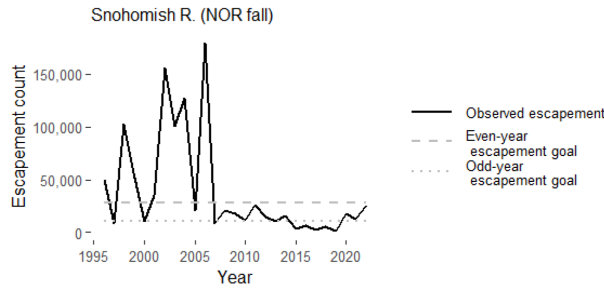


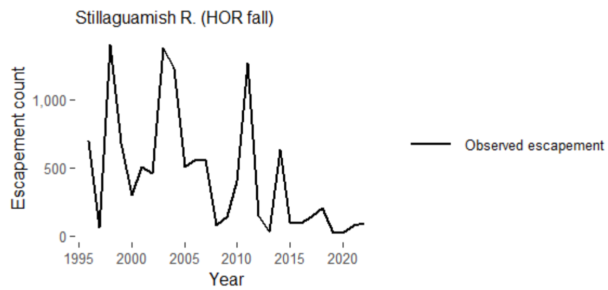

Figure S2. South Puget Sound natural origin chum salmon run size by year (1996–2022) and run reconstruction type.

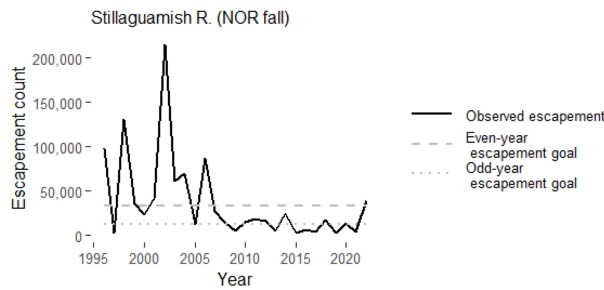
b. Chum salmon stocks with low recent escapement. Listed below are stocks currently tracked in the GSI-corrected run reconstruction and/or the traditional run reconstruction that have an average escapement from the last 10 years of less than 10 fish. Since stocks used in the traditional run reconstruction are aggregates of stocks used in the GSI-corrected run reconstruction, some traditional run reconstruction stocks on this list contain other GSI-corrected stocks that have a recent average escapement of greater than or equal to 10 fish. These stocks are marked with an asterisk (*). Chum salmon escapement by traditional run reconstructed stock

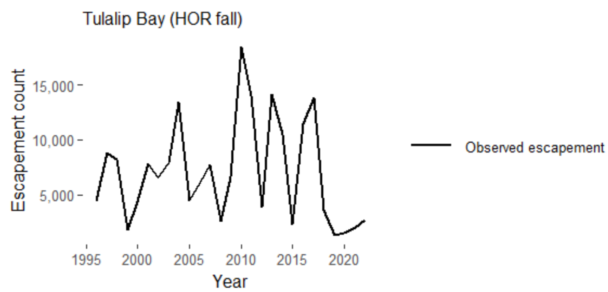

Strait of JDF (HOR fall)
Strait of JDF (NOR fall)
Strait of JDF (NOR summer)
Misc 7B streams (HOR fall)
Misc 7B streams (NOR fall)
Nooksack R. (HOR fall)
Nooksack R. (NOR fall)
Samish R. (HOR fall)
Samish R. (NOR fall)
Sauk River (Sauk-Suiattle Tribe) (HOR fall)
Skagit R. (HOR fall)
Skagit R. (NOR fall)
Escapement count
Year
Observed escapement
Even- and odd-year escapement goal
Even-year escapement goal
Odd-year escapement goal

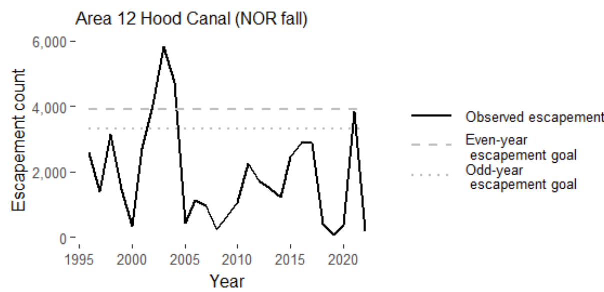

Snohomish R. (HOR fall)
Escapement count
0
50
100
150
200
1995
2000
2005
2010
2015
2020
Year
Observed escapement

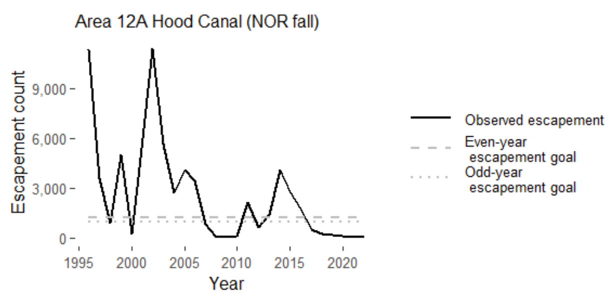

Snohomish R. (NOR fall)
Escapement count
0
50,000
100,000
150,000
1995
2000
2005
2010
2015
2020
Year
Observed escapement
Even-year escapement goal
Odd-year escapement goal

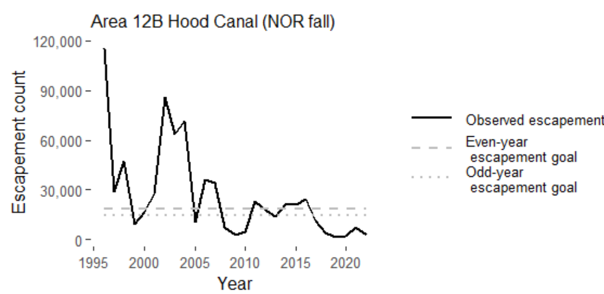

Stillaguamish R. (HOR fall)
Escapement count
0
500
1,000
1995
2000
2005
2010
2015
2020
Year
Observed escapement

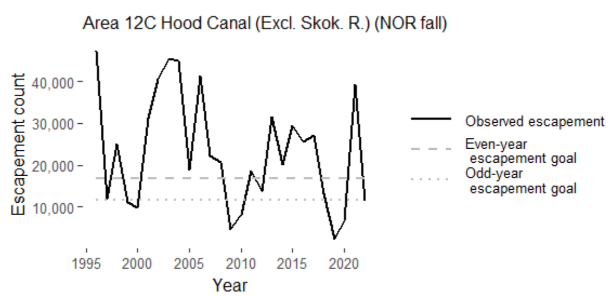

Stillaguamish R. (NOR fall)
Escapement count
0
50,000
100,000
150,000
200,000
1995
2000
2005
2010
2015
2020
Year
Observed escapement
Even-year escapement goal
Odd-year escapement goal

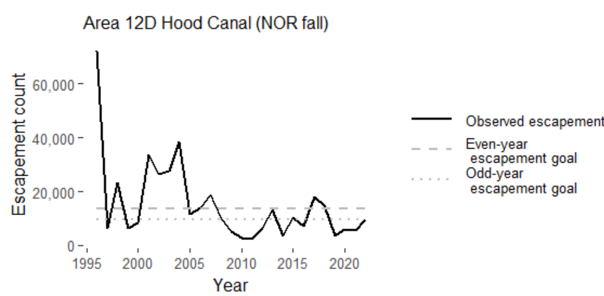

Tulalip Bay (HOR fall)
Escapement count
5,000
10,000
15,000
1995
2000
2005
2010
2015
2020
Year
Observed escapement

