EA4300

Cowichan Assessment Unit Report Card

Final Draft Report

Prepared for

Island Marine Aquatic Working Group
IMAWG

and

Q'ul-lhanumutsun Aquatic Resources Society
QARS

Prepared by

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EXECUTIVE SUMMARY

The A-Tlegay Member Nations Territory consist of marine areas and waterbodies of the northern Strait of Georgia and Johnstone Strait regions. Within this territory, is a section of Vancouver Island roughly located between Nanaimo and Shawnigan Lake termed the Cowichan Assessment Unit. The Cowichan Assessment Unit includes the Cowichan, Koksilah, Chemainus, and associated tributaries which drain from the East Coast of Vancouver Island into the Salish Sea (Strait of Georgia). The region has been impacted by increasing threats from climate and associated hydrological changes, forestry, agriculture, water withdrawals and development. Added to this, there is increased pressure for changes in fisheries management in the area. As a result, streams in the Cowichan Assessment Unit were identified as a priority to understand the current health of the stocks, address potential data gaps, and identify threats and other issues that may affect the multiple salmon species the region.

The Department of Fisheries and Oceans Canada (DFO) is responsible for Pacific salmon enumeration, conservation of natural populations, as well as the management of fisheries. Escapement data collected from surveys are recorded in the DFO New Salmon Escapement Database System (NuSEDS). Population abundance estimates for some salmon species began in the 1950, however, the recording of data and methodology did not become standardized until 1995 when enumeration became part of DFO Science. As a result, historical data are incomplete and often missing methodological information and was used in part to illustrate where complete time series exist. After 1995, the data is more robust, however, still incomplete. The escapement data was combined with harvest, hatchery, habitat, and weather station data to create a gap analysis.

This baseline and data gap analysis is presented in a report card format which allows for a rapid comparison among the different streams within the assessment unit and highlights areas with little background data. This report contains analysis of four of the five key Pacific salmon species Chinook (*Oncorhynchus tshawytscha*), Coho (*O. kisutch*), Chum (*O. keta*), and Pink (*O. gorbuscha*) salmon and includes escapement, harvest, hatchery releases, juvenile production, habitat, river hydrology, and weather information. Priority salmon-bearing watercourses within the assessment unit are identified throughout as well as limiting factors, and restoration opportunities.

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We are profoundly thankful for the Indigenous knowledge shared by the staff of Q'ul-lhanumutsun Aquatic Resource Society (QARS) and Quw'utsun Elder, Wayne Paige Sr. (Sina'htun), which has significantly enriched our understanding and approach towards this report. This perspective has been invaluable in guiding the project to success.

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Lastly, we acknowledge the financial support from British Columbia Salmon Restoration and Innovation Fund (BCSRIF), administered by IMAWG, which was instrumental in the realization of this project. This funding has not only facilitated the project, but also underscored the importance of collaborative efforts in achieving our shared goals.

We are immensely grateful to all who contributed to this project, directly or indirectly, for their invaluable support and cooperation.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

LIST OF ABBREVIATIONS

The following abbreviations are used in this report:

BC	British Columbia
BCCF	British Columbia Conservation Foundation
BCSRIF	British Columbia Salmon Restoration and Innovation Fund
CLRSS	Cowichan Lake and River Stewardship Society
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CPUE	catch per unit effort
CVRD	Cowichan Valley Regional District
DFO	Fisheries and Oceans Canada
DIDSON	dual-frequency identification sonar
DO	dissolved oxygen
eDNA	environmental DNA
EO	Economic Opportunity
EPAD	Enhancement Planning and Assessment Database
FLNRORD	BC Ministry of Forests, Lands, Natural Resource Operations and Rural Development
FSC	Food, Social, and Ceremonial
GSVI	Georgia Strait Vancouver Island
IMAWG	Island Marine Aquatic Working Group
LGL	LGL Limited
MSF	Mark Selective Fishery
NuSEDS	New Salmon Escapement Database System
PFMA	Pacific Fisheries Management Area
PNI	proportionate natural influence
PSF	Pacific Salmon Foundation
PST	Pacific Salmon Treaty
QARS	Q'ul-lhanumutsun Aquatic Resources Society
SE	standard error
SEP	Salmonid Enhancement Program
US	United States
UVic	University of Victoria
VISC	Vancouver Island Salmon Committee
WCVI	West Coast Vancouver Island

1 Background

The A-Tlegay Member Nations Territory consist of marine areas and waterbodies of the northern Strait of Georgia and Johnstone Strait regions. Within this territory, is a section of Vancouver Island roughly located between Nanaimo and Shawnigan Lake termed the Cowichan Assessment Unit. The Cowichan Assessment Unit, the Cowichan, Koksilah, Chemainus, and associated tributaries were included in the data survey (Figure 1). All four systems drain from the East Coast of Vancouver Island into the Salish Sea (Strait of Georgia). The Cowichan Assessment Unit occurs within both the Coastal Douglas Fir and the Coastal Western Hemlock biogeoclimatic zones. The upper half of the watersheds is mountainous and drains into coastal lowlands (Nelitz et al. 2007). Rainfall is the main form of precipitation, with the mountainous western areas receiving twice as much precipitation as the lowland areas (Nelitz et al. 2007). The region has been impacted by forestry, agriculture, water withdrawals and development, and there are increasing threats from climate and associated hydrological changes and invasive species.

The Committee on the Status of Endangered Wildlife in Canada has identified overharvest, habitat degradation, hatchery effects, pathogens, and climate change as the primary threats to Chinook salmon in BC with ecosystem modifications and drought and water management as the main threats in the Cowichan watershed (COSEWIC 2018). Lower water levels and an increase in the number of low flow days over the past 50 years have affected the ability of salmon to migrate to spawning areas and has reduced the amount of suitable spawning and rearing habitat available (Araujo et al. 2021; Nelitz et al. 2007). Low flows in the Cowichan River have been associated with delays in fish migration, which can lead to increased predation while in the marine environment, stressful holding conditions and an increase in exposure time to pathogens (Pike et al. 2017; Bowerman et al. 2016).

In addition, there has been a threefold increase in the number of water licences for the Cowichan basin since 1954, including an increase in larger users, as well as an increase in groundwater extraction and well densities (Pike et al. 2017). There are also effluent discharges from sewage and aquaculture operations to the Cowichan River (Pike et al. 2017). Most of the Cowichan watershed has been logged, and historically these logging practices did not maintain streamside buffers and completely removed the riparian vegetation (Zaldokas 1999). In the Cowichan watershed, logging has caused an increase in fall/winter discharge which has led to accelerated bank erosion and an increase in gravel deposition in the lower reaches of tributaries; as a result, there is a decrease in stable spawning and rearing habitat in the mainstem and off-channel habitat areas and a decline in habitat connectivity as certain sections experience only subsurface flow (Zaldokas 1999). Increased sedimentation in areas throughout the Cowichan River have reduced egg to fry survival of salmon species (Gaboury et al. 2012).

Due to these increasing threats, strong interest in restoration in the area and the general lack of comparable knowledge a baseline and data gap analysis was undertaken allowing for a rapid comparison among the different streams within the assessment unit and highlight areas with little background data. This report contains analysis of four of the five key Pacific salmon species Chinook (*Oncorhynchus tshawytscha*), Coho (*O. kisutch*), Chum (*O. keta*), and Pink (*O. gorbuscha*) salmon which spawn concurrently within these systems.

1.1 Objectives

The specific objectives of this study are to

1) Increase our understanding of Pacific salmon escapement monitoring in the Cowichan watershed and associated tributaries and identify key waterbodies, species and run timing stocks of concern.
2) Understand the historic and current trends in escapement, harvest, hatchery releases, and juvenile production, in the context of habitat, river hydrology, and weather information.

3) Determine if the current DFO escapement monitoring structure aligns with A-Tlegay Member Nations priorities and expectations; and
4) Identify recommendations for based on the analysis described in this report and the values put forth by the member nations.

2 Reported NuSEDS Escapement

Escapement records within the assessment unit began in 1953 with a continuous record of escapement only available for Chinook (fall-run), Chum, and Coho salmon in the Cowichan and Chemainus rivers (Figure 2) (NuSEDS; DFO 2024a). These two systems also generally had the highest reported escapement levels, although notable escapement also occurred in other systems including Bonsall Creek, Bush Creek, Haslam Creek, Holland Creek, and Koksilah River (Figure 3). Monitoring in these five systems appears to either have occurred historical or during an abbreviated period when monitoring was moved to the DFO Science section in 1995 (DFO 2005). Coincidental with 1995 organizational restructure, there was expanded monitoring coverage in the Cowichan Assessment Unit. At the peak of the expanded coverage close to or more than 60% of the salmon populations within assessment unit were being monitored (Figure 4). This period of expanded monitoring did not last, however, and ended in approximately 2008, when escapement monitoring shifted primarily to the Cowichan and Chemainus river systems (Figure 2). This represents a potentially problematic change in escapement monitoring as monitoring stopped for many smaller runs (Figure 2 and Figure 3) making the status of the populations in these smaller systems largely unknown outside of anecdotal reports.

The shift in salmon enumeration to DFO Science Section was also coincident with a notable decline in the total reported escapement to the Cowichan Assessment Unit (Figure 5a). Total salmon returns to the Cowichan Assessment Unit showed variable returns at a similar overall level until approximately 1995 when there was an extended period of reduced returns that appeared to coincide with an increase in monitoring effort. It is not clear whether this was caused by a true decline in escapement, changes in how salmon escapement was being monitored or a combination of the two factors. Starting in 1995, DFO Science Section became responsible for salmon escapement, the switch also corresponds with an overall increase in the number of populations being monitored and potentially a change of methods (Figure 2). Due to the number of concurrent changes that occur it is not clear whether these different possibilities can be disentangled. Prior to that period Strait of Georgia Coho Salmon was undergoing a general decline that predated the change in salmon enumeration, however, total Chum Salmon returns appeared to also undergo declines in the period, with a rapid reversal after 2005 when inspections largely stabilized to a few key systems. With the expansion of monitoring coverage, and potential methodology changes, it is possible that scaling or detection efficiency associated with estimates prior to 1995 make the estimates not directly comparable to monitoring after 1995. For example, reporting on additional species may have derived from incidental reporting of non-target species. Total returns to the assessment unit returned to levels similar to the pre-1995 period, after 2005, when monitoring coverage was reduced. It may be worth investigating whether the period of expanded monitoring coverage was associated with changes in detection efficiency. If evidence is found for this hypothesis, then analyses considering overall trends may need to either exclude or adjust returns in this period.

In terms of returns for individual species, Chinook Salmon escapement reporting is fairly limited for early spring- and summer-runs with most consistent reporting occurring for the fall-run Chinook Salmon in the Cowichan River and Chemainus River systems (Figure 2 and Figure 3). Historical Chinook Salmon escapement also occurred in other systems within the Cowichan Assessment Unit. *Quw'utsun Knowledge Holder, Sina'htun* (Wayne Paige Sr.), shared further insight that during the 1980s and 1990s, Cowichan Tribes River Management staff conducted salmon monitoring by walking and swimming a variety of rivers. However, reporting in these smaller systems ended by 2008 (Figure 2). Of particular concern is that many systems had repeated occurrences of no observed escapement, making it unclear whether the population was extirpated, or the lack of observed escapement was due to insufficient monitoring effort (e.g., temporal coverage). With most reporting systems outside of Cowichan River and Chemainus River ending by 2008, it makes it impossible to assess the fate of these smaller Chinook Salmon populations.

For Chinook Salmon, most of the reported escapement in NuSEDS is for the fall run with five recorded observations of early Chinook Salmon reported in the Chemainus River (2015−2019) and one potential observation of early Chinook Salmon in the Cowichan River in 2015. NuSEDS reported early Chinook Salmon observations in the Chemainus River likely represent summer Chinook Salmon. The single recorded instance of potential spring Chinook Salmon was derived from a dual-frequency identification sonar (DIDSON) counter, suggesting a count of 200 individuals. According to NuSEDS, the survey dates were from June 12 to August 31, 2015, which is more consistent with summer-run; that said this may also be a recording error in NuSEDS as biologists from Cowichan Tribes report that the DIDSON counter deployment time was May 2016, consistent with spring Chinook Salmon. It is not clear on what day the early-run Chinook Salmon were recorded, nor is it clear whether they were an early spring-entry run holding in the river until closer to the fall spawning period. Other reports from anglers and the annual Cowichan River swim survey conducted by biologists with the Provincial government also contain anecdotal notes and reports of early Chinook Salmon occurring much earlier in the year than would be the case for summer Chinook Salmon. Furthermore, there also have been documented counts of spring Chinook in the Nanaimo River (see Appendix B2) In general, most Chinook Salmon escapement effort within the Cowichan Assessment Unit have focused almost exclusively on fall run-timing stocks, and so it is difficult to assess the potential contribution of earlier run-timing groups. The historical accounts of spring Chinook Salmon run potentially larger than the fall runs an important consideration as they represent a genetically distinct run-timing group that could require protection. Further studies are required to confirm the status of any spring- or other early-run Chinook Salmon population.

Jacks have been reported within NuSEDS to make up a significant proportion Chinook Salmon total returns in the Chemainus and Cowichan rivers (Figure 6). Over the years, from 1953 to 2022, the proportion of Chinook jacks recorded has seen a significant increase, ranging from 0% to 80% in the Chemainus River and 0% to 60% in the Cowichan River (Figure 6). This trend has been confirmed by Elder Wayne Paige, who observed that historically, Chinook jacks were not as prevalent. Escapement records were available for 25 systems (Table 1), with most systems featuring smaller populations of returning adults (Table 2). There were also frequent methodology changes for Chinook Salmon monitoring which may also impact the ability to compare escapement values across years (Table 3). Finally, most reported broodstock removals in the Cowichan Assessment Unit occurred in the dominant Chinook Salmon runs, with the majority of broodstock removals coming from the Cowichan River (Figure 7).

Coho Salmon escapement showed a general decline since 1950 with a period of no significant reports of escapement from 2008 to 2019 (Figure 5). Additionally, Strait of Georgia Coho Salmon also experienced significant declines in recreational Coho Salmon catches since the 1980s (English et al. 2002). However, the lack of reported Coho Salmon escapement from 2008 was also confounded with an extended period of limited monitoring coverage of Coho Salmon populations in the Cowichan Assessment Area, which could result in under representation of total Coho Salmon returns (Figure 2). There were also significant methodological changes in that period with a move to presence/absence type estimators on the Cowichan and Chemainus rivers, with only a very recent change to true abundance estimates on the Chemainus River(Figure 2 and Figure 3). As such, the decline total reported Coho Salmon escapement may be confounded by reductions in monitoring coverage, as well as methodology changes.

Chum Salmon escapement typically dominates the total escapement to the Cowichan Assessment Unit (Figure 5b), with multiple systems showing consistent historical returns (Figure 3). However, after approximately 2008, consistent monitoring was reduced to the Cowichan and Chemainus rivers (Figure 2).

Coincidental with the general reduction in Chum Salmon monitoring coverage (Figure 4) was an increase in total reported Chum Salmon escapement (Figure 5). This again raises the issue of whether this was related to changes in survey efficiency during the period of expanded monitoring coverage.

While escapement records were available for 30 locations with Pink Salmon only being counted in six different streams (Table 1 and Table 2). Chum Salmon return in the greatest numbers over the entire assessment unit, followed by Coho and then Chinook salmon species (Figure 5 and Table 2). The methods for recording the counts varied over time, with more recent years primarily using Peak Live + Dead and Area Under the Curve estimate procedures (Table 3).

Currently, there are only limited reports of Sockeye Salmon escapement in the Cowichan Assessment Unit, however, there are estimates of up to 4 million Kokanee in Cowichan Lake with a small number end up migrating or being forced down the estuary and residualizing to the Sockeye Salmon life history (Tim Kulchyski, pers. comm.). Indigenous knowledge holders have indicated that there has always been a small amount of Sockeye Salmon; however, it is unclear if there has ever been a substantial Sockeye Salmon run within the Cowichan Assessment Unit (Tim Kulchyski, pers. comm.).

Finally, while outside the spatial scope of the current assessment unit escapement summaries for Nanaimo River were provided in Appendix B.

3 Harvest

Canadian First Nation, recreational, and commercial catch was obtained through a direct request to the DFO catch unit. Current analysis has focused on First Nation, recreational, and commercial Canadian fisheries in Pacific Fisheries Management Areas (PFMAs) 14−18, 28, and 29 due to the proximity to Cowichan Assessment Unit (Figure 8). As part of the Pacific Salmon Treaty (PST), stock composition of fisheries targeting southern origin Chum Salmon must be determined and as such we also report catch and composition from the Washington Areas 7/7A commercial Chum fisheries (Figure 9). Comparing total yearly catch across all four fisheries was compared across Pacific Salmon species allows the relative size of each fishery to be compared with one type of fishery tending to dominate (Figure 10). Trends in total Canadian recreational were flat for most salmon species except for Chinook and Coho salmon (Figure 11).

The First Nations catch data, spanning from 2012 to 2022, was finally received 14 months after the initial request. The data was broken down into categories of Food, Social, and Ceremonial (FSC) kept catch, as well as Economic Opportunity (EO) kept catch. For privacy considerations, the data was aggregated into three geographical regions: Inside (PFMAs 11-19, 29-1 to 29-5), Outside (PFMAs 20-27, 121-12), and Fraser River (PFMA 29-6 to 7 and 29-9 to 17). This report focuses exclusively on the data for the “Inside” area. Additionally, the catch data was summarized annually by quarter, instead of by month as originally requested. Further aggregation of the data may be necessary to capture additional data.

In comparison, the catch data from recreational fisheries shows that the number of Chinook Salmon released is nearly three times greater than the combined FSC and EO First Nations catch (Figure 10). Moreover, the estimated mortality rate for the released Chinook exceeds 20%. This suggests a concerning trend: recreational catch-and-release practices are growing, whereas FSC catches are in decline.

Historically, Elder Wayne Paige recalled his youth, when he would spearfish for salmon in the Cowichan River with friends, bringing home the catch to share with his family, including his aunts. His father, a commercial fisherman, adapted a net specifically for river fishing, which proved highly effective, capturing so many fish that the net seemed to vibrate. Wayne's mother was responsible for the labor-intensive task of processing the fish for smoking. These personal anecdotes highlight the profound changes in fish populations and fishing practices over the years.

The Canadian recreational fishery tended to dominate the Chinook Salmon catch (Figure 10) with a steady increase in total recreational Chinook Salmon catch over time (Figure 11). Total recreational catch showed a significant increasing trend (p-value < 0.001) of approximately 14,890 Chinook Salmon per year (standard error [SE]: 784) within the monitoring period. Of the total recreational Chinook Salmon catch, about 30% was retained, with 70% released. Of all the Chinook Salmon catch that was retained, generally less than 1% was kept by the Canadian commercial fishery, except for 2014, where 21% was retained by the Canadian commercial fishery. Chinook Salmon catch retained by the recreational fishery also showed a significant temporal trend (p-value < 0.001) with an average increase of approximately 4,200 Chinook Salmon per year (SE: 784). The consistent increase in the number of caught and released Chinook should be monitored as a potentially additional significant source of fishery related mortality as there is approximately a 20% post-release mortality rate for recreational Chinook releases (Nicole Frederickson, pers. comm.).

For Chum Salmon, the Canadian commercial Chum fishery represented the largest source of Chum Salmon catch. Canadian recreational catch, with relatively non-existing levels, combined with much lower level of total US commercial catch make up approximately 24% of the total Canadian commercial catch. In addition to the US commercial catch making up a small proportion of the total Chum Salmon catch, only 10−20% of the Area 7/7A catch was found to be fish bound for areas in and around the Cowichan Assessment Unit (Figure 12). Unsurprisingly, stock composition from PFMAs in close proximity to the Cowichan Assessment Unit (e.g., Areas 14, 17, and 18) showed a substantially higher proportion of stocks found either within or with proximity to the Cowichan Assessment Unit (Figure 8). The number of Cowichan bound Chum Salmon intercepted by First Nation fisheries is currently unknown.

Within the Canadian fisheries, most of the reported Coho Salmon catch within the area adjacent to the Cowichan Assessment Area was from Canadian recreational fishery (Figure 10). Recreational Coho Salmon catch showed a significant trend of increasing total catch over the monitoring period (p-value < 0.01) of about 5,600 Coho per year (SE: 784). Of the total Canadian recreational catch, approximately 77% was released, with 23% being retained. Retained Coho Salmon catch by the Canadian recreational fishery did not show a significant temporal trend (p-value = 0.058). The proportion of Coho Salmon catch that comprised Cowichan bound Coho is currently unknown, similarly the number of Cowichan bound Coho intercepted by US fisheries and First Nation fisheries is also unknown.

Finally, Canadian commercial catch of Pink and Sockeye salmon dominated compared to Canadian recreational catch in PFMAs adjacent to the Cowichan Assessment Unit. Canadian commercial catch of Pink and Sockeye salmon could be of a similar or higher magnitude compared the Canadian Chum Salmon fishery, however, these commercial fisheries tended to also to be more sporadic compared to the Canadian commercial Chum fishery. That said, Canadian recreational Pink Salmon catch showed significant temporal trends in both total recreational catch (p-value < 0.002). The proportion of Pink Salmon catch that comprised Cowichan bound Pink is currently unknown, similarly the number of Cowichan bound Pink Salmon intercepted by US fisheries and First Nation fisheries is also unknown, while there are currently no significant runs of Cowichan bound Sockeye Salmon.

Total catch in the Canadian commercial fishery across was broken down by species and management area, with nearly all catch within the vicinity of Cowichan Assessment Unit occurring in Management Area 29 (see Figure 8) for all five salmon species (Figure 13a). The only exception was Chum Salmon which also had harvest in Areas 14, 17, and 18. Adjusting for effort did not notably change the observed catch patterns, except for Chinook Salmon, which showed a relatively higher levels of by-catch per unit effort in the commercial salmon fishery (Figure 14b). A summary of total effort by management area showed the highest total effort generally occurred in Area 29, but there were also notable levels of effort in Areas 14, 17, and 18, in most years (Figure 15). Given that nearly all the catch in these areas consisted of Chum Salmon indicates that fishing activity in these areas effectively targeting Chum Salmon with little bycatch.

