



RECOVERY POTENTIAL ASSESSMENT OF EAST VANCOUVER ISLAND SUMMER CHINOOK (DESIGNATABLE UNITS 19 AND 20)



Chinook Salmon (Oncorhynchus tshawytscha)
Credit: Eiko Jones

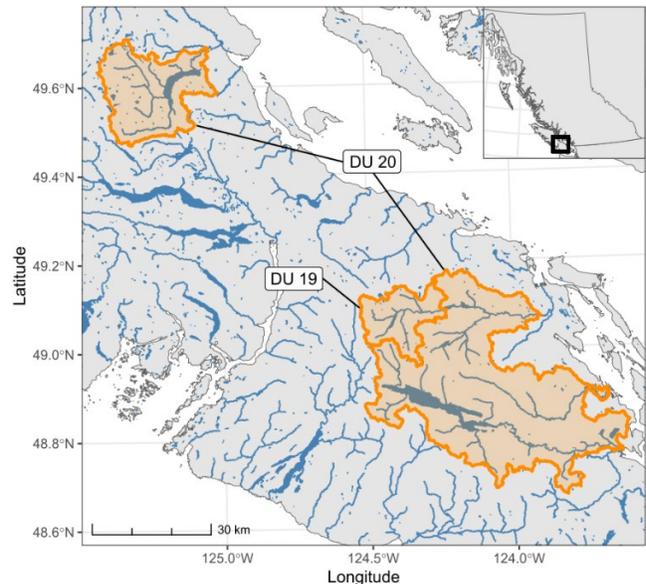


Figure 1. Geographic boundaries of East Vancouver Island Summer Chinook Salmon, including Designatable Units 19 and 20.

CONTEXT

This Science Advisory Report is from the regional peer review of March 18-20, 2025, on Recovery Potential Assessment for Southern British Columbia Chinook Salmon, East Coast Vancouver Island (Designatable Units 19 and 20). Participants included DFO South Coast Area, DFO Science, DFO Salmonid Enhancement Program, members of Snuneymuxw and K'ómoks First Nations, academics and subject matter experts. Additional publications from this meeting will be posted on the [Fisheries and Oceans Canada \(DFO\) Science Advisory Schedule](#) as they become available.

SUMMARY

- East Vancouver Island (EVI) Stream, Spring Chinook Designatable Unit (DU) 19 and EVI Ocean, Summer, Chinook DU 20 are both assessed as Endangered by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). This initiated the current DFO process to provide advice needed to meet various requirements of the *Species at Risk Act*.

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- DU 19 spawns above Second Lake in the upper reaches of the Nanaimo River. DU 20 spawns in the Nanaimo River and the Puntledge River. While data are limited, some summer-run fish are known to spawn in the Cowichan River and Chemainus River systems. Herein, we will refer to these DUs collectively as EVI Summer Chinook.
- Marine distribution of EVI Summer Chinook ranges from Southeast Alaska in the north to the Puget Sound in the south. There are some indications that there is a high residency within the Strait of Georgia.
- EVI Summer Chinook are enhanced by hatcheries in the Nanaimo and Puntledge River systems. These two watersheds have consistently monitored annual returns. Adult EVI Summer Chinook enter the Nanaimo River as early as February, and the Puntledge River in April through to August, with the peak of upstream migration happening in June. Main holding pools in Nanaimo River are at the South Fork Junction, downstream of White Rapid Falls, and First and Second Lake. In the Puntledge River, the main holding location is Comox Lake.
- Impacts to EVI Summer Chinook were assessed by subject matter experts and high-risk threats identified were harvest, human disturbance, system modification, competition and hatchery practices. Limiting factors that were also affecting EVI Summer Chinook are predation and climate change.
- EVI Summer Chinook have a survival target of 1,000 natural-origin spawners (based on COSEWIC Criterion D). Precautionarily, we have used system-specific survival targets, the target for the Nanaimo River is 1,000 and the target for the Puntledge River is 1,000 natural spawners. The system-specific recovery target for Nanaimo River is 1,785, and the target for Puntledge River is 2,125 natural spawners.
- On the Puntledge River a portion of juveniles were coded-wire tagged (CWT) and marked (adipose fin removed) each year for estimation of marine survival and exploitation rate (ER) as well as their movement and distribution. A population viability assessment for the Puntledge River component of EVI Summer Chinook was conducted using an age-structured, state-space life cycle model fit to data from 1980-2020, with future projections extending 40 years in the future. We assume that the sensitivity of the Puntledge River component to threats is representative of all EVI Summer Chinook.
- Forward simulations were run by varying ten parameter and data inputs organized into five categories: harvest rates, hatchery supplementation, freshwater habitat, marine predation and climate. The probabilities of achieving the survival and recovery targets were most sensitive to changes in pre-spawn survival, ocean harvest rates and regional hatchery releases.
- The population viability analysis (PVA) model indicated that under baseline conditions, the Puntledge River component of EVI Summer Chinook is as likely as not to achieve the survival target and unlikely to achieve the recovery target by 2042.
- Scenarios that increased pre-spawn survival, decreased ocean harvest and decreased regional hatchery releases resulted in higher probabilities of achieving the survival and recovery targets. While simulations reflecting improvements in freshwater habitat and

productivity show improved survival, freshwater habitat improvement alone will not likely achieve the recovery targets.

- Other than activities that promote survival and recovery of EVI Summer Chinook, all ongoing and future human-induced mortality, along with activities that result in harmful alteration, disruption, or destruction of their habitat, should be prevented.
- Due to data availability, not all threats to EVI Summer Chinook could be modelled. There is a need for improved monitoring for compliance (e.g., illegal harvest, forestry, water use, hydroelectric dams), effectiveness of changes (e.g., mitigation, hatchery practice), and ecological populations (e.g., seal predation).
- First Nations food, social, and ceremonial (FSC) harvest, such as practiced by Snuneymuxw and K'omoks First Nations, is guided by traditional ecological knowledge and aligns with natural cycles. FSC harvest are not considered within the scenarios that considered changes to human-induced fishing mortality. A balanced and culturally informed approach to allowable harm would include FSC harvest as part of the natural system.

INTRODUCTION

Rationale for Recovery Potential Assessment

After the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assesses an aquatic species as threatened, endangered, or extirpated, Fisheries and Oceans Canada (DFO) undertakes several actions to support implementation of the *Species at Risk Act* (SARA). Many of these actions require scientific information on the current status of the species, threats to its survival and recovery, and the species' potential for recovery. Formulation of this science advice has typically been developed through a Recovery Potential Assessment (RPA) following the COSEWIC assessment. This peer-reviewed scientific analysis is part of the suite of information that informs the decision whether or not to list the species under SARA, along with ongoing and post-listing decision management actions.

In November 2018, COSEWIC assessed the East Vancouver Island (EVI), Stream, Spring, population (designatable unit [DU] 19) of Chinook salmon as endangered. DU19 is a small population that spawns above Second Lake in the upper reaches of the Nanaimo River, with no hatchery supplementation. In November 2020, COSEWIC also assessed the EVI, Ocean, Summer population (DU 20) of Chinook salmon as endangered. DU20 consists of two major spawning locations: one in the Puntledge River and the other in the Nanaimo River. Both are augmented by hatchery fry releases from adult salmon collected from those runs. Herein, we will refer to these DUs collectively as EVI Summer Chinook. Any reference to Nanaimo Summer Chinook throughout the document includes information from both DU 19 and 20 fish unless otherwise stated.

DFO manages these populations as a single conservation unit (CU; (DFO 2023)), one of three CUs in the Middle Georgia Strait Chinook stock management unit (SMU). Table 1 illustrates the crosswalk between DFO's CU and SMU classification and the corresponding Designatable Unit (DU).

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*Table 1. Crosswalk table illustrating Stock Management Unit, Conservation Unit, Designatable Unit and COSEWIC status. *CK-23: East Vancouver Island-Nanaimo_SP_1.X CU has been deprecated and is now included with CK-83. The corresponding DU structure remains unchanged, and DU19 remains active.*

Stock Management Unit (SMU)	Conservation Unit (CU)	Designatable Unit (DU)	COSEWIC Status	Reasoning for Status
Middle Georgia Strait	CK-83: East Vancouver Island-Georgia Strait_SU_0.3*	DU19: East Vancouver Island, Stream, Spring	Endangered	This spring run of Chinook to the Nanaimo River has been at a very low abundance for a long time. Declines in marine and freshwater habitat quality pose a significant threat to this population (COSEWIC 2018).
Middle Georgia Strait	CK-83: East Vancouver Island-Georgia Strait_SU_0.3*	DU20: East Vancouver Island, Ocean, Summer	Endangered	Mature fish in this population return in summer to spawn in the upper reaches of rivers draining the east side of Vancouver Island, from the Koksilah River in the south to the Puntledge River in the north. According to a consensus of expert opinion, fewer than 1000 wild spawners remain in this population. Exploitation rates are relatively high (about 40%), and marine survival estimates have been low for many years. Additional threats include ecosystem modifications (dam construction and channelization) and drought. The contribution of fish from hatcheries confounds the determination of population trends; hatchery-origin spawners may be a continued threat through direct competition and gene flow (COSEWIC 2020).

Background

Summer Chinook typically return to their natal rivers from April to August, with the peak of migration in June (Healey 1991). EVI Summer Chinook spawners in Puntledge River follow this typical pattern, whereas the spawners return to Nanaimo River as early as February. Spawning takes place from September to October, with adults moving out of summer holding areas onto

spawning locations with appropriate flow and gravel composition. Juveniles emerge from the gravel from February to April, with ocean-type juveniles migrating downstream either immediately or several months post-emergence. Stream-type juveniles remain in freshwater for an additional year. The Nanaimo population has both stream-type and ocean-type strategies, while the Puntledge population has primarily an ocean-type life strategy with immediate (April) and delayed (July) migration to the K'ómoks (Comox) Estuary.