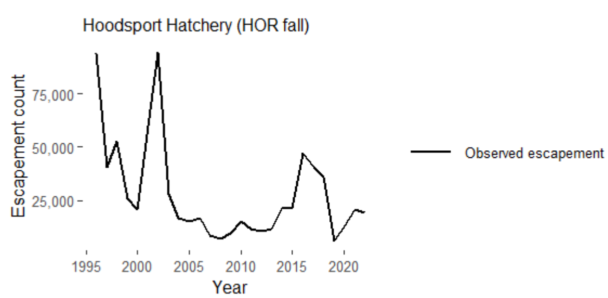

Area 12 Hood Canal (NOR fall)
Escapement count
0
2,000
4,000
6,000
1995
2000
2005
2010
2015
2020
Year
Observed escapement
Even-year escapement goal
Odd-year escapement goal

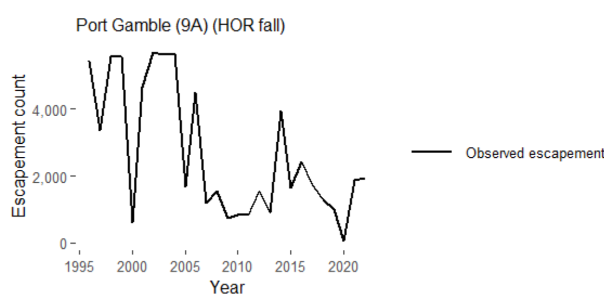

Area 12A Hood Canal (NOR fall)
Escapement count
0
3,000
6,000
9,000
1995
2000
2005
2010
2015
2020
Year
Observed escapement
Even-year escapement goal
Odd-year escapement goal

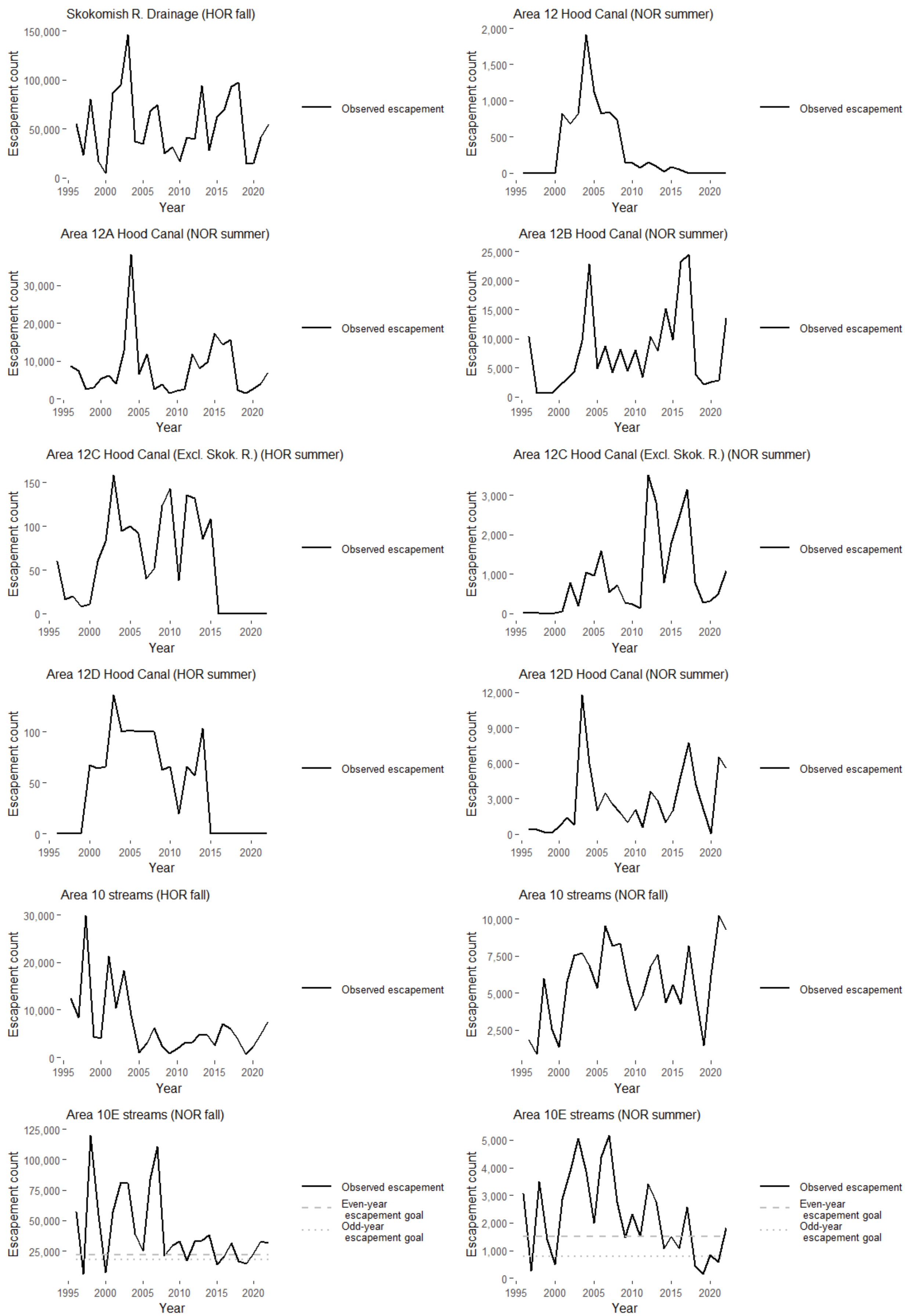

Area 12B Hood Canal (NOR fall)
Escapement count
0
30,000
60,000
90,000
120,000
1995
2000
2005
2010
2015
2020
Year
Observed escapement
Even-year escapement goal
Odd-year escapement goal


Area 12C Hood Canal (Excl. Skok. R.) (NOR fall)
Escapement count
10,000
20,000
30,000
40,000
1995
2000
2005
2010
2015
2020
Year
Observed escapement
Even-year escapement goal
Odd-year escapement goal