Most catch was derived from either gillnet or seine fisheries over all areas (Figure 16). For catch data by gear type summaries on two-year intervals were only available due to privacy concerns. Catch from seine fisheries tended to dominant in Areas 14–18, and 28, with a mix of seine and gillnet in Area 29 that varied by species. Within Area 29, most Chinook Salmon catch was from gillnet, except for the 2011−2012, 2013−2014, and 2021−2022 periods which featured notable seine catch. Most Chum Salmon catch was derived from gillnet fisheries, unlike Areas 14 and 18, where either seine or a mix of seine and gillnet catch tended to dominate each year. Coho Salmon catch in Area 29 came from primarily a mix of seine and gillnet, while almost all Pink Salmon catch in Area 29 was from the seine fishery. Sockeye Salmon also showed a mix of catch from all three fisheries, with gill net catch dominating before 2010 and a mix of primarily seine and gillnet thereafter with some troll catch in the 2009−2010, 2013−2014, and 2017−2018 periods.

4 Hatchery Releases

Hatchery information was obtained from the Fisheries and Oceans Canada (DFO) Enhancement Planning and Assessment Database (EPAD), which represents releases associated with DFO's Salmonid Enhancement Program (SEP).

Hatchery releases have occurred in 10 river systems within the Cowichan Assessment Unit, starting in the 1970s and continuing until present day (Figure 17). Four Pacific salmon species have been released (Chinook, Chum, Coho, and Pink salmon) with fall-run species making up the majority of all releases, with a total of 51.9 million Chinook Salmon released followed by 31 million Chum, 10.3 million Coho, and approximately 38 thousand Pink salmon (Table 4).

Chinook Salmon hatchery releases have been occurring since the 1980s (Figure 17 and Table 5), with the highest number released in the 1990s to early 2000s (Figure 18) and the average release size remaining fairly consistent (Figure 19). Chinook Salmon hatchery releases in some systems were consistent over this period, while others were abbreviated. Extended durations of Chinook Salmon releases occurred primarily in two river systems (i.e., Chemainus River and Cowichan River; Table 5) with the highest single year release of 2.5 million Chinook occurring in the upper Cowichan River in 2002 (Table 6). Chinook Salmon releases have also occurred in Koksilah River, Cowichan Lake, but for a shorter period of time, with a smaller number of average releases (Table 5 and Table 6).

Hatchery source stock for Chinook Salmon has also remained relatively consistent over time. Most Chinook Salmon releases (46.8 million; 90%) used Cowichan River as the source stock with 4.9 million releases using Chemainus River (Table 7). Cowichan River was also the dominant source stock for Chum (27.9 million; 90%) and Coho (4 million; 38%) salmon. Finally, most Chinook Salmon release sites used either the same source stock or a similar source stock across release years, this was not the case for Coho Salmon which had more variation in the source stock used (Table 8).

While hatchery releases may be used to rebuild populations and produce fish for harvest, there are also genetic risks associated with the release. As indicated in Canada's Policy for the Conservation of Wild Pacific Salmon (herein referred to as the Wild Salmon Policy), there is a critical need to maintain natural genetic diversity within the population to ensure fitness in current and future salmon populations. The proportionate natural influence (PNI) is a metric that measures the relative degree of hatchery influence in a population ranging from 0 (all hatchery) to 1 (all wild) and whether gene flow favours hatchery or the natural environment (Figure 20). PNI data for Vancouver Island was available for Coho and Chinook salmon, but only Chinook PNI data was available within the Cowichan Assessment Unit.

Long-term PNI data for Chinook Salmon populations was only available for the Cowichan River population, showing a substantive and concerning decline in PNI until the early 2000s where it reached a low of about 0.5, based on coded wire tagging data, before trending back towards 1 over the last couple decades (Figure 21). This suggests the Cowichan River fall Chinook Salmon population has made significant gains towards being more naturalized in recent years, with the trend being a clear reflection of the changes in hatchery releases that occurred within the same period of time (Figure 22). PNI estimates declined as total releases into the Cowichan River increased from 1980 to 2000, with the peak in total hatchery releases occurring just prior to the early 2000s when PNI estimates were at their lowest. As hatchery releases declined into the 2010s and into the present period, PNI estimates trended back towards being higher wild influence and represents a substantive change in gene flow dynamics within the population, with population currently trending towards dominant wild influence. That said, it is not clear if there are, or have been, long standing genetic consequences from the extended hatchery influence that occurred from 1990s to 2010s. While long-term PNI estimates were not available for Chemainus River Chinook Salmon, hatchery releases into Chemainus River followed similar trends as Cowichan River, suggesting the possibility that Chemainus River fall Chinook Salmon are also trending towards a dominant wild influence, but this would need to be confirmed (Figure 22).

Finally, while outside the spatial scope of the current assessment unit hatcher release summaries for Nanaimo River were provided in Appendix B.

5 Smolt Enumeration

Currently, there is only limited smolt enumeration data available for Coho Salmon in the Cowichan Assessment Unit (Figure 23; Wade and Irvine 2018). Only streams that had five or more years of data were reported on and included Bush Creek (6 years of data) and Cowichan Lake (9 years of data). The information shows increased numbers of smolts in 2000−2002, and a declining trend to 2007. The number of hatchery fish that make up the smolt count is not known, although a high number of hatchery fish was released in 1999 in the Cowichan system. Other smolt capture data exists in the Cowichan Assessment Unit but it was collected as part of hatchery release survival study and not designed to provide accurate estimates of total smolt abundances.

6 River Hydrology and Weather

Discharge and weather data was downloaded from the BC Water Tool for stations that had 10 or more years of monitoring data available. River discharge is reasonably well documented in the assessment unit, but detailed records are only available for three priority streams (Figure 24). Overall, across all the monitoring locations in the Cowichan Assessment Unit there appears to be a general trend of lower river discharge rates in both the spring and summer that has occurred over the last decade. This trend appears to be stronger for the summer as the number of days where daily discharge has exceeded the historical average has shown a precipitous decline over time, indicating a general trend of fewer days with elevated flow which could result in more stagnant water during the summer (Figure 25). These discharge patterns also appear to be consistent across the different monitoring locations and therefore likely indicate watershed wide changes.

Weather monitoring (i.e., air temperature and precipitation) within the assessment unit has historically occurred at seven locations, with monitoring ending at all locations except for one (i.e., Jump Creek) within the last decade (Figure 26). The only active location (i.e., Jump Creek) represents a relatively recent monitoring location, that is fairly remote and at a distance from most salmon bearing systems within the assessment unit. As such, it is unclear whether this location provides a good indicator of the general weather patterns affecting salmon bearing streams within the assessment unit. Furthermore, the termination of monitoring at most historical locations makes it difficult to assess changes in long-term weather patterns, as any changes in recent weather patterns will also be confounded with changes in monitoring locations. Taken together, while there has been reasonably good historical weathering monitoring within the assessment unit, current monitoring effort does not provide sufficient information about how recent weather patterns may be impacting salmon bearing systems within the assessment unit.

Snowpack records from Heather Mountain indicate potentially lower snowpack in recent years relative to the 1970s, however, the time series appears to be missing data from the mid-1990s to early 2010s making the assessments of long-term trends difficult (Figure 27a). That said, snowpack at the end of the season (i.e., April and May) appear to show the largest decline over time (Figure 27b).

7 Supporting Watershed Health

7.1 Collaborations

As is the case in many watersheds across BC, the Cowichan−Koksilah watershed (collectively known as the Cowichan watershed) faces a number of challenges, including threats to water quality, water supply, and cumulative impacts to habitat. Over 150 years of land use – forestry, agriculture, and development has disrupted the habitat of the area. Sustainable solutions are required to ensure long-lasting restoration.

Recently, there has been an improvement towards collaborative management and decision-making to protect and enhance the health of the Cowichan watershed. Outside of this project, some examples of current collaborations that are providing solutions to support the health of the watershed are:

- Q'ul-lhanumutsun Aquatic Resource Society (QARS) represents six Coast Salish communities. The non-profit society creates opportunities to carry out strategic planning on fisheries and aquatic resources. For example, QARS partnered with DFO stock assessment to enumerate Chum Salmon returning to the Chemainus with a DIDSON counter since 2016.
- Twinned Watershed Project was initiated in 2021 in partnership with Cowichan Watershed Board, Cowichan Tribes, and Halalt First Nation. It is a multi-year project supporting the needs of salmon in the Chemainus and Koksilah rivers.
- Cowichan Stewardship Roundtable provides a forum (includes various partners and participants) to deal with fish and wildlife habitat restoration, enhancement, and stewardship issues in the Cowichan Basin. The motivation for initiating the forum was to guide the preparation of the Cowichan Recovery Plan (Bocking et al. 2005).
- Cowichan Watershed Board is a partnership between Cowichan Tribes First Nation and the Cowichan Valley Regional District (CVRD). The purpose of the board is to provide leadership for sustainable water management and to protect and enhance environmental quality and quality of life in the Cowichan and Koksilah watersheds.
- Xwulqw'selu Water Steering Committee includes participants from Cowichan Tribes and FLNRORD (BC Ministry of Forests, Lands, Natural Resource Operations and Rural Development) with a purpose to pursue and oversee a Water Sustainability Plan for the Xwulqw'selu (Koksilah) watershed.
- Cowichan Watershed Resiliency Program is a collaborative effort of multiple partners with the goal of improving watershed resilience by increasing the capacity of the watershed to buffer both drought and flooding (winter storms).
- Cowichan Lake and River Stewardship Society (CLRSS) purpose is to help protect the health of the Cowichan watershed with focus on Cowichan Lake and upper Cowichan River. The society is an active partnership with residents of Honeymoon Bay, Youbou, and Town of Lake Cowichan, as well as the Cowichan Valley Regional District, Cowichan Watershed Board, British Columbia Conservation

Foundation (BCCF), and Cowichan Stewardship Roundtable. Every year, by end of June, salmon fry are stranded as the river flow decreases. CLRSS volunteers, community members and Cowichan Tribe members have collaborated to rescue thousands of salmon fry and relocate them to the lake.
- Chemainus Watershed Initiative is a Quw'utsun-led (built off of Halalt First Nation Watershed Framework) Chemainus River habitat restoration project initiated in 2023.

7.2 Next Steps in Supporting Watershed Health

Collaborate partnerships will need to continue to guide a long-term plan towards healing the watershed. In May 2023, Quw'utsun territory – Cowichan Tribes First Nation and the Province of British Columbia signed a Xwulqw'selu (Koksilah) Watershed Planning Agreement that outlines a plan to address the needs of the 'whole watershed' (flora, fauna, land, and communities). At a community event (held 30 January 2023) to support Cowichan watershed initiatives, "*Quw'utsun Knowledge Holder and biologist Q'utxulenuhw (Tim Kulchyski) shared a similar insight indicating that in order to come up with sustainable solutions for the land and water, people need to think about watersheds as a whole and learn about how everything — including the forest, water, plants, fish, wildlife, insects and people — is connected)*" (from Five ways to support Cowichan watersheds – The Discourse).

Moving forward it will be important to understand the deep history and traditional connection to the land. In an interview, Quw'utsun Elder Sina'htun (Wayne Paige Sr.) highlighted his ongoing commitment to sustainable living. However, he expressed concerns about the increasing difficulty of maintaining these practices, such as fishing and hunting, due to diminishing resources. He emphasized that recognizing and appreciating this traditional connection is vital for conservation and management efforts, as it should inform the context for both current and future initiatives within the watershed.

This perspective is particularly pertinent considering the environmental challenges faced by the Cowichan headwater lake tributaries, which have suffered from years of habitat degradation due to past and ongoing forestry practices. Over time, forest harvesting practices have led to more fluctuation in seasonal flows, in addition to, increased salmon fry stranding, siltation, and late summer water temperatures (Rajala 2012). Currently, University of Victoria (UVic), British Columbia Conservation Foundation, and Cowichan Tribes are working together to study the impact of log booms on Chinook Salmon survival (Impact of Log Booms – Pacific Salmon Foundation (PSF) Marine Science Program). Cowichan Tribes recommends changing log boom practices so there is less impact on fish (Tim Kulchyski, pers. comm.). These types of projects are helping to identify the constraints and opportunities for future enhancement.

8 Conclusions & Recommendations

The following recommendations are identified based on the goals described in this report and the values put forth by the member nations. The recommendations are provided for each of the following: Escapement Monitoring, Hatchery Programs, Habitat, and environmental monitoring. There are also recommendations provided that may be beneficial but fall outside the scope of the project.

8.1 Escapement Monitoring

- Expand escapement monitoring for smaller systems rather than current focus on larger systems only. Try to include as many streams as possible in counts or develop good indicator stream/index stock relations; otherwise, count when possible (such as every other year).
- Use robust estimation procedures for escapement estimates.
- Focus on obtaining information on early-run stocks, including additional searches and robust counting techniques and estimation; these surveys will include the collection of data to establish run timing.

- Investigate potential of using environmental DNA (eDNA) to identify early Chinook Salmon runs.
- Investigate potential causes for the increase in jack returns.
- Continue to count Pink Salmon and include additional systems where present.

8.2 Hatchery Programs

- Have clear objectives for hatchery programs and release strategies and monitor to determine whether they are achieving the desired results.
- For hatchery programs, keep to one stock per release stream and use best practices to reduce the likelihood of straying.
- For systems with a high proportion of natural spawners, aim to keep PNI values between 75% to 100%; reduce stocking rates if PNI values are decreasing.

8.3 Habitat

- Conduct freshwater or other habitat assessments on the major rivers and associated tributaries, focusing on areas of concern or importance (spawning sites, barriers, highly degraded habitats).
- Increase habitat complexity to allow more areas of refuge and reduce potential channelization of the water bodies.
- Ensure riparian areas are as intact as possible.
- Confirm culverts are in good working order.
- Ensure river connectivity to allow fish passage.
- Reestablish estuarian connectivity and complexity.
- Target areas for bank stabilization to decrease excessive sedimentation.
- Compile and assess results from recent and ongoing watershed projects to determine current state of watershed health.

8.4 Environmental Monitoring

- Increase river discharge monitoring.
- Increase river temperature monitoring.
- Increase weather monitoring.
- Increase snowpack monitoring.
- Implement a water contaminant sampling program.

8.5 Future Work (Out of Report Card Scope)

- A map showing early-run Chinook, and Chinook X Coho salmon hybrids around Lake Cowichan and its tributaries, which could help prioritize habitat restoration efforts.
- Impact of DFO Management actions in response to changes in Chinook Salmon population and Chinook Salmon recreational fishery, such as the shift to Mark Selective Fishery (MSF).
- Further analyses identifying factors contributing to reduced total escapement between 1995 and 2005.
- Upload data collected from Cowichan Report to QARS central database.
- Fry genetic data is lacking as it is currently being analysed by Eric Rondeau from Molecular Genetics lab.
- There was a fish kill above Skutz Falls and EDI was hired by Catalyst Paper to assist with the fry salvage. No DNA nor biosample data was collected due to the sheer number of fish collected.

Limited in situ water quality data was collected (e.g. dissolved oxygen [DO] and temperature). EDI to confirm that water quality data can be released publicly.

- Data on Cowichan salmon caught in West Coast Vancouver Island (WCVI) troll fishery has been received. Analysis and summary to be included at a future date.
- Add May snowpack datal contact confirmation is currently delayed.
- Literature additions on salmon predation related to from seals and sea lions during low flow years.
- Include US Chum Salmon fishery data 2007−2008, 2010, 2012, 2013−2014.
- Summarize Chinook salmon interception from troll ground fishery.
- Add information on hatchery Chinook Salmon straying; the CSAS report not available until new year (Nicholas Komick).
- Summarize recreational data from 2009 and earlier available on the Fisheries and Oceans Canada Open Government Portal (difficult format to analyze).

REFERENCES

de Araujo, G.R., T. de Deco-Souza, R.G. Morato, et al. 2021. Use of foot snares to capture large felids. Methods in Ecology and Evolution 12:322−327. Accessed: https://doi.org/10.1111/2041-210X.13516.

Bocking, R., M. Gaboury, J. Smith, P. Hudson, and C. Seymour. 2005. Cowichan Recovery Plan. Prepared for Cowichan Treaty Office, Duncan, BC, by LGL Limited, Sidney, BC.

Bowerman, T., M.L. Keefer, and C.C. Caudill. 2016. Pacific salmon prespawn mortality: patterns, methods, and study design considerations. Fisheries 41(12):738–749. Accessed: https://doi.org/10.1080/03632415.2016.1245993.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2018. COSEWIC assessment and status report on the Chinook Salmon *Oncorhynchus tshawytscha*, Designatable Units in Southern British Columbia (Part One – Designatable Units with no or low levels of artificial releases in the last 12 years), in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. https://wildlife-species.canada.ca/species-riskregistry/virtual_sara/files/cosewic/ChinookSalmon-v00-2019-Eng.pdf.

DFO (Fisheries and Oceans Canada). 2005. Canada's Policy for Conservation of Wild Pacific Salmon. Fisheries and Oceans Canada, Wild Salmon Policy. Vancouver BC. Accessed: www.pac.dfo-mpo.gc.ca/fm-gp/salmon-saumon/wsp-pss/policy-politique-eng.html.

DFO (Fisheries and Oceans Canada). 2024a. NuSEDS (New Salmon Escapement Database System) [online database]. Fisheries and Oceans Canada, Vancouver, BC. Accessed: https://open.canada.ca/data/en/dataset/c48669a3-045b-400d-b730-48aafe8c5ee6.

DFO (Fisheries and Oceans Canada). 2024b. VI Hydromets. Fisheries and Oceans Canada, Vancouver, BC. Accessed: http://www.pacfish.ca/wcviweather/Default.aspx.

English, K., G.F. Searing, and D.A. Nagtegaal. 2002. Review of the Strait of Georgia recreational creel survey, 1983−1999. Canadian Technical Report of Fisheries and Aquatic Sciences 2414: xi+81 p.

Gaboury M., D. Robichaud, and J. Damborg. 2012. Effectiveness monitoring of Stoltz Bluff stabilization works, Cowichan River. Final report. Prepared for BC Conservation Foundation, Nanaimo, BC, and Pacific Salmon Foundation, Vancouver, BC, by LGL Limited, Nanaimo, BC, and BC Conservation Foundation, Nanaimo, BC.

Nelitz, M., K. Wieckowski, D. Pickard, K. Pawley, and D.R. Marmorek. 2007. Helping Pacific salmon survive the impact of climate change on freshwater habitats: case studies. Final report prepared for Pacific Fisheries Resource Conservation Council, Vancouver, BC, by ESSA Technologies Ltd., Vancouver, BC.

Pike, R.G., E.L. Young, J.D. Goetz, and D.L. Spittlehouse. 2017. Cowichan River: A summary of historical disturbances, water use pressures and streamflow trends. Water Science Series WSS2017-05. Prov. B.C., Victoria, BC.

Rajala, R. 2012. Streams being ruined from a salmon producing standpoint: clearcutting, fish habitat, and forest regulation in British Columbia, 1900−45. BC Studies 176:93−132.

Wade, J., and J.R. Irvine. 2018. Synthesis of smolt and spawner abundance information for Coho Salmon from South Coast British Columbia streams. Canadian Manuscript Report of Fisheries and Aquatic Sciences 3161: vi + 39 p.

Zaldokas, D.O. 1999. Annual Compendium of Aquatic Rehabilitation Projects for the Watershed Restoration Program 1998–1999. Watershed Restoration Program. Ministry of Environment, Lands and Parks, Vancouver, BC.

TABLES

Table 1. **Summary of range of years with reported escapement by stream, species, and run type (includes records to 2022).** Priority streams have been bolded and highlighted yellow. Data derived from NuSEDS database (September 6, 2023, release).

Stream	Run Type	Priority Stream	Chinook	Chum	Coho	Pink
Averill Creek	Fall	No			2014–2015	
Bings Creek	Fall	No			2014–2015	
Bonsall Creek	**Fall**	**Yes**	**1995–2002**	**1953–2020**	**1953–2020**	**1995–2002**
Bush Creek	**Fall**	**Yes**	**1995–2002**	**1953–2019**	**1953–2019**	**1967–2002**
Chemainus River	**Summer**	**Yes**	**2002–2022**			
Chemainus River	**Fall**	**Yes**	**1953–2022**	**1953–2022**	**1953–2022**	**1953–2022**
Cowichan River	**Summer**	**No**	**2015**			
Glenora Creek	Fall	No	1999–2001	1977–2020	1977–2020	1999–2001
Haslam Creek	Fall	No	1953–2020	1953–2020	1953–2020	1953–2002
Holland Creek	Fall	No	1995–2002	1953–2022	1953–2022	1970–2002
Holt Creek	Fall	No		2013–2015	2013–2015	
Kelvin Creek	Fall	No	2001	1976–2020	1976–2020	2001
Koksilah River	**Fall**	**Yes**	**1953–2019**	**1953–2019**	**1953–2019**	**1995–2001**
Marshall Creek	**Fall**	**Yes**				
Mesachie River	Fall	No	1986–2001	1987–2001	1986–2020	1999–2001
Nanaimo River	Summer	No	1979–2020			
Nanaimo River	Fall	No	1953–2020	1953–2019	1953–2020	1953–2020
Napoleon Creek	Fall	No	1995–2020	1953–2020	1994–2020	1995–2020
Nixon Creek	**Fall**	**Yes**				
Norrie Creek	Fall	No	2001	2000–2020	2000–2020	2001
North Nanaimo River	Fall	No	1999–2002	1999–2002	1999–2020	1999–2002
Oliver Creek	Fall	No	1999	1996–2020	1989–2020	1999–2001
Patricia Creek	Fall	No	1989–2004	1989–2020	1989–2020	1999–2001
Porter Creek	Fall	No	1982–2002	1953–2020	1953–2020	1982–2002
Quamichan Creek	Fall	No			2014–2015	
Richards Creek	Fall	No	1999	1998–2020	1989–2020	1999–2001
Robertson River	Fall	No	1990–2000	1989–2020	1989–2020	1999–2001
Shaw Creek	**Fall**	**Yes**	**1989–2020**	**1989–2020**	**1989–2020**	**1999–2001**
Stocking Creek	**Fall**	**Yes**	**1995–2002**	**1953–2019**	**1953–2019**	**1995–2002**
Sutton Creek	Fall	No			1992–2020	
Tyee Creek	Fall	No	1976–2002	1953–2020	1953–2020	1976–2002
Whitehouse Creek	Fall	No	1995–2002	1993–2020	1993–2020	1995–2002

Table 2. Summary of the average escapement and the last 5-year average with range in escapement indicated in brackets.