Indigenous Knowledge (IK) from the Snuneymuxw First Nation's Elders indicates that four groups of Chinook salmon historically spawned in the Nanaimo River: a spring group that entered the river as early as March, peaking in April; a summer group that peaked in June; a fall group that peaked in September; and a winter group that peaked in February. The spring and summer run timings overlapped in May, reflecting a gradual transition between life histories. The spring Chinook were the least abundant, with an estimated 800–1000 individuals spawning between First and Second Lake over 50 years ago, before major declines in abundance (Snuneymuxw Elder Henry Bob, pers. comm.). These fish were small, with deep red flesh and high fat content. The Summer Chinook, usually numbering 600–1500, were larger—some up to 40 pounds—and were described as having very sweet flesh (Snuneymuxw Elders, pers. comm.), likely due to their higher lipid reserves, which support extended freshwater residency with limited or no feeding (Hearsey and Kinziger 2015). This detailed IK not only supports biological differentiation among Chinook runs but also highlights the cultural importance and ecological functions of spring and summer fish in the Nanaimo River system.

The Chemainus and Cowichan rivers also have potential Summer Chinook populations with small numbers of Chinook sporadically observed entering the rivers during the summer months. Due to data deficiencies, these populations were not initially included in the scope of the Recovery Potential Assessment. Therefore, the Cowichan, Stz'uminus, Halalt, Lyackson, Penelakut, Ts'uubaa-asatx and Q'ul-lhanumutsun Aquatic Resources Society (QARS) salmon biologists and knowledge keepers were not included in this process and IK and science information from those groups was not included. Following the regional peer review meeting, the authors have invited the aforementioned First Nations, along with QARS, to contribute expertise IK and any information on Chemainus and Cowichan Summer Chinook to the research document.

ASSESSMENT

Abundance

The Nanaimo River Hatchery (NRH) began operations in 1978 and conducted periodic swim surveys on all three spawning locations. However, records in the Salmon Escapement Database (NuSEDS) before 1978 were only created for the Nanaimo summer and fall populations. Subsequently, Watson (2015) examined the NRH data, estimated the population abundance for the section above Second Lake, and created Stream Estimate Narratives (SEN) records in NuSEDS for what was then called the spring run population. The time series of Nanaimo Summer Chinook escapement data and origin are depicted in Figure 1. For most years, the data consists of spot counts or one to two swim surveys per year, which only provide a low-resolution estimate (Type 5 – Relative Abundance). More recent and detailed escapement data for Nanaimo Summer Chinook (Figure 2) are mostly Type 3 (high resolution) and Type 4 (medium resolution). The Other Removal category for Nanaimo in 2020, 2021 and 2024 (years with increased monitoring effort) are the lower river losses, either due to natural mortality or

unsanctioned fishing. The nuances of those losses are being investigated by stock assessment staff with more enumeration sites along the river starting in spring of 2025.

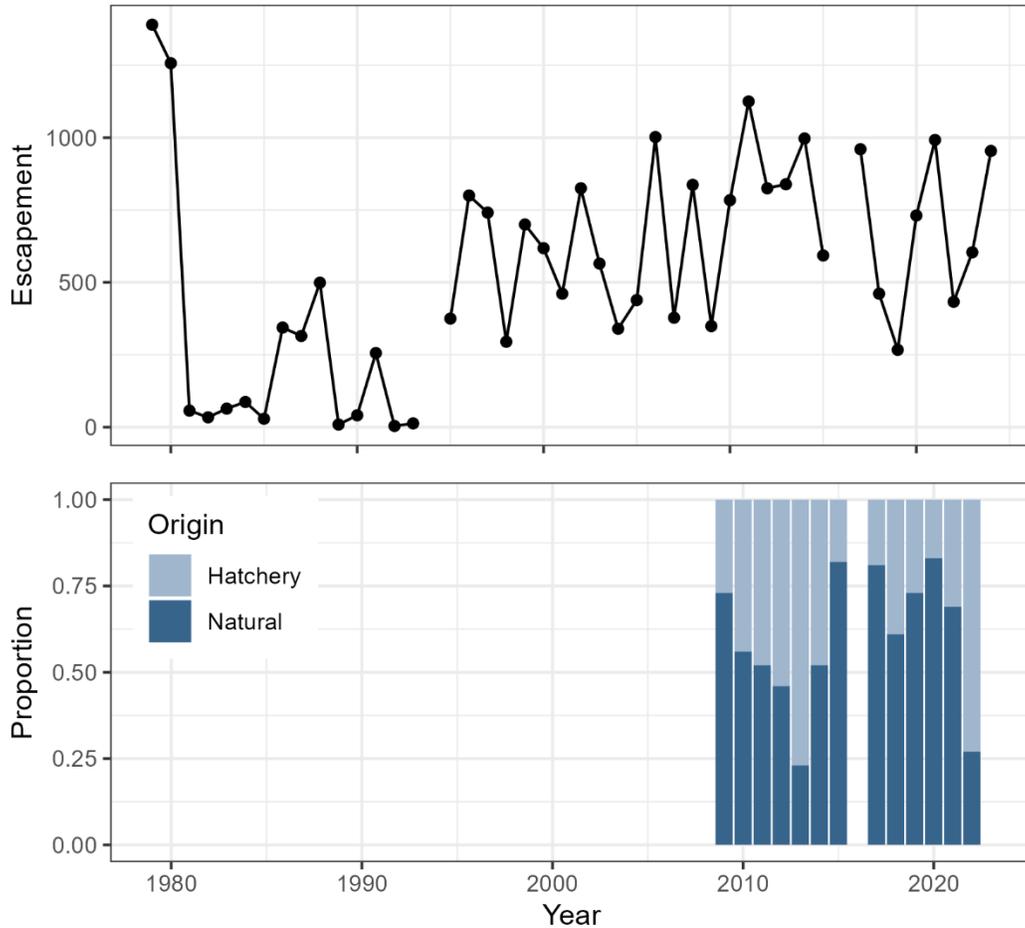


Figure 2. Time series of Nanaimo Summer Chinook escapement (top panel) and proportions of hatchery-origin and natural-origin spawners (pHOS and pNOS), when available (bottom panel). The numbers include the formerly known Nanaimo spring population when available.

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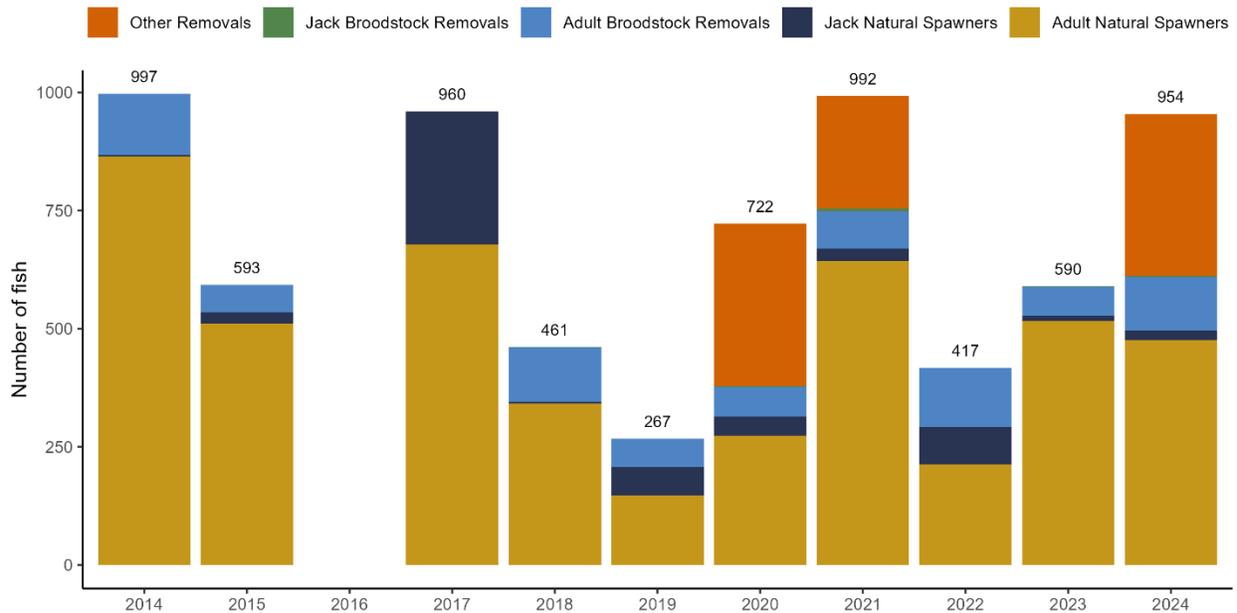


Figure 3. Breakdown of Nanaimo Summer chinook returns over the 2014-2024 period.

The early records for the Puntledge River Chinook listed only the total return to the river, not the breakdown of escapement by summer/fall runs. As time progressed the amount of monitoring increased and the data evolved into two run timing groups; however, when the data was transcribed from the BC-16 reports into the original Salmon Escapement Database System (SEDS) several errors were made in assigning the estimates to the summer and fall populations, and to the Sockeye population as well. The data shown in Figure 3 reflect the corrected data with a breakdown of origin from natural or hatchery. Figure 4 depicts details of the more recent Puntledge Summer Chinook return. The Other Removals category in 2017 is fish harvested by the K'ómoks First Nation as FSC.