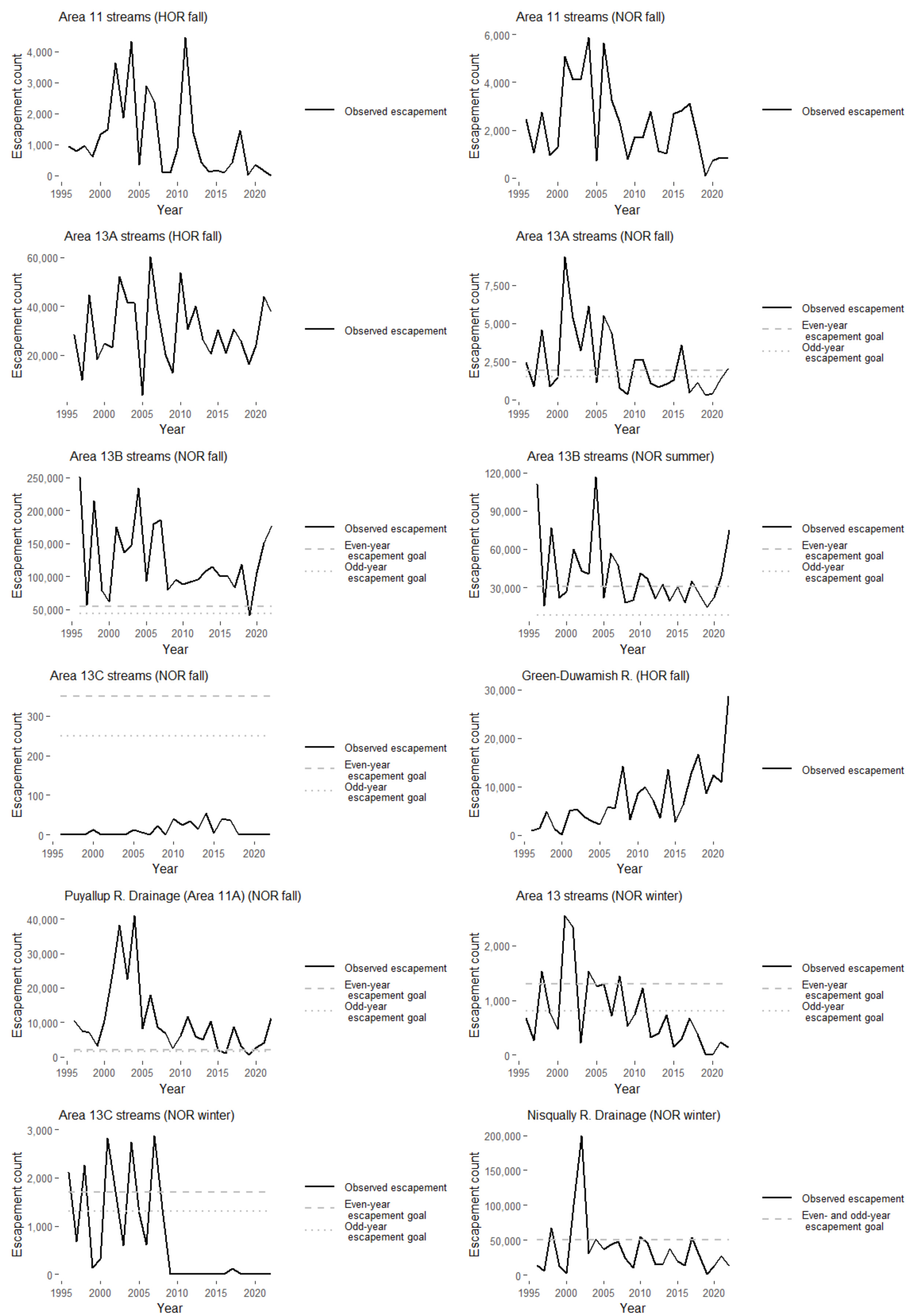

Area 12D Hood Canal (NOR fall)
Escapement count
0
20,000
40,000
60,000
1995
2000
2005
2010
2015
2020
Year
Observed escapement
Even-year escapement goal
Odd-year escapement goal


Hoodsport Hatchery (HOR fall)
Escapement count
25,000
50,000
75,000
1995
2000
2005
2010
2015
2020
Year
Observed escapement


Port Gamble (9A) (HOR fall)
Escapement count
0
2,000
4,000
1995
2000
2005
2010
2015
2020
Year
Observed escapement



Skokomish R. Drainage (HOR fall)
Area 12 Hood Canal (NOR summer)
Area 12A Hood Canal (NOR summer)
Area 12B Hood Canal (NOR summer)
Area 12C Hood Canal (Excl. Skok. R.) (HOR summer)
Area 12C Hood Canal (Excl. Skok. R.) (NOR summer)
Area 12D Hood Canal (HOR summer)
Area 12D Hood Canal (NOR summer)
Area 10 streams (HOR fall)
Area 10 streams (NOR fall)
Area 10E streams (NOR fall)
Area 10E streams (NOR summer)
Escapement count
Year
Observed escapement
Even-year escapement goal
Odd-year escapement goal



Area 11 streams (HOR fall)
Escapement count
Year
Observed escapement
Area 11 streams (NOR fall)
Escapement count
Year
Observed escapement
Area 13A streams (HOR fall)
Escapement count
Year
Observed escapement
Area 13A streams (NOR fall)
Escapement count
Year
Observed escapement
Even-year escapement goal
Odd-year escapement goal
Area 13B streams (NOR fall)
Escapement count
Year
Observed escapement
Even-year escapement goal
Odd-year escapement goal
Area 13B streams (NOR summer)
Escapement count
Year
Observed escapement
Even-year escapement goal
Odd-year escapement goal
Area 13C streams (NOR fall)
Escapement count
Year
Observed escapement
Even-year escapement goal
Odd-year escapement goal
Green-Duwamish R. (HOR fall)
Escapement count
Year
Observed escapement
Puyallup R. Drainage (Area 11A) (NOR fall)
Escapement count
Year
Observed escapement
Even-year escapement goal
Odd-year escapement goal
Area 13 streams (NOR winter)
Escapement count
Year
Observed escapement
Even-year escapement goal
Odd-year escapement goal
Area 13C streams (NOR winter)
Escapement count
Year
Observed escapement
Even-year escapement goal
Odd-year escapement goal
Nisqually R. Drainage (NOR winter)
Escapement count
Year
Observed escapement
Even- and odd-year escapement goal

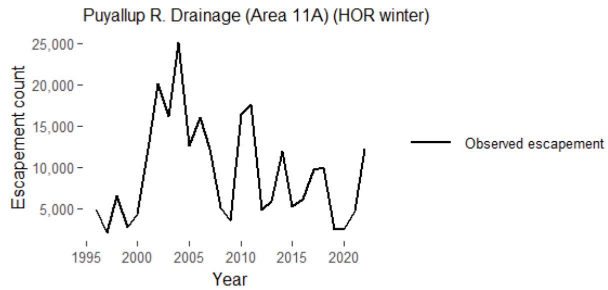
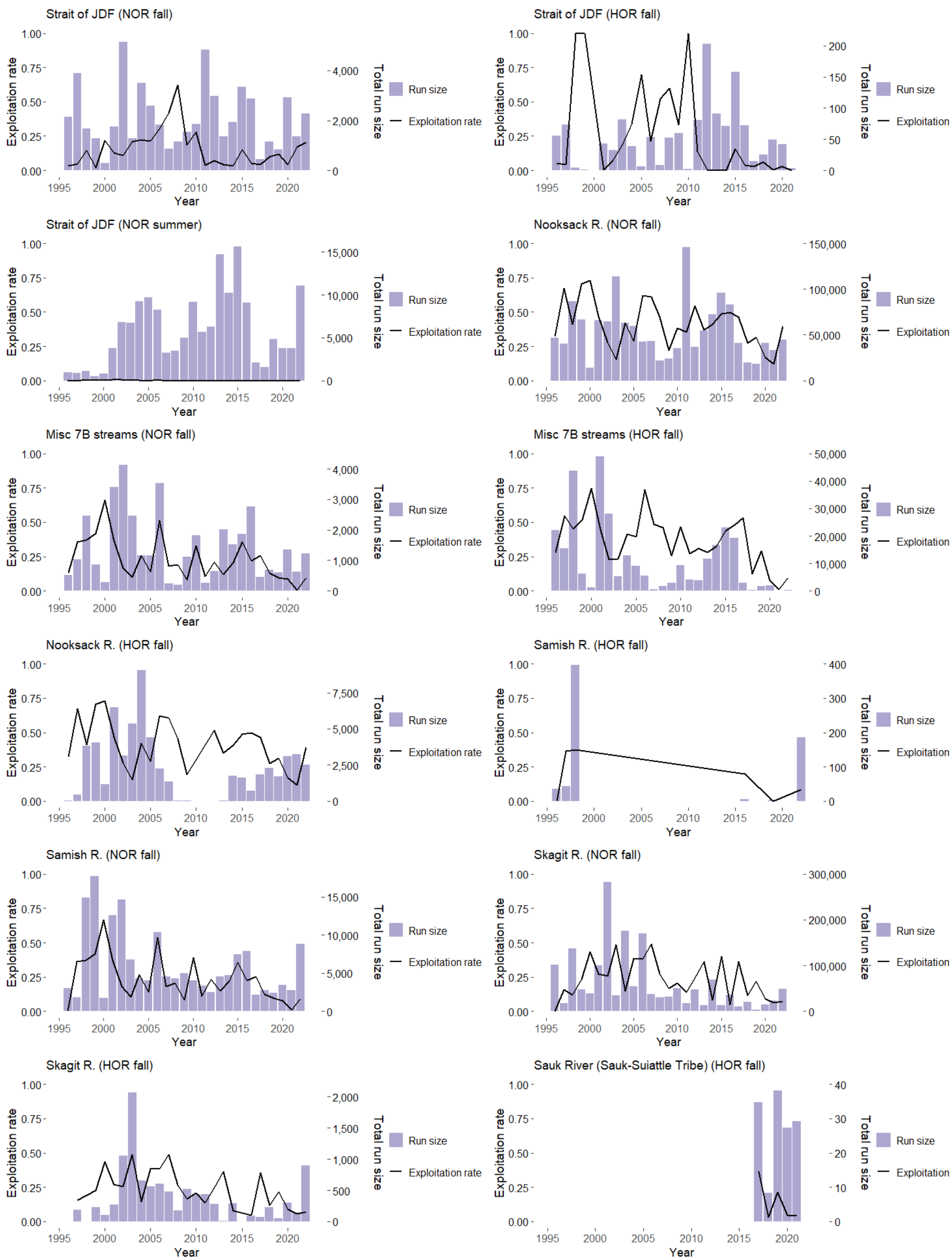