Priority streams have been bolded and highlighted. Data derived from NuSEDS database (September 6, 2023, release).

Stream	Run Type	Priority Stream	Chinook	Chum	Coho	Pink
Bonsall Creek	**Fall**	**Yes**		**500 / - (1–3,620)**	**1,504 / - (200–7,500)**	
Bush Creek	**Fall**	**Yes**		**2,550 / 18 (18–15,000)**	**146 / - (5–750)**	**1 / -**
Chemainus River	**Summer**	**Yes**	**22 / 21 (11–37)**			
Chemainus River	**Fall**	**Yes**	**315 / 134 (16–2,000)**	**15,276 / 26,846 (290–51,000)**	**906 / - (25–7,500)**	**21 / - (1–50)**
Cowichan River	**Summer**	**No**	**200 / -**			
Cowichan River	**Fall**	**No**	**10,249 / 24,256 (1,500–28,736)**	**97,824 / 111,181 (15,000–280,000)**	**28,304 / 22,729 (2,730–75,000)**	**88 / 46 (24–255)**
Glenora Creek	Fall	No		219 / - (95–343)	166 / - (137–195)	
Haslam Creek	Fall	No	61 / - (1–198)	4,920 / - (287–18,800)	458 / - (25–1,394)	
Holland Creek	Fall	No		3,846 / 763 (36–35,000)	71 / 22 (1–750)	2 / -
Kelvin Creek	Fall	No		2,058 / - (378–3,738)	688 / - (250–1,255)	
Koksilah River	**Fall**	**Yes**	**228 / - (8–1,000)**	**4,434 / - (1,000–15,000)**	**5,069 / - (200–35,000)**	
Mesachie River	Fall	No	1 / -	2 / - (1–3)	259 / - (9–1,118)	
Napoleon Creek	Fall	No		930 / - (23–1,567)	40 / - (6–75)	
Norrie Creek	Fall	No		7 / -	486 / - (486–486)	
Oliver Creek	Fall	No		2 / - (2–3)	106 / - (1–578)	
Patricia Creek	Fall	No	7 / - (1–16)	4 / - (1–9)	326 / - (2–947)	
Porter Creek	Fall	No		35 / - (2–200)	17 / - (1–48)	

Stream	Run Type	Priority Stream	Chinook	Chum	Coho	Pink
Richards Creek	Fall	No		146 / - (4–288)	274 / - (14–835)	
Robertson River	Fall	No	8 / - (4–11)	114 / - (2–818)	353 / - (60–1,281)	
Shaw Creek	**Fall**	**Yes**	**4 / - (1–21)**	**4 / - (1–15)**	**688 / - (14–1,888)**	
Stocking Creek	**Fall**	**Yes**		**2,259 / 1,103 (10–8,700)**	**27 / - (1–100)**	
Sutton Creek	Fall	No			66 / - (17–114)	
Tyee Creek	Fall	No		51 / - (1–200)	14 / - (1–65)	
Whitehouse Creek	Fall	No		25 / -	50 / -	

Table 3. **Summary of escapement methods used in priority streams.** Data derived from NuSEDS database (September 6, 2023, release).

Priority Stream	Run Type	Chinook	Chum	Coho	Pink
Bonsall Creek	Fall		1953–1998: Unknown Estimate Method 1999–2000: Peak Live + Dead 2001–2003: Area Under the Curve	1953–1996: Unknown Estimate Method 1998–2004: Area Under the Curve	
Bush Creek	Fall		1953–2001: Unknown Estimate Method 2002–2003: Area Under the Curve 2004–2018: Peak Live + Dead	1953–1995: Unknown Estimate Method 1996: Not Applicable 1998–2003: Area Under the Curve 2004–2012: Peak Live + Dead	1967: Unknown Estimate Method
Chemainus River	Spring/ Summer	2015–2017: Peak Live + Dead 2018: Addition/Subtraction 2019: Peak Live + Dead 2021–2022: Addition/Subtract			
Chemainus River	Fall	1954–1999: Unknown Estimate Method 2000: Peak Live * Expansion 2001: Peak Live + Dead 2002: Area Under the Curve 2003: Not Applicable 2004: Peak Live + Dead 2005: Other Estimate Method 2006–2009: Peak Live + Dead 2011: Peak Live * Expansion 2015: Peak Live + Dead 2018–2020: Addition/Subtraction	1953–2000: Unknown Estimate Method 2001: Peak Live + Dead 2002: Peak Live * Expansion 2003: Cumulative New 2004–2011: Peak Live + Dead 2012–2013: Area Under the Curve 2015: Peak Live + Dead 2016: Fixed Site Census 2017–2020: DIDSON Counter 2021: Combined Methods	1953–2000: Unknown Estimate Method 2001: Peak Live + Dead	1955–2000: Unknown Estimate Method 2015: Peak Live + Dead
Cowichan River	Early	2015: DIDSON Counter			

Priority Stream	Run Type	Chinook	Chum	Coho	Pink
Cowichan River	Fall	1953–1964: Unknown Estimate Method 1965–1966: Fixed Site Census 1967–1975: Unknown Estimate Method 1976–1977: Fixed Site Census 1978: Peak Live + Dead 1979: Peak Live * Expansion 1980: Unknown Estimate Method 1981–1987: Peak Live * Expansion 1988–1996: Fixed Site Census 1997: Mark & Recapture: Petersen 1998–2006: Fixed Site Census 2007: Mark & Recapture: Petersen 2008–2012: Fixed Site Census 2013: Mark & Recapture: Petersen 2014–2016: Fixed Site Census 2017–2020: Combined Methods 2021–2022: Mark & Recapture: Petersen	1953–2001: Unknown Estimate Method 2002–2013: Fixed Site Census 2014–2022: Sonar-DIDSON	1953–1964: Unknown Estimate Method 1965–1966: Fixed Site Census 1967–1975: Unknown Estimate Method 1976–1977: Fixed Site Census 1978–1992: Unknown Estimate Method 1993: Fixed Site Census 1994–2001: Unknown Estimate Method 2002–2007: Area Under the Curve 2020–2022: Mark & Recapture: Petersen	2015–2022: Fixed Site Census
Koksilah River	Fall	1953–1992: Unknown Estimate Method 2003: Peak Live + Dead	1953–1995: Unknown Estimate Method 2015: Area Under the Curve	1953–1992: Unknown Estimate Method 2000–2003: Peak Live + Dead	
Shaw Creek	Fall	1991: Peak Live * Expansion 1992–1996: Peak Live + Dead 1999–2000: Unknown Estimate Method 2001–2004: Peak Live + Dead	1990: Peak Live + Dead 1991: Peak Live * Expansion 1994–1998: Peak Live + Dead 1999: Unknown Estimate Method 2001–2002: Peak Live + Dead	1989: Peak Live * Expansion 1990–1993: Area Under the Curve 1994: Addition/Subtraction 1995–2004: Area Under the Curve 2005: Cumulative New 2008: Peak Live + Dead	

Table 4. **Total number of hatchery releases in the Cowichan Assessment Unit by release location and species.** Release areas with priority streams have been bolded and highlighted yellow. Data derived from EPAD.

Release System	Chinook	Chum	Coho	Pink
Averill Creek	0	1,265	196	0
Bear Creek/GSVI	0	0	73,100	0
Bear Lake	0	0	75,222	0
Beaver Creek/GSVI	0	200	31,391	0
Beaver Lake/GSVI	0	0	700	0
Bings Creek	0	786	40,820	0
Blackjack Swamp	0	0	261,612	0
Bonsall Creek System	**0**	**14,611,090**	**439,080**	**0**
Bush Creek	**0**	**297,661**	**151,559**	**0**
Chemainus River	**5,089,141**	**1,399,996**	**1,716,576**	**0**
Cowichan River System	**46,604,278**	**6,802,948**	**4,711,299**	**0**
Glenora Creek	0	0	21,117	0
Green Creek	0	0	114,622	0
Green Lake	0	0	8,122	0
Haslam Creek	0	0	470,628	37,596
Holland Creek	0	590,721	111,091	0
Kelvin Creek	0	0	86,661	0
Koksilah River	**155,608**	**3,287**	**1,572,530**	**0**
Marshall Creek	**0**	**0**	**0**	**0**
Meade Creek	0	0	21,738	0
Nixon Creek	**0**	**0**	**45,429**	**0**
Oliver Creek	0	1,109	20,684	0
Richards Creek	37,700	0	0	0
Robertson Channel	0	4,375,000	17,500	0
Robertson River	0	23,716	122,072	0
Rush Creek	0	0	52,901	0
Sadie Creek	0	0	10,000	0
Shaw Creek	**0**	**0**	**0**	**0**
Somenos Creek	0	1,300	0	0
Stocking Creek	**0**	**444,252**	**34,923**	**0**
Sutton Creek	0	2,425,985	21,026	0
Wolf Creek/GSVI	0	0	89,822	0
Total Releases	51,886,727	30,979,316	10,322,421	37,596

Table 5. Summary of range of years with hatchery releases by stream, species, and run type in the Cowichan Assessment Unit. Priority streams have been bolded and highlighted yellow. Data derived from EPAD.

Stream	Run Type	Priority Stream	Chinook	Chum	Coho	Pink
Averill Creek	Fall	No		2006–2020	2021	
Bear Creek/GSVI	Fall	No			1983–1996	
Bear Lake	Fall	No			1993–2021	
Beaver Creek/GSVI	Fall	No		2013–2014	1988–2012	
Beaver Lake/GSVI	Fall	No			2021	
Bings Creek	Fall	No		2005–2019	1986–1988	
Blackjack Swamp	Fall	No			1981–2001	
Bonsall Creek	**Fall**	**Yes**		**2008–2014**	**1994–2013**	
Bonsall Slough	Fall	No		1988–2003	1989–2003	
Bush Creek	**Fall**	**Yes**		**1993–2019**	**1993–2012**	
Chemainus River	**Fall**	**Yes**	**1980–2021**	**1998–2017**	**1970–2001**	
Cowichan Estuary	**Fall**	**No**	**1991–2013**			
Cowichan Lake	**Fall**	**No**	**1988–1999**	**1996–2020**	**1989–2021**	
Cowichan Lake Tribs	**Fall**	**No**		**1992**	**1986–2004**	
Cowichan R@Duncan	**Fall**	**No**	**2003**			
Cowichan River	**Fall**	**No**	**1980–2021**	**1977–2020**	**1977–2021**	
Cowichan River Low	**Fall**	**No**	**1992–2007**		**1999**	
Cowichan River Up	**Fall**	**No**	**1988–2008**			
Glenora Creek	Fall	No			1985	
Green Creek	Fall	No			1989–2001	
Green Lake	Fall	No			1988–2011	
Haslam Creek	Fall	No			1981–2020	1993
Holland Creek	Fall	No		1998–2019	1997–2021	
Kelvin Creek	Fall	No			1986–2000	
Koksilah River	**Fall**	**Yes**	**1984–1987**	**1995–2020**	**1970–2015**	
Marshall Creek	**Fall**	**Yes**				
Meade Creek	Fall	No			1999–2002	
Nixon Creek	**Fall**	**Yes**			**1998–2002**	
Oliver Creek	Fall	No		2005–2020	2011–2017	
Richards Creek	Fall	No	1988–1989			
Robertson Channel	Fall	No		1997–2003	1997–2003	
Robertson River	Fall	No		2003	1994–2011	
Rush Creek	Fall	No			1994–2000	

Stream	Run Type	Priority Stream	Chinook	Chum	Coho	Pink
Sadie Creek	Fall	No			1998	
Shaw Creek	**Fall**	**Yes**				
Somenos Creek	Fall	No		2015–2020		
Stocking Creek	**Fall**	**Yes**		**2001–2019**	**2001–2021**	
Sutton Creek	Fall	No		2004–2014	1998–2002	
Wolf Creek/GSVI	Fall	No			1981–2014	

Table 6. **Summary of the average hatchery releases, with range indicated in brackets, by release location, run type, and species for streams within the Cowichan Assessment Unit.** Priority streams have been bolded and highlighted. Data derived from EPAD.

Stream	Run Type	Chinook	Chum	Coho	Pink
Averill Creek	Fall		126 (97–197)	196	
Bear Creek/GSVI	Fall			14,620 (4,000–28,600)	
Bear Lake	Fall			37,611 (1,000–74,222)	
Beaver Creek/GSVI	Fall		100	3,924 (92–14,800)	
Beaver Lake/GSVI	Fall			700	
Bings Creek	Fall		157 (97–293)	13,607 (12,990–14,770)	
Blackjack Swamp	Fall			21,801 (4,332–40,000)	
Bonsall Creek	**Fall**		**4,697 (90–10,000)**	**23,440 (7,500–45,000)**	
Bonsall Slough	Fall		912,312 (389,000–2,275,000)	5,832 (5,800–6,000)	
Bush Creek	**Fall**		**15,666 (110–60,043)**	**8,915 (94–39,000)**	
Chemainus River	**Fall**	**127,229 (9,548–296,546)**	**116,666 (204–500,000)**	**74,634 (23,893–183,487)**	
Cowichan Estuary	**Fall**	**126,247 (5,086–533,925)**			
Cowichan Lake	**Fall**	**500,376 (4–1,001,002)**	**147 (41–400)**	**73,838 (96–217,850)**	
Cowichan Lake Tribs	**Fall**		**166,600 (166,600–166,600)**	**115,757 (8,212–285,040)**	
Cowichan R@Duncan	**Fall**	**288,668 (288,668–288,668)**			
Cowichan River	**Fall**	**388,901 (456–1,563,051)**	**201,079 (200–999,143)**	**96,350 (175–374,835)**	
Cowichan River Low	**Fall**	**489,612 (149,964–829,259)**		**159,479**	
Cowichan River Up	**Fall**	**1,326,108 (160,924–2,572,674)**			
Glenora Creek	Fall			21,117	
Green Creek	Fall			12,736 (8,414–19,909)	

Stream	Run Type	Chinook	Chum	Coho	Pink
Green Lake	Fall			4,061 (100–8,022)	
Haslam Creek	Fall			31,375 (90–74,204)	37,596
Holland Creek	Fall		32,818 (4,784–85,000)	8,545 (197–18,000)	
Kelvin Creek	Fall			17,332 (14,600–23,585)	
Koksilah River	**Fall**	**77,804 (54,608–101,000)**	**274 (53–1,400)**	**87,363 (14–236,990)**	
Meade Creek	Fall			10,869 (7,117–14,621)	
Nixon Creek	**Fall**			**15,143 (10,746–19,198)**	
Oliver Creek	Fall		111 (97–198)	4,137 (300–15,000)	
Richards Creek	Fall	18,850 (10,000–27,700)			
Robertson Channel	Fall		625,000	2,500	
Robertson River	Fall		23,716 (23,716–23,716)	20,345 (2,863–49,532)	
Rush Creek	Fall			13,225 (10,058–20,000)	
Sadie Creek	Fall			10,000	
Somenos Creek	Fall		260 (60–530)		
Stocking Creek	**Fall**		**31,732 (430–75,000)**	**4,989 (85–13,278)**	
Sutton Creek	Fall		242,598 (37,960–385,300)	10,513 (9,012–12,014)	
Wolf Creek/GSVI	Fall			8,982 (3,000–18,364)	

Table 7. **Summary of total number of releases in the Cowichan Assessment Unit by source stock and species.** Data derived from EPAD.

Source Stock	Run Type	Chinook	Chum	Coho	Pink
Bear Cr/GSVI	Fall	0	0	44,500	0
Beaver Cr/GSVI	Fall	0	0	149,136	0
Big Qualicum R	Fall	37,700	0	738,675	0
Bonsall Cr	Fall	0	32,000	351,600	0
Bush Cr	Fall	0	282,512	150,759	0
Chemainus R	Fall	4,874,068	1,400,184	1,277,448	0
ChemainusXCowich	Fall	215,073	0	0	0
Cowichan Lk Tribs	Fall	6	167,041	1,463,851	0
Cowichan R	Fall	46,759,880	27,862,575	3,925,144	0
Giddes Cr	Fall	0	0	148,000	0
Goldstream R	Fall	0	180,000	0	0
Holland Cr	Fall	0	525,885	111,091	0
Kelvin Cr	Fall	0	0	62,526	0
Koksilah R	Fall	0	1,453	813,673	0
Meade Cr	Fall	0	0	7,117	0
Nanaimo R	Fall	0	0	1,007,707	37,596
Nixon Cr	Fall	0	0	15,485	0
Robertson R	Fall	0	3,429	20,071	0
Stocking Cr	Fall	0	524,237	34,838	0
Walker Cr/GSVI	Fall	0	0	800	0
	Total Releases	**51,886,727**	**30,979,316**	**10,322,421**	**37,596**

Table 8. Summary of contiguous release years for source stock by release site and species in the Cowichan Assessment Unit. Data derived from EPAD.

Release Site	Run Type	Chinook	Chum	Coho	Pink
Averill Cr	Fall		2006: Cowichan R 2008: Chemainus R 2011–2020: Cowichan R	2021: Beaver Cr/GSVI	
Bear Cr/GSVI	Fall			1983–1986: Bear Cr/GSVI 1996: Beaver Cr/GSVI	
Bear Lk	Fall			1993: Cowichan R 2021: Beaver Cr/GSVI	
Beaver Cr/GSVI	Fall		2013–2014: Cowichan R	1988–1996: Beaver Cr/GSVI 1997–1998: Cowichan R 2008: Beaver Cr/GSVI 2012: Cowichan Lk Tribs	
Beaver Lk/GSVI	Fall			2021: Beaver Cr/GSVI	
Bings Cr	Fall		2005–2006: Cowichan R 2008: Chemainus R 2012–2019: Cowichan R	1986–1987: Cowichan R 1988: Cowichan Lk Tribs 1988: Cowichan R	
Blackjack Swamp	Fall			1981–2001: Nanaimo R	
Bonsall Cr	**Fall**		**2008–2009: Bonsall Cr 2014: Chemainus R**	**1994–2013: Bonsall Cr**	
Bonsall Sl	Fall		1988–1994: Cowichan R 1995: Bonsall Cr 1995–2003: Cowichan R	1989–2003: Cowichan R	
Bush Cr	**Fall**		**1993–2014: Bush Cr 2019: Stocking Cr**	**1993–1998: Bush Cr 1999: Walker Cr/GSVI 2000–2012: Bush Cr**	
Chemainus R	**Fall**	**1980–1981: ChemainusXCowich 1982–2021: Chemainus R**	**1998–2001: Chemainus R 2006: Cowichan R 2006–2017: Chemainus R**	**1970–1972: Big Qualicum R 1982–2001: Chemainus R**	
Cowichan Est	**Fall**	**1991–2013: Cowichan R**			
Cowichan Lk	**Fall**	**1988–1994: Cowichan R 1995: Cowichan Lk Tribs 1995–1997: Cowichan R 1998: Cowichan Lk Tribs 1999: Cowichan R**	**1996–1997: Cowichan Lk Tribs 2018–2020: Cowichan R**	**1989–1995: Cowichan Lk Tribs 1996: Cowichan R 1996–1998: Cowichan Lk Tribs 1999: Cowichan R 1999: Cowichan Lk Tribs 2003: Cowichan R 2003: Cowichan Lk Tribs 2013: Cowichan R 2014–2021: Beaver Cr/GSVI**	

Release Site	Run Type	Chinook	Chum	Coho	Pink
Cowichan Lk Tribs	Fall		1992: Cowichan Lk Tribs	1986–1988: Cowichan Lk Tribs 1989: Beaver Cr/GSVI 1989: Cowichan R 1990: Beaver Cr/GSVI 1990–2003: Cowichan Lk Tribs 2004: Cowichan R	
Cowichan R	Fall	1980–2021: Cowichan R	1977–2020: Cowichan R	1977–1994: Cowichan R 1994: Giddes Cr 1995: Cowichan R 1995: Giddes Cr 1995–2003: Cowichan R 2012: Cowichan Lk Tribs 2021: Beaver Cr/GSVI	
Cowichan R Low	Fall	1992–2007: Cowichan R		1999: Cowichan R	
Cowichan R Up	Fall	1988–2008: Cowichan R			
Cowichan R @Duncan	Fall	2003: Cowichan R			
Glenora Cr	Fall			1985: Koksilah R	
Green Cr	Fall			1989–2001: Nanaimo R	
Green Lk	Fall			1988–2011: Nanaimo R	
Haslam Cr	Fall			1981–2020: Nanaimo R	1993: Nanaimo R
Holland Cr	Fall		1998: Bush Cr 1998–2009: Holland Cr 2011: Bush Cr 2011–2015: Holland Cr 2015: Stocking Cr 2017–2019: Holland Cr 2019: Stocking Cr	1997–2021: Holland Cr	
Kelvin Cr	Fall			1986–1988: Cowichan R 1988–1989: Kelvin Cr 2000: Koksilah R 2000: Kelvin Cr	
Koksilah R	Fall	1984–1987: Cowichan R	1995–1999: Koksilah R 2005–2020: Cowichan R	1970–1972: Big Qualicum R 1984: Koksilah R 1985–1987: Cowichan R 1988: Kelvin Cr 1990–1991: Cowichan R 1994–1995: Koksilah R 1996: Cowichan R 1996–2000: Koksilah R 2013: Cowichan R 2015: Beaver Cr/GSVI	