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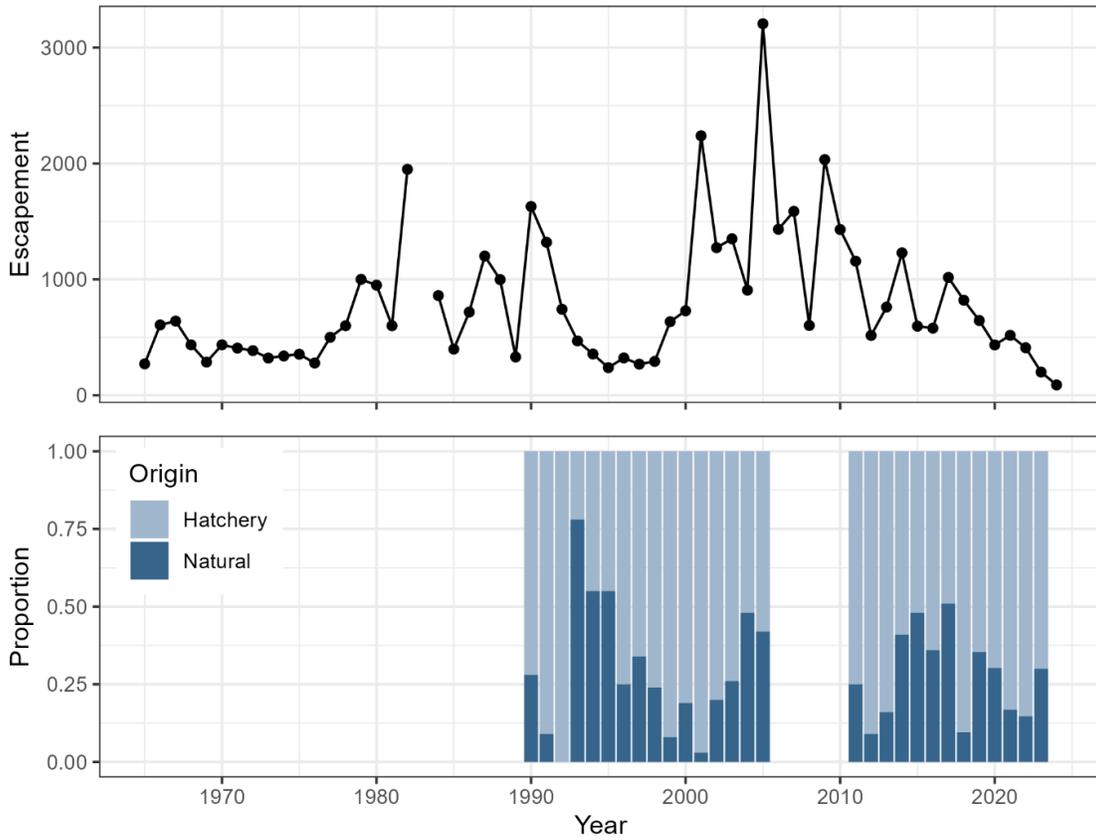


Figure 4. Time series of Puntledge Summer Chinook escapement (top panel) and proportions of hatchery-origin and natural-origin spawners (pHOS and pNOS), when available.

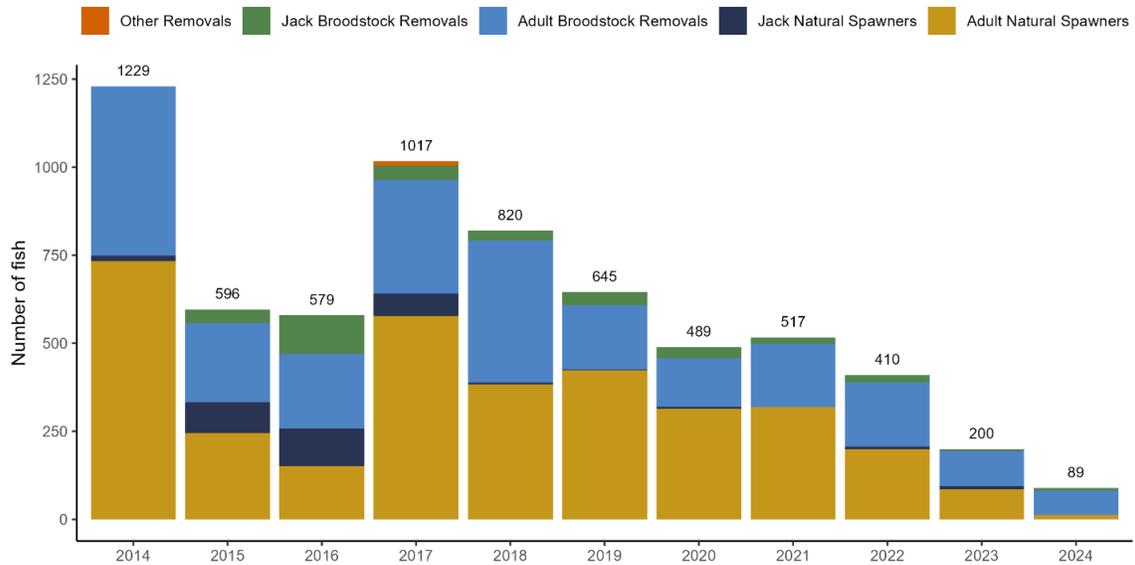


Figure 5. Breakdown of Puntledge Summer chinook returns over the 2014-2024 period.

DFO Stock Assessment, in coordination with Q'ul-Ihanumutsun Aquatic Resources Society, conducts 1-2 swim surveys during the migration period of Summer Chinook in the Chemainus River to estimate their abundance. While the estimates from the limited number of surveys are low-resolution, the highest estimated count was 32 adults and 7 jacks observed in the 2021 swim survey (Fisheries and Oceans Canada 2025).

EVI Summer Chinook returns to the Puntledge River have had a sharp decrease since a peak in the early 2000s. The majority of these returning fish are also hatchery origin, with a small proportion from natural spawning. Whereas returns to the Nanaimo River have been low but stable since the mid-1990s. Natural origin fish have made up most of the returns but may be starting to decline. A large concern for the Nanaimo population is also the number pre-spawn mortalities and lower river losses observed. Meaning that escapement levels of Chinook entering the system is stable, however, 30-50% of those fish do not make it to spawn in the upper river. In Chemainus, very few Summer Chinook have been observed during swim surveys below the Canyon in recent years (Nicolette Watson, DFO, pers. comm.).

Distribution

Nanaimo Summer Chinook spawners move quickly through the lower river and hold in deep pools below White Rapids Falls before migrating to pools downstream of First Lake and into First Lake. Two major holding locations are the Borehole and the South Fork Nanaimo confluence. Observations during regular weekly snorkel surveys in 2024 suggest that a fairly large number of spawners hold in the pool at South Fork junction throughout summer and migrate to spawning grounds in late September and early October just downstream of First Lake. However, the nuances of the spawners' movement in the Nanaimo River and the extent of using First and Second Lake for holding are not well understood. This data gap is noted by the authors, and attempts are underway to monitor the movement of spawners past the White Rapid Falls and into the First and Second Lakes. Some individuals continue upstream to deep pools above Second Lake; however, surveys upstream of Second Lake in recent years have not located spawners. Spawning occurs below First Lake to Wolf Creek (Figure 5) and to a lesser extent between Second and Fourth Lakes.

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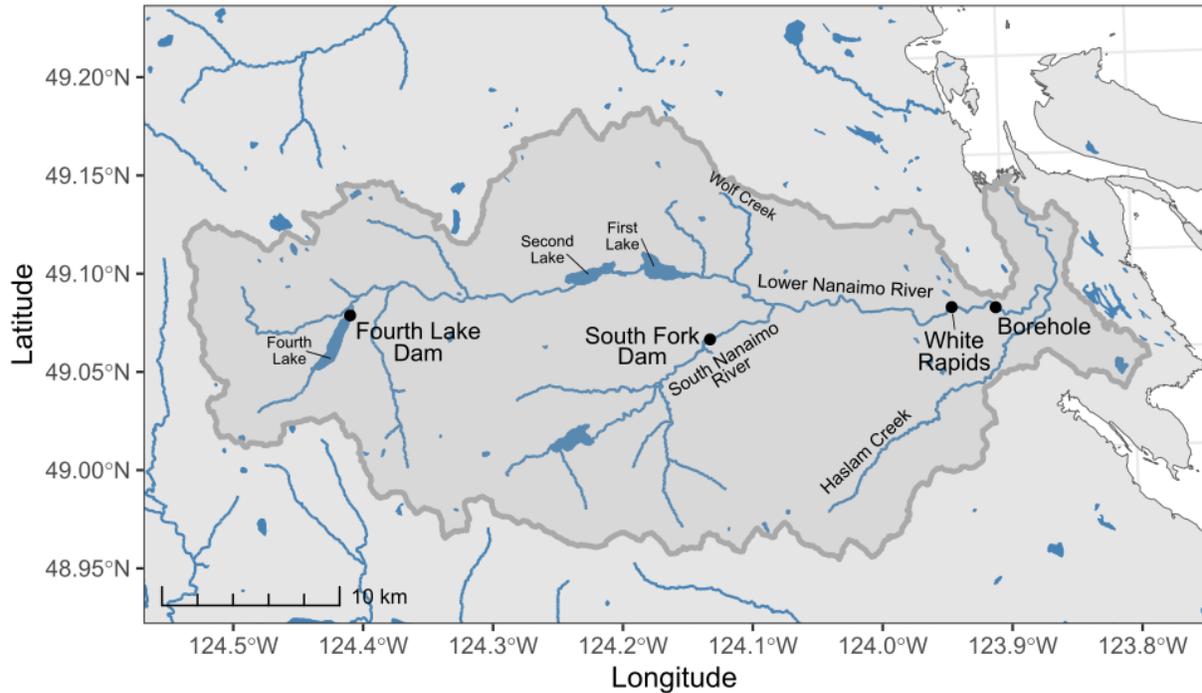


Figure 6. Map of the Nanaimo River watershed highlighting key locations relevant to summer Chinook spawning.

Puntledge Summer Chinook enter the system through the K'ómoks (Comox) Estuary and Courtenay River before travelling upstream to Comox Lake. Chinook first encounter the Puntledge River Hatchery fence (km 6) where they are either enumerated by a video camera in the fence bypass tunnel or are collected by the hatchery. Collected fish are used for broodstock or are trucked up to Comox Lake. Chinook that bypass the fence have to traverse Stotan Falls, Nib Falls, the BC Hydro Diversion Dam fishway, and the Impoundment Dam fishway before reaching Comox Lake. The lake is the primary holding habitat for adult summer Chinook before they drop down into Reach B (Comox Lake Impoundment Dam to the BC Hydro Diversion Dam) to spawn in the fall (Figure 6).