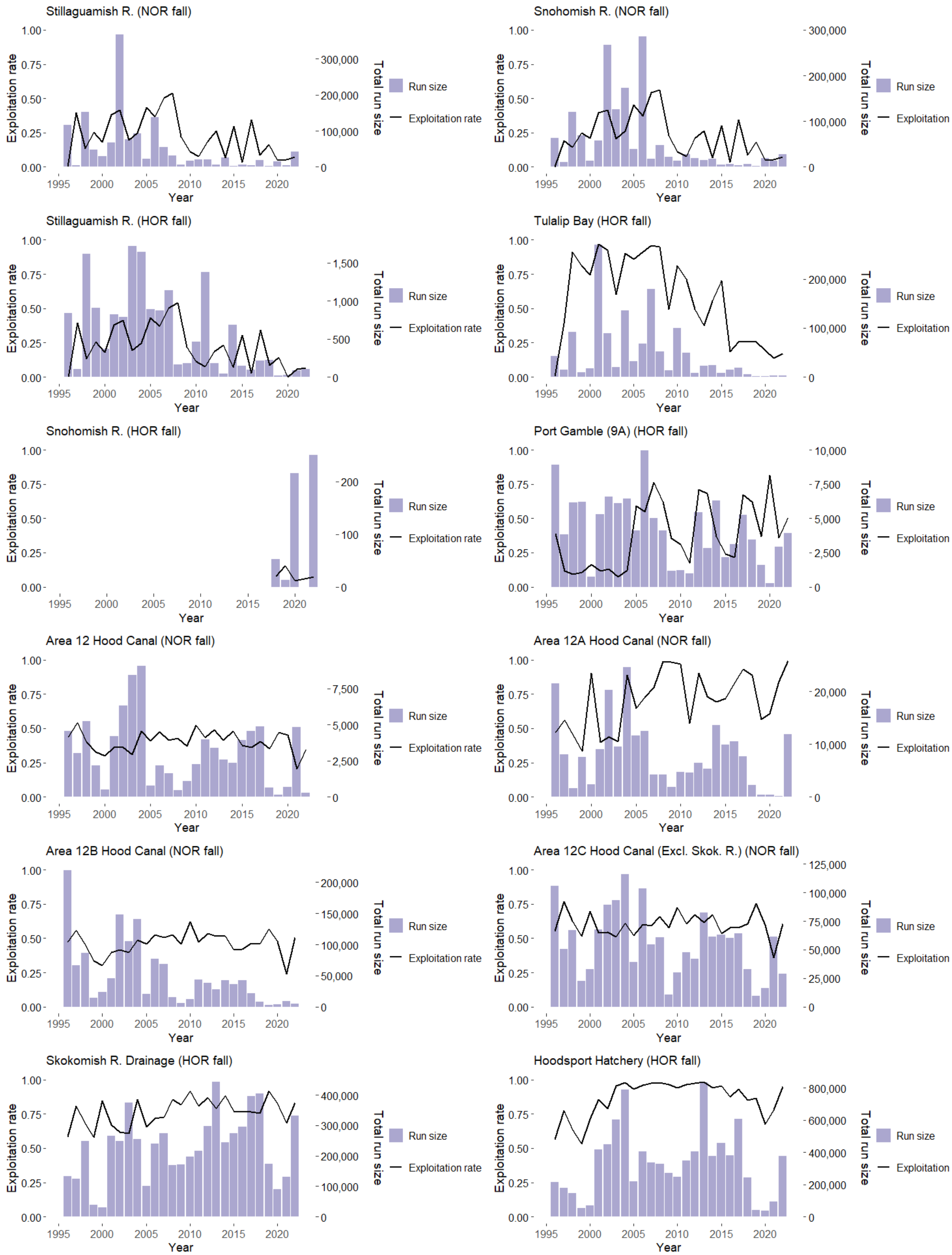

Figure S3. Chum salmon escapement by run reconstructed stock from 1996–2022. Escapement goal is plotted for natural origin stocks with a co-manager agreed-to escapement goal. Note that within a stock, the escapement goal may vary between even and odd years. Stocks with low escapement (recent 10–year average escapement of less than 10 fish) are not included.