Release Site	Run Type	Chinook	Chum	Coho	Pink
Marshall Cr					
Meade Cr	Fall			1999: Meade Cr 2002: Cowichan R	
Nixon Cr	**Fall**			**1998: Cowichan Lk Tribs** **1999: Nixon Cr** **2002: Cowichan R**	
Oliver Cr	Fall		2005–2020: Cowichan R	2011–2012: Cowichan Lk Tribs 2013: Beaver Cr/GSVI 2013: Cowichan R 2014: Beaver Cr/GSVI 2017: Robertson R	
Richards Cr	Fall	1988–1989: Big Qualicum R			
Robertson Ch	Fall		1997–2003: Cowichan R	1997–2003: Cowichan R	
Robertson R	Fall		2003: Cowichan R 2003: Robertson R	1994: Robertson R 1997: Cowichan R 1998: Cowichan Lk Tribs 1998–1999: Robertson R 2002: Cowichan R 2011: Cowichan Lk Tribs	
Rush Cr	Fall			1994–2000: Nanaimo R	
Sadie Cr	Fall			1998: Nanaimo R	
Shaw Cr					
Somenos Cr	Fall		2015–2020: Cowichan R		
Stocking Cr	**Fall**		**2001–2019: Stocking Cr**	**2001–2014: Stocking Cr** **2021: Beaver Cr/GSVI**	
Sutton Cr	Fall		2004–2009: Cowichan R 2010: Goldstream R 2011–2014: Cowichan R	1998: Cowichan Lk Tribs 2002: Cowichan R	
Wolf Cr/GSVI	Fall			1981–2014: Nanaimo R	

FIGURES

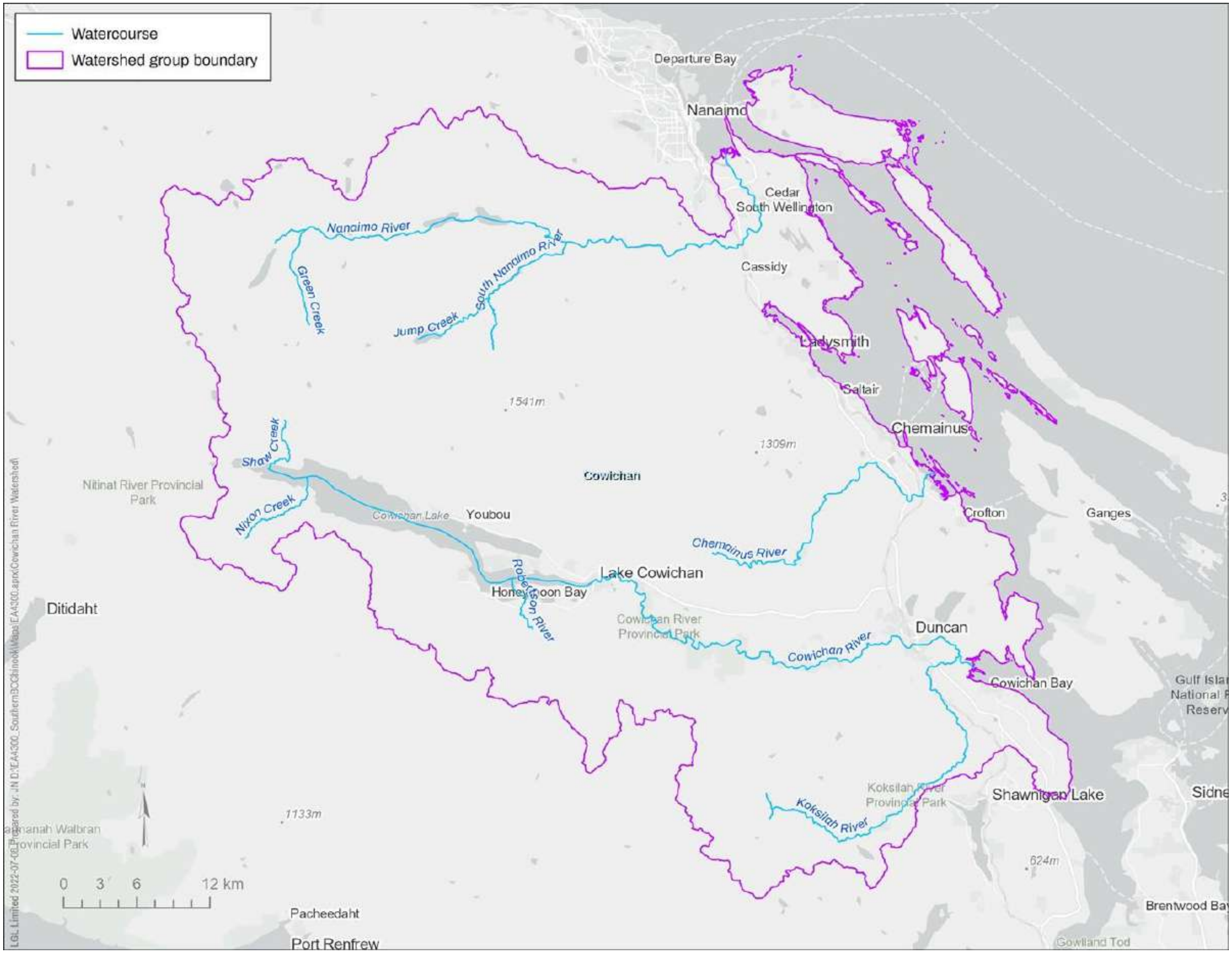

Figure 1. Map indicating spatial extent of the Cowichan Assessment Unit reviewed in the Report Card.

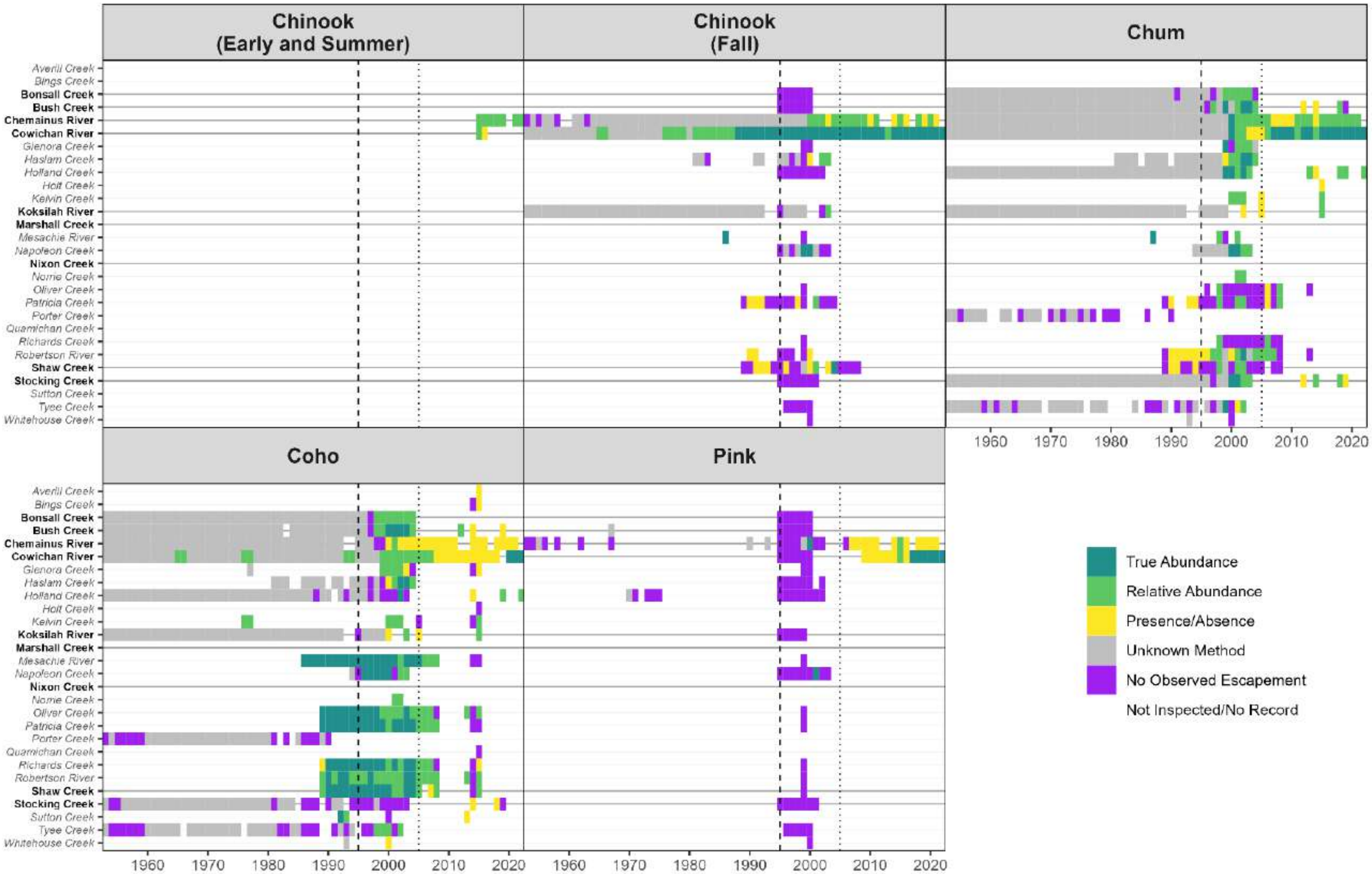

Figure 2. NuSEDS reported escapement monitoring methods by year and waterbody.

Response categories for each year include waterbodies where there was no record or not inspected (white), no observed escapement (purple), reported escapement with using a true abundance estimator (dark green), relative abundance (light green), presence/absence (yellow), and unknown methods (grey). Note that there were no references to either Nixon Creek or Marshall Creek within NuSEDS. Bolded names indicate waterbodies identified as priority streams within the assessment unit. Dashed vertical line indicates when salmon enumeration was moved to the DFO Science section, while the dotted vertical line indicates the release of the Wild Salmon Policy. Data derived from NuSEDS database (September 6, 2023, release).

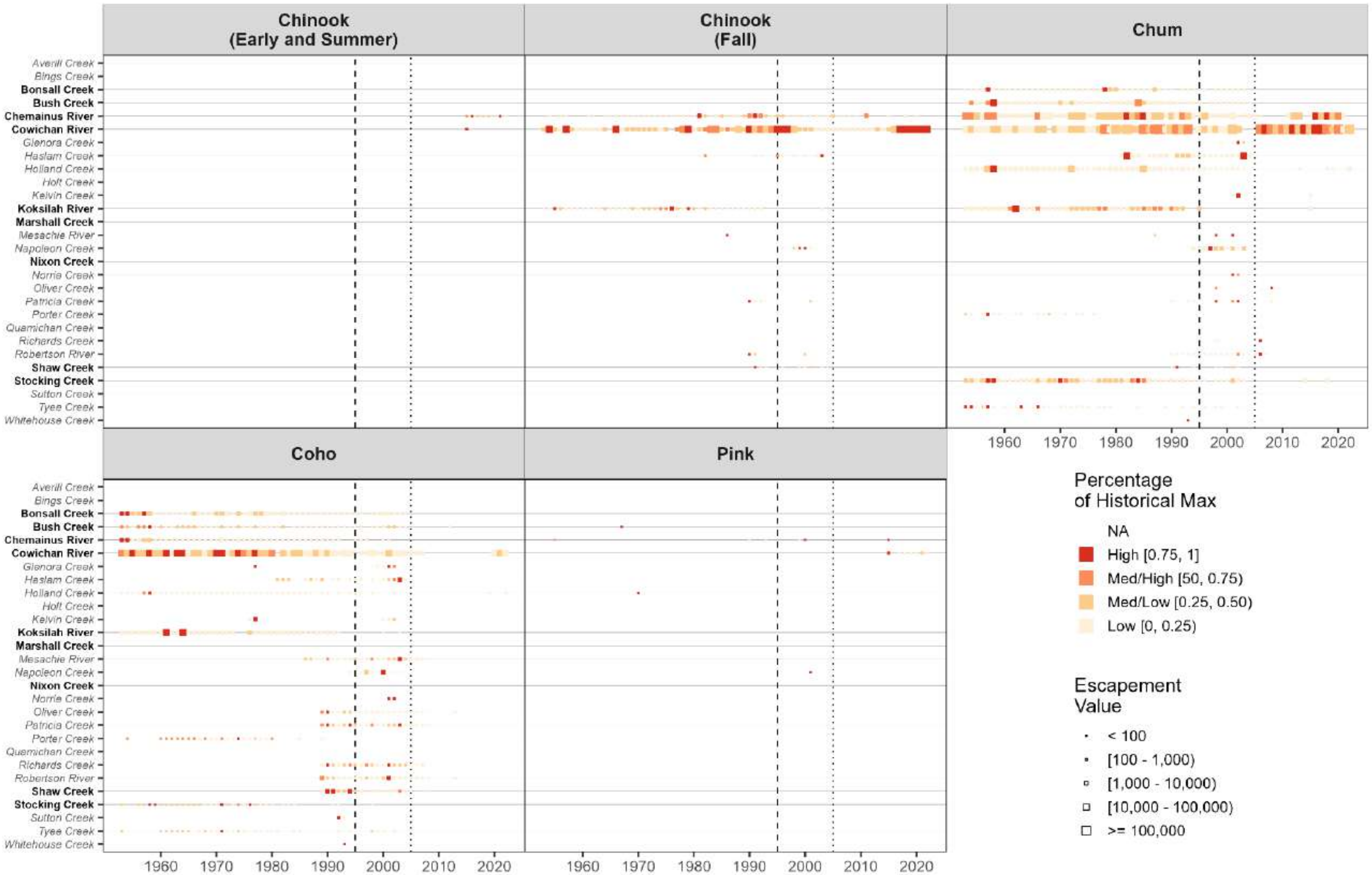

Figure 3. Summary of reported escapement abundances for Chinook, Chum, Coho, and Pink salmon in the Cowichan Assessment Unit.

Symbol size indicates abundance of reported escapement, while fill colour indicates level of escapement as a percentage of the historical maximum for a given population. Bolded stream names indicate identified priority streams within the assessment unit. Dashed vertical line indicates when salmon enumeration was moved to DFO Science, while the dotted vertical line indicates the release of the Wild Salmon Policy. Data derived from NuSEDS database (September 6, 2023, release).

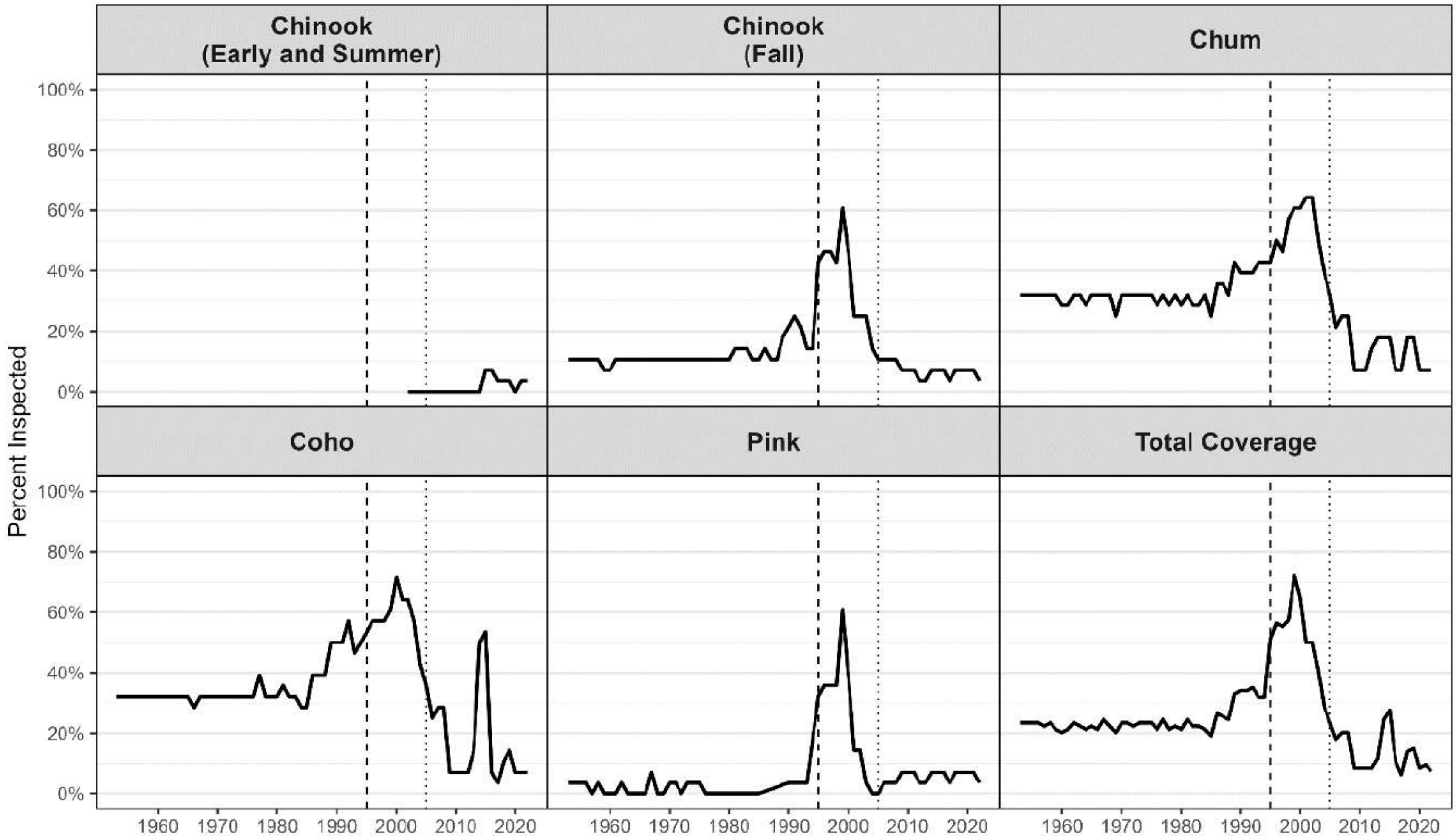

Figure 4. **Percentage of NuSEDS waterbodies that have records indicating a site inspection for escapement.**

Dashed vertical line indicates when salmon enumeration was moved to DFO Science, dotted vertical line indicates end of expanded monitoring coverage. Data derived from NuSEDS database (September 6, 2023, release).

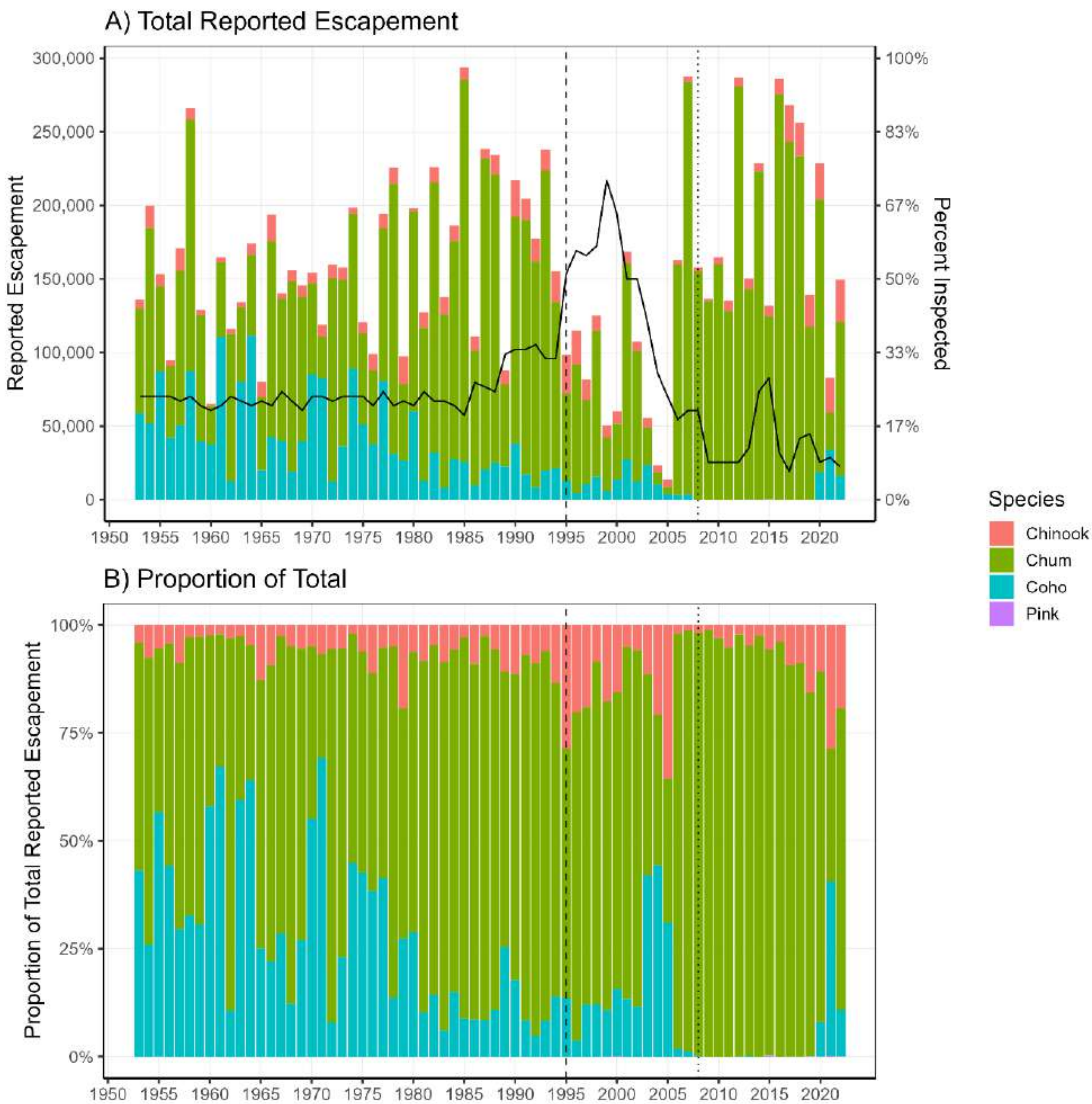

Figure 5. Summary of (A) total yearly escapement and monitoring effort and (B) proportion of total reported yearly escapement for Chinook, Chum, Coho, and Pink salmon in the Cowichan Assessment Unit.

Bar height indicates sum of reported escapement across all assessed Pacific salmon species, while colour indicate species. Data derived from NuSEDS database (September 6, 2023, release).