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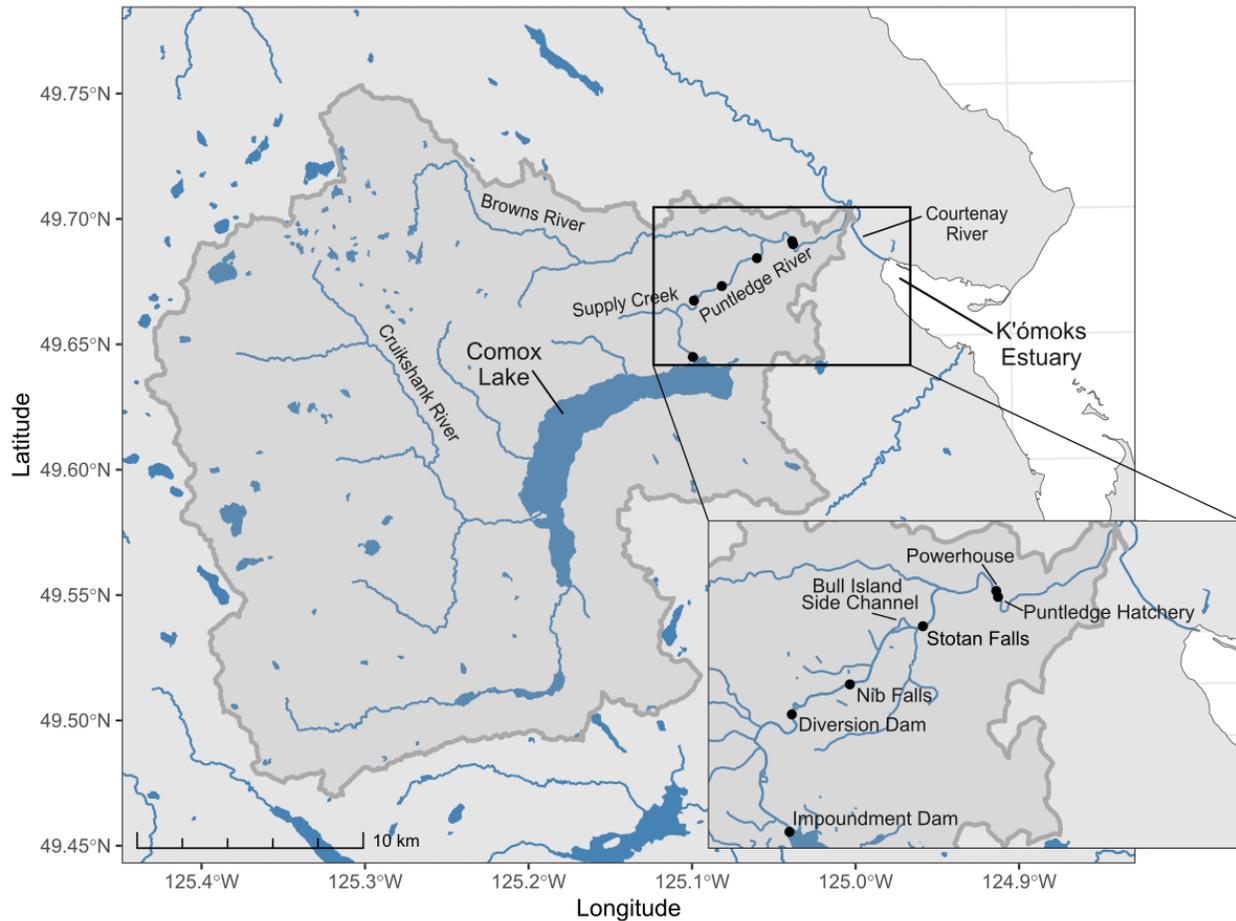


Figure 7. Map of the Puntledge River watershed, Courtenay River and K'ómoks (Comox) Estuary, highlighting key locations relevant to summer Chinook spawning.

CWT recoveries from 1999-2022 reported catch indicate the Puntledge population migrates to Alaska and Northern BC but may also have local migrants that remain in Southern BC (Chinook Technical Committee 2025). While the CWT recoveries provide insight into where Puntledge Summer Chinook are distributed, results must be interpreted carefully due to differences in fisheries openings and opportunities, which might result in higher catches in some areas.

Genetic Stock Identification (GSI) samples from Chinook in the Southern BC sport fishery from 2014 to 2023 ($n=78,533$) indicate that Puntledge Summer Chinook make up a very small portion ($n=137$) of total biological samples (0.17%) in Southern BC. In Pacific Fisheries Management Areas (PFMA) where Puntledge Summer Chinook are identified, the highest proportions occur in Area 16 (Texada Island to Jarvis Inlet), Area 12 (Northern Johnstone Strait), Area 15 (Brettell Point to Powell River) and Area 13 (Quadra Island to Cortes Island) (Figure 7).

As with CWT recoveries, GSI samples reflect area-specific openings. It should also be noted that samples are obtained from both kept and released catches. Released catch samples are taken by Avid Anglers and reference fishery programs. DNA is extracted from the samples by the DFO Molecular Genetics Lab with polymerase chain reaction amplification of target amplicons from published Chinook salmon sequence data. Samples are identified to stock using parentage-based tags (PBT) or targeted single-nucleotide polymorphism (SNP) amplicon

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sequencing. Sampled offspring of PBT parents are assigned with a high degree of confidence (Beacham et al. 2022).

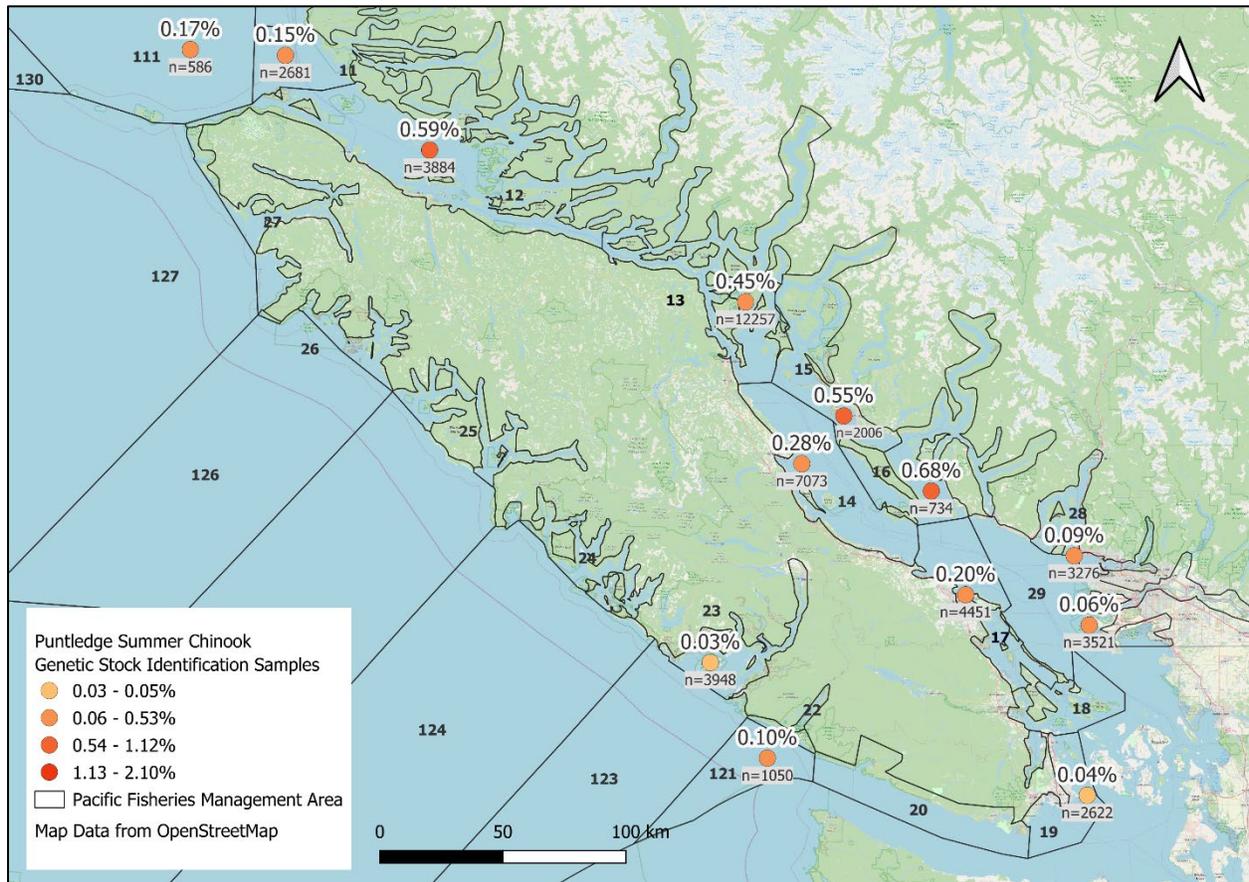


Figure 8. Puntledge Summer Chinook (n=137) distribution in all Genetic Stock Identification (GSI) Chinook samples (n= 78,533) by Pacific Fisheries Management Area (2014-2023). Sample sizes displayed represent the total number of GSI Chinook samples for each PFMA. Percent labels represent the proportion of samples in each PFMA identified as Puntledge Summer Chinook.

For Nanaimo Summer Chinook, the Puntledge Summer Chinook indicator stock is generally used as a surrogate, however, the Nanaimo population was tagged over 9 years (1980, 1982-83, 1995-97, 1999-01). CWT tag recoveries from commercial and recreational fisheries from the northeast Pacific Ocean show that the majority of this population was captured in the Strait of Georgia (Chinook Technical Committee 2025).

Figure 8 shows the geographic distribution of samples identified as Nanaimo Summer Chinook by PFMA. Similar to the past CWT results, most of the Nanaimo Summer Chinook were caught in the Strait of Georgia. As with Puntledge Summer Chinook, those from the Nanaimo River make up a small portion (0.49%) of total biological samples in Southern BC (2014-2023). Compared to Summer Chinook in the Puntledge River, those from the Nanaimo River are more evenly distributed between PFMA 17 (Nanosee Bay to Galiano Island), 16, 28 (Squamish to Indian Arm), and 15. Some were also found in Area 14. Very few were from the Strait of Juan de Fuca, and almost none were caught on the west coast of Vancouver Island. Healey (1983) also noted that ocean-type Chinook, which comprise most of the Nanaimo summer run, remain relatively close to shore and are seldom encountered in the offshore northeast Pacific Ocean.

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These two sources of data suggest that the Nanaimo Summer Chinook can be found in the Strait of Georgia during the marine habitat phase when they are vulnerable to marine exploitation.

