Fisheries and Oceans Canada | Pêches et Océans Canada
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Pacific Region | **Canadian Science Advisory Secretariat**
Science Response 2025/027

INTERIOR FRASER COHO (*ONCORHYNCHUS KISUTCH*) STOCK ASSESSMENT FOR 2022

CONTEXT

The Fisheries Management sector of Fisheries and Oceans (DFO) has requested stock status advice for the Interior Fraser Coho stock management unit. This stock is prescribed as a major fish stock under Schedule IX of the Fishery (General) Regulations and subject to the Fish Stocks Provisions of the Fisheries Act. The most recent published stock assessment information can be found in Arbeider et al. (2020) and Holt et al. (2023). This Science Response Report is from the April 29-May 3, 2024 regional peer review of the Interior Fraser Coho Salmon (*Oncorhynchus kisutch*) Stock Assessment in 2024, and the follow-up meeting on November 15, 2024. Although the report was written in 2024, 2022 is the most recent year in the stock recruitment timeseries analyzed, hence the use of 2022 in the title. Given the technical nature of the document, a glossary is provided in Appendix 1.

SCIENCE ADVICE

Status

The Interior Fraser Coho (IFC) Stock Management Unit (SMU) is above its Conservation Unit (CU) status-based Limit Reference Point (LRP) and, therefore not in the critical zone under the Precautionary Approach (PA) framework. This is based on the DFO's Wild Salmon Policy (WSP) rapid status approach combined with local expert input with data up to 2022, which results in the assignment of 'Green' status to four of the IFC CUs (Lower Thompson, South Thompson, North Thompson, and Middle Fraser) and 'Amber' status to one CU (Fraser Canyon; Holt et al. 2023a, 2023b; Table 1; see Figure 1 for a map of the CUs).

Additional information in chronological order:

- IFC aggregate natural origin spawner abundance declined more than 60% in the early 1990s (Figure 2).
- In 2014 during the last Integrated Status Assessment of IFC, three of the five CUs were assigned a status of 'Amber' (Middle Fraser, Fraser Canyon, and South Thompson) and two CUs were assigned a status of 'Amber/Green' (Lower Thompson and North Thompson; DFO 2015a).
- In 2016, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assessed IFC as Threatened (COSEWIC, 2017).
- Since 2020, the natural origin abundances in all CUs within the IFC SMU have increased.

Ecosystem and Climate Change Considerations

- IFC are threatened by diverse anthropogenic and natural threats, all of which will be exacerbated by anthropogenic driven climate change (Bradford and Irvine 2000; Arbeider et al. 2020).

- Smolt-to-adult survival (SAS) declined from a period of high survival (return year 1987-1994) to low survival (return year 1994-current) due to changing ocean conditions (Decker and Irvine 2013).

Stock Advice

- The maximum sustainable harvest rate for the SMU is 0.39 (based on the Lower Thompson CU, which has the lowest U_{MSY} (median fishing mortality rate that will lead to the maximum sustainable yield); Tables 2 and 3).
- When one generation (3-yr) mean aggregate natural origin spawner abundance exceeds 24,900 and 41,100 fish (Fisheries Reference Points-Lower (FRP-L)), the probability of the IFC SMU being above the CU-based LRP (i.e., no CUs below their lower benchmarks), is 66% and 90%, respectively (Holt et al. 2023b; Table 2).
- In the last 5 years of escapement data (2017-2022), one generation mean aggregate natural origin spawner abundance has exceeded 24,900 fish in all five years, and 41,100 fish in three of five years (Figure 2).

BASIS FOR ASSESSMENT

Assessment Details

Year Assessment Approach was Approved

DFO methods to assess the status of Pacific Salmon CUs were identified and approved in 2009 and the Pacific Salmon SMU LRP methods were approved in 2022/2023 (Holt et al. 2009; DFO 2013, 2024a; Grant and Pestal 2013; Pestal et al. 2023)

Assessment Type

Full Assessment

Most Recent Assessment Date

1. Last Assessment: Interior Fraser Coho Salmon Recovery Potential Assessment (Arbeider et al. 2020).
2. Last Full Assessment: 2014 (DFO 2015a). A Full Assessment has not been made under the *Precautionary Approach* (PA) Framework.
3. Last Interim-Year Update: Not Applicable.

Assessment Approach

1. Broad category: Stock assessment model.
2. Specific category: WSP Rapid Status Assessment (Grant and Pestal 2013; DFO 2024a) Spawner Recruit Analysis (Ricker Model; Bailey 2024); Simulation Analysis (Bailey 2024).

This IFC assessment used previously established, peer-reviewed methods to identify stock status, calculate reference points, and describe spawner trends.

Briefly, the WSP rapid status approach approximates WSP integrated status assessment results using a decision tree trained on historical WSP integrated status assessments and standardized data on CU spawner abundances and trends (Pestal et al. 2023; DFO 2024a). It also relies on an iterative process with CU experts' input on data and results used to finalize status determinations and associated narratives (see Appendix 2).

For spawner-recruit analysis, the Ricker spawner-recruit curves fit to brood-year estimates of spawners and recruits described in Holt et al. (2023b) were reproduced with a Bayesian approach using statistical programming languages R (R Core Team 2024) and Stan (Stan Development Team 2024). Each CU was modeled with the following linearized stock-recruit function:

$$\ln\left(\frac{R}{S}\right) \sim normal(p_3 * (\beta * S + \gamma * SAS_3 + \alpha) + p_4 * (\beta * S + \gamma * SAS_4 + \alpha), \sigma)$$

where R = recruits, S = natural origin spawner abundance, p = proportion of recruits at age, β = density dependence coefficient, α = productivity coefficient, γ = smolt-to-adult survival (SAS) coefficient, SAS = SAS of recruits at age, and σ = standard deviation of variation in recruitment. Stock recruit relationships were fit to each CU (Holt et al. 2023b; Bailey 2024) and parameter means, medians and credible intervals were calculated from the posterior distributions (see Holt et al. 2023b; Bailey 2024 for details). Note that the methods used in this stock assessment diverge from Holt et al. (2023b) by omitting Ricker models with strong priors on capacity (Spawners at Replacement (S_{rep}); see Appendix 3 for details). Finally, using the fitted parameters from the stock-recruit analysis, IFC SMU abundance was simulated into the future using code adapted from Arbeider et al. (2020) to estimate the frequency with which the IFC SMU abundance will exceed FRP-Ls and achieve positive population growth under differing *SAS* and exploitation rates (*ER*s; Figures 4-6). Briefly, the code simulated IFC abundance from 2022 to 2031 with 500 iterations, drew α, β, and γ parameters at random from the stock recruit model posterior, and was seeded with the most recent 4 years of escapement data (see Bailey 2024 for simulation code, and Arbeider et al. 2020 for additional details).

Stock Structure Assumption

Stock overview information: (Arbeider et al. 2020).

The IFC SMU includes all Coho Salmon that spawn in the Fraser River Watershed upstream of Hells Gate in British Columbia and consists of five CUs: Fraser Canyon, Middle Fraser, Lower Thompson, South Thompson, and North Thompson (Table 1; Figure 1). The CUs are further delineated into 11 subpopulations. The Fraser Canyon has one, the Middle Fraser has two, the Lower Thompson has two, the South Thompson has three, and the North Thompson has three subpopulations (Interior Fraser Coho Recovery Team 2006). IFC are genetically distinct from Lower Fraser Coho, and the current assignment of spawning populations to CUs generally agrees with the most recent genetic evidence (Xuereb et al. 2022). On average 88% of IFC have a three-year life-cycle and 12% have a four-year life-cycle, with both spending one winter in saltwater. Rarely do IFC return at ages older than four or less than three years.

*Table 1. List of Conservation Units (CUs) within the Interior Fraser Coho Stock Management Unit with corresponding Designatable Units (DUs), WSP Integrated Statuses, COSEWIC status, and WSP Rapid Statuses. *At the time of assessment, all IFC CUs were considered and assessed by COSEWIC as a single DU.*

CU name	Coded Wire Tag (CWT) indicator	CU	DU	WSP Integrated Status (2015)	COSEWIC (2016)	WSP Rapid Status (2024)
Fraser Canyon	None	CO-5	Fraser Canyon	Amber	Threatened*	Amber, medium confidence
Middle Fraser	None	CO-48	Middle Fraser	Amber	Threatened*	Green, high confidence
Lower Thompson	Coldwater River	CO-7	Lower Thompson	Amber/green	Threatened*	Green, high confidence
North Thompson	None	CO-9	North Thompson	Amber/green	Threatened*	Green, high confidence
South Thompson	Salmon, Eagle Rivers	CO-8	South Thompson	Amber	Threatened*	Green, high confidence

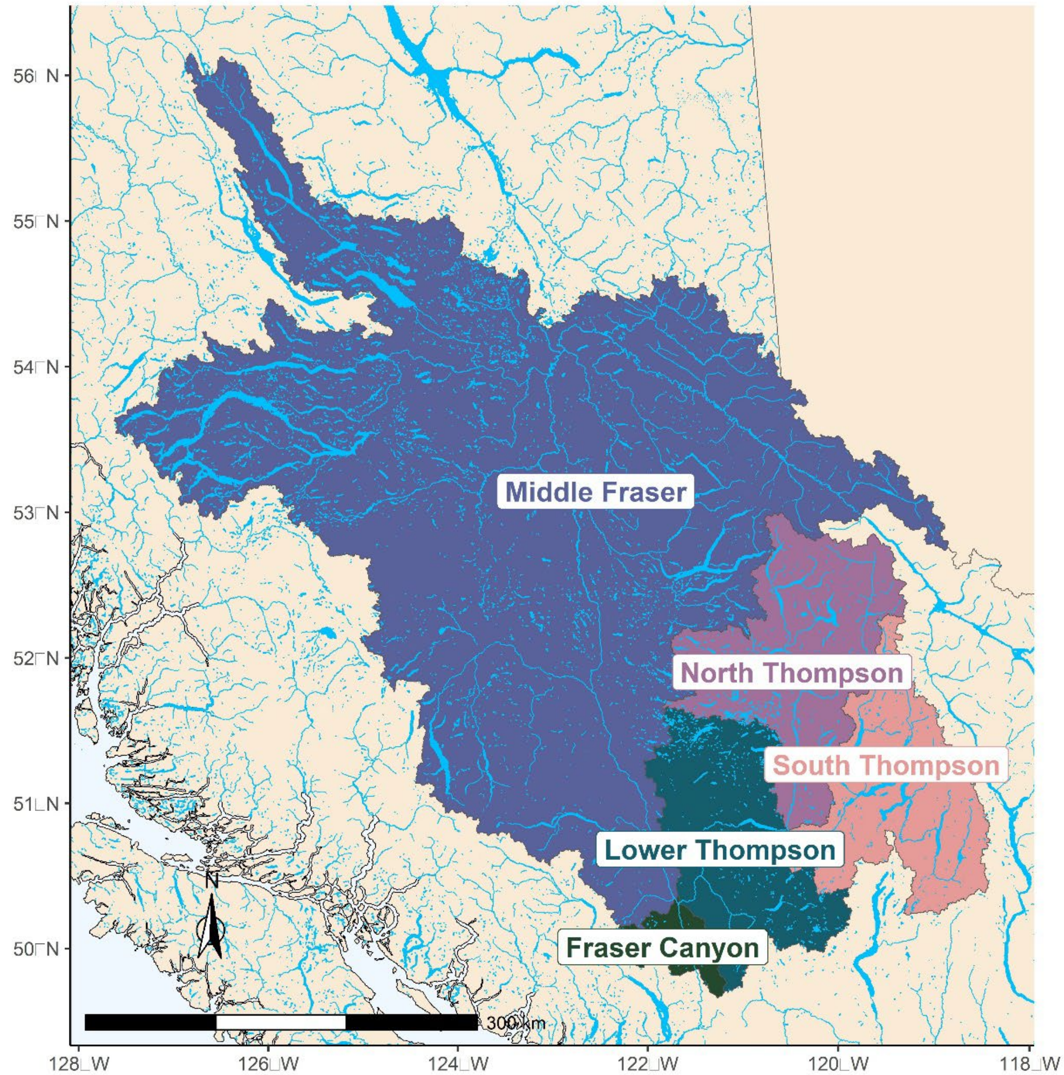

Figure 1. Delineation of freshwater distribution for Interior Fraser Coho conservation units (CUs). Interior Fraser Coho spawn in areas upstream of Hell's Gate and are widely distributed throughout the watershed. Conservation units include Fraser Canyon, Middle Fraser, Lower Thompson, North Thompson, and South Thompson. There are 1-3 subpopulations within each CU for a total of 11: The South Thompson CU includes the Adams River, Shuswap Lake/Tributaries, and Middle/Lower Shuswap subpopulations. The North Thompson CU includes the Lower North Thompson, Middle North Thompson, and Upper North Thompson subpopulations. The Lower Thompson CU includes the Lower Thompson and Nicola subpopulations. The Fraser Canyon CU is only 1 subpopulation within Interior Fraser Coho, which is above Hells Gate. The Middle Fraser CU includes the Lower Middle Fraser and Upper Middle Fraser subpopulations.