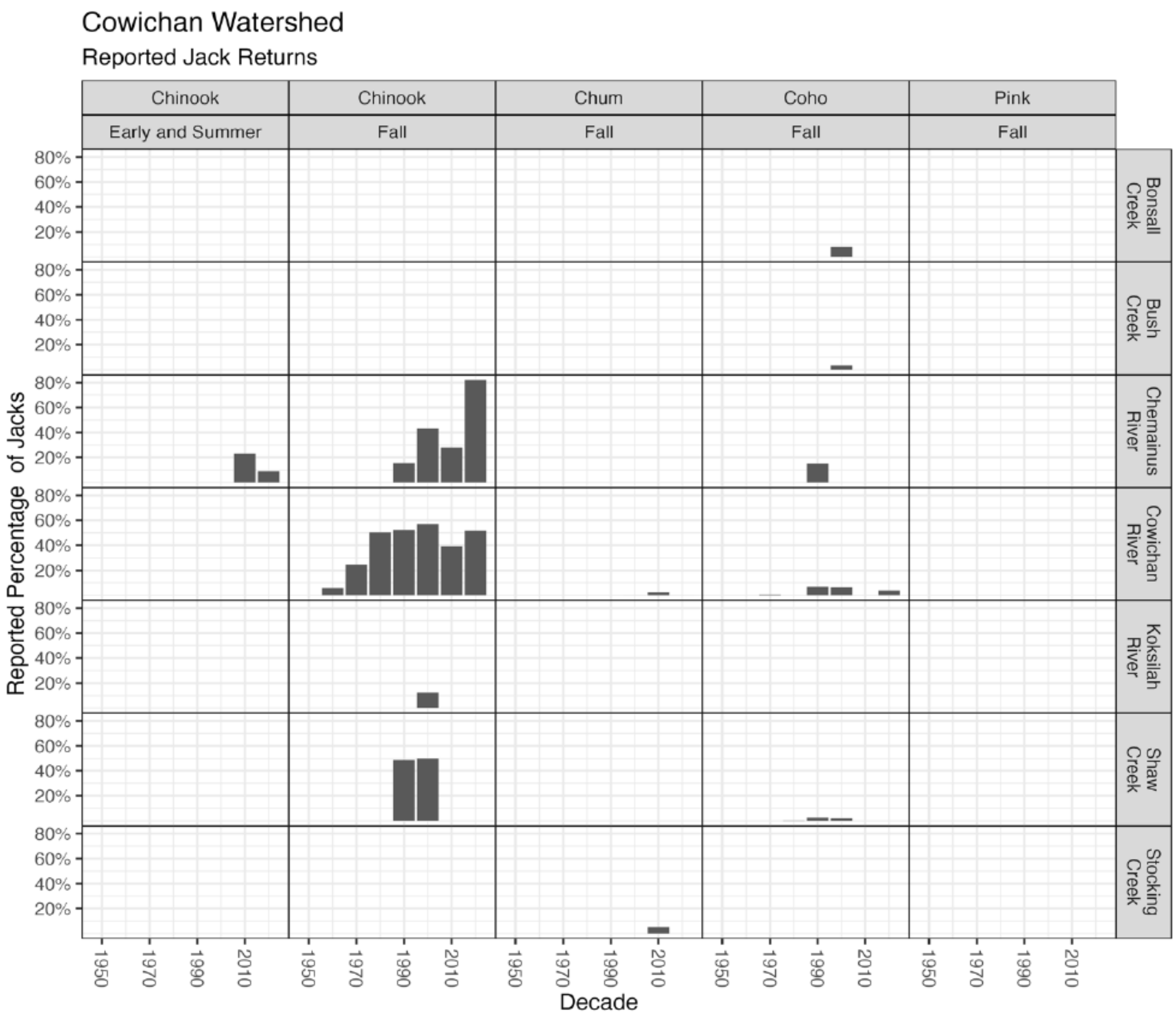

Figure 6. **Percentage of natural adult spawners reported as natural jacks spawners in reported escapement data for streams where jack spawners were reported.**

Data derived from NuSEDS database (September 6, 2023, release).

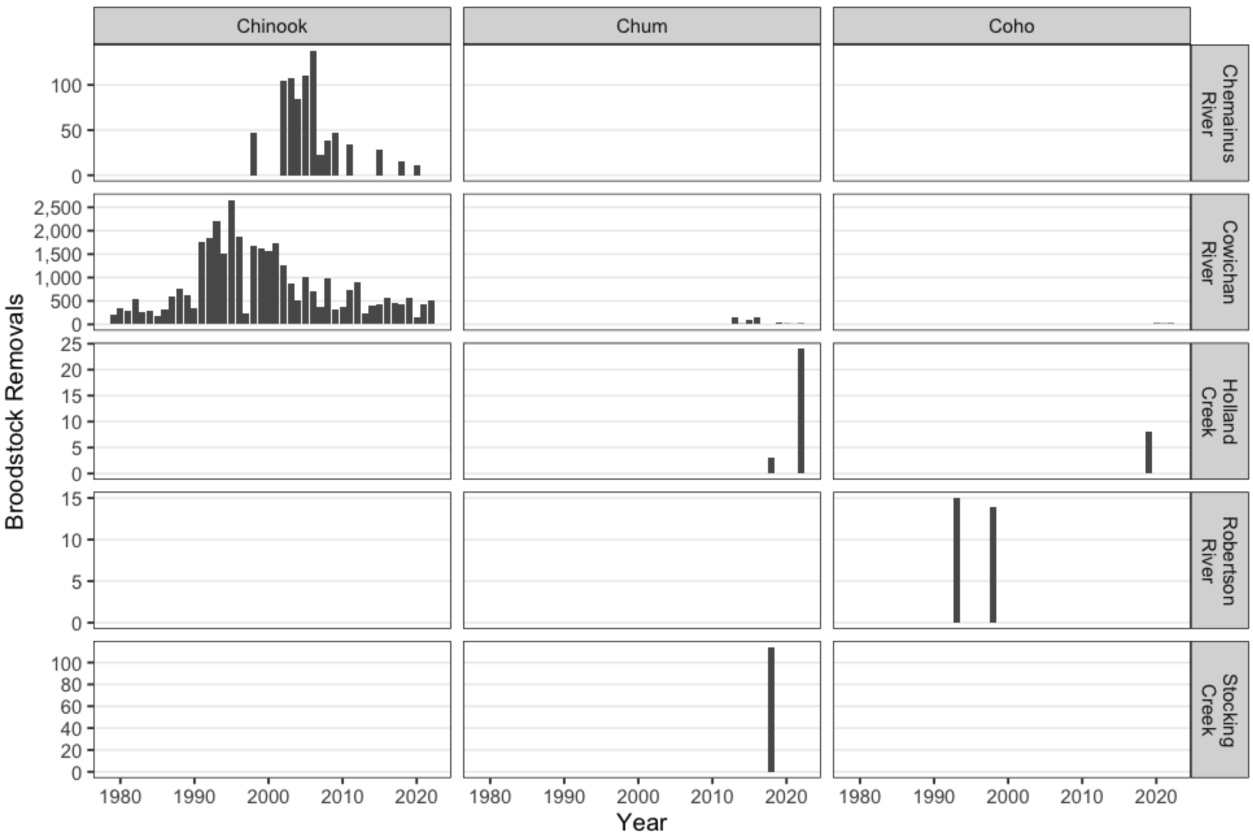

Figure 7. Summary of recorded yearly broodstock removals by Pacific Salmon species and waterbody where the removal occurred.

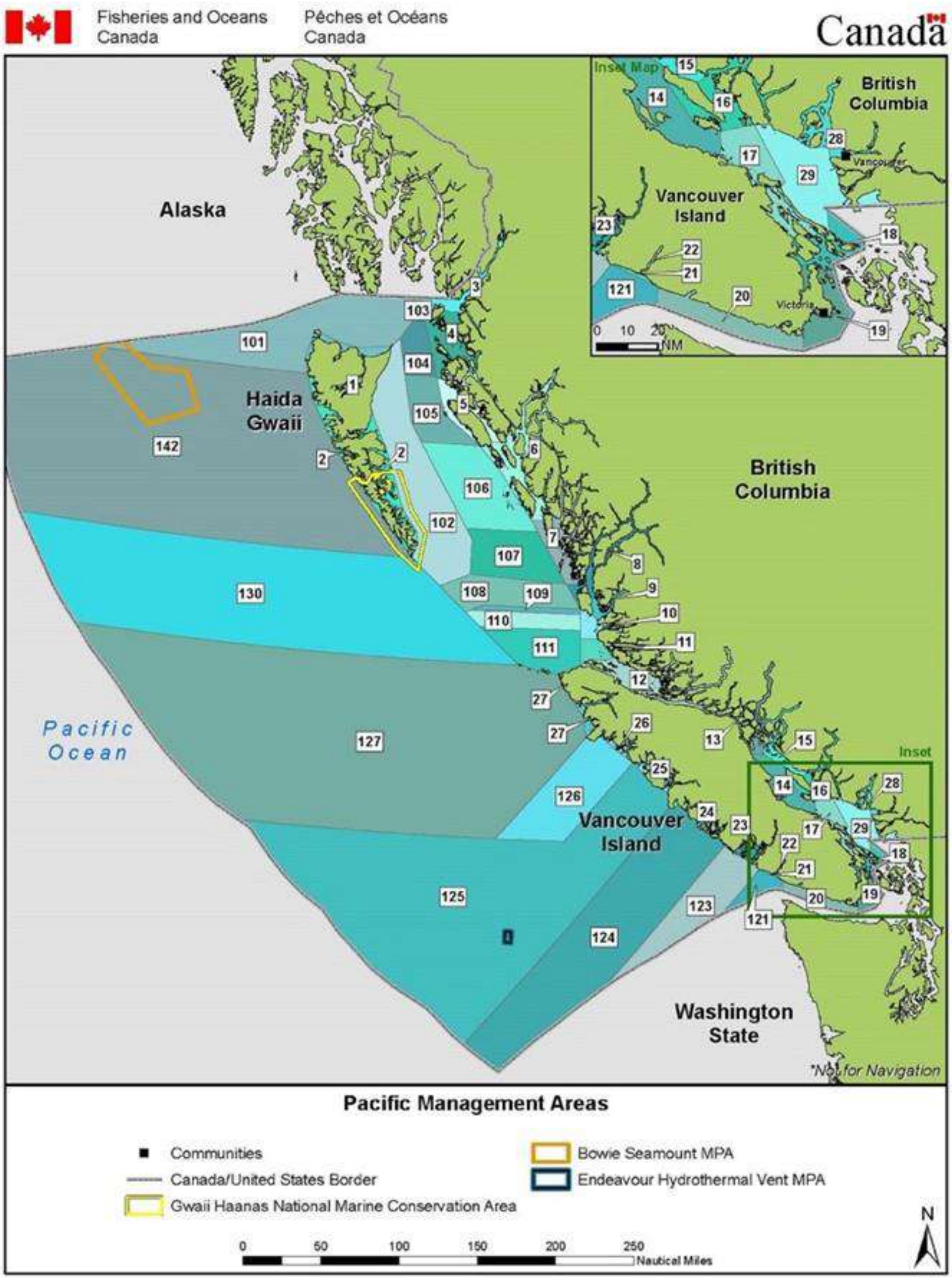

Figure 8. Map of Fisheries and Ocean Canada's Pacific Management Areas. Map reproduced from: www.pac.dfo-mpo.gc.ca/fm-gp/maps-cartes/areas-secteurs/docs/pfma-sgpp-eng.pdf.

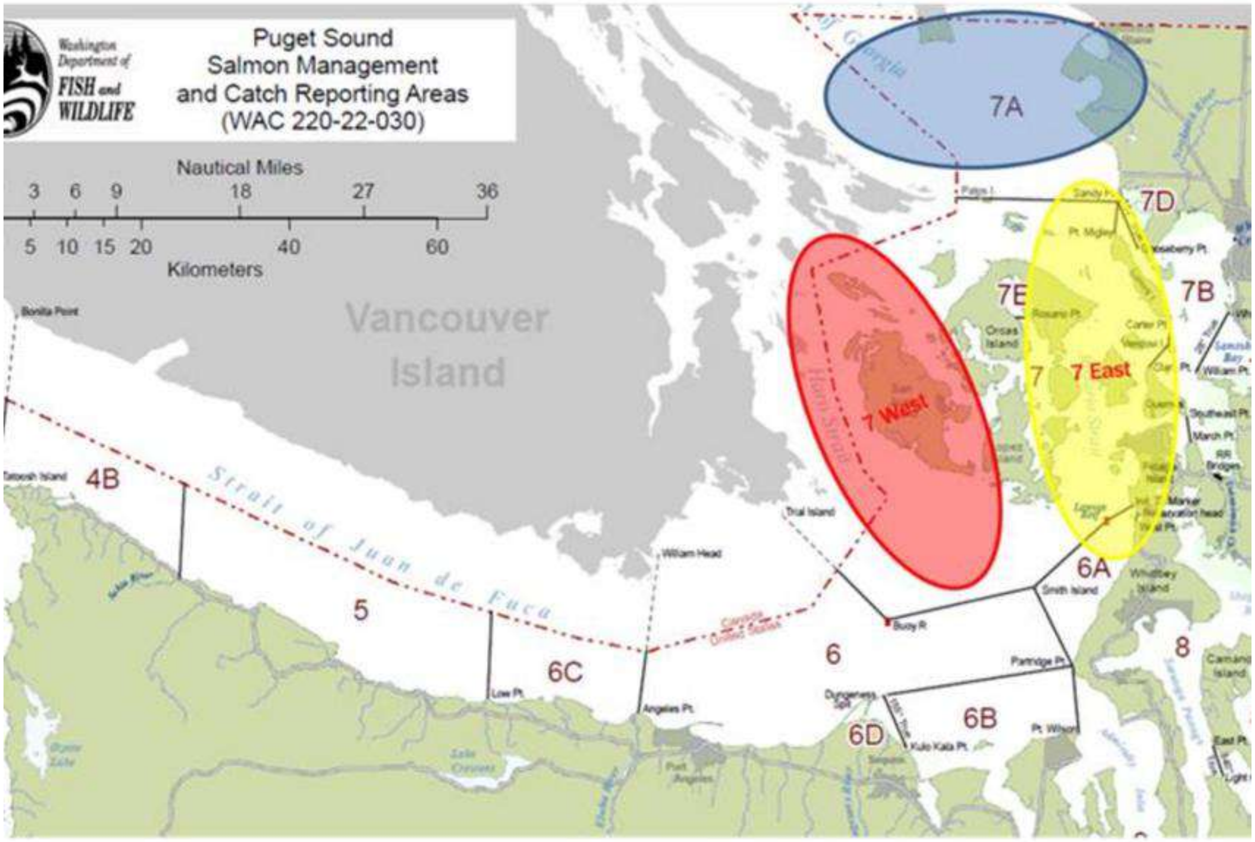

Figure 9. Map of the Washington Areas 7/7A commercial Chum Salmon fisheries.

Figure 10. Total yearly catch of Canadian First Nation, recreational and commercial fisheries in PFMA 14−19, 28, and 29, and the Washington Areas 7/7A commercial fishery. Final disposition (i.e., kept or released) is reported for the Canadian fisheries, while origin (i.e., Canadian or US) was reported for the US fisheries.

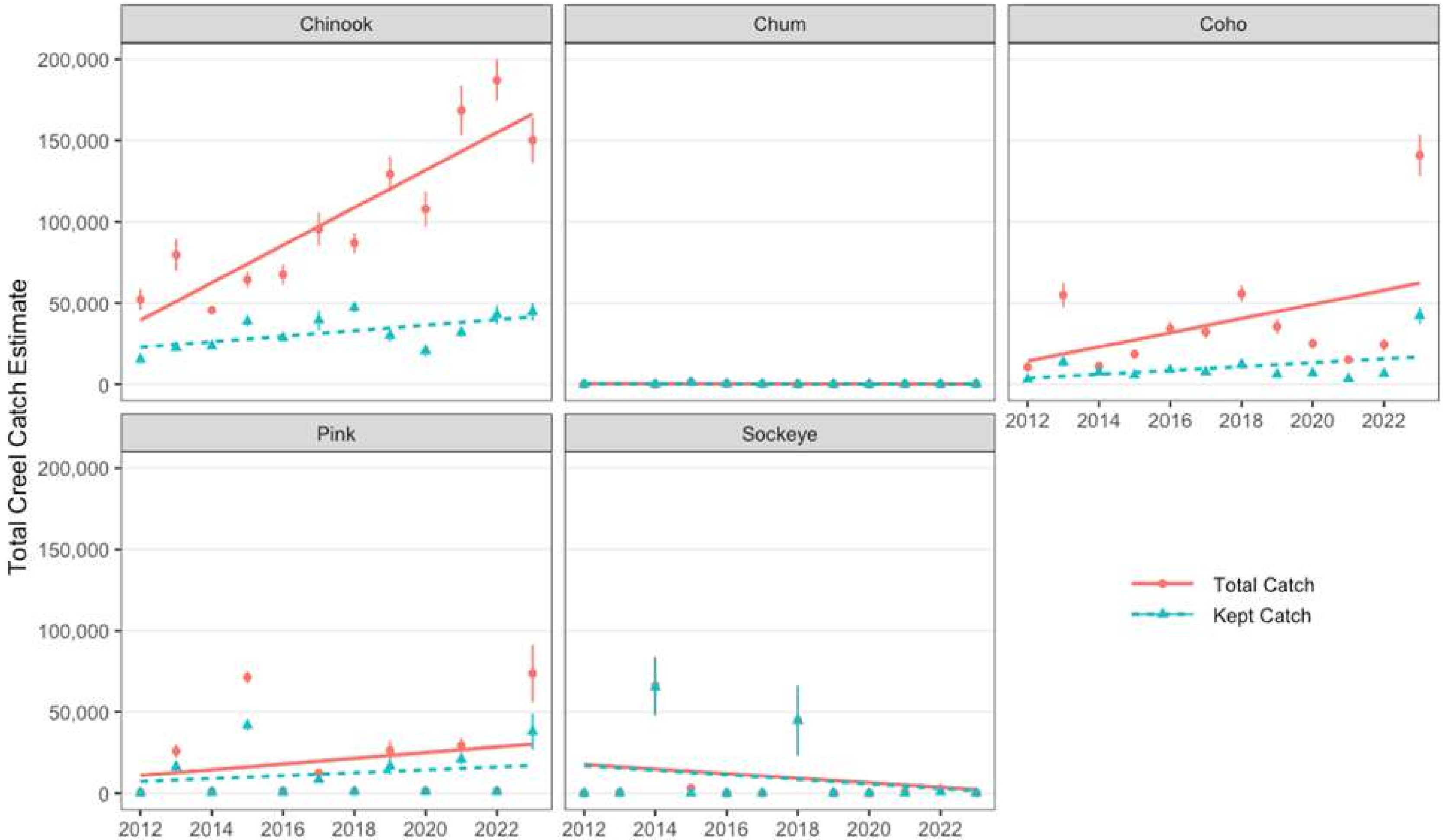

Figure 11. Estimate of total Canadian recreational catch in the PFMA adjacent to the Cowichan Assessment Unit. Error bars indicate 95% confidence interval, line represents linear temporal trend.

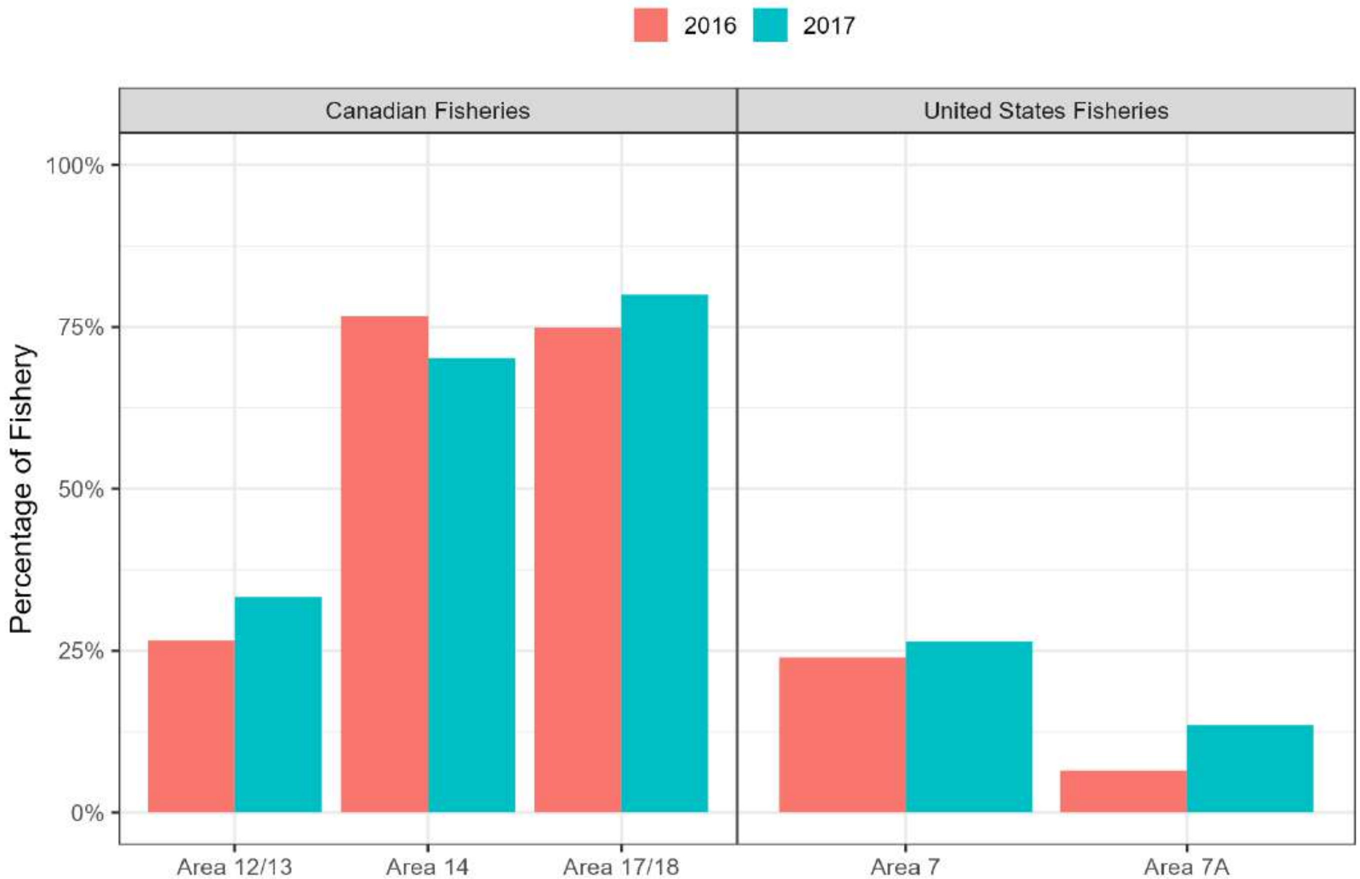

Figure 12. Percentage of fisheries targeting southern origin Chum Salmon that is made up of Strait of Georgia West stocks composition data. Stocks include: Goldstream R, Cowichan R, Nanaimo R, Chemainus R, Puntledge R, Qualicum R, Little Qualicum R, Campbell R, Cold Cr, and Englishman R.