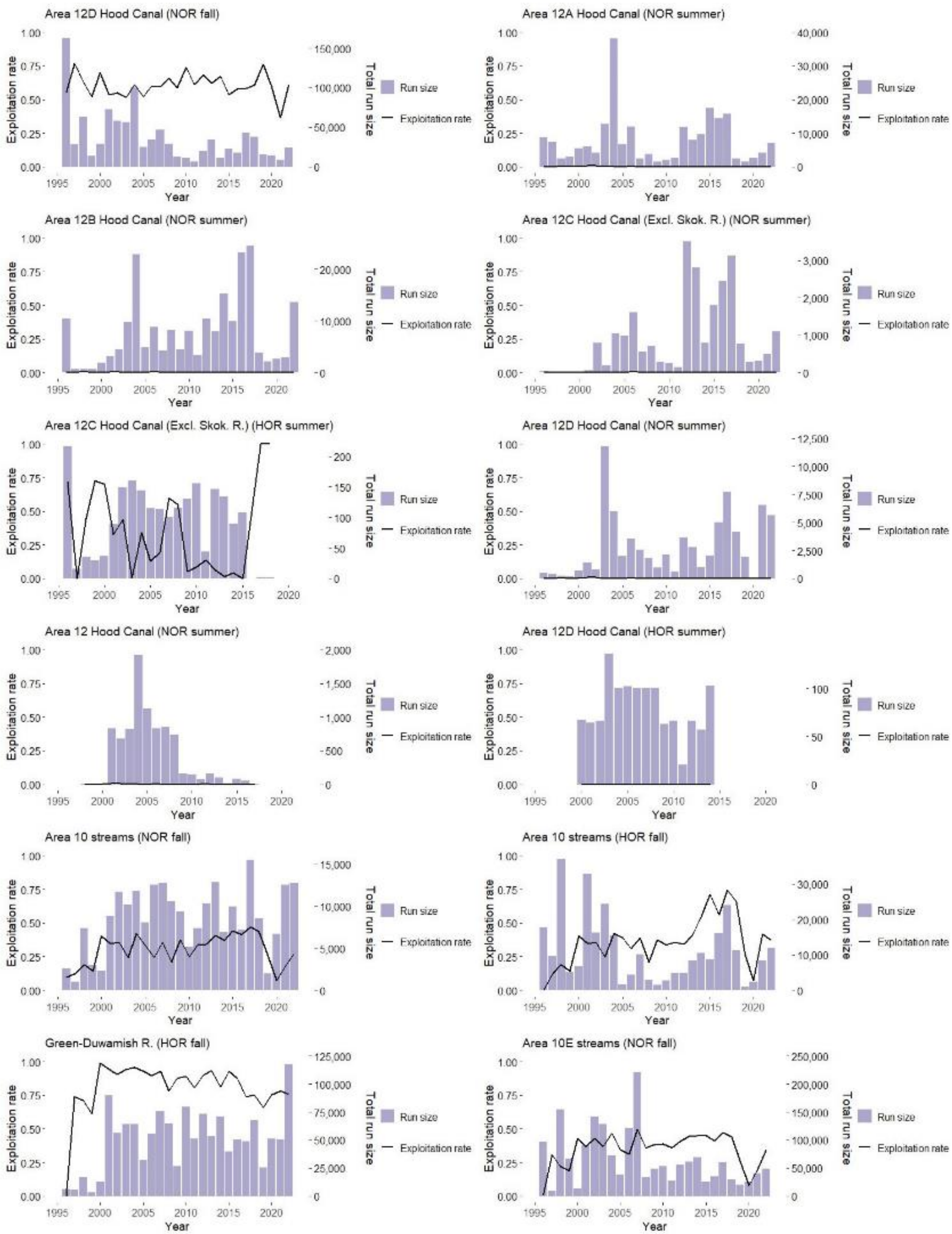
c. Chum salmon harvest by region, split Tribal and non-tribal.

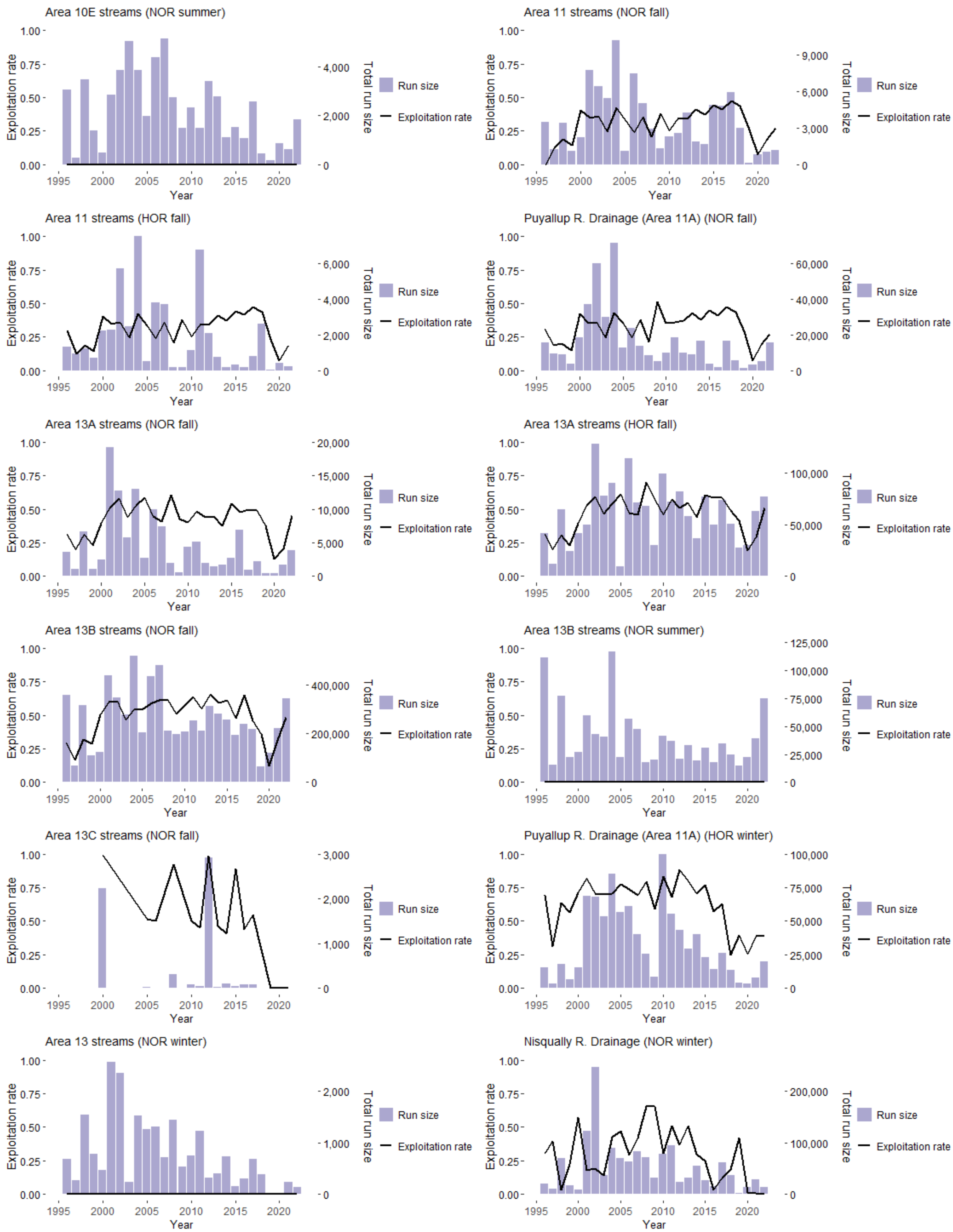

Figure S4. Chum salmon harvest by Tribal and non-tribal fishers parsed by geographic region where harvest occurred from 2003–2022. Both terminal and pre-terminal, and all types of dispositions except test catch were included. The panel for Hood Canal does not include Areas 9 and 9A, as these areas have been shown separately in their own panels. These data are combined from TOCAS (Apr. 12, 2024; all Tribal catch and non-tribal commercial catch) and the WDFW recreational database (all remaining non-tribal catch). The data are subject to change based on ongoing reconciliations. Note that the catch range on the y-axis varies by region.