Reference Points

A CU status-based LRP has been defined for IFC based on the recommendations from (Holt et al. 2023b). The CU status-based LRP was recommended to reconcile the scale mismatch between the major stocks (SMUs) referenced in the *Fish Stock Provisions* and the Wild Salmon Policy (DFO 2015a) recommendation to manage populations at the CU scale.

To provide information relevant to the scale of fisheries management (i.e., escapement targets at the SMU scale), aggregate SMU FRP-Ls (Table 2) representing aggregate abundances with 66% and 90% probabilities of all CUs being above their lower benchmarks (S_{gen} (spawner abundance required for recovery to S_{MSY} in one generation under equilibrium conditions), Table 3) were adopted from Holt et al. (2023b). Briefly, these targets are based on logistic regression analysis where success is defined as all CUs escaping spawner abundances greater than or equal to their lower benchmarks (CU-specific S_{gen}; see Holt et al. 2023b for details).

CU-specific Removal Reference points (RR) and Upper Benchmarks (80% of S_{MSY}) are described in Table 2 and provided in Table 3.

Table 2. Interior Fraser Coho (IFC) reference points. Note that the Upper Stock Reference (USR) and Target Reference Points (TRP) are the same for IFC but will not necessarily be the same for other SMUs as setting different USR and TRP values is optional (DFO 2024)

Reference Point	Value	Description	Reference
CU status-based Limit Reference Point (LRP)	100% of CUs within an SMU have WSP biological status estimates above red.	CU status-based LRPs use the proportion of CUs within an SMU that are above the WSP ‘Red’ zone. (Appendix 2)	Holt et al. (2023a, 2023b); DFO (2024a)
Fisheries Reference Point-Low (FRP-L)	Aggregate spawner abundance of 24,900 or 41,100	Aggregate spawner abundances at which the probability of all CUs exceeding their lower benchmarks (S_{gen}) is 66% or 90%, respectively	Table 6 in Holt et al. (2023b)
Upper Stock Reference (USR)	80% S_{MSY} (see Table 3)	Candidate USR; 80% of CU natural spawner abundance (S) at Maximum Sustainable Yield (MSY).	Holt (2009); Holt et al. (2009)
Removal Reference (RR)	U_{MSY} (see Table 3)	Candidate RR; Discrete fishing mortality (U) that will produce Maximum Sustainable Yield (MSY) under equilibrium conditions. Note that this value is the lowest CU-specific U_{MSY} value.	Hawkshaw and Walters (2015)
Target Reference Point (TRP)	80% S_{MSY} (see Table 3)	Candidate TRP; 80% of CU natural spawner abundance (S) at Maximum Sustainable Yield (MSY).	Holt (2009); Holt et al. (2009)

Other Stock Reference Points

Wild Salmon Policy (WSP) Biological Benchmarks

Under the WSP, Pacific Salmon CUs are assigned statuses of ‘Green’, ‘Amber’, or ‘Red’, delineated by upper and lower abundance-based benchmarks (DFO 2005, 2015b; Holt et al. 2009; Table 3). The values shown below were produced by rebuilding the stock-recruit analysis from Holt et al. (2023b) in R and Stan (Bailey 2024).

Table 3. Interior Fraser Coho conservation unit (CU) specific abundance-based benchmarks and reference points with credible intervals.

CU	Benchmark	Mean	2.5% CI	50% CI	97.5% CI
Fraser Canyon	S_{gen}	364	141	327	797
Fraser Canyon	80% S_{MSY}	1116	916	1099	1409
Fraser Canyon	U_{MSY}	0.62	0.42	0.63	0.78
Lower Thompson	S_{gen}	2612	1160	2359	5184
Lower Thompson	80% S_{MSY}	3250	2264	3170	5134
Lower Thompson	U_{MSY}	0.39	0.18	0.39	0.57
Middle Fraser	S_{gen}	1863	976	1676	3396
Middle Fraser	80% S_{MSY}	2539	1867	2380	3453
Middle Fraser	U_{MSY}	0.40	0.25	0.40	0.52
North Thompson	S_{gen}	2946	1502	2692	5670
North Thompson	80% S_{MSY}	5029	4257	4975	6119
North Thompson	U_{MSY}	0.50	0.38	0.51	0.62
South Thompson	S_{gen}	2854	1234	2599	5486
South Thompson	80% S_{MSY}	3619	2593	3529	5824
South Thompson	U_{MSY}	0.41	0.22	0.41	0.57

Pacific Salmon Treaty (PST) Management Reference Points

Allowable exploitation rates (ER) for Canada and the U.S. are defined by the status of the IFC SMU, as outlined in Chapter 5 of the PST. Under this approach, SMU statuses, described as ‘Low’, ‘Moderate’, and ‘Abundant’, are delineated by management reference points that identify joint minimum SAS and aggregate escapement objectives (Arbeider et al. 2020; Treaty between the Government of Canada and the Government of the United States of America Concerning Pacific Salmon, as Amended through June 2023, 2023; Table 4). The aggregate objectives were historically set through qualitative analysis by the Interior Fraser Coho Recovery Team (2006) at 40,000 spawners and has been updated by Decker et al. (2014), Korman et al. (2019), and finally Arbeider et al. (2020) to 35,935 spawners. This target provides a 95% probability that all 11 subpopulations of IFC escape at least 1000 spawners based on logistic regression analysis (Arbeider et al. 2020).

Table 4. Pacific Salmon Treaty smolt-to-adult survival (SAS) and spawner abundance (escapement) reference points delineating Interior Fraser Coho stock management unit (SMU) statuses of 'Low', 'Moderate', and 'Abundant'. Changes in status from low to moderate or moderate to high require that both criteria (SAS, escapement) are met for three consecutive years at the higher levels.

SMU Characteristic	Low status	Moderate status	Abundant status
SAS	SAS ≤ 0.03	Three consecutive years 0.03 < SAS ≤ 0.06	Three consecutive years SAS > 0.06
Escapement	Monitored in CUs and subpopulations but no thresholds	Three consecutive years: Half of subpopulations in each CU > 1000	Three consecutive years: All subpopulations in each CU > 1000; or Aggregate SMU escapement objective: 35,935 spawners

Harvest Decision Rule

Established in 2002 and most recently updated in 2019, the Southern Coho Management Plan in Chapter 5 of the PST identifies Coho ER for U.S. and Canadian Coho fisheries based on the stock status of the IFC SMU (i.e. 'Low', 'Moderate', and 'Abundant'), as described previously. Under Chapter 5, total ER caps are set to 20%, 30%, and 45% according to the 'Low', 'Moderate', and 'Abundant' statuses, respectively (Table 5; DFO 2023; Pacific Salmon Commission 2023). As per the objectives outlined in DFO's PA, Canada has taken a precautionary approach to IFC exploitation, targeting a domestic ER of 3-5% (DFO 2023). In Table 3, the median U_{MSY} for 3 CUs (0.39-0.41) are lower than the ER cap set in the PST under abundant IFC spawner escapements (0.45). However, geometric mean SAS for the most recent generation of IFC included in this analysis is 2.2% (Figures 4-6), and SAS would need to exceed 6% for the stock to qualify as abundant. Because SAS impacts the estimation of U_{MSY}, an ER of 0.45 may be sustainable at 6% SAS.

Table 5. Pacific Salmon Treaty Interior Fraser Coho exploitation rate (ER) caps delineation by stock management unit (SMU) statuses of 'Low', 'Moderate', and 'Abundant'.

ER Cap	Low	Moderate	Abundant
Total	0.2	0.30	0.45
(Canada/U.S.)	(0.10/0.10)	(0.18/0.12)	(0.30/0.15)

Enhancement Plan

DFO's Salmonid Enhancement Program determines hatchery production targets through an annual Integrated Production Planning process, which considers DFO's priorities and mandate, First Nations' priorities, and WSP goals for fish health and hatchery-wild interactions. Additionally, each hatchery program is guided by specific production objectives (harvest, conservation, rebuilding, assessment, stewardship, or education) and population-specific considerations outlined in associated Enhancement Plans.

Enhancement Plans are documents that summarize the enhancement objective(s), goals and intended outcomes of individual salmon hatchery programs. Enhancement Plans outline project performance methods and/or metrics to support program adaptive management and ensure alignment with enhancement objectives. Formalized enhancement plans are currently in development for all populations in the IFC SMU.

Current IFC enhancement is summarized in Table 6. Release numbers of hatchery-origin fry and smolts have varied considerably through time (Figure A3.0) with the objectives (DFO 2018) being set for each river as one of more of the following:

1. Rebuilding enhancement, which is used in systems where Coho abundance is deemed to be below apparent freshwater carrying capacity. Note that not all systems that are below carrying capacity are enhanced for rebuilding purposes.
2. Assessment enhancement, where releases of coded wire tagged fish provide information for assessment (e.g., ER, SAS, effects of hatchery-origin salmon on natural-origin salmon etc.).
3. Stewardship/education, where small-scale hatchery supplementation is part of a strategy to increase community stewardship.
4. Conservation enhancement takes place when a population is at a high risk of extirpation or extinction. No systems in the IFC SMU are currently undergoing conservation enhancement.

Table 6. IFC enhancement by stream, CU, enhancement type. Each line of fish production has a single enhancement objective. In some cases, a single production line serves more than one purpose but is only given a single enhancement type label (for example, the Salmon River "rebuilding" fish production line also serves for assessment. AD means fish were adipose fin-clipped, and CWT means fish were coded wire tagged.

Stream	CU	Lines of production	Enhancement objective(s)	2024 fry production target	2024 smolt production target	2024 CWT target	Marking/ Tagging
Bridge River	Middle Fraser	1	Rebuilding	0	20,000	20,000	AD
Seton River	Middle Fraser	1	Education	900	0	0	NA
Gates Creek	Middle Fraser	1	Education	900	0	0	NA
Coldwater River	Lower Thompson	1	Assessment	25,000	185,000	185,000	AD/CWT
Deadman River	Lower Thompson	2	Rebuilding Education	9,000 390	19,000 0	0	NA
Spius Creek	Lower Thompson	1	Education	2,450	0	0	NA
Dunn Creek	North Thompson	2	Stewardship Education	0 9,310	30,000 0	0	NA
Eagle River	South Thompson	1	Assessment	20,000	65,000	65,000	AD/CWT
Salmon River	South Thompson	1	Rebuilding	5,000	25,000	25,000	AD/CWT

Habitat Restoration Plan

There is no formal IFC-specific habitat restoration plan at present. However, there are many isolated, small-scale restoration activities taking place that are either targeted at IFC or on habitat associated with IFC streams, but not associated with a larger coordinated plan.

Data

Escapement

IFC stock assessment data are available from brood year 1984 onwards (Figure 2). IFC spawner assessments have changed over the years in terms of the number of systems surveyed, the extent of coverage, and the quality of the data generated based on changing priorities and resource levels. Though IFC spawner estimates exist for a few systems prior to 1975, the accuracy and precision of those counts cannot be determined (Arbeider et al. 2020), therefore data from that period have been omitted from this assessment (Figure 7). Between 1975 and 1997, more effort was expended to estimate IFC escapement in the North and South Thompson CUs. However, these were low precision, non-standardized visual surveys conducted by fisheries officers and hatchery staff, thus the repeatability and accuracy of these counts remain inestimable (Arbeider et al. 2020). Beginning in 1998, coverage within all CUs increased both for the number of systems assessed and the extent of coverage within previously assessed systems. Simultaneously, higher precision, replicable counting methods were introduced increasing confidence in spawner abundance estimates (Arbeider et al. 2020).

Escapement estimates from 1975 to 1997 were revised in 2006 (Interior Fraser Coho Recovery Team 2006). Revisions were based on calibration studies where paired assessments were conducted between 1998 and 2000. The calibration approach was described in detail in the Conservation Strategy for Coho Salmon, Interior River Populations (Interior Fraser Coho Recovery Team 2006). Despite improvements via calibration, population estimates from this period remain too unreliable to be used for anything more than describing abundance trends (hence omission from the Ricker stock-recruit analysis; Richard Bailey, former Fraser Chinook and Coho Stock Assessment Program Head, Fraser and Interior Stock Assessment, Kamloops, *pers. comm.*).

Exploitation Rate (ER)

ER is the proportion of adult recruit mortality attributed to fishing for a given return year. In simplified terms, it can be described with the following formula:

$$ER = \frac{catch}{catch + escapement}$$

For IFC, ER has been estimated with varying methods through time (Arbeider et al. 2020). For the 1975-1985 period, ER was set as the arithmetic mean of the 1986-1996 period due to a lack of information (Irvine et al. 2001). From 1986-1997, ER was estimated using recoveries of marked CWT-tagged coho in fisheries (Simpson et al. 2004). From 1998-2001, IFC ER in Canada was estimated using genetic stock identification (GSI) and CWT in the United States (Irvine et al. 2001; Simpson et al. 2004). Historically, from 2002 onwards, a combination of the Fisheries Regulation Assessment Model (FRAM), the Canadian Spreadsheet Model (CSM), and the Fraser River Decay Model were used to estimate IFC ER (see Arbeider et al. 2020 for details). As of January 2024, the IFC ER data have been updated to use Fraser River Decay and FRAM model estimates from 2004 onwards to increase the consistency in ER methodology (see Appendix 4 for details on data changes).