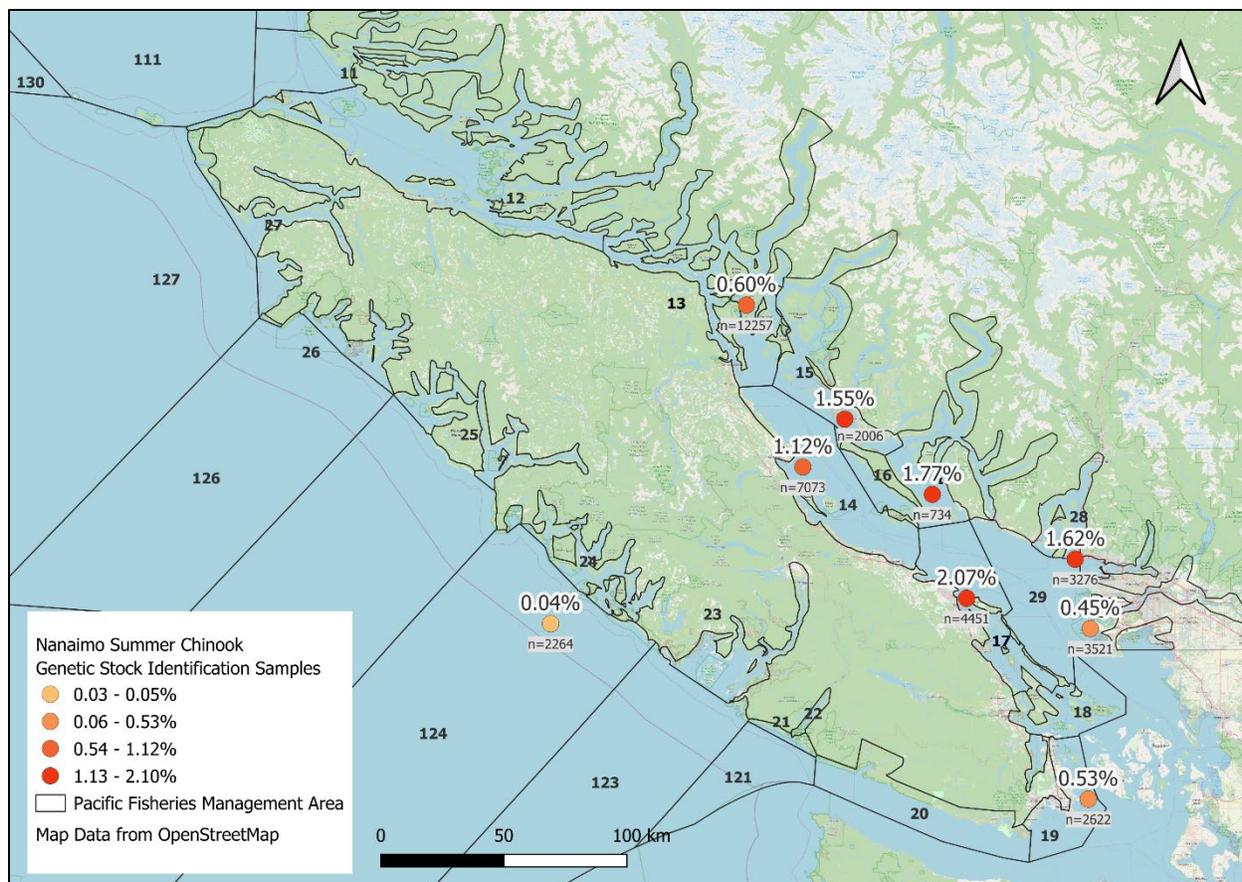


Figure 9. Nanaimo Summer Chinook (n=383) distribution in all Genetic Stock Identification (GSI) Chinook samples (n=78,533) by Pacific Fisheries Management Area (2014-2023). Sample sizes displayed represent the total number of GSI Chinook samples for each PFMA. Percent labels represent the proportion of samples in each PFMA identified as Nanaimo Summer Chinook.

Distribution of Chemainus and Cowichan Summer Chinook is currently unknown as they are not tagged with CWTs, there is a lack of genetic baseline information, and the population sizes are very small. Efforts are currently underway to collect genetic samples from early migrants and juveniles from these rivers.

Overall, EVI Summer Chinook have a marine distribution from Southern BC to Alaska. However, CWT recoveries and genetic samples, especially from the Nanaimo population, indicate that individuals may remain in Southern BC and the Strait of Georgia instead of migrating to Northern BC and Alaska. While in Southern BC, EVI Summer Chinook are found in small proportions around the Strait of Georgia and Johnstone Strait. When these Chinook migrate into freshwater in the spring and summer, they utilize deep pools and cold water refugia on their way to the upper reaches and lakes until spawning occurs in the fall.

Threats and Limiting Factor Assessment

Assessment of threats and limiting factors was completed by conducting two Risk Assessment Methods for Salmon (RAMS) workshops. Where threats are human activities and limiting factors are non-anthropogenic processes that negatively impact a population’s ability to survive (DFO 2014). RAMS was developed to facilitate the identification and prioritization of threats and factors that limit the productivity of salmon. The second of five sequential stages of the process involves a workshop with key experts who provide an analysis of risk. The expert panel includes representation from local First Nations, government agencies, stakeholder groups, and academics. Following the standardized RAMS framework, the panel performs the risk assessment scoring by ranking the threats and limiting factors by the biological risk posed to the population of concern (Pearsall et al. 2020¹, Irvine et al. 2024).

The following list of threats to Nanaimo Summer Chinook was initially reviewed at the RAMS meeting in January 2020 (Baillie 2024). Atkinson and James (2025) updated some of the risk factors in their report in light of new data from the Bottleneck to Survival Project. Here we are presenting the threats that are deemed as high or very high risk to the survival of the population by RAMS and include those updates when applicable.

Table 2. The list of threats scored as high or very high for Nanaimo River Summer Chinook (Baillie 2024).

Life History Phase:	Threats	Spatial	Temporal	Impact	Confidence	Current risk	Future risk	Updated Ranking
Adult return and freshwater migration	Potential delays in upstream migration due to the physical barriers	4	5	5	H	Very high	Very high	-
Adult return and freshwater migration	Loss of safe migration route through the lower river due to channelization, loss of habitat complexity and	5	5	4	H	Very high	Very high	-
-	instream cover features	-	-	-	-	-	-	-
Spawning and incubation	Lack of high quality and quantity of spawning habitat	4	5	5	H	Very high	Very high	-

¹ Pearsall, I.A., W. Luedke, and K.D. Hyatt, 2020. A Risk-Assessment Methodology for Salmon (RAMS) - Methodology Guidance Document.

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Life History Phase:	Threats	Spatial	Temporal	Impact	Confidence	Current risk	Future risk	Updated Ranking
Spawning and incubation	More frequent and higher peak flows overwinter can scour/disturb redds	5	5	3	H	Very high	Very high	-
Estuary rearing	Low early marine survival of Chinook fry and smolts in estuary / nearshore marine due to the lack of adequate food supply and reduced water quality	5	5	5	L	Very high	Very high	-
Estuary rearing	Loss of good quality marine riparian habitat	4	5	4	H	Very high	Very high	-
Estuary rearing	Loss of good quality intertidal habitat (i.e. loss of natural abundance and composition of benthic communities and associated ecological communities)	4	5	4	M	Very high	Very high	-
Estuary rearing	Loss of good quality subtidal habitat (i.e. loss of natural abundance and composition of benthic communities, eelgrass habitat, kelp forests and associated ecological communities)	4	5	4	H	Very high	Very high	-
Adult return and freshwater migration	Limited or delayed spawner access due to inadequate water flow	3	5	4	H	High	Very high	-

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Life History Phase:	Threats	Spatial	Temporal	Impact	Confidence	Current risk	Future risk	Updated Ranking
Spawning and incubation	High suspended sediment loads and low DO that reduce egg-to-fry survival and emergence of alevins	5	5	3	L	High	Very High	-
Juvenile rearing and migration	Mortality or fitness impacts as a result of inadequate in-stream and riparian complexity	5	5	3	H	High	Very high	-
Juvenile rearing and migration	High flows impacting fry and smolts	5	5	3	L	High	Very high	-
Juvenile rearing and migration	Mortality or fitness impacts as a result of lack of food	4	4	4	L	High	Very high	-
Juvenile rearing and migration	Increased stranding in isolated off-channel habitats and tributaries can	5	5	4	H	High	High	-
-	occur with rapid decreases in flow	-	-	-	-	-	-	-
Estuary rearing	Reduced survival due to decreased water quality from ballast dumping, industrial discharge and sewage effluent in the estuary	5	5	3	L	High	High	Data Gap (Atkinson and James 2025)
Marine phase	Low marine survival due to inadequate food supply (abundance or value)	5	5	3	L	High	High	Moderate (Atkinson and James 2025)
Marine phase	Mortality due to fishing	3	5	4	M	High	High	-

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In 2023, local experts gathered for the Puntledge RAMS workshop. Out of seventy threats and limiting factors, eight were deemed Very High-Risk to the current productivity and success of the population. One threat affecting early rearing could not be assessed due to a lack of consensus (Table 3). Specifically, this was the impact of Eicher Screens and the BC Hydro Diversion Dam on the mortality of juvenile Summer Chinook (Cantera 2023²). In a reassessment by Sheng et al. (2024), the impacts of Eicher screens were ranked as having Very High current risk.

Table 3. List of threats scored as high or very high for Puntledge River Summer Chinook during RAMS meeting (Cantera 2023).

Life History Phase:	Threats	Spatial	Temporal	Impact	Confidence	Current risk	Future risk	Updated Ranking
Adult return and freshwater migration	Mortality or fitness reduction due to unfavourable water temperatures	5	5	4	M	Very High	Very High	Very High
Juvenile rearing and migration	Mortality or fitness reduction as a result of decreased access to or quality of floodplain habitat	5	5	4	H	Very High	Very High	Very High
Juvenile rearing and migration	Mortality or fitness reduction as a result of competition with hatchery fry	5	5	4	L	Very High	Very High	Very High
Estuary Rearing	Mortality or fitness reduction due to inter- and intra-specific competition from hatcheries	5	5	4	L	Very High	Very High	Data Gap

² Cantera, K. 2023. Puntledge Summer Chinook Risk Assessment Methods for Salmon (RAMS) Workshop. DFO.