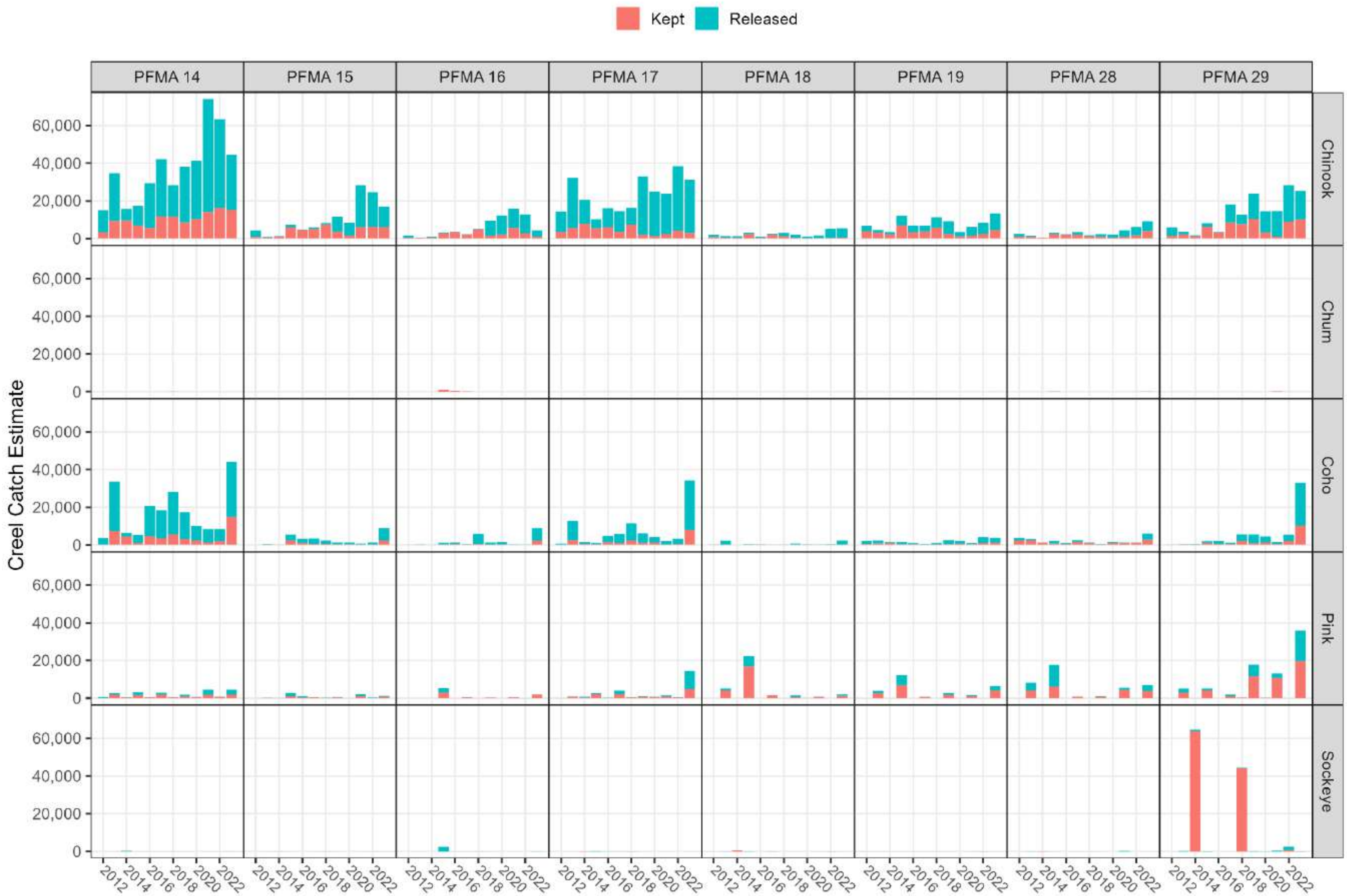

Figure 13. Summary of total Canadian recreational catch type (kept or released) by Pacific Fisheries Management Areas (columns), and species (rows).

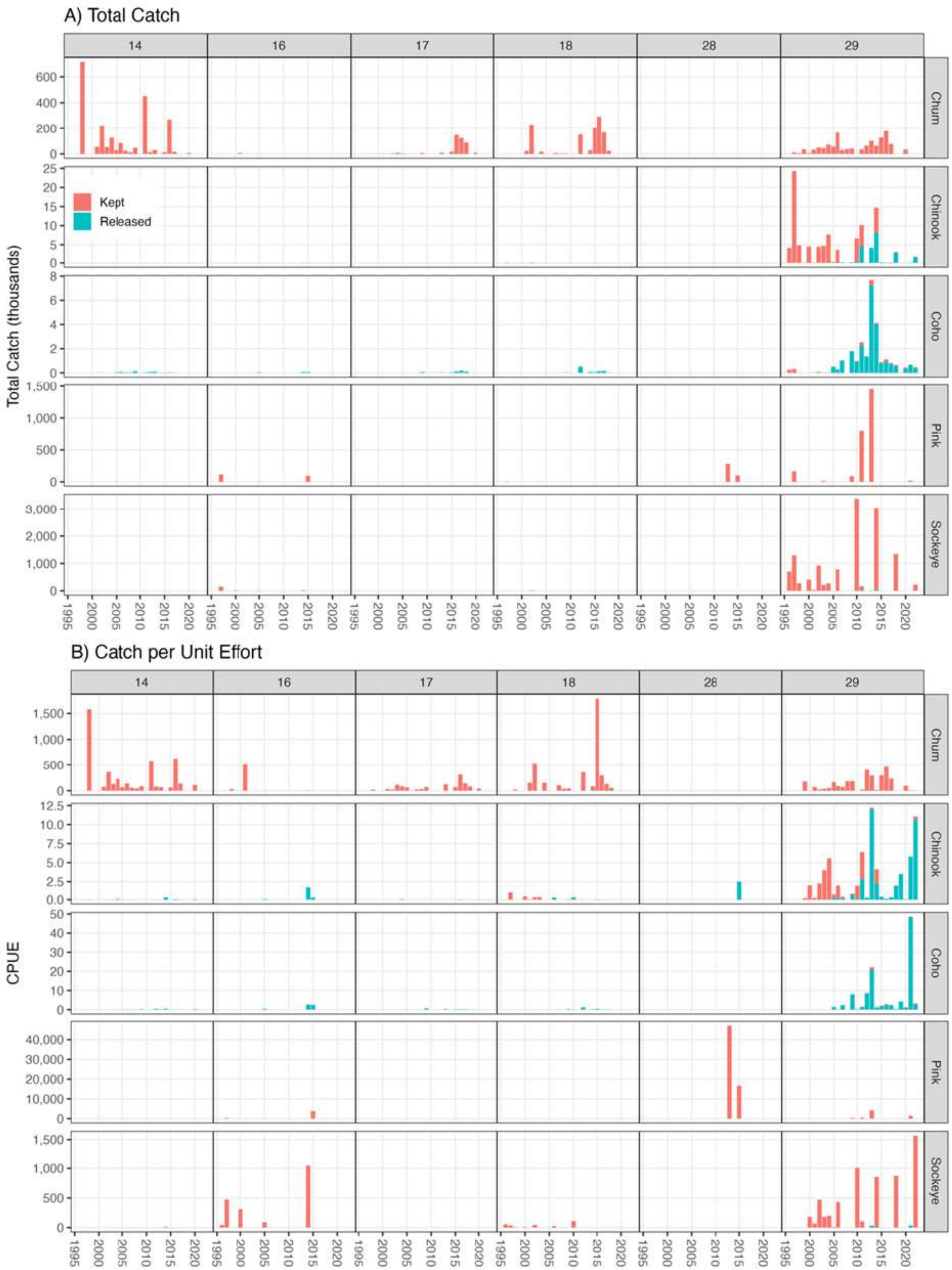

Figure 14. Summary of total Canadian Salmon commercial catch (A) and catch per unit of effort (B) by type (kept or released), Pacific Fisheries Management Areas (columns), and species (rows). CPUE was defined as number caught per boat day. Data from the DFO catch unit.

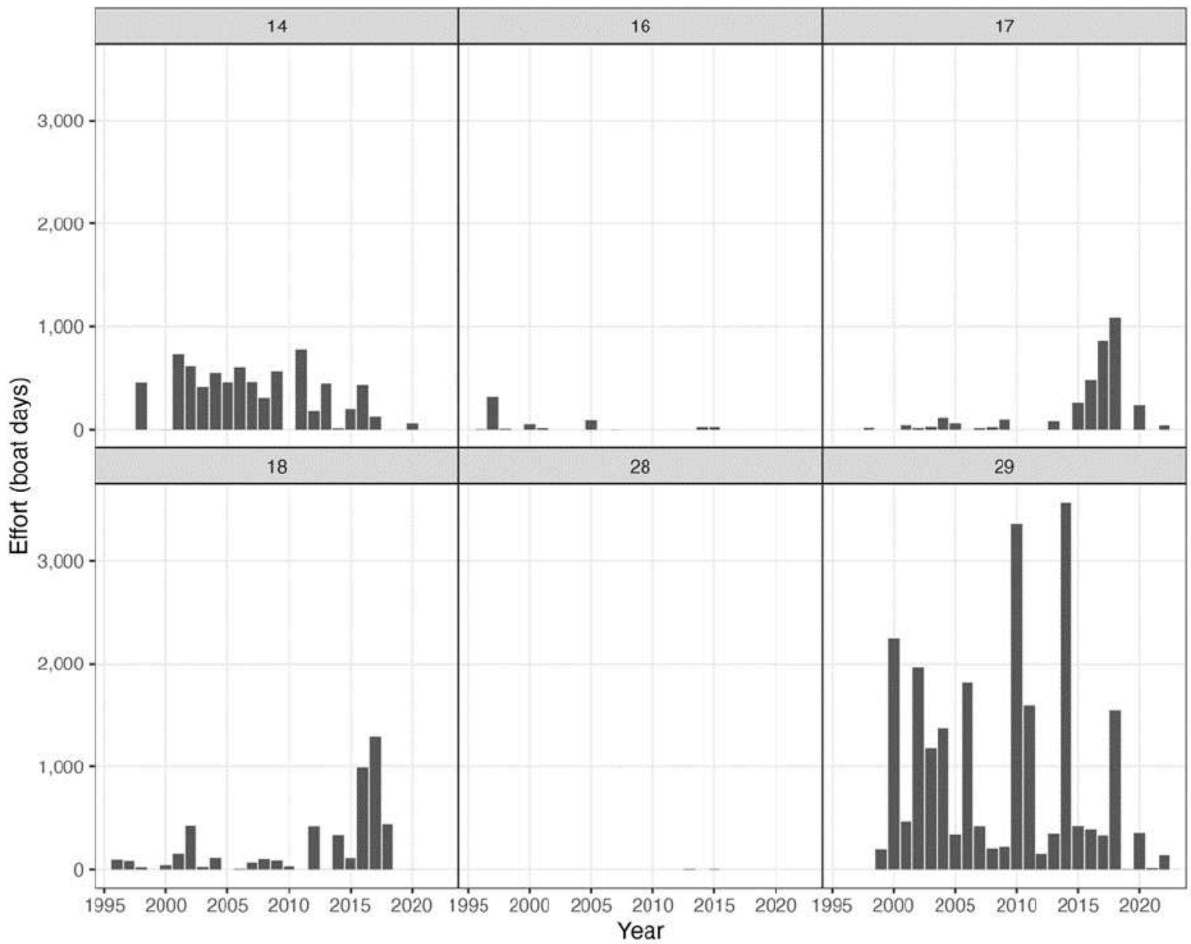

Figure 15. **Total Canadian Salmon commercial fishing effort across all gear types (gill net, seine, and troll) by Pacific Fisheries Management Areas within the vicinity of the Cowichan Assessment Unit.** Data from the DFO catch unit.

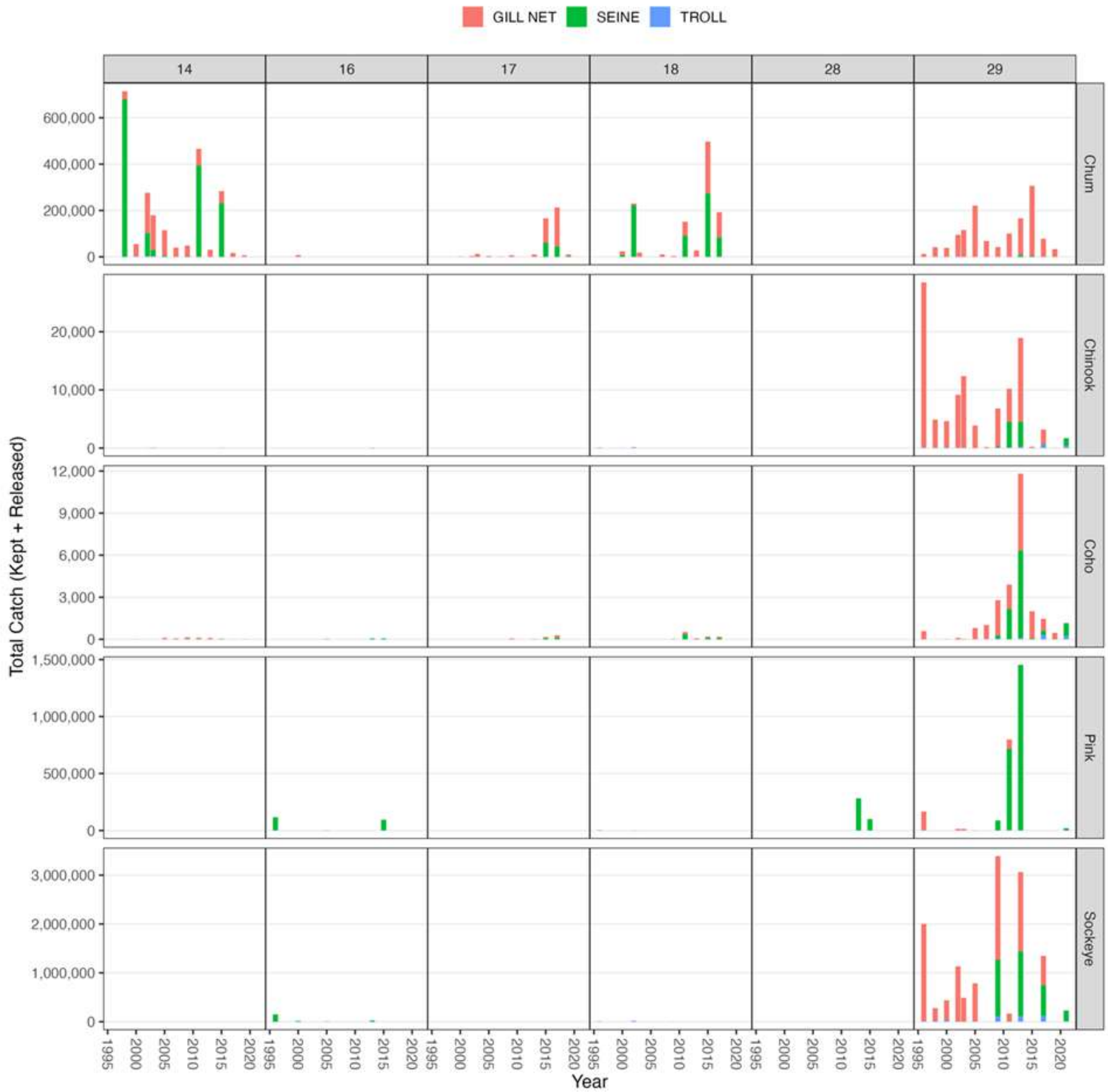

Figure 16. Summary of total Canadian commercial catch by gear type and management areas. Data was summarized on two-year intervals, with the start year indicated on the x-axis. Data from the DFO catch unit.

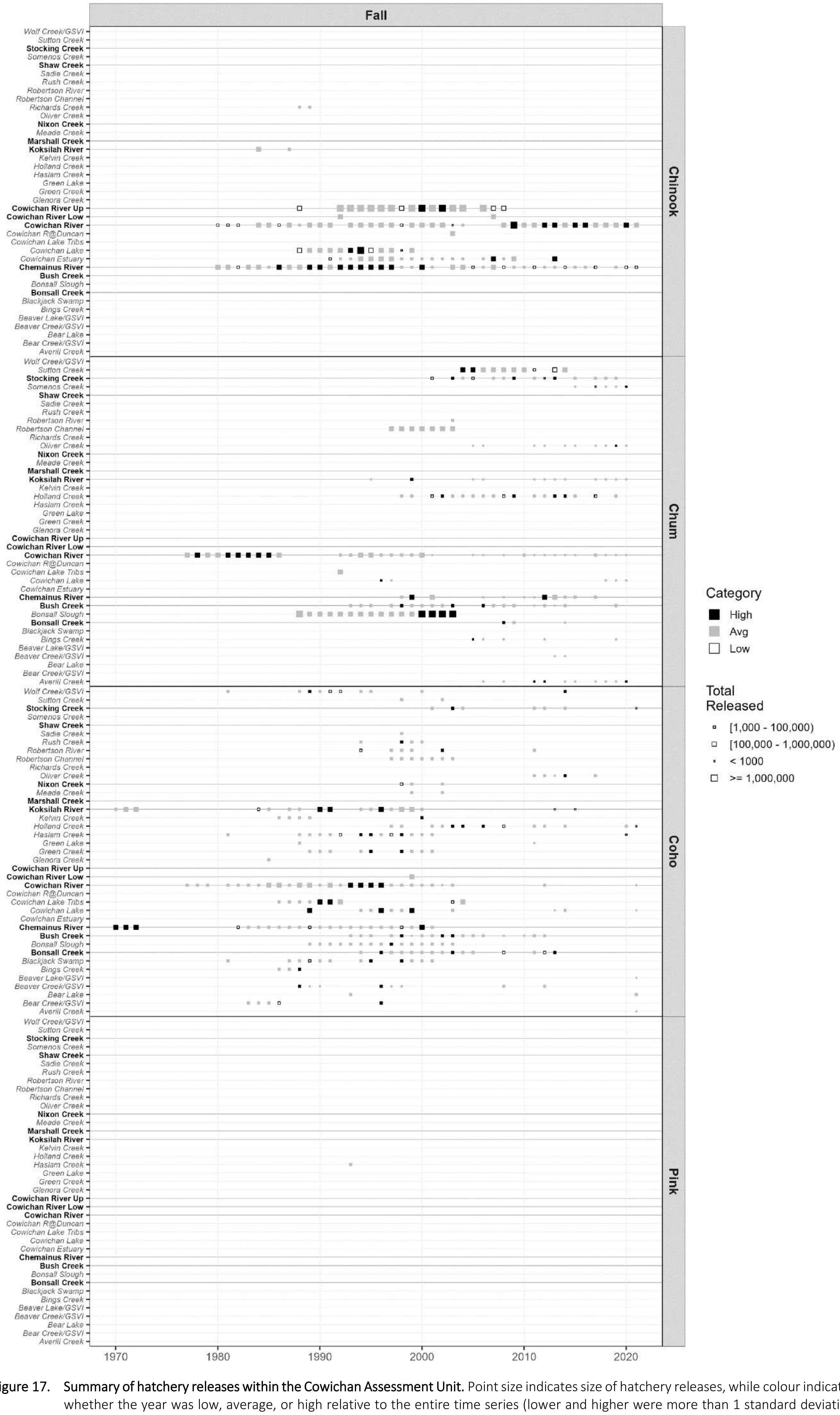

Figure 17. Summary of hatchery releases within the Cowichan Assessment Unit. Point size indicates size of hatchery releases, while colour indicates whether the year was low, average, or high relative to the entire time series (lower and higher were more than 1 standard deviation from the average). Bolded stream names indicate priority streams within the assessment unit. Data derived from EPAD.