Smolt-to-adult Survival (SAS)

SAS is the proportion of out-migrating smolts that survive to the adult recruit stage in the absence of fishing mortality. Thus, SAS is simply calculated as the estimated number of hatchery fish that returned to the spawning grounds plus the estimated number of hatchery fish captured in fisheries divided by the total number of marked smolts released by hatcheries. For IFC, SAS is estimated from hatchery smolts that are marked with adipose fin clips and coded wire tags and then recovered on the spawning grounds when they return or when intercepted by fisheries. The precision of SAS estimates relies on the number of escaped marked fish that are recovered, the precision and accuracy of fisheries mortality estimates, and the degree to which hatchery fish survival mimics natural origin fish survival (Arbeider et al. 2020).

ASSESSMENT

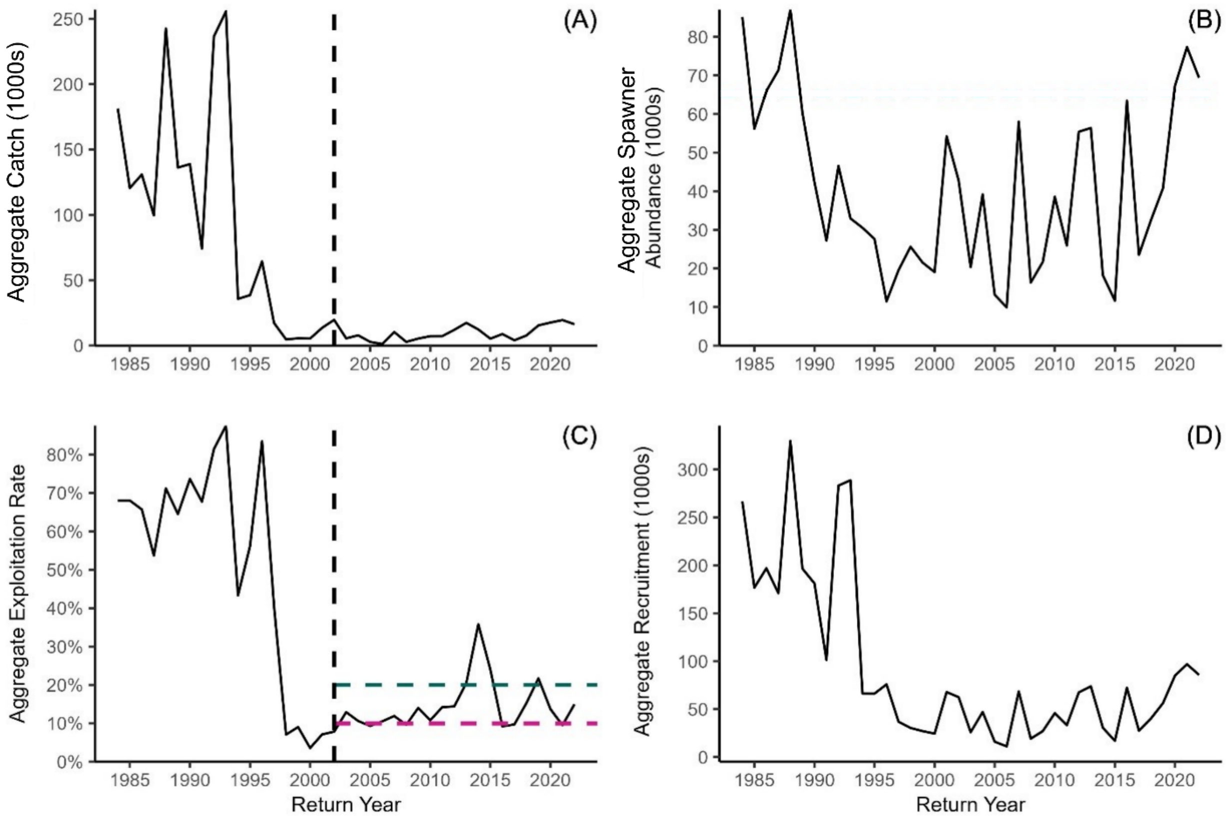

Figure 2. Interior Fraser Coho (A) aggregate (SMU) natural origin catch (1984-2022), (B) aggregate (SMU) natural origin spawner abundance (1984-2022), (C) aggregate (SMU) exploitation rate (1984-2022) and the Pacific Salmon Treaty total exploitation rate cap (20%; green dashed line) and domestic exploitation rate cap (10%; pink dashed line), and (D) aggregate (SMU) natural pre-fishery abundance (1984-2022). Chapter 5 of the PST was finalized in 2002, establishing a management regime for IFC (black dashed line; (A), (B)). CU-specific recruit and spawner abundances as well as SMU exploitation rates can be found in Appendix 5 (Tables A5.0 and A5.1).

Historical and Recent Stock Trajectory and Trends

Productivity

Two regimes are apparent in IFC SAS (which is reflective of productivity experienced by IFC during the marine phase of their life cycle) through time. The 1984 to 1990 brood years were characterized by a period of relatively high SAS, averaging 6.3% over this time and reaching a maximum of 7.2% in 1987. However, SAS began to decrease in 1991, plummeting to 0.8% in 1992 and then to 0.001% in 2003. SAS has increased gradually since then, averaging 1.5% over the last 10 years (2010-2019) but remains low relative to historical averages (Figure 3).

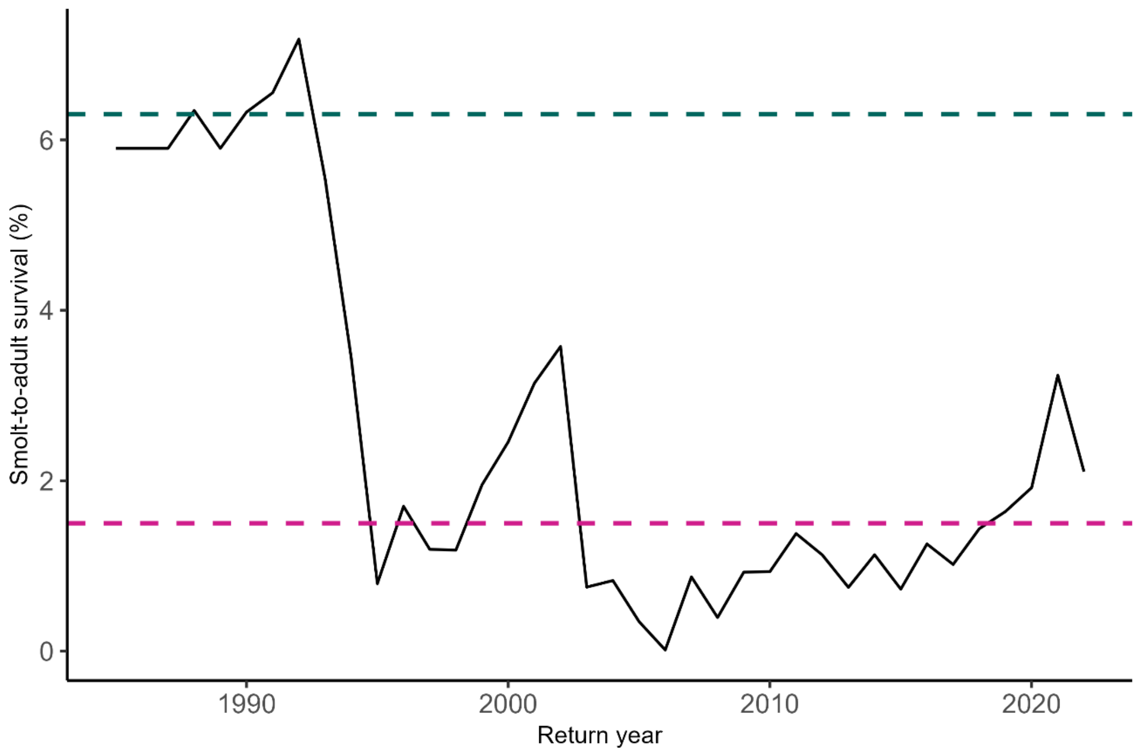

Figure 3. Interior Fraser Coho smolt-to-adult survival (1984-2022). Average smolt-to-adult survival in the historical, high productivity regime (6.3%; 1985-1990; green dashed line). Average smolt-to-adult survival in the last 10 years (1.5%; 2010-2019; pink dashed line). The time series begins in 1985 because that was the first year that ER was no longer an arithmetic mean (see ER data description above). See Appendix 5 (Table A5.1) for the data.

Natural IFC pre-fishery and spawner abundance was high during the period of high survival from return years 1987 to 1993. In 1994, natural pre-fishery and spawner abundance declined rapidly. In the last 10 years (2013-2022), pre-fishery and spawner abundances have increased gradually; spawner abundance 2019-2022 has rebuilt to levels observed prior to the 1990s but pre-fishery abundance has not (Table 7; Figure 2B,D).

Table 7. Interior Fraser coho summarized abundances through time. Note the sharp decline in abundance between 1993 and 1994.

Lifestage	Years	Mean abundance	Range
Pre-fishery adults	1987-1993	198,185	84,390-302,120
Spawners	1987-1993	52,539	27,219-87,021
Pre-fishery adults	1994-2012	38,695	11,075-69,521
Spawners	1994-2012	29,000	9,912-58,006
Pre-fishery adults	2013-2022	54,598	15,337-85,456
Spawners	2013-2022	46,048	11,656-77,338

Based on the results of population simulation analysis (see Bailey 2024 and Arbeider et al. 2020 for details) using current ER and SAS, the probability of the IFC aggregate exceeding the FRP-Ls of 24,900 and 41,100 spawners by 2032 is > 90% (Figures 4-5). The probability of producing a positive population trajectory under current ER and SAS by 2032 was 0-10% (Figure 6), however, current IFC abundances are relatively high compared to the last two decades, thus a positive growth trajectory is unlikely if the current SAS and population productivity remain stable.

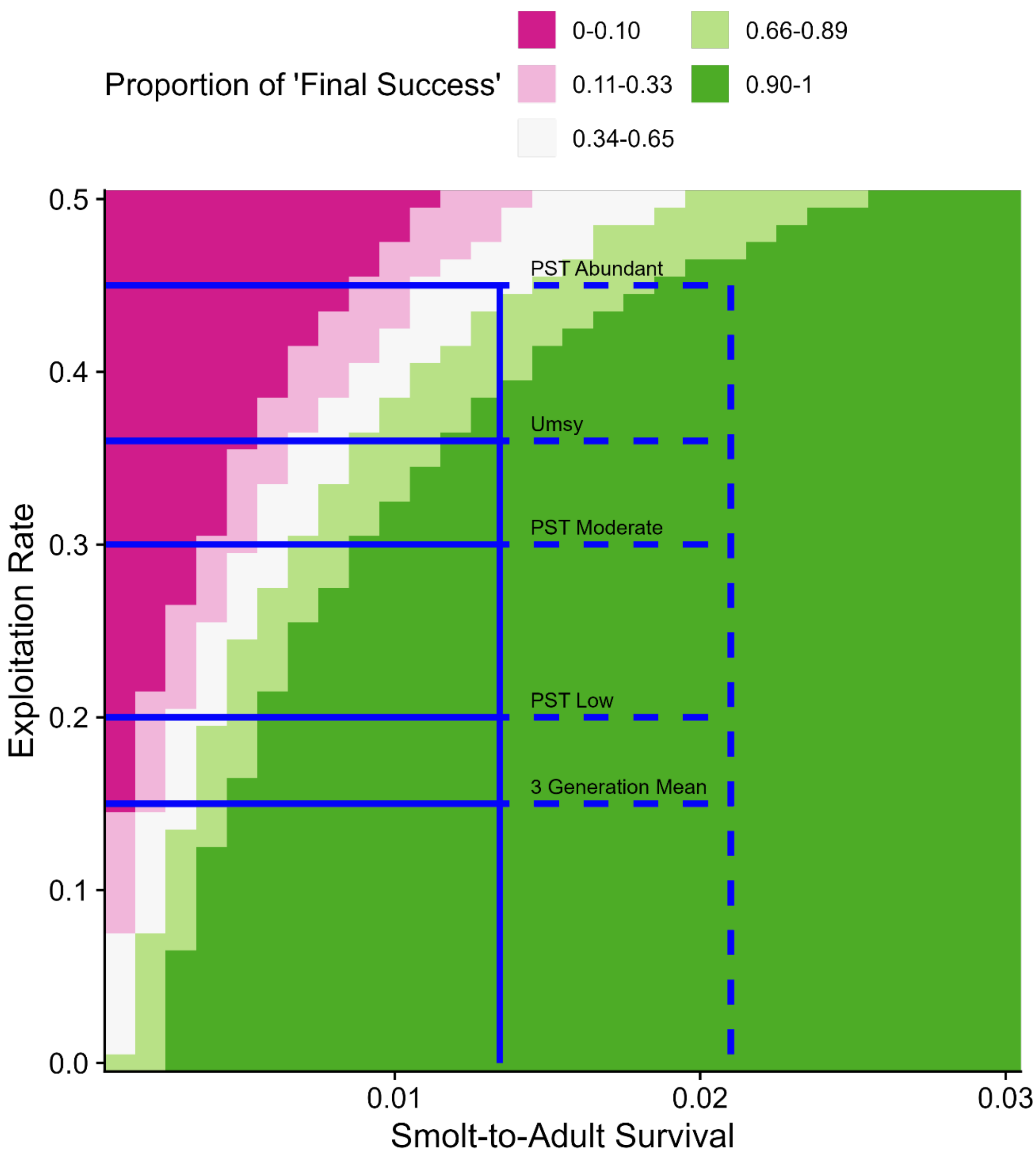

Figure 4. Proportion of simulation results where the final 3-year geometric mean was ≥ 24,900 natural origin spawners ('Final Success'). The solid blue lines intersect at the most recent 3-generation geometric mean smolt-to-adult survival (0.013; vertical blue line) and exploitation rates showing the current 3-generation average, Pacific Salmon Treaty (PST) rates based on IFC abundance, and U_{MSY} *as calculated from stock recruit models (see Table 3). The dashed blue lines intersect at the most recent 1-generation geometric mean smolt-to-adult survival (0.022; vertical dashed blue line) and exploitation rates showing the current 3-generation average, Pacific Salmon Treaty (PST) rates based on IFC abundance, and* U_{MSY} *as calculated from stock recruit models (see Table 3).*