d. Reconstructed chum salmon harvest by stock


Strait of JDF (NOR fall)
Exploitation rate
0.00
0.25
0.50
0.75
1.00
Total run size
0
2,000
4,000
Year
1995
2000
2005
2010
2015
2020
Run size
Exploitation rate
Strait of JDF (HOR fall)
Total run size
0
50
100
150
200
Run size
Exploitation
Strait of JDF (NOR summer)
0
5,000
10,000
15,000
Nooksack R. (NOR fall)
0
50,000
100,000
150,000
Misc 7B streams (NOR fall)
0
1,000
2,000
3,000
4,000
Misc 7B streams (HOR fall)
0
10,000
20,000
30,000
40,000
50,000
Nooksack R. (HOR fall)
0
2,500
5,000
7,500
Samish R. (HOR fall)
0
100
200
300
400
Samish R. (NOR fall)
0
5,000
10,000
15,000
Skagit R. (NOR fall)
0
100,000
200,000
300,000
Skagit R. (HOR fall)
0
500
1,000
1,500
2,000
Sauk River (Sauk-Suiattle Tribe) (HOR fall)
0
10
20
30
40


Stillaguamish R. (NOR fall)
Snohomish R. (NOR fall)
Stillaguamish R. (HOR fall)
Tulalip Bay (HOR fall)
Snohomish R. (HOR fall)
Port Gamble (9A) (HOR fall)
Area 12 Hood Canal (NOR fall)
Area 12A Hood Canal (NOR fall)
Area 12B Hood Canal (NOR fall)
Area 12C Hood Canal (Excl. Skok. R.) (NOR fall)
Skokomish R. Drainage (HOR fall)
Hoodsport Hatchery (HOR fall)
Exploitation rate
Total run size
Year
Run size
Exploitation rate
Exploitation


Area 12D Hood Canal (NOR fall)
Area 12A Hood Canal (NOR summer)
Area 12B Hood Canal (NOR summer)
Area 12C Hood Canal (Excl. Skok. R.) (NOR summer)
Area 12C Hood Canal (Excl. Skok. R.) (HOR summer)
Area 12D Hood Canal (NOR summer)
Area 12 Hood Canal (NOR summer)
Area 12D Hood Canal (HOR summer)
Area 10 streams (NOR fall)
Area 10 streams (HOR fall)
Green-Duwamish R. (HOR fall)
Area 10E streams (NOR fall)
Exploitation rate
Total run size
Year
Run size


Area 10E streams (NOR summer)
Area 11 streams (NOR fall)
Area 11 streams (HOR fall)
Puyallup R. Drainage (Area 11A) (NOR fall)
Area 13A streams (NOR fall)
Area 13A streams (HOR fall)
Area 13B streams (NOR fall)
Area 13B streams (NOR summer)
Area 13C streams (NOR fall)
Puyallup R. Drainage (Area 11A) (HOR winter)
Area 13 streams (NOR winter)
Nisqually R. Drainage (NOR winter)
Exploitation rate
Total run size
Year
Run size
Exploitation rate

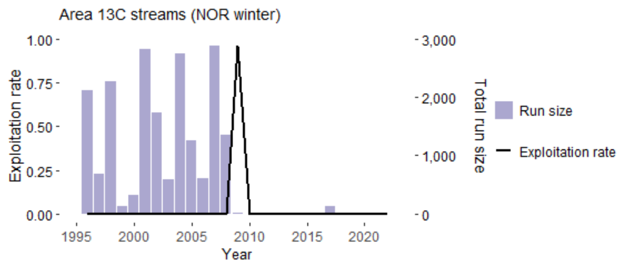



Figure S5. Reconstructed chum salmon run size and harvest by year for each run reconstruction stock from 1996–2021. Note that the range of the y-axis on the right side varies between stocks. Stocks with low escapement (recent 10–year average escapement of less than 10 fish) are not included.

## Tables

Table S1. Map key for Figure 2, relating collection or stream name to location code.

| Map Number | Collection |
|---|---|
| 1 | Hopedale |
| 2 | Peach |
| 3 | Squakum |
| 4 | Big Qualicum |
| 5 | Campbell |
| 6 | Cheakamus |
| 7 | Cowichan |
| 8 | Lang |
| 9 | Little Qualicum |
| 10 | Nanaimo |
| 11 | Phillips |
| 12 | Puntledge |
| 13 | Snake |
| 14 | Southgate |
| 15 | Anderson |
| 16 | Big Beef |
| 17 | Dewatto |
| 18 | Duckabush Fall |
| 19 | Hamma Hamma Fall |
| 20 | Lilliwaup Fall |
| 21 | NF Skokomish |
| 22 | Dosewallips Summer |
| 23 | Hamma Hamma Summer |

| | |
|---|---|
| 24 | Duckabush Summer |
| 25 | Nimpkish |
| 26 | I 205 |
| 27 | Horsetail |
| 28 | Ives Island |
| 29 | Lower Sauk |
| 30 | Nooksack |
| 31 | Skagit lower mainstem |
| 32 | Snohomish |
| 33 | Stillaguamish |
| 34 | Upper Skagit |
| 35 | Dungeness |
| 36 | Chico/Grovers |
| 37 | Kennedy |
| 38 | Skookum |
| 39 | Diru/Puyallup |
| 40 | Nisqually |
| 41 | Conuma |
| 42 | Nitinat |
| 43 | Sooke |

Table S2. Tribal and non-tribal commercial catch of chum salmon in Hood Canal, by catch location, Area 9A, Area 9, and the rest of Hood Canal. This data includes pre-terminal catch from both natural and hatchery origin fish 2014–2022. The panel for Hood Canal does not include Areas 9 and 9A, as these areas have been shown separately in their own panels. These data were pulled from TOCAS (Apr. 12, 2024). The data are subject to change based on ongoing reconciliations.

| Year | Tribal catch | | | Non-tribal catch | | |
|---|---|---|---|---|---|---|
| | Hood Canal | Area 9A | Area 9 | Hood Canal | Area 9A | Area 9 |
| 2013 | 512339 | 1653 | 79 | 649356 | 0 | 0 |
| 2014 | 312316 | 1662 | 6465 | 276294 | 0 | 0 |
| 2015 | 393389 | 355 | 4460 | 257657 | 0 | 0 |
| 2016 | 334620 | 442 | 20436 | 236979 | 0 | 0 |
| 2017 | 446388 | 2905 | 42103 | 390819 | 96 | 0 |
| 2018 | 263890 | 1605 | 43349 | 187155 | 14 | 0 |
| 2019 | 86915 | 344 | 20231 | 94322 | 17 | 0 |
| 2020 | 45963 | 181 | 13709 | 53481 | 1 | 0 |
| 2021 | 134620 | 663 | 16653 | 15821 | 0 | 0 |
| 2022 | 308699 | 1387 | 34804 | 259102 | 49 | 0 |

Table S3. Tribal and state (non-tribal) commercial catch of chum salmon in South Puget Sound, including both natural and hatchery origin fish 2014–2022. This data includes pre-terminal catch from both natural and hatchery origin fish 2014–2022. These data were pulled from TOCAS (Apr. 12, 2024). The data are subject to change based on ongoing reconciliations.

| Year | Tribal catch | Non-tribal catch |
|---|---|---|
| | South Puget Sound | South Puget Sound |
| 2013 | 174014 | 224760 |
| 2014 | 177874 | 192297 |
| 2015 | 109782 | 223342 |
| 2016 | 79781 | 126242 |
| 2017 | 114888 | 257910 |
| 2018 | 105803 | 162346 |
| 2019 | 33029 | 38573 |
| 2020 | 62814 | 0 |
| 2021 | 86233 | 68487 |
| 2022 | 211076 | 184413 |