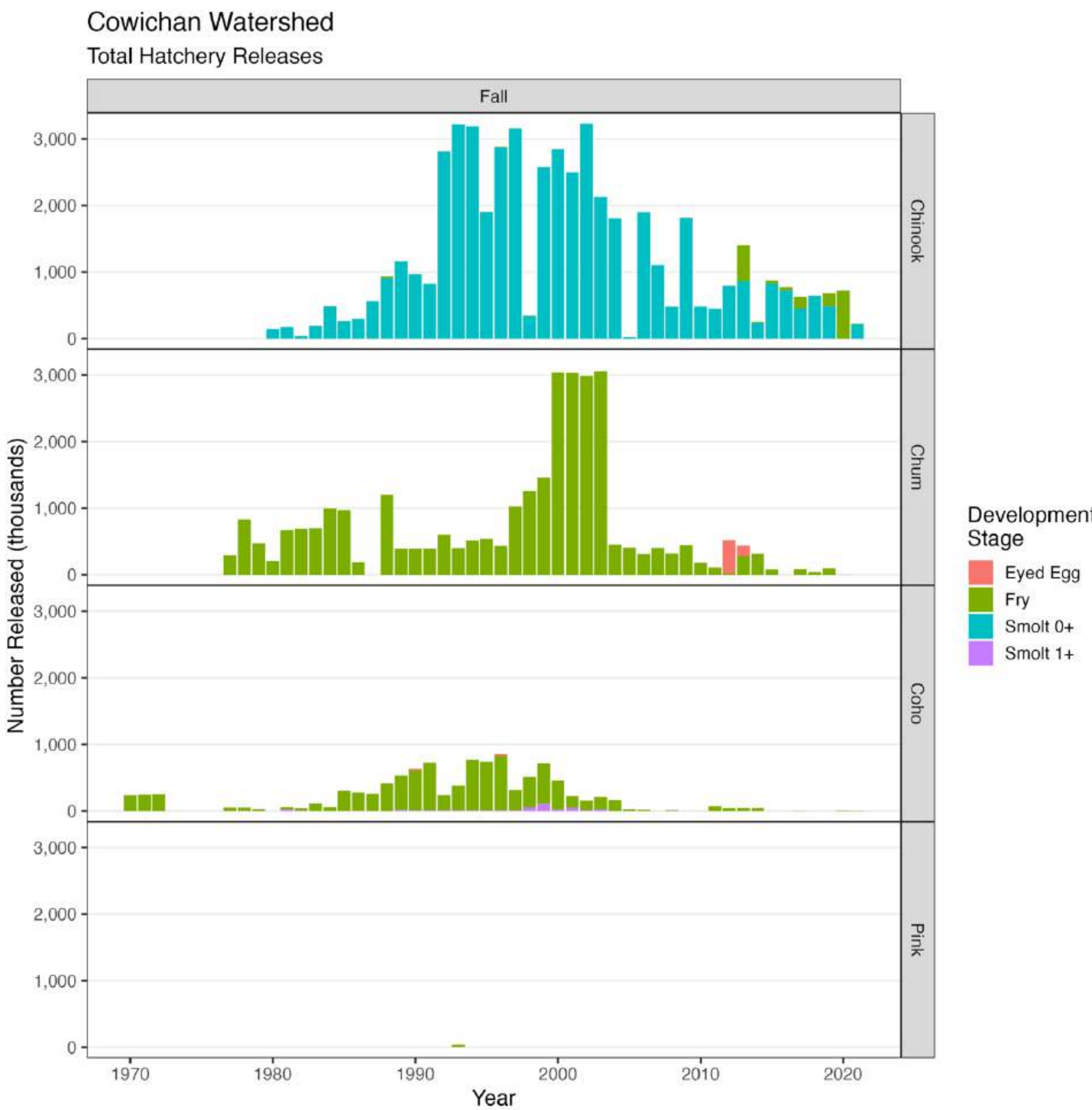

Figure 18. Total number of yearly hatchery releases in the Cowichan Assessment Unit across all streams by species and development stage. Data derived from EPAD.

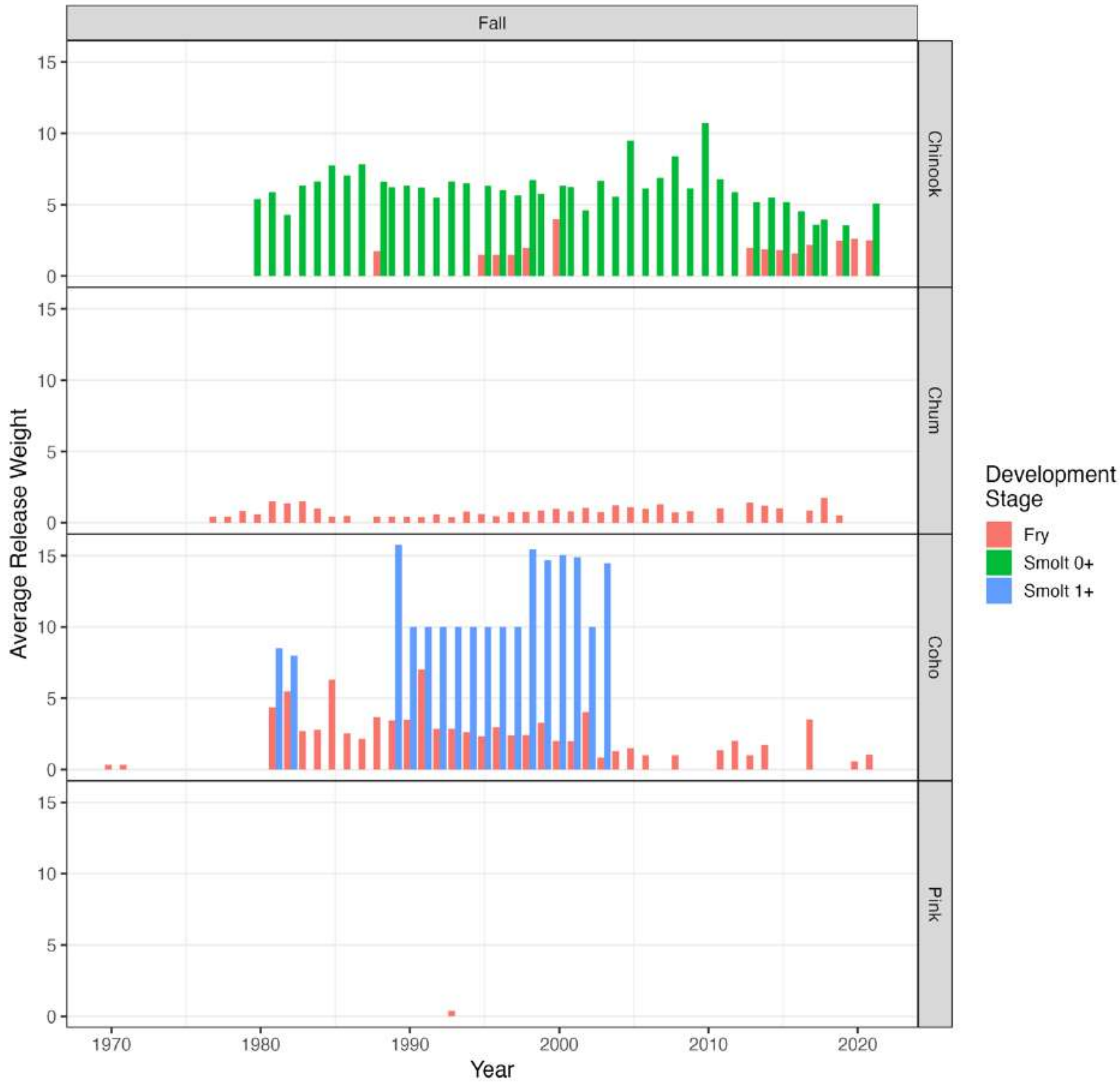

Figure 19. Average release weight of hatchery releases in the Cowichan Assessment Unit by species and development stage. Data derived from EPAD.

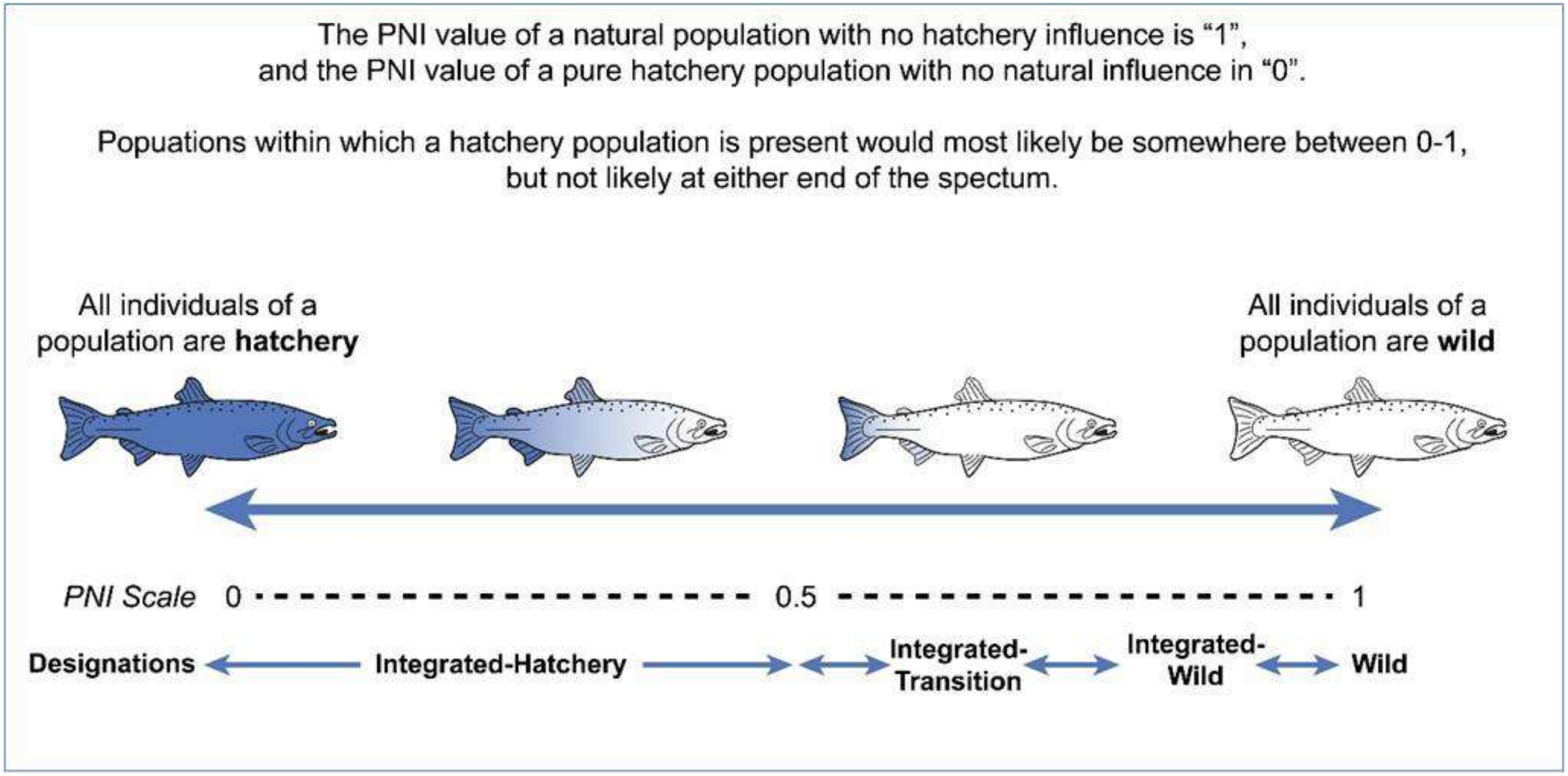

Figure 20. **Proportionate natural influence (PNI) estimates the relative influence of hatchery fish on population, summarizing the relative strength of selective pressures resulting from gene flow between hatchery and natural environments.** Figure reproduced from DFO's SEP PNI Calculation Guidelines document.

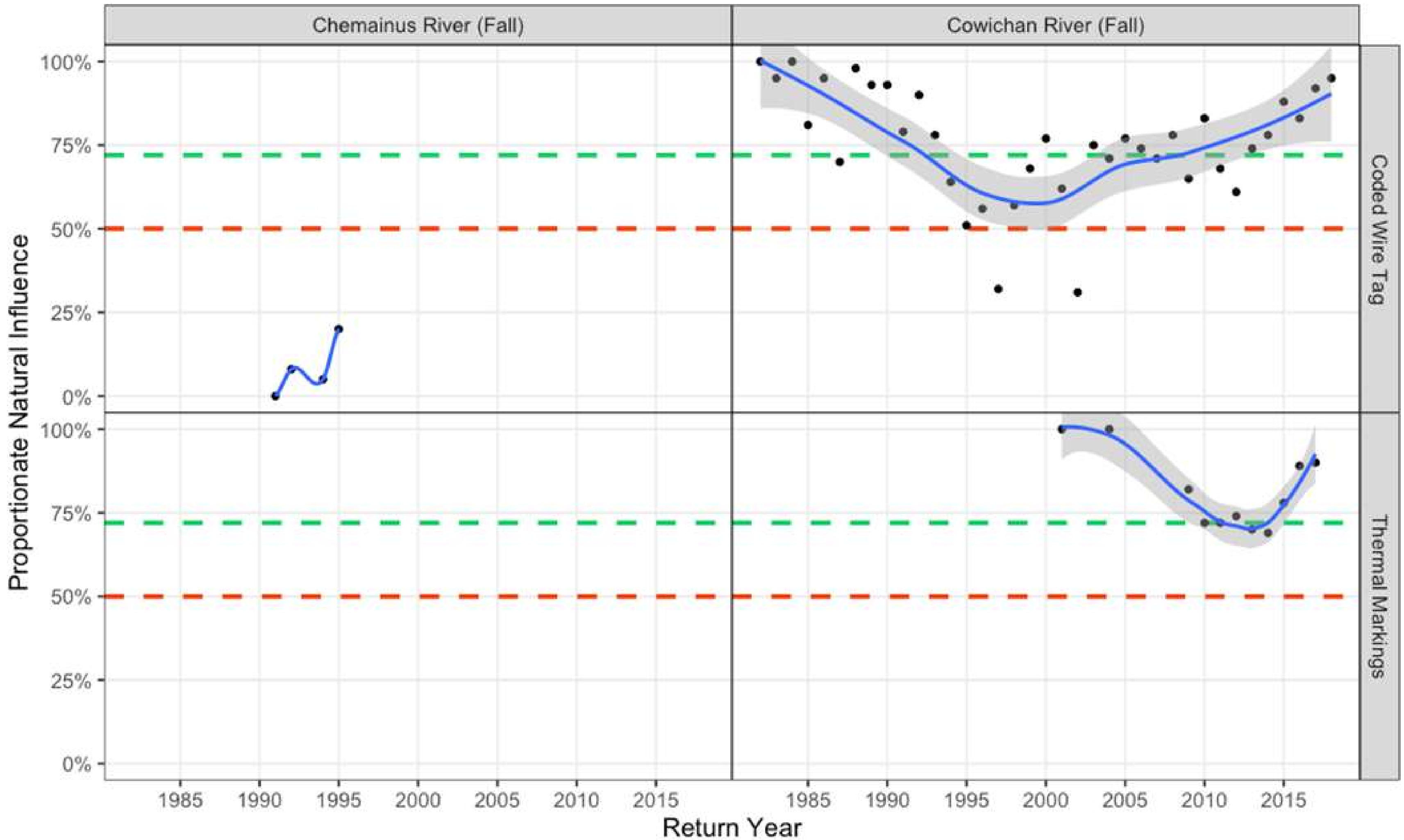

Figure 21. **Long-term changes in Cowichan Assessment Unit Chinook PNI, based on estimates from coded wire tags (top row) and thermal markings (bottom row).** Data from DFOs SEP internal databases (primarily the *Enhancement Planning and Assessment Database* – EPAD). Red horizontal line indicates the cut-off between an Integrated-Hatchery and an Integrated-Transition population, while the green horizon dashed line indicates the transition between an Integrated-transition population and an Integrated-Wild population. Blue line indicates a fit from a local polynomial regression model, with the shading indicating the 95% confidence region.

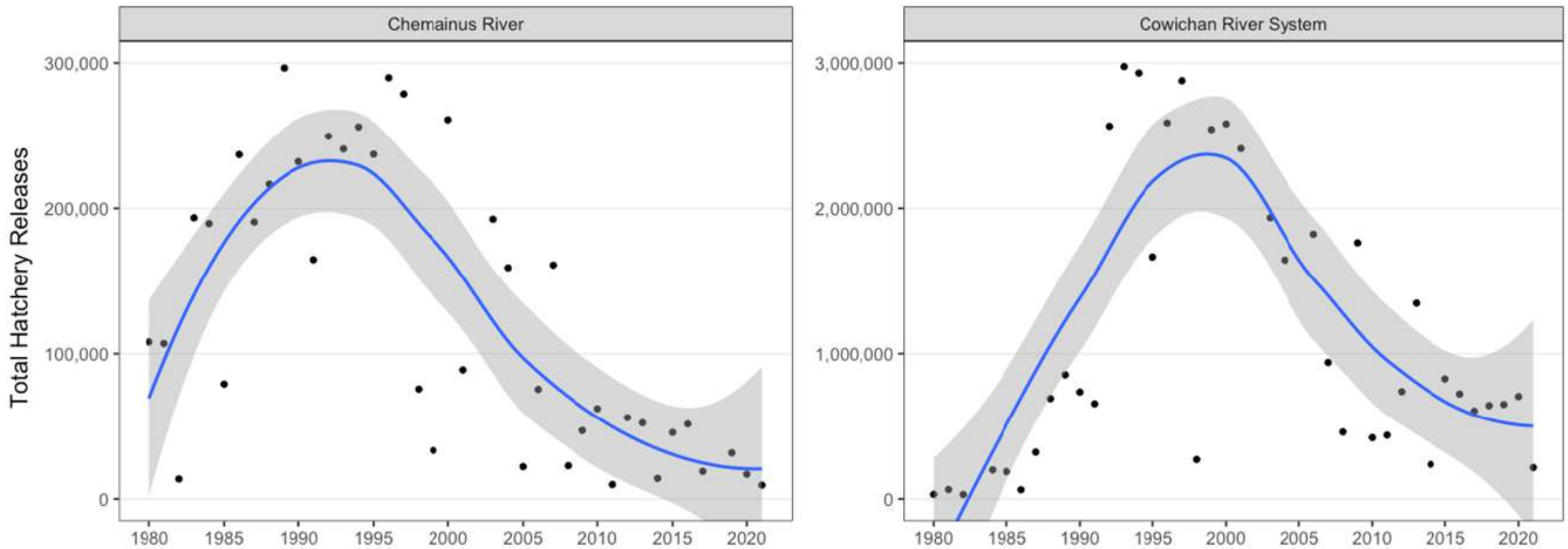

Figure 22. Summary of total yearly hatchery releases in the Chemainus River and Cowichan River System from 1980 to 2020. Blue line indicates a fit from a local polynomial regression model, with the shading indicating the 95% confidence region.

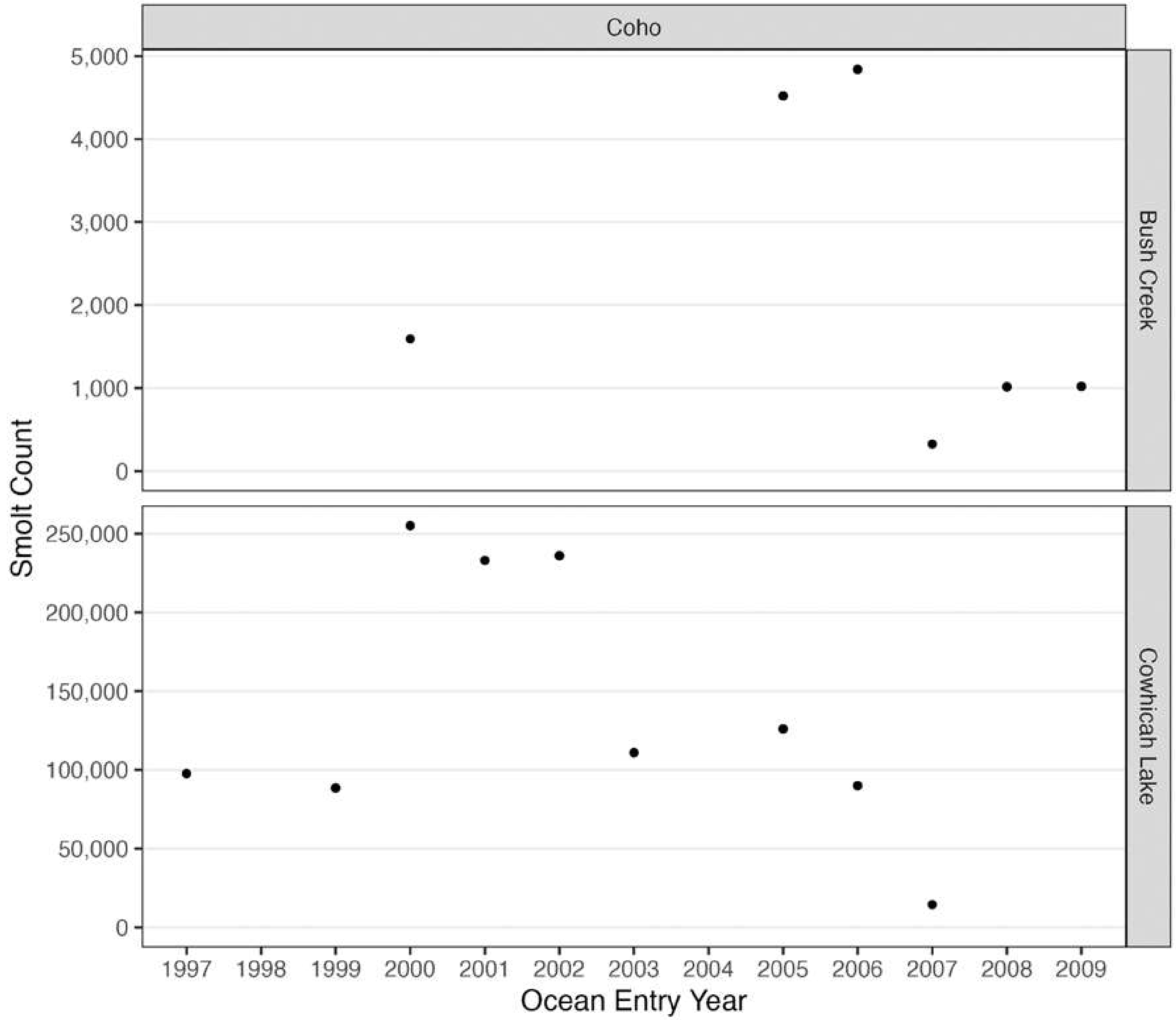

Figure 23. Summary of available smolt enumeration data in the Cowichan Assessment Unit by species and stream. Cowichan Lake counts should be considered incomplete (Wade and Irvine 2018).