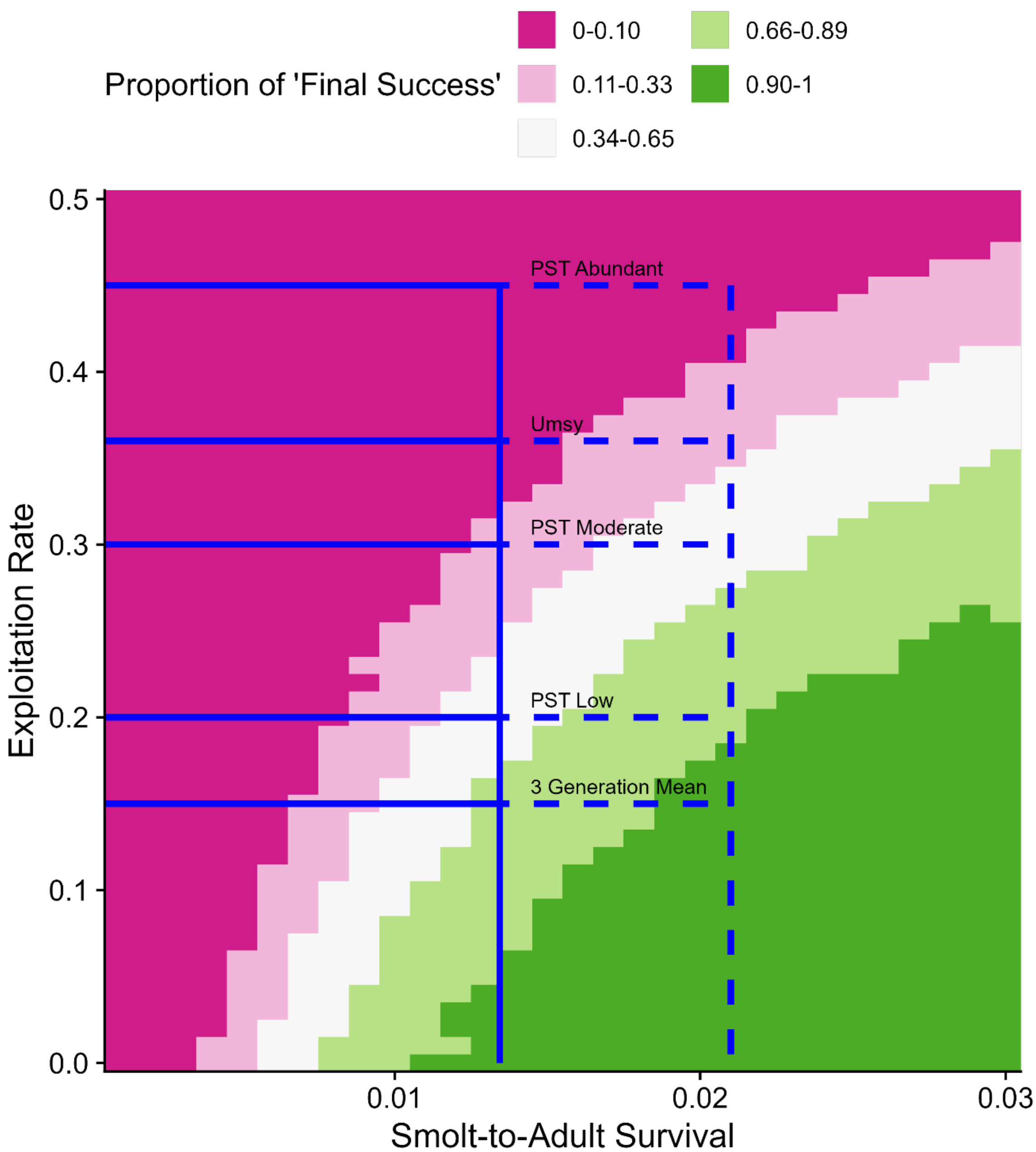

Figure 5. Proportion of simulation results where the final 3-year geometric mean was ≥ 41,100 natural origin spawners ('Final Success'). The blue lines intersect at the most recent 3-generation geometric mean smolt-to-adult survival (0.013; vertical blue line) and exploitation rates showing the current 3-generation average, Pacific Salmon Treaty (PST) rates based on IFC abundance, and U_{MSY} as calculated from stock recruit models (see Table 3). The dashed blue lines intersect at the most recent 1-generation geometric mean smolt-to-adult survival (0.022; vertical dashed blue line) and exploitation rates showing the current 3-generation average, Pacific Salmon Treaty (PST) rates based on IFC abundance, and U_{MSY} as calculated from stock recruit models (see Table 3).

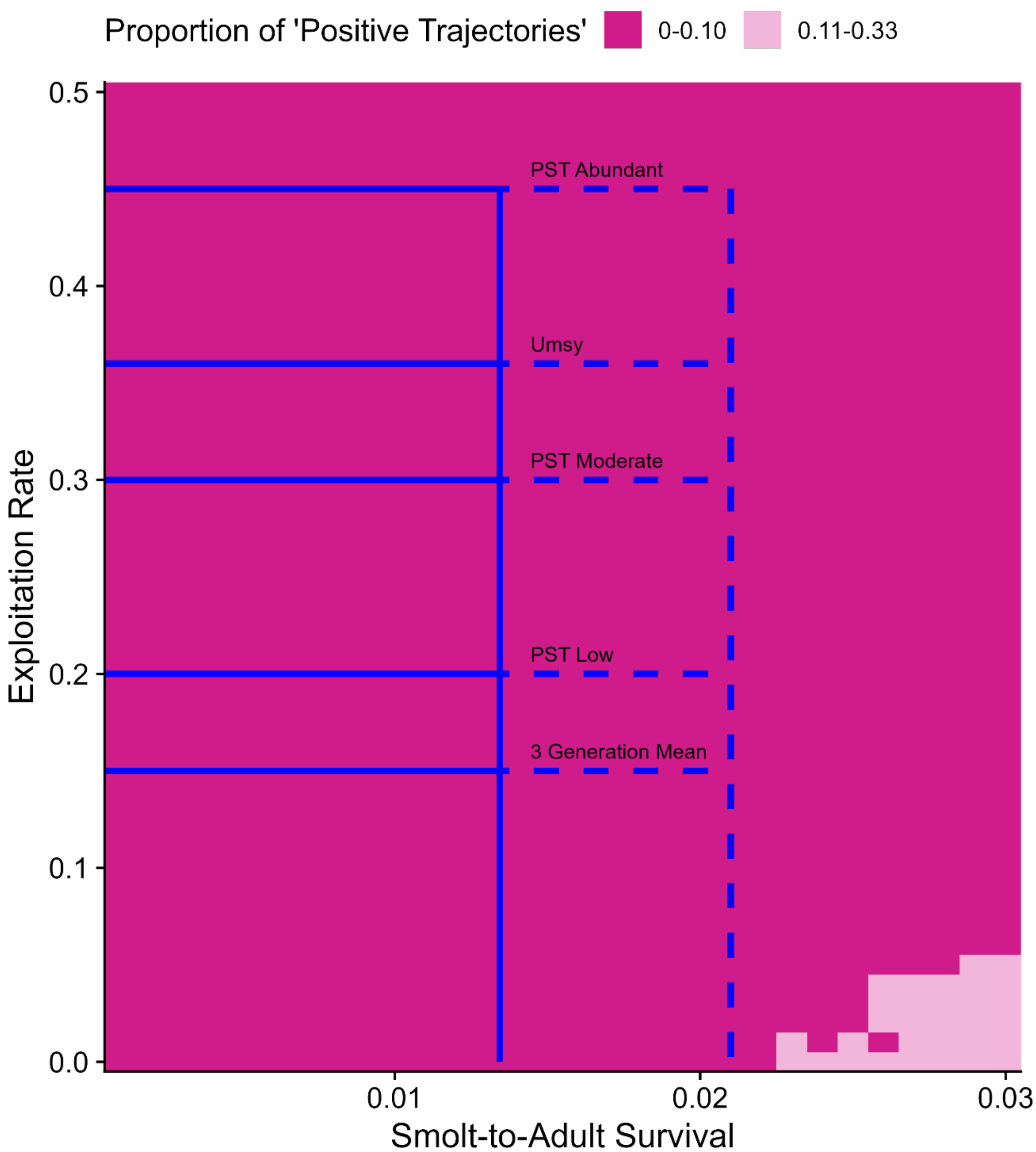

Figure 6. Proportion of simulation results where the population trajectory was positive ('Positive Trajectory'). The blue lines intersect at the most recent 3-generation geometric mean smolt-to-adult survival (0.013; vertical blue line) and exploitation rates showing the current 3-generation average, Pacific Salmon Treaty (PST) rates based on IFC abundance, and U_{MSY} *as calculated from stock recruit models (see Table 3). The dashed blue lines intersect at the most recent 1-generation geometric mean smolt-to-adult survival (0.022; vertical dashed blue line) and exploitation rates showing the current 3-generation average, Pacific Salmon Treaty (PST) rates based on IFC abundance, and* U_{MSY} *as calculated from stock recruit models (see Table 3). Note that simulated abundances at the beginning of simulations are relatively high due to recently high IFC abundances, and thus negative population trajectories are likely.*

History of Harvest

Historical IFC ERs in Canada were high, averaging 66% between 1984 and 1997 (Figure 3). However, declines in IFC productivity, followed by declines in natural pre-fishery and spawner abundance in the mid-1990s resulted in the initiation of a recovery program in 1998 with measures to reduce ER to less than 13% (Decker et al. 2014). Since 1998, the aggregate ER inclusive of Canada and the US has averaged 12.5% (return year 1998-2023; Figure 2C). The ER spike that occurred in 2014 was a result of a one-time DFO policy allowing up to 16% ER on IFC to create flexibility for harvesting late South Thompson Sockeye on a dominant return year (DFO 2024b). However, the ER target was exceeded by a factor of 2, resulting in 32% ER in 2014 (Figure 2C).

History of Hatchery and Supplementation

IFC hatchery enhancement has occurred since the early-1980s and peaked in the late-1980s to early-1990s, averaging 1,600,000 total fry and smolt releases between 1987 and 1993. IFC enhancement has decreased steadily since then with total hatchery releases averaging 339,000 juveniles annually in the last 10 years (2013-2022; see Appendix 5, Figure A5.0). Adult returns from smolt releases are removed from natural escapement estimates by sampling the proportion of clipped and tagged fish captured in fisheries and recovered on spawning grounds. The impact of fry releases on stock-recruit relationships are less certain, but are accounted for using assumptions on fry-to-smolt survival, and then applying the specific year's smolt-to-adult survival to calculate unclipped hatchery return, which is then excluded from natural return estimates. Four CUs (i.e., South Thompson, North Thompson, Lower Thompson, and Middle Fraser) contain integrated-wild populations while the Fraser Canyon CU has a single-site wild-only population.

History of Freshwater Habitat Impacts

Freshwater habitat is important to IFC given that they spend approximately 50% of their life in freshwater. As juveniles, IFC typically spend a year or more rearing in small- and medium-sized tributaries, and off-channel habitats throughout the Fraser River watershed. Adult IFC will spend weeks or even months in freshwater when they return to spawn (Arbeider et al. 2020). In addition to a severe reduction in SAS, the regime shift to low IFC abundance that started in 1990 was also driven in part by anthropogenic alterations to freshwater habitat (Bradford and Irvine 2000).