Table S4. Recent 12-year assessment of scale data collection sample size parsed by geographic management population including ecotype. Collection sites with a sum of less than 200 samples across all years have been excluded.

| | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | Sample size | Sum total of samples | Plot of total samples |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Strait of JDF fall** | | | | | | | | | | | | | | | |
| Chimacum Creek | 0 | 0 | 0 | 0 | 236 | 0 | 170 | 199 | 149 | 40 | 77 | 165 | | 1036 | |
| Jimmy Come Lately Creek | 0 | 0 | 0 | 0 | 328 | 0 | 134 | 26 | 175 | 180 | 166 | 0 | | 1009 | |
| Pysht R. | 0 | 0 | 21 | 28 | 21 | 28 | 1 | 14 | 2 | 135 | 0 | 0 | | 250 | |
| Salmon Creek | 0 | 0 | 0 | 0 | 299 | 5 | 182 | 163 | 229 | 229 | 235 | 213 | | 1555 | |
| Snow Creek | 0 | 0 | 0 | 0 | 158 | 25 | 47 | 105 | 59 | 7 | 49 | 207 | | 657 | |
| **Strait of JDF summer** | | | | | | | | | | | | | | | |
| Chimacum Creek | 0 | 0 | 0 | 0 | 236 | 0 | 170 | 199 | 149 | 40 | 77 | 165 | | 1036 | |
| Jimmy Come Lately Creek | 0 | 0 | 0 | 0 | 328 | 0 | 134 | 26 | 175 | 180 | 166 | 222 | | 1231 | |
| Salmon Creek | 0 | 0 | 0 | 0 | 299 | 0 | 182 | 163 | 229 | 229 | 235 | 213 | | 1550 | |
| Snow Creek | 0 | 0 | 0 | 0 | 158 | 0 | 47 | 105 | 59 | 7 | 49 | 207 | | 632 | |
| **Nooksack/Samish/7B & 7C independents** | | | | | | | | | | | | | | | |
| 77B | 1503 | 1188 | 900 | 1656 | 106 | 844 | 39 | 220 | 862 | 332 | 640 | 706 | | 8996 | |
| 7B | 0 | 904 | 645 | 664 | 825 | 812 | 527 | 322 | 535 | 20 | 20 | 193 | | 5467 | |
| 8 | 0 | 160 | 85 | 231 | 56 | 1 | 47 | 0 | 14 | 44 | 0 | 0 | | 638 | |
| Kendall Creek Hatchery | 0 | 0 | 0 | 80 | 133 | 0 | 0 | 0 | 211 | 536 | 302 | 0 | | 1262 | |
| Whatcom Creek Hatchery | 245 | 256 | 319 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 820 | |
| **Skagit** | | | | | | | | | | | | | | | |
| 78C | 109 | 1169 | 337 | 492 | 347 | 96 | 182 | 462 | 61 | 8 | 75 | 80 | | 3418 | |
| 78D | 239 | 0 | 206 | 191 | 157 | 186 | 9 | 234 | 73 | 96 | 0 | 37 | | 1428 | |
| Marblemount Hatchery | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 268 | 0 | 752 | | 1020 | |
| Red Creek Hatchery | 0 | 164 | 0 | 260 | 0 | 0 | 49 | 0 | 40 | 0 | 0 | 0 | | 513 | |
| **Stillaguamish/Snohomish** | | | | | | | | | | | | | | | |
| 8D | 1466 | 869 | 174 | 601 | 345 | 37 | 0 | 0 | 0 | 0 | 0 | 0 | | 3492 | |
| Battle Cr. Hatchery | 0 | 213 | 0 | 0 | 0 | 571 | 0 | 707 | 431 | 260 | 463 | 230 | | 2875 | |
| Misc. WRIA 07 | 234 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | | 235 | |
| NF Stillaguamish River | 126 | 0 | 0 | 0 | 0 | 5 | 15 | 17 | 0 | 20 | 17 | 40 | | 240 | |
| Sky Slough | 1743 | 0 | 0 | 0 | 0 | 0 | 54 | 86 | 70 | 166 | 132 | 318 | | 2569 | |
| Snohomish R. | 725 | 15 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 740 | |
| Stillaguamish R. | 30 | 258 | 0 | 0 | 0 | 8 | 0 | 0 | 23 | 0 | 0 | 0 | | 319 | |
| Wallace River Hatchery | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 194 | 139 | 211 | | 544 | |