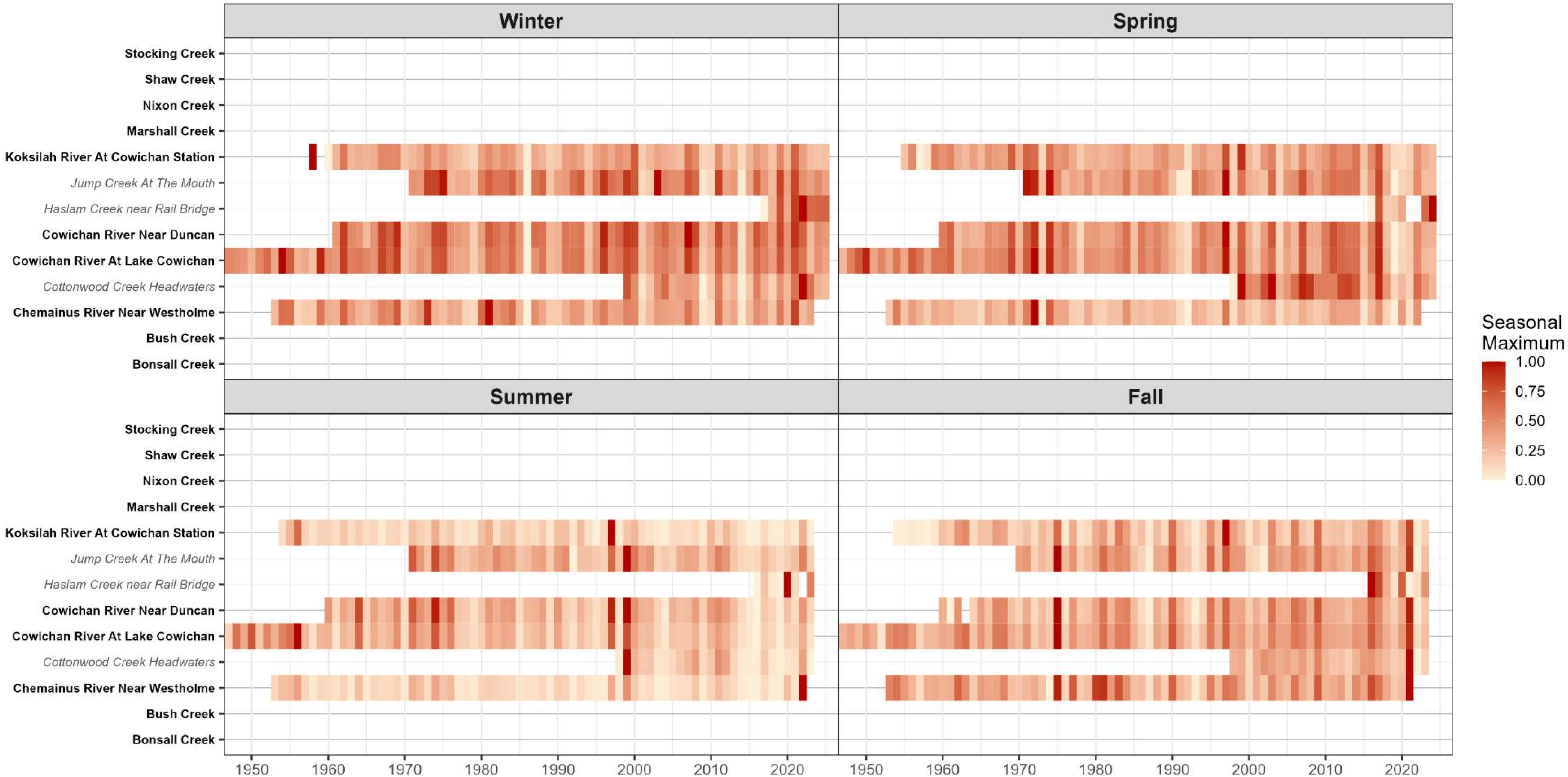

Figure 24. **Summary of reported river discharge and water levels for streams within the Cowichan Assessment Unit.** Color indicates the yearly average as a percentage of the maximum seasonal yearly average observed at a given location. Bolded stream names indicate priority streams within the assessment unit.

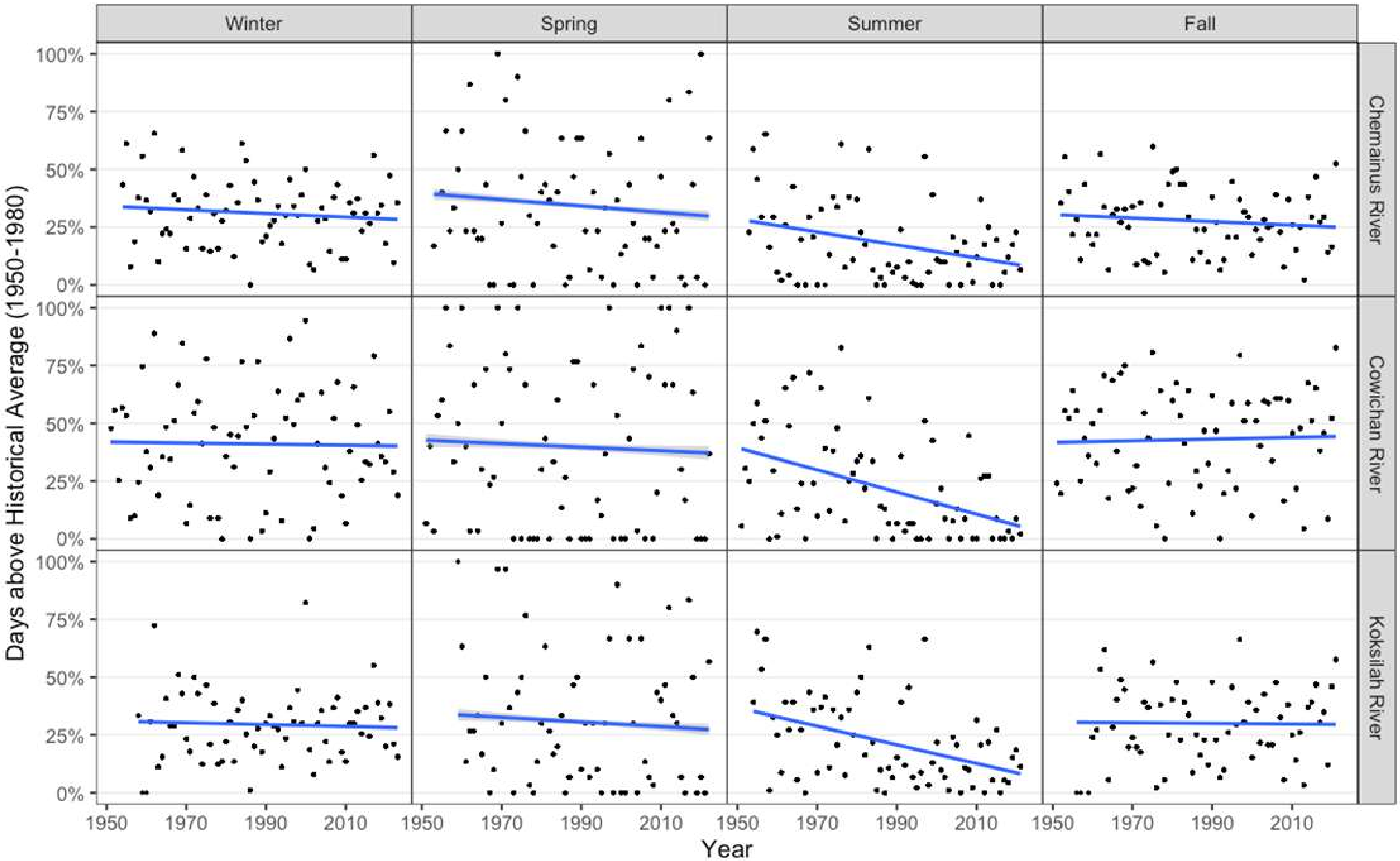

Figure 25. Percentage of days within a season where flows exceed historical average from 1950 to 1980. Blue line indicates best fit linear trend.

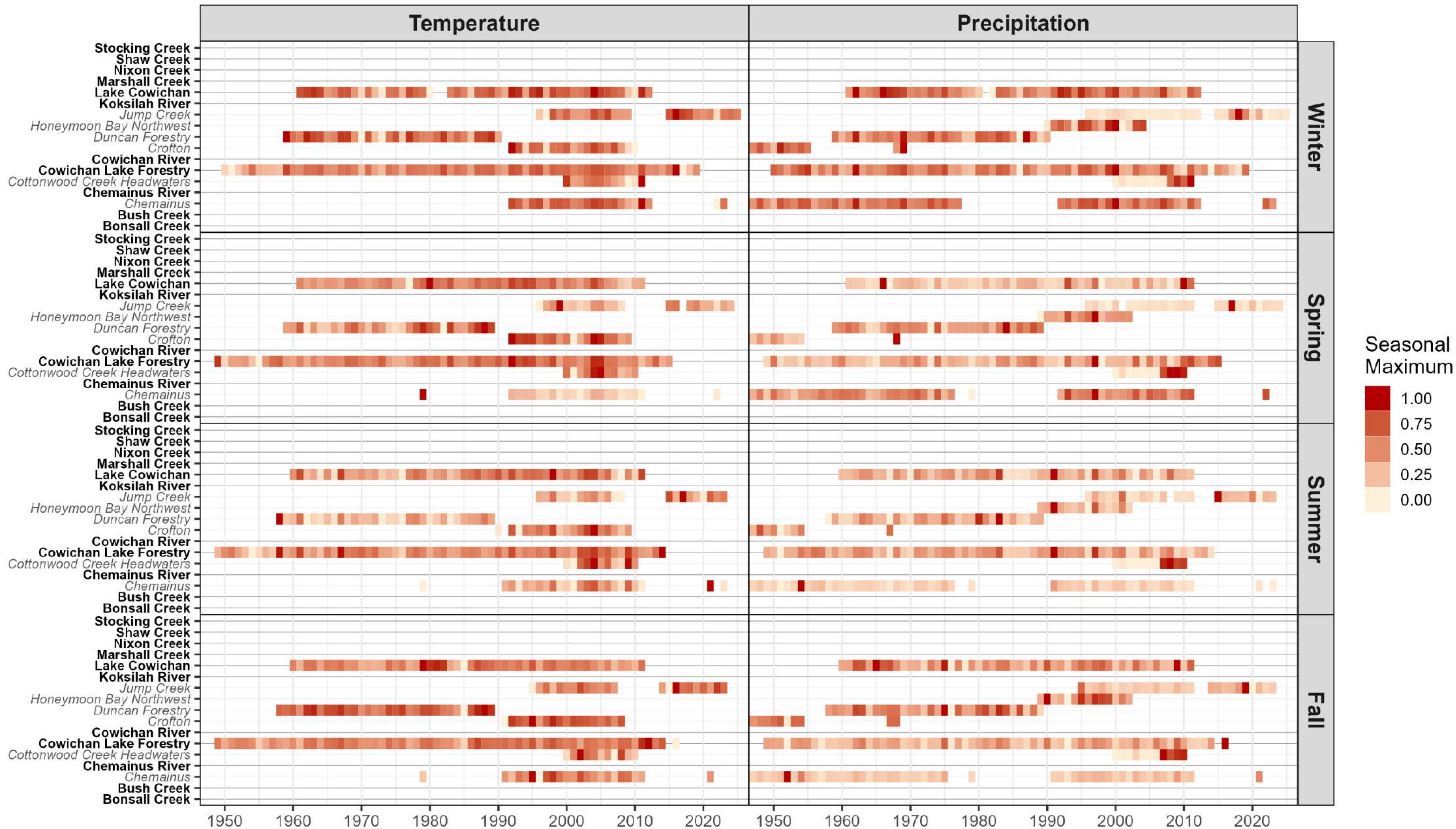

Figure 26. **Summary of available weather data in the Cowichan Assessment Unit.** Color indicates the yearly average as a percentage of the maximum seasonal yearly average observed at a given location. Bolded stream names indicate priority streams within the assessment unit.

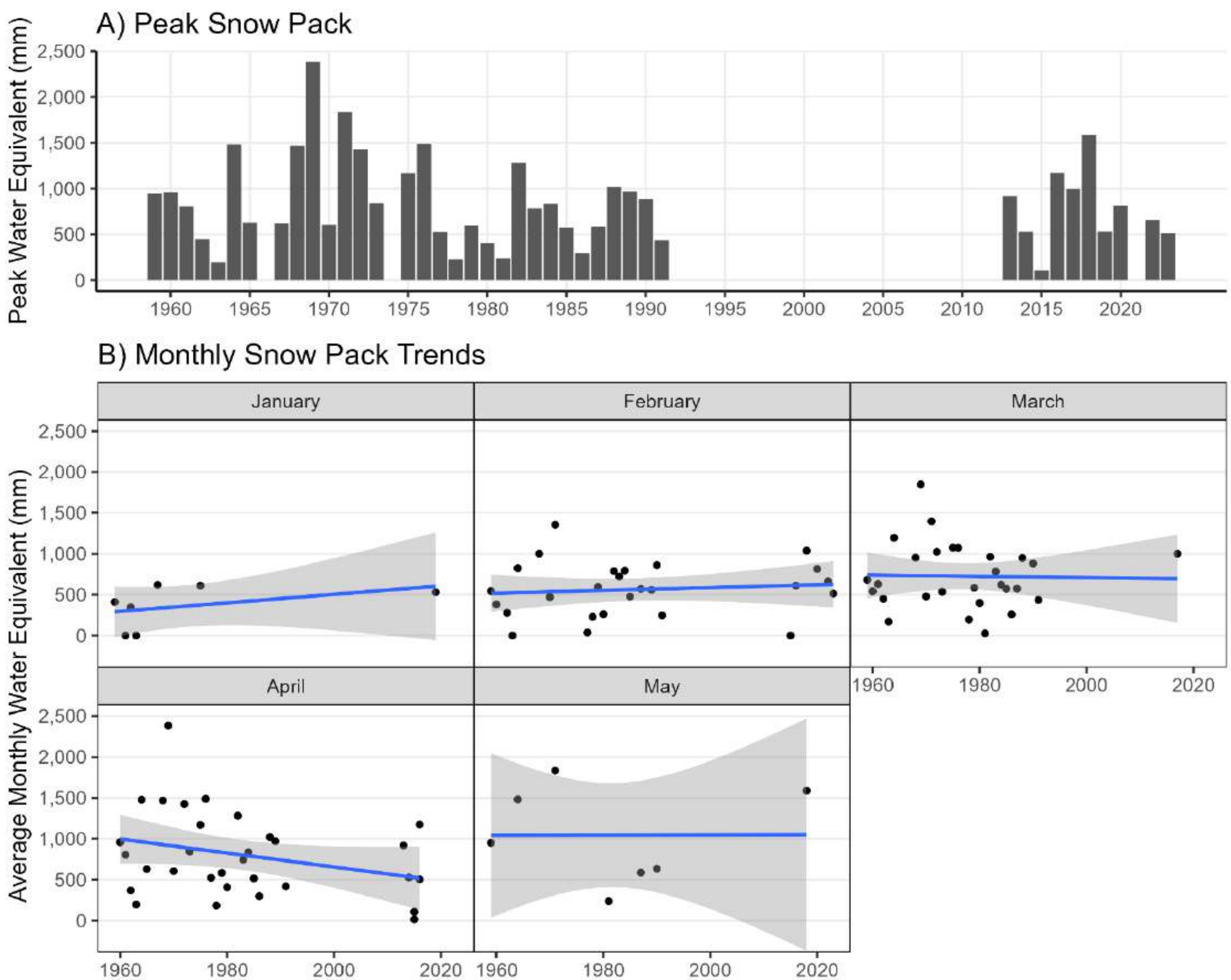

Figure 27. Summary of (A) peak yearly snow pack and (B) within month trends in snow pack on Heather Mountain.

Peak snowpack was determined as the highest monthly snow water equivalents measured within a year. Data obtained from Aquarius.

APPENDICES

APPENDIX A
NUSEDS METHOD SUMMARY

Appendix A1. Summary of escapement method types used within NuSEDS and corresponding colour coding used within the Cowichan Assessment Unit.

Class Type	Description	Survey Methods	Analytical Method	Reliability Within Stock Comparisons	Units	Accuracy
1	True Abundance, high resolution	Total, seasonal counts through fence or fishway; virtually no bypass	Simple, often single step	Reliable resolution of between year differences >10% (in absolute units)	Absolute abundance	Actual, very high
2	True Abundance, medium resolution	High effort (5 or more trips), standard methods (e.g., mark-recapture, serial counts for area under curve)	Simple to complex multi-step, but always rigorous	Reliable resolution of between year differences >25% (in absolute units)	Absolute abundance	Actual or assigned estimate and high
3	Relative Abundance, high resolution	High effort (5 or more trips), standard methods (e.g., equal effort surveys executed by walk, swim, overflight)	Simple to complex multi-step, but always rigorous	Reliable resolution of between year differences >25% (in absolute units)	Relative abundance linked to method	Assigned range and medium to high
4	Relative Abundance, medium resolution	Low to moderate effort (1–4 trips), known survey method	Simple analysis by known methods	Reliable resolution of between year differences >200% (in relative units)	Relative abundance linked to method	Unknown assumed fairly constant
5	Relative Abundance, low resolution	Low effort (e.g., 1 trip), use of vaguely defined, inconsistent or poorly executed methods	Unknown to ill defined; inconsistent or poorly executed	Uncertain numeric comparisons, but high reliability for presence or absence	Relative abundance, but vague or no i.d. on method	Unknown assumed highly variable
6	Presence or absence	Any of the above	Not required	Moderate to high reliability	(+) or (-)	Medium to high

APPENDIX B
NANAIMO RIVER ESCAPEMENT AND HATCHERY RELEASES

Appendix B1. Summary of range of years with reported escapement by stream, species, and run type for Nanaimo River. Data derived from NuSEDS database (September 6, 2023, release).

Stream	Run Type	Chinook	Chum	Coho	Pink
Nanaimo River	Summer	1979–2021			
Nanaimo River	Spring	2020			
Nanaimo River	Fall	1953–2022	1953–2022	1953–2022	1953–2022
Nanaimo River – Upper	Spring	1979–2012			
North Nanaimo River	Fall			1999–2004	

Appendix B2. Summary of the average escapement and the last 5-year average with range in escapement indicated in brackets for Nanaimo River. Data derived from NuSEDS database (September 6, 2023, release).

Stream	Run Type	Chinook	Chum	Coho	Pink
Nanaimo River	Summer	644 / 610 (256–1,191)			
Nanaimo River	Spring	9 / 9 (9–9)			
Nanaimo River	Fall	2,569 / 7,851 (233–15,074)	44,901 / 49,896 (3,500–129,000)	3,649 / 8,248 (539–15,000)	18,233 / 32,066 (1–125,490)
Nanaimo River – Upper	Spring	44 / - (1–264)			
North Nanaimo River	Fall			115 / - (14–363)	

Appendix B3. Summary of escapement methods for Nanaimo River. Data derived from NuSEDS database (September 6, 2023, release).

Stream	Run Type	Chinook	Chum	Coho	Pink
Nanaimo River	Summer	1979–1980: Mark Recapture: Petersen 1986–1991: Unknown Method 1995–2003: Expert Opinion 2004: Peak Live + Dead 2005: Mark & Recapture: Petersen 2006–2012: Peak Live + Dead 2013: Addition/Subtraction 2014–2018: Peak Live + Dead 2019–2020: Addition/Subtraction 2021: Combined Methods			
Nanaimo River	Spring	2020: Peak Live + Dead			
Nanaimo River	Fall	1953–1978: Unknown Method 1979–1980: Mark Recapture: Petersen 1981–1994: Unknown Method 1995–2003: Fixed Site Census 2004–2013: Area Under the Curve 2014: Peak Live + Dead 2015–2022: Area Under the Curve	1953–2001: Unknown Method 2002: Expert Opinion 2003: Cumulative New 2004–2009: Peak Live + Dead 2010–2012: Area Under Curve 2013–2015: Sonar-DIDSON 2016: Addition/Subtraction 2017–2018: Sonar-DIDSON 2019: Area Under the Curve 2020–2021: Sonar-DIDSON 2022: Combined Methods	1953–2001: Unknown Method 2002: Fixed Site Census 2004–2013: Area Under Curve 2014: Peak Live + Dead 2015: Area Under the Curve 2017: Addition/Subtraction 2018–2022: Area Under the Curve	1953–2001: Unknown Method 2003: Fixed Site Census 2005: Peak Live + Dead 2007–2013: Area Under Curve 2014: Peak Live + Dead 2015: Area Under the Curve 2016–2018: Peak Live + Dead 2019: Area Under the Curve 2020–2022: Peak Live + Dead
Nanaimo River – Upper	Spring	1979: Addition/Subtraction 1980–1981: Peak Live + Dead 1982–1983: Addition/Subtraction 1984–2002: Peak Live + Dead 2003–2004: Addition/Subtraction 2005–2008: Peak Live + Dead 2012: Addition/Subtraction			
N. Nanaimo River	Fall			1999–2002: Area Under Curve 2003–2004: Peak Live + Dead	

Appendix B4. Total number of hatchery releases in the Nanaimo River System. Release areas with priority streams have been bolded and highlighted yellow. Data derived from EPAD.

Release System	Priority Stream	Chinook	Chum	Coho	Pink
Nanaimo River System	No	13,251,683	15,251,387	3,172,946	161,330

Appendix B5. Summary of range of years with hatchery releases by species and run type for the Nanaimo River. Data derived from EPAD.

Stream	Run Type	Priority Stream	Chinook	Chum	Coho	Pink
Nanaimo Estuary	Fall	No			2001	1991
Nanaimo River	Summer	No	1981–1986			
Nanaimo River	Fall	No	1974–2021	1980–2021	1980–2021	2012
Nanaimo River S	Fall	No			1998–2001	
Nanaimo River Up	Fall	No			1998–2021	

Appendix B6. Summary of the average hatchery releases, with range indicated in brackets, by release location, run type, and species for the Nanaimo River. Data derived from EPAD.

Stream	Run Type	Chinook	Chum	Coho	Pink
Nanaimo Estuary	Fall			108,783	
Nanaimo Estuary	Fall				32,191
Nanaimo River	Summer	37,048 (2,809–82,576)			
Nanaimo River	Fall				129,139
Nanaimo River	Fall	139,703 (6,002–442,830)			
Nanaimo River	Fall			37,504 (78–259,491)	
Nanaimo River	Fall		371,985 (150–901,000)		
Nanaimo River S	Fall			35,620 (18,523–52,718)	
Nanaimo River Up	Fall			39,822 (10,390–74,590)	