The conditions and availability of freshwater habitat used by IFC are impacted by a range of threats including decreased stream discharge (i.e., drought), increased water temperatures, altered land use, urbanization, and invasive species, all of which are associated with or worsened by anthropogenic factors. In particular, the expansion of forestry, agriculture, and urban development throughout the Fraser River has resulted in modifications to catchment surfaces, linear development, and forestry and agricultural effluent, and is correlated with altered flow regimes and hydrology, increased water temperatures, reduced habitat complexity, diversity and connectivity, pollution and contamination, and increased sedimentation. However, in occupying a broad range of freshwater habitats over a large geographical area (i.e., the Fraser River watershed), the relative severity of a given threat to IFC freshwater habitats will vary (Table 8; Arbeider et al. 2020). Unfortunately, these habitat alterations have not been systematically monitored, and thus there are few data available for generating quantitative relationships other than what can be assessed through historical satellite imagery.

Ecosystem and Climate Change Considerations

Declines in IFC pre-fishery abundance in the 1990s is attributed to a reduction in SAS resulting from changing ocean conditions, freshwater habitat alterations, and overexploitation (Bradford and Irvine 2000). Although exploitation has decreased substantially, the severity and immediacy of the other threats have not decreased significantly since the 1990s. Limiting factors currently posing the greatest threat to IFC are

1. urban development and forestry affecting catchment surfaces,
2. varying freshwater conditions, and
3. varying ocean conditions.

The effects of these threats are summarized by life stage in Table 8.

Table 8. Interior Fraser Coho required habitat and the effect of the top 3 threats by life stage. Information adapted from Arbeider et al. (2020).

Life stage	Required habitat	Top threats
Egg/alevin	Stable, submerged, oxygenated gravel with a mix of ground and surface water	Modifications to catchment surfaces increase the likelihood of dewatering or egg/alevin-scouring flood events. Climate change increases freshwater environmental variation, further increasing the probability of de-watering or scour.
Fry/parr	Side channels, shaded small streams, and deeper pools	Modifications to catchment surfaces and freshwater variation driven by climate change alters the freshet, affecting the timing and duration of access to off-channel rearing habitat. In addition, climate change increases variation in stream temperature, increasing the number of metabolically stressful days.
Smolt	Large rivers, estuaries, non-natal tributaries	Modifications to catchment surfaces and freshwater variation driven by climate change alters the freshet, changing the timing of smolt migration and ocean entry. Additionally, marine variation driven by climate change can increase or decrease early marine survival through competition and predation.
Immature adult	Coastal waters	Marine variation driven by climate change can increase or decrease growth rates and survival through competition and predation.
Spawning adult	Deep pools and stable, submerged, oxygenated gravel with a mix of ground and surface water	Modifications to catchment surfaces and freshwater variation driven by climate change alters surface and groundwater availability, determining whether fish can access preferred spawning areas.

BYCATCH

Small numbers of Coho Salmon are caught as bycatch in the groundfish trawl fishery in British Columbia, however the stock composition of this bycatch has yet to be examined (Table A6.0 in

Appendix 6). As groundfish trawl fisheries are not fisheries considered in the PST, they are not factored into estimates of ER nor SAS provided here.

SOURCES OF UNCERTAINTY

Several sources of uncertainty exist in the IFC data, including:

1. Escapement (i.e., spawner abundance) data contains unrepresented observational and statistical error due to variations in spawner assessment methodology (Figure 7) and effort (i.e., quality) (Figure 8), environmental conditions, as well as the as number of systems assessed and the extent of coverage, through time. Changes in assessment methodology were not accounted for in the stock-recruit relationships presented in this document;
2. Generation time and age-at-maturity data are based on ageing scales from senesced adults. Approximately 100 scale samples/CU/year are taken, resulting in small sample sizes and limited spatial representation;
3. ERs have been estimated by the Fisheries Regulation Assessment Model (FRAM) since 2002, which has many assumptions and potential sources of uncertainty, as described by the Model Evaluation Workgroup (Rankis et al. 2008) and more recently examined/validated by Hagen-Breaux et al. (2022); and
4. The measurement scale at the population, CU or SMU-level can be an influential source of uncertainty when inferences are made at a scale that is different from the measurement scale.

Sources of uncertainty are described in further detail by Arbeider et al. (2020).

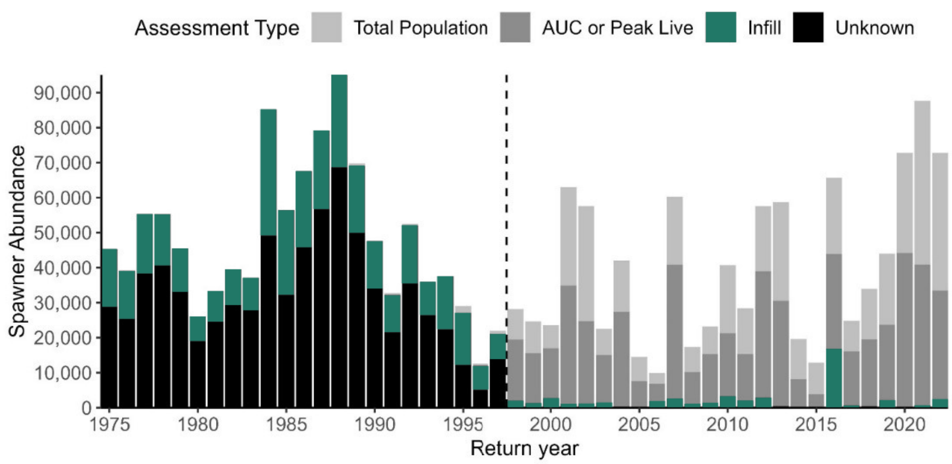

Figure 7. Interior Fraser Coho aggregate natural spawner abundance (1975-2022) by assessment type (lightest grey-Total Population, medium light grey-AUC or Peak Live, teal-Infill, black-Unknown). Data quality increases as the shade of grey becomes lighter.

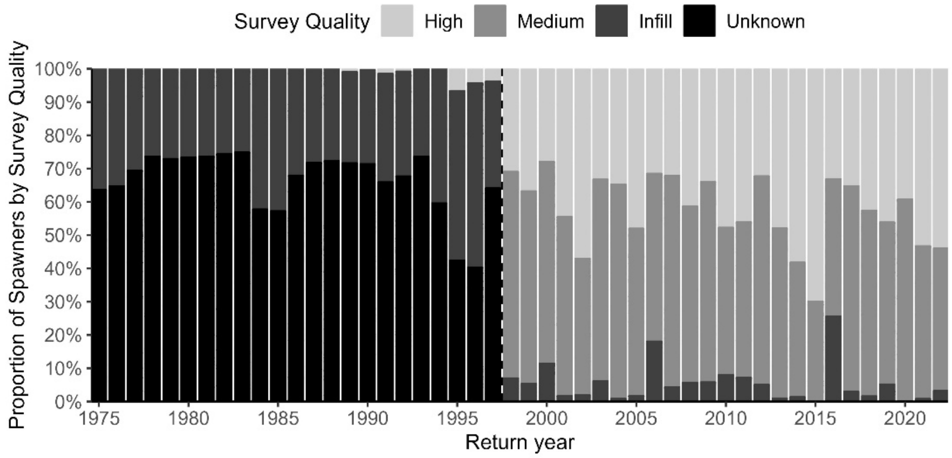

Figure 8. Proportion of Interior Fraser Coho natural spawners by survey quality (1975-2022). High survey quality = absolute abundance. Medium survey quality = relative abundance. Infill = abundance was infilled during data preparation steps. Unknown survey qualities occur prior to 1998 and Irvine et al. (Irvine et al. 1999a, 1999b) describe the quality of these data in detail. Data quality increases as the shade of grey becomes lighter.

RECOMMENDED RESEARCH

Research recommendations identified during the drafting of this document include:

1. increasing the resources applied to assessing SAS data and estimating SAS in a more robust manner;
2. indigenous participants in the IFC Rapid Status review identified a spawner distribution benchmark and some alternative non-S_{MSY} benchmarks that should be developed and incorporated into the Rapid Status Scanner algorithm (Appendix 2).

Future work and research on IFC was also compiled in 2006 by the Interior Fraser Coho recovery team (Interior Fraser Coho Recovery Team 2006). The status of these projects was updated by Arbeider et al. (2020) and is further updated below in Table 9.

Table 9. Studies suggested by the Interior Fraser Coho Recovery Team to identify important habitat for IFC. The study columns and duration are from Table 5 of Interior Fraser Coho Recovery Team (2006). The status column was added by the authors of the 2020 IFC Recovery Potential Assessment (Arbeider et al. 2020).

Study	Duration	Status
Map spawning and rearing habitat in the areas used by the Fraser Canyon Coho Salmon population; determine proportions that are within the Nahatlatch River. (Applicable to all CUs).	2 years	To be done
Quantify the relationships between river discharge, velocity, and depth and Coho Salmon passage success at Hells and Little Hells gates.	2 years	To be done
For each Coho Salmon life history stage, characterized the habitat features that support essential life history attributes of IFC	2 years	Partially complete (Warren 2009)

Study	Duration	Status
Determine the amount and configuration of habitat features including stream flow requirements, required to support each IFC DU and sub-population at or above the recovery objectives.	3 years	To be done
Determine the amount and configuration of habitat features currently available for each IFC DU and sub-population	4 years	To be done
Map the habitat required to meet population recovery objectives.	5 years	To be done
Compare the habitat available with the habitat required for each IFC sub-population with the objective of determining the need for additional important habitat.	5 years	To be done
Develop an age-structured model and carry out population viability analyses to evaluate relationships among combinations of habitat, marine survival and fishery exploitation rates to estimate probabilities of population extinction, decline, survival, or recovery	5 years	To be done
Map ephemeral streams and assess the importance of ephemeral areas to Coho Salmon rearing and over-wintering behaviour	4 years	To be done
Assess the importance of groundwater levels during winter low water and summer drought periods.	4 years	Partially complete (McRae et al. 2012)

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SOURCES OF INFORMATION

Arbeider, M., Ritchie, L., Braun, D., Jenewein, B., Rickards, K., Dionne, K., Holt, C., Labelle, M., Nicklin, P., Mozin, P., Grant, P., Parken, C., and Bailey, R. 2020. Interior Fraser Coho Salmon Recovery Potential Assessment. DFO Can. Sci. Advis. Sec. Res. Doc. 2020/025. xi + 211 p.

Bailey, C. 2024, October 30. IFC_FSAR_v2.0.

Bradford, M.J., and Irvine, J.R. 2000. Land use, fishing, climate change, and the decline of Thompson River, British Columbia, coho salmon. Canadian Journal of Fisheries and Aquatic Sciences, 57: 13–16.

Chaput, G., Cass, A., Grant, S., Huang, A.-M., and Veinott, G. 2013. Considerations for defining reference points for semelparous species, with emphasis on anadromous salmonid species including iteroparous salmonids. DFO Can. Sci. Advis. Sec. Res. Doc. 2012/146. v + 48 p.

Committee on the Status of Endangered Wildlife in Canada. 2017, October 23. Coho Salmon (*Oncorhynchus kisutch*) interior Fraser population: COSEWIC assessment and status report 2016.

Decker, A.S., Hawkshaw, M.A., Patten, B.A., Sawada, J., Jantz, A.L., Canada, O., Hawkshaw, D.A.S., and Jantz, A.L. 2014. Assessment of the Interior Fraser Coho Salmon (*Oncorhynchus kisutch*) management unit relative to the 2006 conservation strategy recovery objectives. DFO Can. Sci. Advis. Sec. Res. Doc. 2014/086. xi + 64 p.

Decker, A.S., and Irvine, J.R. 2013. Pre-COSEWIC Assessment of Interior Fraser Coho Salmon (*Oncorhynchus kisutch*). DFO Can. Sci. Advis. Sec. Res. Doc. 2013/121. x + 57 p. (Erratum: September 2014.

DFO. 2005. Canada's policy for conservation of wild Pacific Salmon. Fisheries and Oceans Canada, Vancouver, June 2005. vi + 49 p.

DFO. 2013. Integrated biological status of Fraser River Sockeye Salmon (*Oncorhynchus nerka*) under the Wild Salmon Policy. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2012/056.

DFO. 2015a. Wild Salmon Policy Biological Status Assessment for Conservation Units of Interior Fraser River Coho Salmon (*Oncorhynchus kisutch*). DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2015/022.

DFO. 2015b. Development of reference points for Atlantic salmon (Salmo salar) that conform to the Precautionary Approach. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2015/058.

DFO. 2018. SEP production planning: a framework. Fisheries and Oceans Canada, Salmonid Enhancement Program. Pacific Region, January 2018. 19 p.

DFO. 2023. Integrated Fisheries Management Plan, June 1, 2023 - May 31, 2024, salmon, southern BC. Fisheries and Oceans Canada, Fisheries Management, Pacific Region, 639 p.

DFO. 2024a. Rapid status approximations for Pacific salmon derived from integrated status assessments under DFO's Wild Salmon Policy. DFO Can. Sci. Advis. Sec. Sci. Resp. 2024/004.

DFO. 2024b. 2024 management Interior Fraser coho. Fisheries and Oceans Canada, Kamloops, BC. Presentation at Fraser Forum, April 9, 2024, 15 slides. [accessed 30 October 2024].

DFO. 2024c. August 8. Introduction to stock assessment. Unit 1.3: Stock status and reference points. [accessed 17 December 2024].