Comprehensive Chum Salmon Management Report (2023–2024)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Hood Canal fall** | | | | | | | | | | | | | |
| 12 | 820 | 1392 | 916 | 1230 | 831 | 1139 | 1058 | 909 | 1807 | 1214 | 783 | 1132 | 13231 |
| 12A | 0 | 0 | 0 | 0 | 0 | 0 | 706 | 0 | 0 | 0 | 0 | 0 | 706 |
| 12B | 0 | 0 | 0 | 277 | 309 | 206 | 195 | 0 | 583 | 200 | 664 | 1120 | 3554 |
| 12C | 845 | 2167 | 1419 | 2467 | 734 | 1400 | 1068 | 762 | 2236 | 932 | 1571 | 1225 | 16826 |
| 12H | 0 | 1077 | 2623 | 1082 | 0 | 692 | 419 | 241 | 953 | 29 | 473 | 1130 | 8719 |
| 82G | 645 | 1529 | 1262 | 2126 | 901 | 1370 | 850 | 963 | 1894 | 1239 | 2084 | 1329 | 16192 |
| 9 | 0 | 0 | 0 | 0 | 198 | 200 | 0 | 0 | 519 | 177 | 0 | 0 | 1094 |
| 9 - Above Bridge Test | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 740 | 740 |
| 9-ACP Test | 804 | 940 | 1152 | 1207 | 1076 | 1010 | 1129 | 1182 | 895 | 944 | 1138 | 1322 | 12799 |
| 9A | 7 | 33 | 0 | 0 | 5 | 5 | 79 | 0 | 51 | 57 | 0 | 0 | 237 |
| Anderson Creek | 204 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 204 |
| Big Beef Creek | 25 | 0 | 45 | 0 | 0 | 0 | 0 | 0 | 0 | 7 | 108 | 21 | 206 |
| Big Quilcene R. | 62 | 51 | 177 | 94 | 377 | 51 | 513 | 0 | 0 | 142 | 0 | 0 | 1467 |
| Dosewallips R. | 0 | 59 | 29 | 11 | 305 | 78 | 214 | 0 | 0 | 50 | 45 | 171 | 962 |
| Duckabush R. | 0 | 66 | 203 | 68 | 366 | 76 | 401 | 0 | 0 | 27 | 87 | 0 | 1294 |
| Enetai Creek | 0 | 0 | 451 | 0 | 144 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 595 |
| Enetai Hatchery | 116 | 97 | 0 | 134 | 0 | 197 | 195 | 0 | 0 | 0 | 0 | 0 | 739 |
| George Adams Hatchery | 0 | 0 | 199 | 0 | 139 | 0 | 0 | 195 | 0 | 0 | 0 | 0 | 533 |
| Hamma Hamma R. | 0 | 0 | 0 | 163 | 190 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 353 |
| Hamma Hamma Slough | 0 | 0 | 206 | 0 | 118 | 134 | 383 | 0 | 0 | 19 | 108 | 133 | 1101 |
| Hoodsport Hatchery | 802 | 815 | 399 | 794 | 1395 | 995 | 911 | 790 | 588 | 905 | 784 | 791 | 9969 |
| Jackson Creek | 1 | 111 | 10 | 10 | 10 | 39 | 1 | 0 | 0 | 53 | 81 | 0 | 316 |
| Little Quilcene R. | 169 | 4 | 10 | 1 | 127 | 79 | 168 | 0 | 0 | 74 | 17 | 0 | 649 |
| MS Skokomish R. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8 | 68 | 217 | 293 |
| McKernan Hatchery | 798 | 794 | 796 | 618 | 797 | 798 | 797 | 781 | 791 | 962 | 785 | 791 | 9508 |
| Skokomish R. | 0 | 0 | 0 | 0 | 89 | 0 | 288 | 166 | 0 | 0 | 0 | 30 | 573 |
| Spencer Creek | 176 | 98 | 148 | 57 | 78 | 100 | 66 | 0 | 0 | 86 | 62 | 12 | 883 |
| Tahuya Tribs | 0 | 0 | 0 | 0 | 212 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 212 |
| Union R. | 0 | 0 | 46 | 0 | 0 | 0 | 0 | 0 | 205 | 262 | 212 | 240 | 965 |
| Vance Creek | 0 | 0 | 0 | 0 | 1 | 20 | 0 | 0 | 20 | 46 | 7 | 150 | 244 |
| Wolcott Slough | 22 | 142 | 170 | 188 | 156 | 115 | 120 | 0 | 0 | 37 | 25 | 7 | 982 |
| **Hood Canal summer** | | | | | | | | | | | | | |
| 12 | 0 | 1392 | 916 | 1230 | 831 | 0 | 1058 | 0 | 1807 | 0 | 0 | 0 | 7234 |
| 12A | 0 | 32 | 199 | 260 | 154 | 215 | 706 | 66 | 0 | 1 | 59 | 193 | 1885 |
| 12B | 0 | 0 | 0 | 277 | 0 | 206 | 0 | 85 | 0 | 200 | 664 | 1120 | 2552 |
| 12C | 0 | 2167 | 1419 | 2467 | 734 | 1400 | 1068 | 762 | 2236 | 932 | 1571 | 1225 | 15981 |
| 12H | 0 | 0 | 0 | 0 | 0 | 692 | 0 | 0 | 0 | 0 | 0 | 0 | 692 |
| 9-ACP Test | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1138 | 1322 | 2460 |
| Big Quilcene R. | 0 | 0 | 0 | 94 | 377 | 0 | 513 | 233 | 124 | 142 | 198 | 154 | 1835 |
| Dewatto R. | 0 | 0 | 0 | 0 | 137 | 0 | 139 | 5 | 2 | 1 | 0 | 37 | 321 |
| Dosewallips R. | 0 | 59 | 0 | 0 | 305 | 0 | 214 | 84 | 0 | 50 | 0 | 171 | 883 |
| Duckabush R. | 0 | 0 | 203 | 0 | 366 | 0 | 401 | 56 | 33 | 27 | 87 | 147 | 1320 |
| Hamma Hamma R. | 0 | 0 | 0 | 163 | 190 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 353 |
| Hamma Hamma Slough | 0 | 0 | 0 | 0 | 0 | 0 | 383 | 232 | 28 | 19 | 108 | 133 | 903 |
| Lilliwaup Creek | 0 | 0 | 0 | 0 | 0 | 0 | 175 | 93 | 73 | 63 | 1 | 132 | 537 |
| Little Quilcene R. | 0 | 0 | 10 | 0 | 127 | 0 | 168 | 0 | 0 | 74 | 17 | 5 | 401 |
| Spencer Creek | 0 | 98 | 148 | 57 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 303 |
| Tahuya R. | 0 | 0 | 0 | 0 | 0 | 0 | 140 | 144 | 7 | 10 | 0 | 52 | 353 |
| Tahuya Tribs | 0 | 0 | 0 | 0 | 212 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 212 |
| Union R. | 0 | 0 | 0 | 0 | 154 | 0 | 144 | 145 | 205 | 262 | 212 | 240 | 1362 |
| Wolcott Slough | 0 | 0 | 170 | 188 | 156 | 0 | 0 | 20 | 0 | 0 | 0 | 0 | 534 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **South Sound summer & fall** | | | | | | | | | | | | | |
| 10 | 1334 | 1705 | 1837 | 2250 | 2481 | 1777 | 1298 | 1375 | 591 | 397 | 770 | 2272 | 18087 |
| 10A | 197 | 756 | 1634 | 1362 | 738 | 1578 | 596 | 1335 | 654 | 2071 | 1247 | 1737 | 13905 |
| 10_11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 388 | 0 | 388 |
| 11 | 1664 | 0 | 957 | 2126 | 610 | 394 | 780 | 430 | 198 | 0 | 195 | 481 | 7835 |
| 11-Test | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1004 | 1004 |
| 80B | 1557 | 994 | 1294 | 1066 | 812 | 1660 | 597 | 1194 | 340 | 1528 | 1453 | 1366 | 13861 |
| 81B | 0 | 383 | 0 | 646 | 539 | 392 | 0 | 0 | 37 | 58 | 0 | 0 | 2055 |
| 82J | 204 | 0 | 189 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 18 | 197 | 608 |
| 83D | 734 | 746 | 793 | 814 | 439 | 219 | 1165 | 1224 | 377 | 0 | 0 | 0 | 6511 |
| 83D - Test | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 211 | 211 |
| Clarks Creek (Diru Hatchery) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 568 | 568 |
| Cranberry Creek | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 555 | 556 |
| Diru Creek Hatchery | 496 | 661 | 762 | 722 | 759 | 294 | 786 | 0 | 0 | 398 | 423 | 0 | 5301 |
| Fennel Cr. /Canyon Falls | 0 | 0 | 0 | 88 | 0 | 55 | 164 | 93 | 5 | 57 | 14 | 159 | 635 |
| Fiscus Creek | 0 | 0 | 111 | 0 | 20 | 60 | 0 | 0 | 0 | 0 | 57 | 0 | 248 |
| Grovers Hatchery | 877 | 615 | 988 | 534 | 414 | 480 | 795 | 650 | 119 | 433 | 704 | 774 | 7383 |
| John's Creek | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 11 | 0 | 463 | 474 |
| Kennedy Creek | 59 | 0 | 119 | 151 | 60 | 3 | 72 | 19 | 44 | 100 | 58 | 512 | 1197 |
| McLane Creek | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 18 | 20 | 369 | 407 |
| Minter Creek | 0 | 0 | 418 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 789 | 1207 |
| Perry Creek | 0 | 0 | 0 | 80 | 97 | 79 | 98 | 19 | 116 | 79 | 78 | 351 | 997 |
| Sherwood Creek | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 222 | 223 |
| Skookum Creek | 0 | 0 | 98 | 56 | 20 | 58 | 59 | 40 | 0 | 45 | 33 | 534 | 943 |
| **South Sound winter** | | | | | | | | | | | | | |
| 81B | 0 | 383 | 0 | 646 | 539 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1568 |
| 83D | 734 | 746 | 793 | 814 | 439 | 219 | 1165 | 1224 | 377 | 15 | 4 | 0 | 6530 |
| 83D - Test | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 211 | 211 |
| Clarks Creek (Diru Hatchery) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 568 | 568 |
| Diru Creek Hatchery | 496 | 661 | 762 | 722 | 759 | 0 | 786 | 0 | 0 | 398 | 0 | 0 | 4584 |