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Life History Phase:	Threats	Spatial	Temporal	Impact	Confidence	Current risk	Future risk	Updated Ranking
Estuary Rearing	Mortality or fitness reduction due to lack of quantity and quality vegetation habitat in the estuary.	5	5	4	M	Very High	Very High	Very High
Adult return and freshwater migration	Mortality or fitness reduction as a result of stress due to anthropogenic activity (non-fishing)	5	5	3	L	High	Very High	Very High
Juvenile rearing and migration	Mortality or fitness reduction as a result of decreased quality of rearing habitat	5	5	3	M	High	Very High	High
Juvenile rearing and migration	Mortality or fitness reduction as a result of decreased quantity of rearing habitat	5	5	3	M	High	Very High	High
Juvenile rearing and migration	Mortality or fitness reduction due to frequent and higher peak flows causing flushing	5	5	3	M	High	Very High	High

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Life History Phase:	Threats	Spatial	Temporal	Impact	Confidence	Current risk	Future risk	Updated Ranking
Estuary Rearing	Mortality or fitness reduction as a result of lack of access to appropriate food	3	5	4	H	High	Very High	Data Gap
Estuary Rearing	Estuary channel	5	5	3	M	High	Very High	High
Genetic/Multi-Generational	Mortality or fitness reduction as a result of rearing in a hatchery environment leading to maladaptation to the wild environment. This is measured in a reduction in PNI.	5	5	3	M	High	Very High	Not Assessed
Adult return and freshwater migration	Limited or delayed access due to physical migration barriers and/or lack of safe migration routes (including lack of cover and complexity)	4	4	4	M	High	High	Very High
Genetic/Multi-Generational	Mortality or fitness reduction due to negative effects of small population size - including inbreeding depression and gene flow	2	5	3	M	Moderate	High	Not Assessed

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Life History Phase:	Threats	Spatial	Temporal	Impact	Confidence	Current risk	Future risk	Updated Ranking
Estuary Rearing	Mortality or fitness reduction due to reduction in quality of beach habitat	1	1	1	L	Very Low	Very Low	Very High
Juvenile rearing and migration	Mortality or fitness reduction as a result of stress due to anthropogenic activity. Specifically, the Diversion Dam Eicher Screens.	-	-	-	-	No Consensus	No Consensus	Very High
Estuary Rearing	Mortality or fitness reduction due to unfavourable water temperatures	-	-	-	-	Data Gap	Data Gap	High

Several limiting factors to the survival and recovery of EVI Summer Chinook have been identified; however, all of which are exacerbated or caused by anthropogenic processes. All limiting factors (identified by RAMS) that have a high risk level are the result of anthropogenic activities, including riparian area disturbance and climate change affecting productivity, predation and hydrological regimes.

The Salish Sea Marine Survival Project examined several competing hypotheses around factors influencing juvenile salmon survival in the Salish Sea. In addition to local factors, changes in food supply and an increase in predators have emerged as two overarching factors driving the decline in marine survival. Environmental changes, likely due to climate change, are impacting the oceanic food web in the Salish Sea, affecting phytoplankton, zooplankton, and forage fish that young Chinook depend on. The increased number of harbour seals, following marine mammal protection measures in Canada and the U.S., and consumption of salmon species to varying degrees, could lead to a significant portion of juvenile salmon being eaten. Additionally, human-made changes, such as log booms, create hotspots where predation is intensified (Pearsall et al. 2021).

Table 4 and Table 5 show the limiting factors that were identified as having high or very high risk to Nanaimo and Puntledge Summer Chinook by the respective RAMS processes.

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Table 4. List of Limiting Factors scored as high or very high for Nanaimo River Summer Chinook (Baillie 2024).

Life History Phase	Threats	Spatial	Temporal	Impact	Confidence	Current risk	Future risk
Juvenile rearing and migration	Mortality as a result of high levels of predation	5	5	4	M	Very high	Very high
Adult return and freshwater migration	Low marine survival due to high rate of predations by marine mammals and high rate of predation in nearshore environments	5	5	5	H	Very high	Very high

Table 5. List of Limiting Factors scored as high or very high for Puntledge River Summer Chinook during RAMS meeting (Cantera 2023) and updated rankings from Sheng et al. (2024).

Life History Phase	Threats	Spatial	Temporal	Impact	Confidence	Current risk	Future risk	Updated Ranking
Adult return and freshwater migration	Mortality or fitness reduction due to predation from pinnipeds or other aquatic species	5	5	4	H	Very High	Very High	Very High
Juvenile rearing and migration	Mortality or fitness reduction as a result of elevated predation	4	5	4	M	Very High	Very High	High
Estuary Rearing	Mortality or fitness reduction due to elevated predation	5	5	4	M	Very High	Very High	Very High

Based on RAMS workshops for the Puntledge and Nanaimo populations, key freshwater threats to EVI Summer Chinook are linked to extreme flow conditions, inadequate water quality, lack of structural complexity, barriers to adult and juvenile migration (including impingement from Hydro

Dam Eicher Screens), inter- and intraspecific competition, and increased temperatures. Forestry, Hydro Dams, anthropogenic channelization and barriers, wastewater, recreational river use (tubing/watercrafts, swimming, and fishing), hatcheries, and climate change are human activities responsible for the threats to the survival and recovery. The highest risk natural limiting factors for EVI Summer Chinook are from elevated predation, especially from pinnipeds during adult and juvenile migration. While predation is a natural process, it has been exacerbated by anthropogenic influences (log booms, marine and freshwater structures, channelization, etc.). Expert panels from two RAMS workshops determined that these threats and limiting factors pose a very high and high biological risk to the survival and recovery of EVI Summer Chinook.

Recovery Targets

As per DFO advice on SARA recovery target setting (DFO 2011), two candidate abundance targets for recovery are proposed for EVI Summer Chinook. The first is a survival target at which the DU is not characterized as endangered anymore and would achieve a COSEWIC status of special concern. The second is a recovery target that safeguards the long-term survival of the DU and aims to meet the COSEWIC criteria for a status of not at risk. For the survival target, the spawner abundance that results in reaching an upper benchmark in one generation while there is no fishing (S_{gen}) is used following recommendations from Holt (2009). For the recovery target, a threshold of 85% of S_{msy} , the spawner abundance that would result in maximum sustainable yield is used. Furthermore, following COSEWIC criterion D for very small or restricted populations, any computed thresholds that are below 1,000 are set to 1,000 spawners. These abundance targets are consistent with the lower and upper benchmarks that delineate red, amber, and green status under the Wild Salmon Policy.

Abundance targets were computed using a habitat-based benchmarks model which uses accessible watershed area to predict stock-recruit reference points (S_{gen} and S_{msy}) based on meta-analyses of Chinook populations across the Pacific Northwest (Parken et al. 2006, Liermann et al. 2010, Brown et al. In press). Stock-recruit analyses were also considered but were deemed inadequate due to the high influence of hatchery production and exploitation on the estimation of natural spawner population dynamics. A key assumption of the habitat-based method is that productive capacity does not change over time, and that it scales with watershed area, which is considered a proxy for available freshwater spawning habitat. The model also makes an optimistic assumption about the productivity parameter value used to calculate reference points, which is drawn from the meta-analysis rather than estimated on a population-specific basis. However, these assumptions resulted in higher benchmarks than would have otherwise been computed from the stock-recruit analyses, and hence the habitat method was considered to be a more precautionary approach and was more aligned with IK indicating historically high abundances of EVI Summer Chinook.

In this document, survival and recovery targets are proposed for two categories of salmon: natural-origin spawners and natural spawners. Per the Wild Salmon Policy, the term natural-origin is used to encompass both wild salmon, which are fish born in the wild from parents also born in the wild, and transitional fish, which are fish born in the wild from one or both parents of hatchery-origin (DFO 2005, Withler et al 2018). Concurrently, natural spawners refer to fish (either natural- or hatchery-origin) that are allowed to spawn in the natural environment and are not taken for broodstock by the hatchery. The establishment of targets for both of these categories aims to recognize the role that enhancement plays in sustaining wild salmon populations, while also implementing targets specifically aimed at promoting the natural-origin components of EVI Summer Chinook.

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Based on COSEWIC criterion D, a survival target of 1000 natural-origin spawners is proposed for EVI Summer Chinook overall, because S_{gen} values generated by the habitat model were very low (250 and 300 for the Nanaimo and Puntledge, respectively). Survival and recovery targets for natural spawners were also developed individually for the Nanaimo and Puntledge populations and are summarized in Table 6. Following the logic of criterion D, the survival targets were set to 1000 natural spawners for each of these populations because of the low S_{gen} values. Based on the 85% of S_{msy} values from the habitat model, the recovery targets were set to 1785 and 2125 natural spawners for the Nanaimo and Puntledge, respectively. Furthermore, an aggregate recovery target of 3910 natural spawners, based on the sum of the recovery targets for the Nanaimo and Puntledge populations, is also proposed as a means of maintaining abundances overall across EVI Summer Chinook systems. No specific targets were developed for the Chemainus and Cowichan populations as they are not regularly monitored and assessed at the same scale as the Nanaimo and the Puntledge systems. However, it is assumed that actions taken to promote the recovery of Nanaimo and Puntledge spawners would benefit the recovery of the Chemainus and Cowichan populations as well.

To mitigate the genetic risks associated with hatchery production, we propose additional thresholds for the proportionate natural influence (PNI) metric, which is aimed at maintaining adequate gene flow between the natural and hatchery components. According to Withler et al. (2018), the designation of an integrated-transition hatchery population is defined by a range of PNI values between 0.5 and 0.8. The minimum threshold of 0.5 indicates that the adaptive influence of the natural-origin component of the population is greater than that of the hatchery component. Therefore, for the Nanaimo and Puntledge, minimum PNI targets are set to 0.5 to maintain their status as integrated-transition hatchery populations. The conditions of the survival or recovery targets are considered to have been achieved when both the abundance and the PNI targets are met.