Duplisea, D.E., and Cadigan, N. 2013. Proceedings of the National Workshop for Technical Expertise in Stock Assessment (TESA): Maximum Sustainable Yield (MSY) Reference Points and the Precautionary Approach when Productivity Varies; December 13-15, 2011. DFO Can. Sci. Advis. Sec. Proceed. Ser. 2012/055.

Grant, S.C.H., and Pestal, G. 2013. Integrated biological status assessments under the Wild Salmon Policy using standardized metrics and expert judgement: Fraser River sockeye salmon (Oncorhynchus nerka) case studies. Can. Sci. Advis. Sec. Res. Doc. 2012/106. v + 132 p.

Hagen-Breaux, A., Cook-Tabor, C., and Auerbach, D. 2022. Coho FRAM Model Validation and Mixed Stock Model Updating. Pac. Salmon Comm., Southern Fund Project 2019-SP-3A, viii + 60 p.

Hawkshaw, M., and Walters, C. 2015. Harvest control rules for mixed-stock fisheries coping with autocorrelated recruitment variation, conservation of weak stocks, and economic well-being. Canadian Journal of Fisheries and Aquatic Sciences 72(5): 759–766.

Holt, C.A. 2009. Evaluation of Benchmarks for Conservation Units in Canada's Wild Salmon Policy: Technical Documentation. DFO Can. Sci. Advis. Sec. Res. Doc. 2009/059. xii + 50p.

Holt, C.A., Cass, A., Holtby, B., and Riddell, B. 2009. Indicators of status and benchmarks for Conservation Units in Canada's Wild Salmon Policy. Can. Sci. Advis. Sec. Res. Doc. 2009/058. viii + 74 p.

Holt, C.A., Holt, K.H., Warkentin, L., Wor, C., Connors, B., Grant, S., Huang, A.-M., and Marentette, J. 2023a. Guidelines for defining limit reference points for Pacific salmon stock management units. DFO Can. Sci. Advis. Sec. Res. Doc. 2023/009. iv + 66 p.

Holt, K., Holt, C.A., Warkentin, L., Wor, C., Davis, B., Arbeider, M., Bokvist, J., Crowley, S., Grant, S.C.H., Luedke, W., McHugh, D., Picco, C., and Will, P. Van. 2023b. Case Study Applications of LRP Estimation Methods to Pacific Salmon Stock Management Units. Can. Sci. Advis. Sec. Res. Doc. 2023/010. iv + 129.

Interior Fraser Coho Recovery Team. 2006. Conservation strategy for coho salmon (*Oncorhynchus kisutch*), interior Fraser River populations. Fisheries and Oceans Canada, Vancouver, BC.

Irvine, J.R., Bailey, R.E., Bradford, M.J., Kadowaki, R.K., and Shaw, W.S. 1999a. 1999 Assessment of Thompson River/Upper Fraser River Coho Salmon. DFO Can. Stock Assess. Sec. Res. Doc. 99/128. 40 p.

Irvine, J.R., Wilson, K., Rosenberger, B., and Cook, R. 1999b.Stock Assessment of Thompson River/Upper Fraser River Coho Salmon. DFO Can. Stock Assess. Sec. Res. Doc 99/28. 66 p.

Irvine, J.R., Parken, C.K., Chen, D.G., Candy, J., Ming, T., Supernault, J., Shaw, W., and Bailey, R.E. 2001. Working Paper S2001-13: 2001 stock status assessment of Coho salmon from the Interior Fraser River, pp. 21-25. M. Stocker and A. Macdonald (eds.) Report of the PSARC Salmon Subcommittee Meeting, May 1-3, 2001. DFO Can. Advis. Sec. Proc. Ser. 2001/12.

Korman, J., Sawada, J., and Bradford, M.J. 2019. Evaluation framework for assessing potential Pacific Salmon Commission reference points for population status and associated allowable exploitation rates for Strait of Georgia and Fraser River Coho Salmon Management Units. DFO Can. Sci. Advis. Sec. Res. Doc. 2019/001. vii + 81 p.

Lagasse, C.R., Fraser, K.A., Braithwaite, E., Komick, N. 2025. Salmon Bycatch Monitoring and Sampling Results for the Pacific Region 2023/24 Groundfish Trawl Fishery. Can. Manuscr. Rep. Fish. Aquat. Sci. 3298: vi + 41 p.

McRae, C.J., Warren, K.D., and Mark Shrimpton, J. 2012. Spawning site selection in interior Fraser River coho salmon Oncorhynchus kisutch: An imperiled population of anadromous salmon from a snow-dominated watershed. Endanger. Species Res. 16(3): 249–260.

Pacific Salmon Commission. 1985. Pacific Salmon Commission Treaty.

Pacific Salmon Commission. 2023. Treaty between the Government of Canada and the Government of the United States of America concerning Pacific salmon, as amended through June 2023. In Treaty. Canada, USA.

Pestal, G., MacDonald, B.L., Grant, S.C.H., and Holt, C.A. 2023. State of the Salmon: rapid status assessment approach for Pacific salmon under Canada’s Wild Salmon Policy. Can. Tech. Rep. Fish. Aquat. Sci. 3570: xiv + 200 p.

R Core Team. 2024. R: A Language and Environment for Statistical Computing. R Foundation for Statistical Computing, Vienna, Austria.

Rankis, A., Clemmons, E., Conrad, R., Grover, A., Packer, J., Sharma, R., Simmons, D., Yuen, H., Tracy, C., Dorval, R., Montgomery, C., Merydith, K., Hagen-Breaux, A., and Haymes, J. 2008. Fishery regulation assessment model (FRAM) - an overview for Coho and Chinook - v3.0. ii + 39 p. Pacific Fishery Management Council, Portland, OR.

Simpson, K., Chamberlain, M., Fagan, J., Tanasichuk, R.W., and Dobson, D. 2004. Forecast for southern and central British Columbia Coho salmon in 2004. DFO Can. Sci. Advis. Sec. Res. Doc. 2004/135. viii + 69p.

Stan Development Team. 2024. “RStan: the R interface to Stan.” R package version 2.32.6.

Tompkins, A., Bailie, S., Chamberlain, M., Sawada, J., Walsh, M., Morishima, G., Cook-Tabor, C., Foster, C., Hayman, R.A., Haymes, J., Lawson, P.W., Packer, J., Patton, B., Weitkamp, L., and Zimmerman, M. 2013. 1986-2009 Periodic Report Revised. Pac. Salmon Comm. Joint Coho Tech. Comm. Report, TCCOHO (13)-1, xiv + 160 p.

Warren, K.D. 2009. Factors influencing habitat use by juvenile Interior Fraser Coho. M.Sc. Thesis, University of Northern British Columbia, Prince George, 99 p.

Withler, R.E., Bradford, M.J., Willis, D.M., and Holt, C. 2018. Genetically Based Targets for Enhanced Contributions to Canadian Pacific Chinook Salmon Populations. DFO Can. Sci. Advis. Sec. Res. Doc. 2018/019. xii + 88 p. (Erratum: October 2023)

Xuereb, A., Rougemont, Q., Dallaire, X., Moore, J.S., Normandeau, E., Bougas, B., Perreault-Payette, A., Koop, B.F., Withler, R., Beacham, T., and Bernatchez, L. 2022. Re-evaluating Coho salmon (*Oncorhynchus kisutch*) conservation units in Canada using genomic data. Evol. Appl. 15(11): 1925–1944.

APPENDIX 1: GLOSSARY

Benchmarks: also known as “benchmarks of biological status”, these are thresholds used to determine the status (e.g., red, amber, green) of a Conservation Unit (DFO 2018).

Brood year: the single or main contributing spawning year that produced a group of juveniles or adult recruits.

Bycatch: non-target fish species captured in commercial or recreational fisheries.

Catchment surface: the land area that rainfall is intercepted by. The qualities of the catchment surface affect how and when water moves through a watershed.

[CU] Conservation Unit: a group of wild Pacific salmon populations that would not recover naturally nor recolonize the habitat after extirpation within a human lifetime (DFO 2005).

[ER] Exploitation Rate: “expressed as a percentage, the proportion of the total return of adult salmon in a given year that die as a result of fishing activity.”

Escapement target: the number of fish fisheries management aspires to return to the spawning grounds.

[FRP-L] Lower Fisheries Reference Point: SMU aggregate abundance reference points (i.e., escapement targets that are relevant to the scale of management and are associated with specific probabilities of the stock exceeding its CU-based LRP.

Fish Stock Provisions: an updated section of the *Fisheries Act* that came into force on April 4, 2022 and triggered the development of Fish Science Advice Reports.

Full assessment: also known as “full integrated status assessment”, these are the traditional stock status assessments under the Wild Salmon Policy using standardized data reviewed over a multi-day meeting of experts to determine the status of individual Conservation Units (DFO 2015a).

[IFC] Interior Fraser Coho: a genetically and behaviourally distinct stock management unit of Coho Salmon that spawn in Fraser Watershed upstream of Hell’s Gate (DFO 2015a).

Integrated-wild population: “populations with an integrated hatchery program that is managed to achieve conservation and genetic goals while contributing to production. Benchmarks associated with this category ensure the majority (>50%) of fish spawning in the river meet the criteria for wild under the Wild Salmon Policy and 80% or more of the spawning population will be of natural origin.” (Withler et al. 2018).

[LRP] Limit Reference Point: a scientifically-determined threshold below which Fisheries and Oceans Canada is legally obligated to develop a stock rebuilding plan for a given Stock Management Unit (Holt et al. 2023b).

Natural fish: a fish produced through natural spawning, but whose parents may be of natural or hatchery origin.

Off-channel habitat: Typically small, shallow, often ephemeral (i.e., not always submerged) wetted channels and pools that are seasonally or continuously connected to the mainstem of a stream.

[PA] Precautionary approach: a policy published by Fisheries and Oceans Canada within the Sustainable Fisheries Framework that states the intention of the federal government to use caution when scientific knowledge is uncertain (e.g., harvest less in the face of uncertainty).

[PNI] Proportionate natural influence: the proportion of natural origin spawners in a salmon population (Withler et al. 2018).

Pre-fishery abundance: The number of estimated adult fish that would have returned to the beginning of their spawning migration in the absence of fishing mortality.

[PST] Pacific Salmon Treaty: An agreement between Canada and the United States to cooperate in the management, research, and enhancement of Pacific Salmon stocks of mutual concern (Pacific Salmon Commission 1985).

Reference points: thresholds that trigger changes in the harvest of stock management units. Limit reference points are scientifically determined, but removal references and upper stock references include both biological and management considerations in their development (Chaput et al. 2013).

Regime shift: a large, rapid change from one relatively stable general pattern to a new pattern.

[RR] Removal Reference: "maximum acceptable removal rate for the stock which would apply when the stock is in the healthy zone and includes all anthropogenic mortality" (DFO 2015b).

[SAS] Smolt-to-Adult Survival: the proportion or percent of smolts that survive to recruit to the fishery. In most cases, smolt counts occur early in the downstream seaward migration, and include downstream freshwater mortality in addition to marine mortality.

[S_{gen}] The number of spawners required for "recovery to S_{MSY} in one generation under equilibrium conditions" (Duplisea and Cadigan 2013).

[S_{MSY}] Spawners at Maximum Sustainable Yield: the number of spawning adults that generates the greatest difference between the number of spawners and the number of adult recruits they produce (where spawners are fish that escaped the fishery, and recruits are the fish available to the fishery before fishing begins).

[SMU] Stock Management Unit: "a group of one or more conservation units (CU) that are managed together with the objective of achieving a joint status." Note that in older documents this is also written as "Management Unit", or MU.

[TRP] Target Reference Points: specific numerical management objectives that managers attempt to reach that are biologically and socio-economically beneficial.

[U_{MSY}] Fishing mortality rate that will lead to the Maximum Sustainable Yield: the highest sustainable fishing mortality, which would lead spawner abundance to match Spawners at Maximum Sustainable Yield (S_{MSY}).

[USR] Upper Stock Reference: the stock level below which losses must be progressively reduced in order to avoid reaching the LRP. In other words, the point below which harvest control rules change as the population size declines until it reaches the LRP.

Wild population: population of salmon that spent their entire life cycle in the wild and originate from parents that were also produced by natural spawning and continuously lived in the wild (DFO 2005).

[WSP] Wild Salmon Policy: a policy published by Fisheries and Oceans Canada that states the intention to "restore and maintain healthy and diverse salmon populations and their habitats for the benefit and enjoyment of the people of Canada in perpetuity" and provides guidelines for achieving this objective (DFO 2005).

WSP Integrated Status: The biological status (green/amber/red) of a conservation unit assessed by a group of experts over a multi-day meeting using standardized data (Pestal et al. 2023).

WSP Rapid Status: A method and process that approximates the Integrated Status Assessment using the same data inputs and a decision tree coded into a computer algorithm to estimate the biological status of a conservation unit (Pestal et al. 2023). The data and results are vetted through Area CU experts, and for official purposes the data and results also go through a broader process with local experts, including Indigenous Knowledge experts, to finalize both statuses and accompanying narratives and information packages for WSP Rapid status.