*Table 6. Survival and recovery targets for natural spawners for the Nanaimo and Puntledge populations of EVI Summer Chinook. An aggregate recovery target is presented for the total natural spawners across both Nanaimo and Puntledge populations. *The aggregate survival target is not presented here because it is based on natural-origin spawners only.*

Population	Survival Target Natural spawners	Recovery Target Natural spawners	PNI Target
Nanaimo	1000	1785	≥0.50
Puntledge	1000	2125	≥0.50
TOTAL	*-	3910	-

Recovery Potential Under Current Population Dynamics Parameters

To assess recovery potential, a state-space age-structured life cycle model was used to conduct population viability analyses (PVA) for the Puntledge River population (Walters and Korman 2024). The Puntledge River has been used as an indicator stock for decades and is the only population with coded wire tag data available, and is therefore assumed to be representative of other EVI Summer Chinook populations in the absence of similar monitoring data for the other systems. The model was conditioned on a historic time series of data spanning 1980-2020, including escapement, CWT data, hatchery releases and ocean covariates such as sea surface

temperature, seal abundance, marine mammal abundance and regional hatchery production. A key assumption of the PVA model is that the population dynamics of hatchery-origin fish, which are tracked through age-specific CWT recoveries in escapement and ocean catch, are representative of the dynamics of natural-origin fish. The model also estimates freshwater mortality rates with a Ricker stock-recruit relationship, under the assumption that there is density-dependence between the egg and smolt life stages. However, the estimation of this relationship may be confounded by hatchery production and the aforementioned lack of distinction between hatchery- and natural-origin spawners.

Forward simulations for a baseline scenario were run using average recent conditions. Baseline values for sea surface temperature, as well as local and regional hatchery production, were set to the mean of the last decade from the historic model, while the seal abundance and large marine mammal abundance indices were set to the last year's value to most accurately represent recent conditions. The ocean harvest rate was set to the mean of the last decade of the parameter value estimated by the model (median = 0.45). Pre-spawn adult survival during upstream migration was set to a total value of 0.6 including an explicit terminal harvest rate of 0.1, consistent with the values modelled in the historic period. FSC harvest is not explicitly modelled but is considered as part of the background mortality rates estimated by the model. Freshwater parameters (egg-smolt mortality rate and freshwater carrying capacity) were set to their estimated values from the model for the historic period.

The probability of reaching the survival and recovery targets was assessed after a short-term simulation period of 12 years (i.e. 3 generations) as well as a long-term simulation period of 30 years. These metrics were evaluated by calculating the percentage of all simulations that met or exceeded the target abundance at the short- and long-term timesteps (in 2042 and 2060, respectively). Specifically, these metrics assess the number of natural spawners (hatchery- and natural-origin fish that spawn in the wild) against the survival and recovery targets for natural spawners outlined for the Puntledge River in Table 6.

Throughout the simulation period, the population trajectory (Figure 9) gradually increased over time. By 2042, the population has a 59% chance of reaching the survival target and a 21% chance of reaching the recovery target. By 2060, the population has a 62% chance of reaching the survival target and a 27% chance of reaching the recovery target. According to risk assessment categories defined by the International Panel on Climate Change (Mastrandrea et al 2011, see footnote on Table 7), these results suggest that the population is as likely as not to reach the survival target of 1000 and unlikely to reach the recovery target of 2125 within both the short- and long-term timeframes. An important caveat is that due to data availability, the historic period is only modelled up to 2020. The future population trajectories do not reflect severe declines that have occurred since 2020, when escapements as low as 89 fish have been observed (Figure 3). The baseline scenario also does not reflect recent declines in harvest that have occurred since 2019, when management actions were taken that resulted in exploitation rates reduced as low as 21.9% (compared to the modelled baseline value of 45%). In light of these assumptions, this scenario should be viewed as a relative baseline against which to compare a range of potential management actions, as opposed to a reflection of realistic future abundances.

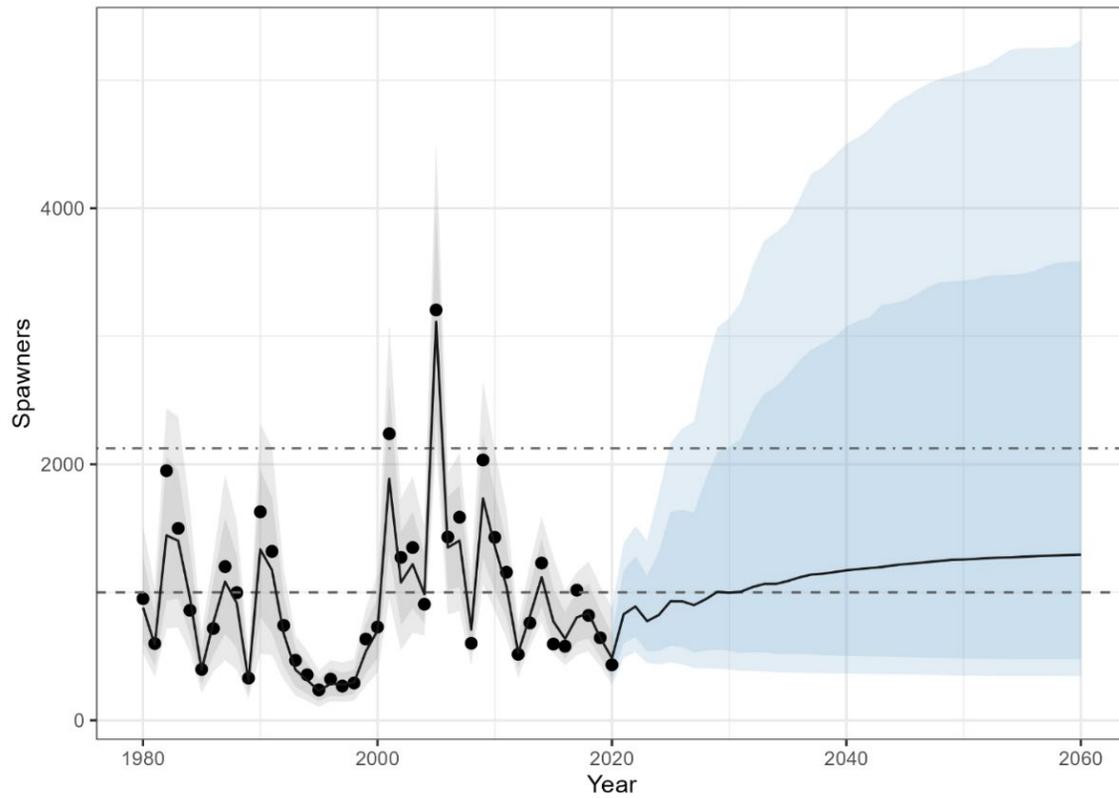


Figure 10. Expected population trajectory over a 40-year simulation period given average environmental conditions and demographic parameter values. The black line depicts the median annual spawner abundance estimated by the model, and shaded regions depict the 95% and 80% quantiles of the annual estimates, colored in grey for the historical period and light blue for the future period. Dashed lines indicate abundance thresholds of 1000 and 2125. The black dots represent escapement data.

Recovery Potential Under Alternative Productivity and Mortality Scenarios

The PVA model was used to assess recovery potential under scenarios of changing harvest, predation, climate, freshwater and hatchery production. These alternative scenarios are based on the modelling of management levers available in the model and are not a comprehensive assessment of specific threats and mitigations identified in the threats assessment. The threats were limited to those that were more feasible to model, such as predation on out-migrating juveniles by seals and predation on ocean adults by marine mammals. As such, key threats such as poaching or seal predation on spawning adults are not explicitly considered here but may be considered implicit in variables such as pre-spawn mortality. The baseline scenario is used here as a basis for comparing the alternative scenarios. Given the assumptions made throughout the modelling process and the optimistic outlook of the baseline scenario, it is important to note that these analyses provide a framework for evaluating feasible alternative management actions and their relative outcomes, rather than providing predictions for absolute abundance values (Shelton et al 2007).

Forward simulations were run by changing key parameter and data inputs and comparing the future spawner abundances to the survival and recovery targets after 12 years and 30 years. These parameters include the annual ocean fishing rate, the egg-smolt mortality rate, the freshwater carrying capacity and the pre-spawn survival rate of adults from the ocean to the

spawning grounds. Data inputs include regional Strait of Georgia environmental conditions such as total regional hatchery production, seal abundance, large marine mammal abundance, sea surface temperature, and local hatchery production from the Puntledge hatchery. These variables were increased and decreased incrementally by a certain percentage of their baseline value. A selection of scenarios is presented in Table 7. Scenarios where pre-spawn survival was increased, ocean harvest was decreased, and regional hatchery releases were decreased resulted in higher probabilities of survival and recovery. Scenarios reflecting improvements in freshwater habitat through decreased egg-smolt mortality rates and increased productivity showed improved survival as well but were not able to achieve very likely (>90%) recovery probabilities. Scenarios with incremental changes across many parameters and management levers also resulted in more likely recovery.

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Table 7. Summary table of results for a selection of PVA scenarios for the Puntledge River population. For each recovery target, the percent of all simulations that achieve the target within a shorter time frame of three generations (by 2042) and within a longer time frame (by 2060) are presented. Colors ranging from pink to green represent categories developed by the Intergovernmental Panel on Climate Change (IPCC) for describing uncertainty in the likelihood of achieving targets³ (Mastrandrea et al. 2011).