APPENDIX 2: WILD SALMON POLICY RAPID STATUS

The Wild Salmon Policy Rapid Status assessment assigns a ‘Red’ (poor), ‘Amber’ (intermediate), or ‘Green’ (good) status with ‘Low’, ‘Medium’, or ‘High’ confidence rating to WSP conservation units (CU) with applicable data. CU statuses are generated by applying Pacific salmon CU data to a computer-coded WSP rapid status algorithm that assigns status depending on answers to twelve Yes/No questions that approximate the decision-making process that experts used in WSP integrated status assessments. The combination of metrics applied, and their individual status values compared to metric thresholds, leads to a final WSP rapid status. Metric Dashboards (figures) are also produced for WSP rapid status assessment processes. However, it should be noted that the algorithm thresholds are not always one-to-one with metric benchmarks because the algorithm uses decision rules to approximate expert-driven decisions. Methods and background information are described in greater detail in DFO (DFO 2024a).

In an unpublished review (M. Arbeider, DFO, Fraser and Interior Stock Assessment, Kamloops, B.C., pers. comm), First Nation participants stressed the importance of distribution that was a metric lacking in the rapid status algorithm. CU-level averages and metrics have the potential to mask underlying stream level risks and observations. The main recommendation was to develop a distribution metric that could be explicitly included in the rapid-status algorithm. Distribution data and targets should also be included in the next Integrated Status Assessment. The lack of distribution metrics has been acknowledged previously in the rapid-status algorithm working group. First Nation participants identified that the S_{gen} and 80% S_{MSY} benchmarks did not appear to be adequate or representative of local knowledge. Streams did not appear to be “seeded” to levels from known history. Similarly, these benchmarks do not include distribution information and misalign with other values of Indigenous groups. A common comment was that the values looked too low or that they have been estimated using only data from a low-productivity period. The future work suggested was to investigate alternative benchmarks or methods in developing the benchmarks.

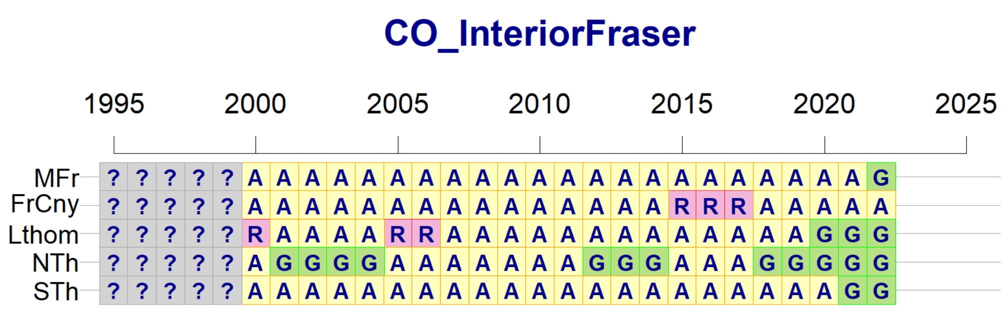

Figure A2.0. Interior Fraser Coho WSP rapid statuses for years with applicable data. Each row summarizes the rapid statuses available for each CU in this SMU (Middle Fraser = ‘MFr’, Fraser Canyon = ‘FrCny’, Lower Thompson = ‘Lthom’, North Thompson = ‘Nth’, South Thompson = ‘STh’).

*Table A2.0. Wild Salmon Policy (WSP) rapid statuses for 2022**:** The WSP rapid status algorithm was used to assess annual statuses for each Interior Fraser Coho CUs.*

CU #	CU Name	WSP Rapid Status (2022)	WSP rapid status node
CO-5	Fraser Canyon	AMBER, MEDIUM CONFIDENCE	The recent year's status (2022) is designated *Amber* with *Medium* confidence based on the algorithm. The recent generational average falls between *absolute abundance* lower (1,500) and upper (10,000) thresholds, and also falls above the r*elative-abundance* metric lower benchmark (S_{gen}) (node 22) (Figure A2.1). This status has been consistent throughout the time series (2000-2022), except for three years that were *Red* (2015-2017) (Figure A2.1). The 2013 WSP rapid status of *Amber* matches the WSP integrated status (DFO 2015a). Stock assessment moved from a float-based AUC to flight given road access lost after 2020; precision of estimate has gone down. Since it is a single stream CU, there is a risk that one landslide could block passage into spawning grounds. There have been substantial fires in the area that have increased slide risk and impacted the watershed. It is important to track incidences related to landslides and blockages. No First Nation subject matter experts were successfully engaged for this CU.
CO-7	Lower Thompson	GREEN, HIGH CONFIDENCE	The recent year's status (2022) is designated *Green* with *High* confidence based on the algorithm. The recent generational average falls above the *absolute abundance* upper threshold (10,000), and also fall above 1.1 (the *relative-abundance* upper benchmark (80% S_{MSY}) (Node 36) (Figure A2.2). This *Green* status has been consistent for the past three years (2020-2022) (Figure A2.2). Status was *Red* in 2000, the first year in the time series, and in 2005 and 2006. Status was *Amber* for all other years up to 2019. The 2013 WSP rapid status of *Amber* is consistent with the WSP integrated status of *Amber/Green* (DFO 2015a). One reviewer recommended that the status should be Amber due to the variable time series and recent impacts to the landscape. There is potential capacity and productivity issues from the severe degradation of rearing and spawning habitats due to fires, floods, and drought which are not reflected in the benchmarks of this assessment. Access to the Bonaparte River through it's fishway was blocked in 2018, resulting in few to no spawners there in 2018 and the primary return year of 2021. It is expected that this impact will persist in 2024. The Coldwater River also experienced extreme flood conditions (>1/100-year-event impact) in Nov 2021, which has potential to cause a recruitment failure in 2024 due to redds being scoured, increased pre-spawn mortality, and other persistent impacts to spawning and rearing areas.

CU #	CU Name	WSP Rapid Status (2022)	WSP rapid status node
CO-8	South Thompson	GREEN, HIGH CONFIDENCE	The recent year's status (2022) is designated *Green* with *High* confidence based on the algorithm. The recent generational average falls above the *absolute abundance* metric upper threshold (10,000), and also falls above 1.1 (the *relative-abundance* upper benchmark (80% S_{MSY}) (Node 36)(Figure A2.3). This status has been *Green* for the past two years (2021-2022). The status was *Amber* from 2000 to 2020 (Figure A2.3). The 2013 WSP rapid status of *Amber* matches the WSP integrated status (DFO 2015a). One reviewer recommended that the status should be Amber due the highly variable time series and that the most recent data point is just greater than 10,000. There is potential capacity and productivity issues from the severe degradation of rearing and spawning habitats due to fires, floods, and drought which are not reflected in the benchmarks of this assessment. Salmon River and Bessette River complex are two systems that suffered extreme drought conditions in 2023 and have been experiencing impacts from variable drought conditions in recent years. Widespread fires in the Adams and Little River and Shuswap Lake watersheds will also have persistent impacts to habitat quality and productivity.
CO-9	**North Thompson**	**GREEN, HIGH CONFIDENCE**	The recent year's status (2022) is designated *Green* with *High* confidence based on the algorithm. The recent generational average falls above the *absolute abundance* metric algorithm upper threshold (10,000), and falls above 1.1 (the *relative-abundance* upper benchmark (80% S_{MSY}) (Node 36) (Figure A2.4). Status has been *Green* since 2018. WSP rapid status has alternated between *Green* and *Amber* throughout the time series (2000-2022) (Figure A2.4). The 2013 WSP rapid status of *Green* is consistent with the WSP integrated status of *Amber/Green* (DFO 2015a). One reviewer was hesitant to agree that the status should be Green due similar recent impacts to spawning and rearing habitat from fires, floods, and droughts that the other Thompson CUs have experienced. Stream access was particularly impacted in 2023 on several North Thompson tributaries due to drought that triggered remediation action (joint activities between Secwepemc Fisheries Commission and DFO). This CU was exemplary that the COSEWIC and WSP benchmarks did not align with local knowledge of Secwepemc as the abundances were still too low and not all spawning areas were as fully seeded as in Secwepemc memory.
CO-48	**Middle Fraser ('Interior**	**GREEN, HIGH CONFIDENCE**	The recent year's status (2022) is designated *Green* with *High* confidence based on the algorithm. The recent generational average falls above the *absolute abundance* algorithm upper threshold (10,000), and also falls above 1.1

CU #	CU Name	WSP Rapid Status (2022)	WSP rapid status node
	Fraser' in NuSeds)		(the *relative-abundance* metric upper benchmark (80% S_{MSY}) (node 36) (Figure A2.5). This status has improved over all previous years, which were *Amber* (2000-2021). WSP rapid status could be assigned for all years starting 2000 (Figure A2.5). The 2013 WSP rapid status of *Amber* matches the integrated status (DFO 2015a).

Fraser Canyon Conservation Unit (CO-5)

In 2022, the Fraser Canyon CU status was estimated as ‘Amber’ with medium-confidence by the Rapid Salmon Scanner (Figure A2.0, A2.1; Table A2.0). The recent generational average falls above the *absolute abundance* lower (1,500) threshold (node 1) but below the *absolute abundance* upper (10,000) threshold (node 2). Following algorithm Pathway 2, there is a *relative abundance* metric for this CU (node 5) and the recent generational average falls above the lower benchmark (S_{gen}) (node 11). Status for this CU is therefore designated as Amber with Medium confidence at Node 22.

During an unpublished expert review (M. Arbeider, DFO, Fraser and Interior Stock Assessment, Kamloops, B.C., pers. comm), it was recorded: There were no dissenting experts on the status of Fraser Canyon as ‘Green’; however, it was noted that no First Nation reviewer’s present could claim to be subject matter experts in this CU. The other major concerns were that this is a single site CU in a canyon with a risk of landslides blocking access and that a 2021 landslide has blocked road access and changed the assessment method.

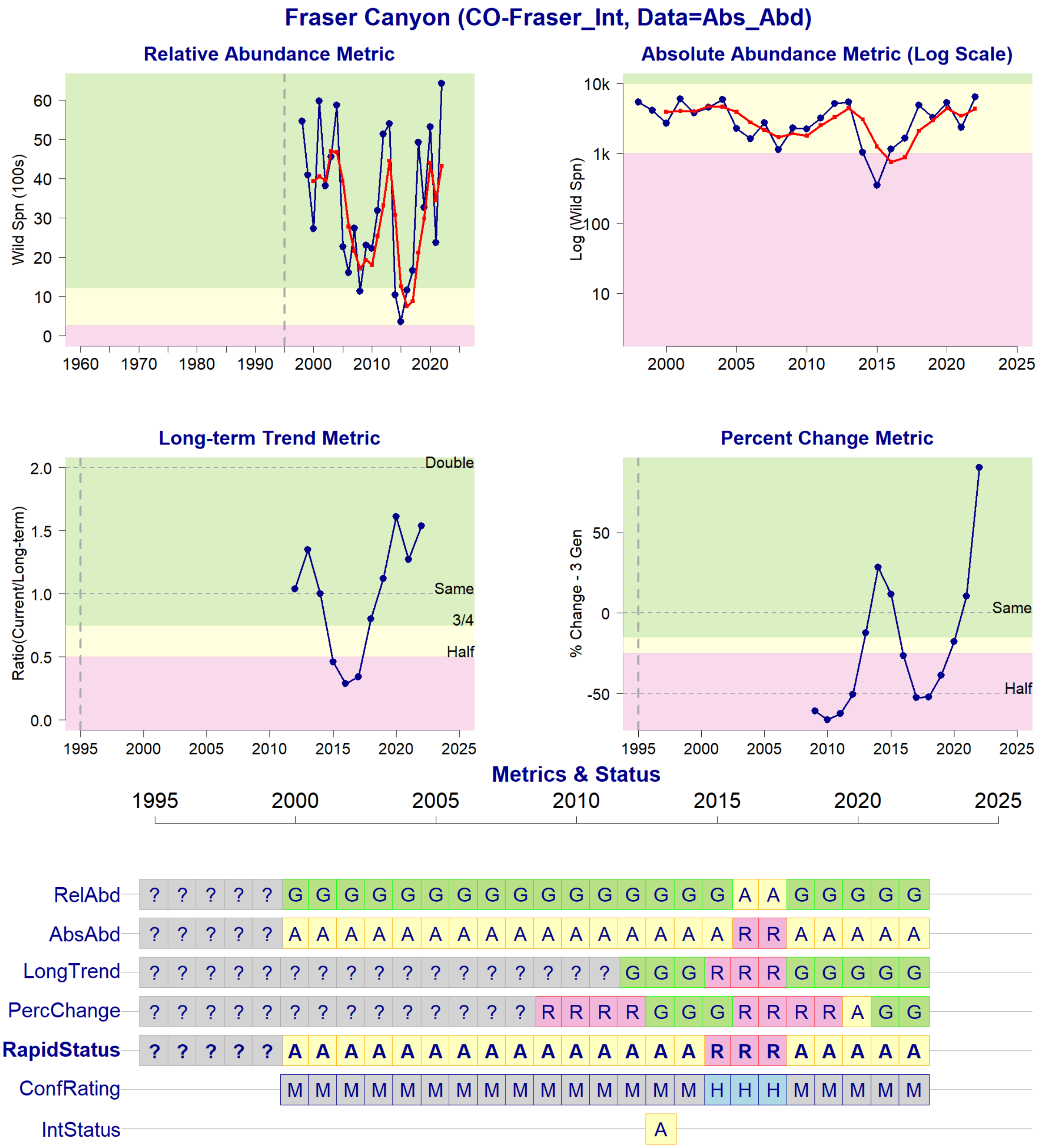

Figure A2.1. Metrics and Status for Fraser Canyon Coho (CO-5). Panels on top show the four standard WSP metrics, calculated based on the available time series of spawner abundances. Bottom panel summarizes the status for each individual metric and shows the resulting rapid status for the CU with a confidence rating. If integrated WSP status assessments have been completed for this CU, they are shown on the last row (IntStatus). In the last integrated assessment, the Fraser Canyon CU was assigned a status of 'Amber'.