Scenario	Scenario Type	Recovery Target of 1000 By 2042	Recovery Target of 1000 By 2060	Recovery Target of 2125 By 2042	Recovery Target of 2125 By 2060
Baseline	Baseline	59	62	21	27
Harvest	No ocean harvest	100	100	97	99
Harvest	20% reduction in fishing mortality rate	75	81	36	47
Harvest	50% reduction in fishing mortality rate	95	97	65	83
Harvest	10% increase in fishing mortality rate	48	49	16	19
Harvest	20% increase in fishing mortality rate	40	39	11	13
Terminal harvest only	5% terminal harvest rate	72	76	32	40
Terminal harvest only	15% terminal harvest rate	45	45	14	16
Hatchery supplementation	No local hatchery production, status quo regional hatchery production	36	33	13	15
Hatchery supplementation	High local (50% increase) and intermediate regional hatchery production (20% increase)	57	58	17	20
Hatchery supplementation	High local and high regional hatchery production (50% increase)	31	26	5	5
Hatchery supplementation	Very high local and very high regional hatchery production (80% increase)	14	8	1	1
Hatchery supplementation	Low local and low regional hatchery production (50% decrease)	75	79	44	57
Freshwater habitat improvements	Increase carrying capacity and decrease egg-smolt mortality rate 10%	64	69	28	38
Freshwater habitat improvements	Increase carrying capacity and decrease egg-smolt mortality rate 20%	70	76	33	46

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Scenario	Scenario Type	Recovery Target of 1000 By 2042	Recovery Target of 1000 By 2060	Recovery Target of 2125 By 2042	Recovery Target of 2125 By 2060
Freshwater habitat improvements	Increase carrying capacity and decrease egg-smolt mortality rate 30%	75	81	39	56
Marine predation	Increase large marine mammal abundance 30%, stable seal population	51	52	20	24
Marine predation	Increase large marine mammal abundance 30%, decrease seal population 10%	54	56	20	25
Marine predation	Increase large marine mammal abundance 10%, decrease seal population 10%	59	62	25	30
Climate	Increasing sea surface temperature 0.4 deg	65	69	27	37
Climate	Increasing sea surface temperature 0.8 deg	70	75	36	47
Climate	Increasing sea surface temperature 0.4, decreasing pre-spawn survival by 20% (to 0.48)	30	29	8	10
Climate	Increasing sea surface temperature 0.4, decreasing pre-spawn survival by 40% (to 0.36)	6	3	1	0
Climate	Increasing sea surface temperature 0.4, increasing pre-spawn survival by 20% (to 0.72)	89	93	56	69
Additional Scenario Combinations					
Climate	50% reduction local hatchery production, 20% reduction in fishing and 20% increase in carrying capacity	66	70	33	42
Climate	Status quo local hatchery production, 20% reduction in fishing and 20% increase in carrying capacity	75	82	38	52
Climate	50% increase in local hatchery production, 20% reduction in fishing and 20% increase in carrying capacity	84	92	47	62
Climate	50% increase in local hatchery production, 20% reduction in fishing, 20% increase in carrying capacity and 20% increase in pre-spawn survival	90	93	59	78
Climate	30% increase in large marine mammal abundance, 10 % decrease in seal abundance, 20 % reduction in fishing and 20% increase in carrying capacity	73	79	38	49

Scenario	Scenario Type	Recovery Target of 1000 By 2042	Recovery Target of 1000 By 2060	Recovery Target of 2125 By 2042	Recovery Target of 2125 By 2060
Climate	30% increase in large marine mammal abundance, 20 % decrease in seal abundance, 20 % reduction in fishing, 20% increase in carrying capacity, and 10% increase in pre-spawn survival	87	92	54	70
Climate	10% decrease in fishing, 10% increase in carrying capacity, 10% decrease in egg-smolt mortality, 10% increase in pre-spawn survival	85	92	52	67
Climate	10% improvement across multiple variables: 10% decrease in fishing, 10% increase in carrying capacity, 10% decrease in seal abundance, 10% increase in pre-spawn survival, 10% increase in local hatchery releases, 10% decrease in egg-smolt mortality, with 30% increase in large marine mammal abundance and 0.5 deg increase in sea surface temperature	91	94	62	77
Climate	20% improvement across multiple variables: 20% decrease in fishing, 20% increase in carrying capacity, 10% decrease in seal abundance, 20% increase in pre-spawn survival, 10% increase in local hatchery releases, 20% decrease in egg-smolt mortality, with 30% increase in large marine mammal abundance and 0.5 deg increase in sea surface temperature	98	99	84	96

³ The color palette based on the IPCC risk categories is defined as follows: dark green: certain (99-100%) and very likely (90-99%); light green: likely (66-90%); grey: as likely as not (33-66%); light pink: unlikely (10-33%); dark pink: very unlikely (1-10%) and extremely unlikely (0-1%)

Sources of Uncertainty

- Recent abundance estimates for both Nanaimo River and Puntledge River have been derived from high- to medium-resolution escapement data, whereas historical assessments relied on low-resolution estimates. A detailed analysis of adult returns in both rivers indicates variability in lower river loss across certain years, introducing a degree of uncertainty in overall population estimates.
- Abundance-based recovery targets for these populations are generated by a habitat-based model that makes significant assumptions about productivity, presenting uncertainty in the derivation of stock-recruit benchmarks.
- Future spawner abundances predicted by the PVA model explicitly incorporate uncertainty in estimated mortality and productivity parameters and inherently increase in uncertainty through time. Key limitations of the PVA are that the historic model only includes data up to 2020, which does not reflect recent observed declines in escapement, and that the model estimates total abundances without differentiating between hatchery- and natural-origin spawners. This precludes the ability to model natural population dynamics and assess only natural-origin returns against the recovery targets.
- The future scenarios focus on a suite of general threats and parameters available in the PVA model and do not cover the full range of threats, limiting factors and mitigations identified in this process.
- The effects of ocean environment, predation and hatchery competition are poorly estimated by the PVA model through a combination of data limitations (e.g. no timeseries of local seal abundance data available for the Puntledge River) and statistical limitations (e.g. assumptions about prior distributions may influence parameter estimates and covariance between variables may hinder the estimation of effect sizes). Future modelling should include more thorough hypothesis-testing to identify drivers of mortality and declines in abundance across both ocean and freshwater life stages.
- The Puntledge population is used as a surrogate for EVI Summer Chinook in the PVA model and for CWT based exploitation rate and distribution. These data are the best available for an indicator and provide information on marine distribution of EVI Summer Chinook that could not be found elsewhere. However, sources of uncertainty include differences in life history and higher amounts of hatchery influence. Puntledge Summer Chinook have a typical summer adult run-timing with ocean-type juveniles, whereas the Nanaimo population includes early/spring adult run-timing with some stream-type juveniles. With higher hatchery influence, Puntledge Summer Chinook have a lower PNI compared to the other EVI Summer populations.
- Puntledge will be discontinued as the Georgia Strait Summer Chinook indicator after 2025. Updating the PVA model will no longer be possible because it relies on age-structured CWT data. Alternative methods (e.g. run reconstruction) may need to be developed to ensure continued monitoring of the population.
- CWT recoveries and GSI samples reflect area-specific fishery openings. GSI samples are obtained from both kept and released catches in Southern BC. Released catch samples are taken by Avid Anglers and reference fishery programs.

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- GSI samples that are assigned to stock using PBT (hatchery origin) are identified with a high degree of confidence. However, targeted SNP amplicon sequencing (natural origin) may be a source of uncertainty if the baseline samples do not accurately represent the population.
- Very-high and high risk threats and limiting factors were determined from expert panels during RAMS workshops for Nanaimo and Puntledge Summer Chinook. While the panels included representation from a range of knowledge holders, it is important to acknowledge that the scoring is representative of the experts in the workshops, resulting in a potential source of uncertainty.
- Due to data deficiencies, the Cowichan and Chemainus River Summer Chinook populations were not initially included in the scope of the Recovery Potential Assessment. Therefore, the Cowichan, Stz'uminus, Halalt, Lyackson, Penelakut, Ts'uubaa-asatx and Q'ul-Ihanumutsun Aquatic Resources Society (QARS) salmon biologists and knowledge keepers were not included in this process and Indigenous Knowledge and science information from those groups was not included.

CONCLUSIONS AND ADVICE

EVI Summer Chinook returns to the Nanaimo River have been low but stable since the mid-1990s, whereas in Puntledge River there has been a sharp decline since a peak in the early 2000s. For Nanaimo, a large concern is the number of pre-spawn mortalities and lower river losses observed. Meaning that escapement levels of Chinook entering the system is stable, however, 30-50% of those fish do not make it to spawn in the upper river.

The PVA shows that at baseline conditions, the Puntledge River population, representing EVI Summer Chinook, is as likely as not to reach the survival target of 1,000 spawners, and unlikely to reach the recovery target of 2125 spawners in three generations.

Scenarios that lead to a very likely or certain probability of reaching the survival target were reductions in ocean fishing mortality and increases in pre-spawn survival.

For reductions in ocean fishing mortality, it is important to note that exploitation rates on EVI Summer Chinook have decreased since the 80's and 90's and have been further reduced with the implementation of Chinook non-retention periods in 2019. Current levels of marine exploitation are already at the level that would lead to a very likely probability of reaching the survival target by 2042. However, with these populations experiencing extremely low returns, especially to the Puntledge River, there should be no increase in ocean harvest.

To increase pre-spawn survival, Chinook need cooler river temperatures, lower recreational use, and increased availability of spring freshet spills to aid upstream migration, as determined during RAMS workshops. To achieve this, water flow management strategies that enhance river conditions during migration should be explored for these systems. DFO must continue to work with BC Hydro in Puntledge River and Domtar in Cowichan River on optimal flow strategies for EVI Summer Chinook in the spring and summer months. In the Nanaimo River, an environmental flow study should be conducted. The results from such a study can inform an orchestrated effort to establish an improved water flow and ensure better conditions for migrating early-run Chinook by leveraging the available capacity of Jump Lake and Fourth Lake reservoirs operated by the City of Nanaimo and Nanaimo Forest Products (Harmac), respectively. Recreational use is also a growing concern for pre-spawn survival, with increased public presence during migration periods when fish are under physiological stress from high water temperatures. Regulation changes that make no-fishing zones clearer would also

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increase pre-spawn survival and reduce human-induced mortality. Currently, provincial regulations prohibit fishing in key holding areas, and federal regulations prohibit the retention of Chinook at any time of the year. However, there is evidence of unsanctioned fishing in key Chinook-holding areas of the Nanaimo River (Baillie 2024). Conservation and Protection Officers have raised concerns about not being able to enforce the regulations since some sections of the river remain open for resident trout fishing and the public can claim they are not targeting Chinook when they are.

FSC harvest are not considered within the scenarios that considered changes to human-induced fishing mortality. FSC harvest practiced by Snuneymuxw and K’omoks First Nations is guided by traditional ecological knowledge and aligns with natural cycles. Consequently, a balanced and culturally informed approach to allowable harm would include FSC harvest as part of the natural system, while also considering that FSC fishing practices are evolving in response to growing populations and changing needs.

Other than activities that promote survival and recovery of EVI Summer Chinook, all ongoing and future human-induced mortality, along with activities that result in harmful alteration, disruption, or destruction of their habitat, should be prevented. It is also recommended that local First Nations are involved and co-leaders in future recovery processes, as their knowledge and stewardship of EVI Summer Chinook is imperative for their survival and recovery.

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