Lower Thompson Conservation Unit (CO-7)

In 2022, the Lower Thompson CU status was estimated as ‘Green’ with high-confidence by the Rapid Salmon Scanner (Figure A2.0, A2.2; Table A2.0). The recent generational average falls above the *absolute abundance* lower (1,500) threshold (node 1) and above the *absolute abundance* upper (10,000) threshold (node 2). Following algorithm Pathway 1, there is a *relative abundance* metric for this CU (node 4) and the recent generational average falls above the lower benchmark (S_{gen}) (node 9) and above the upper threshold of 1.1 (the upper benchmark for this metric (80% S_{MSY}). Status for this CU is therefore designated as ‘Green’ with High confidence at Node 36.

During an unpublished expert review (M. Arbeider, DFO Fraser and Interior Stock Assessment, Kamloops, B.C., pers. comm), it was recorded: There was one dissenting expert on the status of Lower Thompson as ‘Green’ who recommended the status be ‘Amber’. One major concern was that although the last three years rapid-status has been ‘Green’, the overall time series is highly variable. Close monitoring of the percent change and abundance levels are required. Additionally, recent and severe fires and drought conditions are expected to negatively impact the spawning and rearing habitats, which will impact the population’s productivity and abundance trajectory. For example, a failure of the Bonaparte fishway due to a fire in 2018 has resulted in near 0 spawner abundances in that system in both 2018 and 2021 (and expected low returns in 2024).

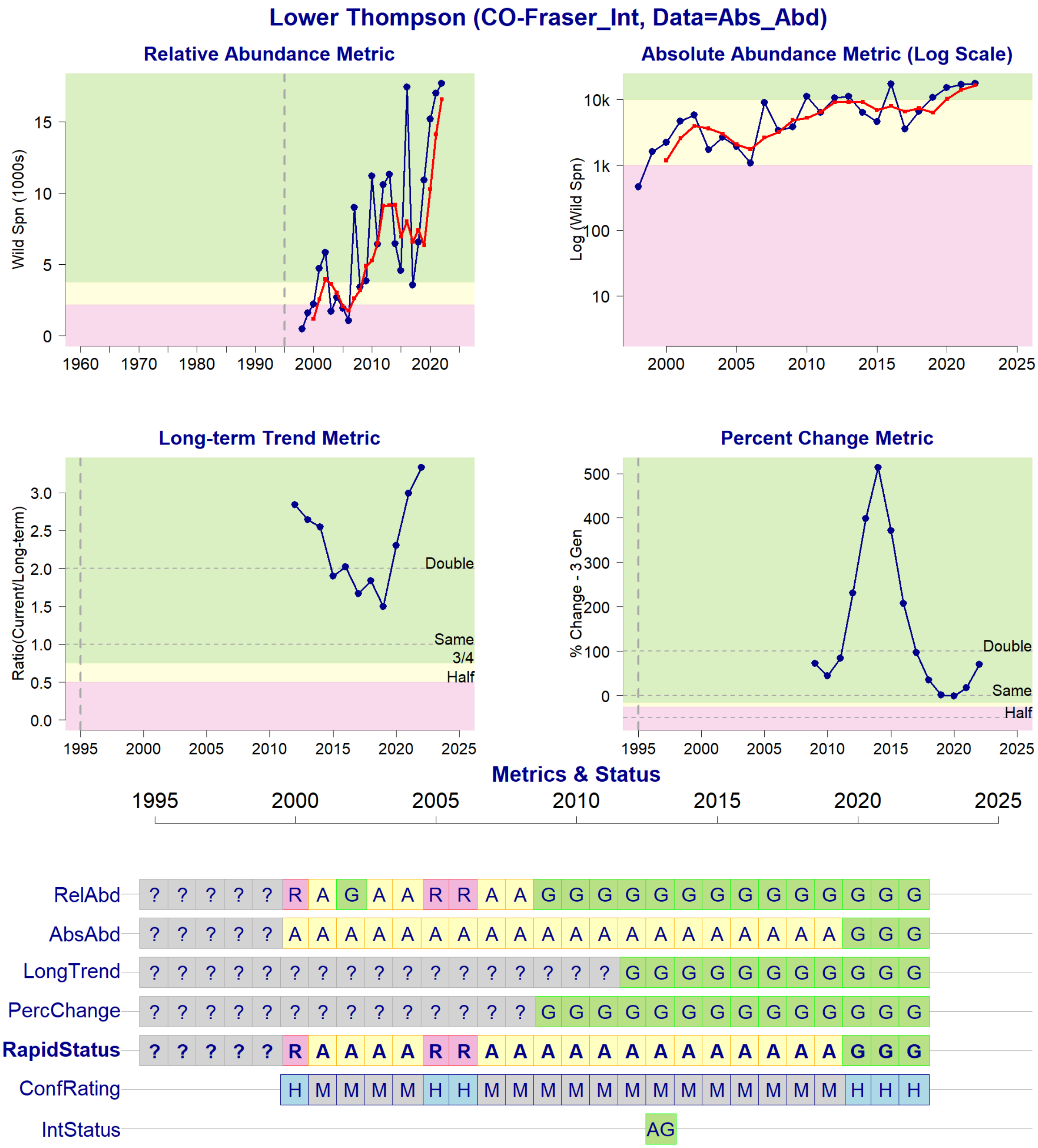

Figure A2.2. Metrics and Status for Lower Thompson Coho (CO-7). Panels on top show the four standard WSP metrics, calculated based on the available time series of spawner abundances. Bottom panel summarizes the status for each individual metric and shows the resulting rapid status for the CU with a confidence rating. If integrated WSP status assessments have been completed for this CU, they are shown on the last row (IntStatus). In the last integrated assessment, the Lower Thompson CU was assigned a status of 'Amber/Green'.

South Thompson Conservation Unit (CO-8)

In 2022, the South Thompson CU status was estimated as 'Green' with high-confidence by the Rapid Salmon Scanner (Figure A2.0, A2.3; Table A2.0). The recent generational average falls above the *absolute abundance* lower (1,500) threshold (node 1) and above the *absolute abundance* upper (10,000) threshold (node 2). Following algorithm Pathway 1, there is a *relative abundance* metric for this CU (node 4) and the recent generational average falls above the lower benchmark (S_{gen}) (node 9) and above the upper threshold of 1.1 (the upper benchmark for this metric (80% S_{MSY}). Status for this CU is therefore designated as 'Green' with High confidence at Node 36.

During an unpublished expert review (M. Arbeider, DFO, Fraser and Interior Stock Assessment, Kamloops, B.C., pers. comm), it was recorded: There was one dissenting expert on the status of South Thompson as 'Green' who recommended the status be 'Amber'. One major concern was that although the last two years rapid-status has been 'Green', the overall time series is highly variable. Close monitoring of the percent change and abundance levels are required. Additionally, recent and severe fires and drought conditions are expected to negatively impact the spawning and rearing habitats, which will impact the population's productivity and abundance trajectory.

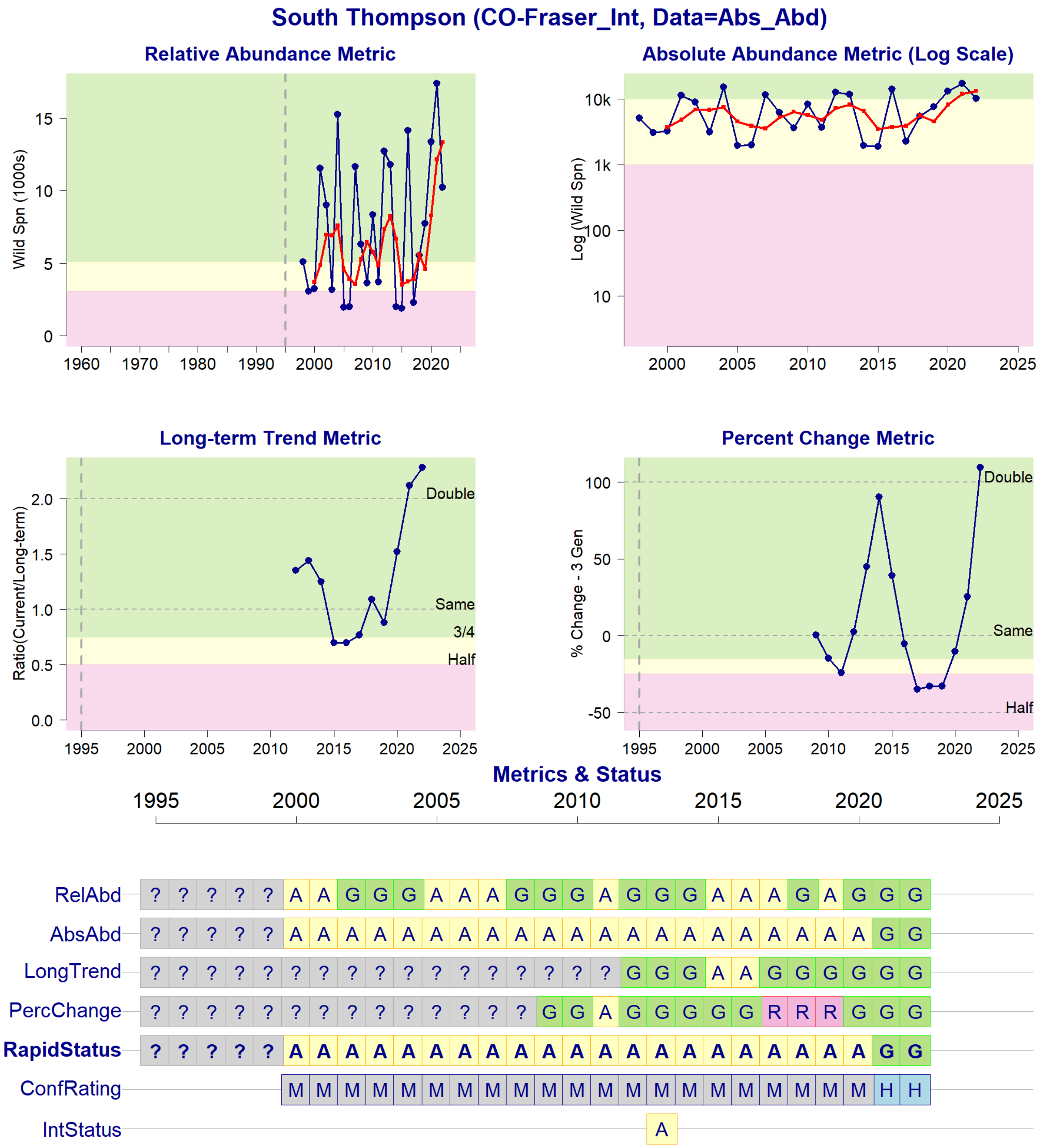

Figure A2.3. Metrics and Status for South Thompson Coho (CO-8). Panels on top show the four standard WSP metrics, calculated based on the available time series of spawner abundances. Bottom panel summarizes the status for each individual metric and shows the resulting rapid status for the CU with a confidence rating. If integrated WSP status assessments have been completed for this CU, they are shown on the last row (IntStatus). In the last integrated assessment, the South Thompson CU was assigned a status of 'Amber'.

North Thompson Conservation Unit (CO-9)

In 2022, the North Thompson CU status was estimated as 'Green' with high-confidence by the Rapid Salmon Scanner (Figure A2.0, A2.4; Table A2.0). The recent generational average falls above the *absolute abundance* lower (1,500) threshold (node 1) and above the *absolute abundance* upper (10,000) threshold (node 2). Following algorithm Pathway 1, there is a *relative abundance* metric for this CU (node 4) and the recent generational average falls above the lower benchmark (S_{gen}) (node 9) and above the upper threshold of 1.1 (the upper benchmark for this metric (80% S_{MSY}). Status for this CU is therefore designated as ‘Green’ with High confidence at Node 36.

During an unpublished expert review (M. Arbeider, DFO, Fraser and Interior Stock Assessment, Kamloops, B.C., pers. comm), it was recorded: There was one uncertain expert on the status of North Thompson as ‘Green’. Recent severe and sustained drought conditions continue to negatively impact spawning and rearing habitat, which will impact the population’s productivity and abundance trajectory.

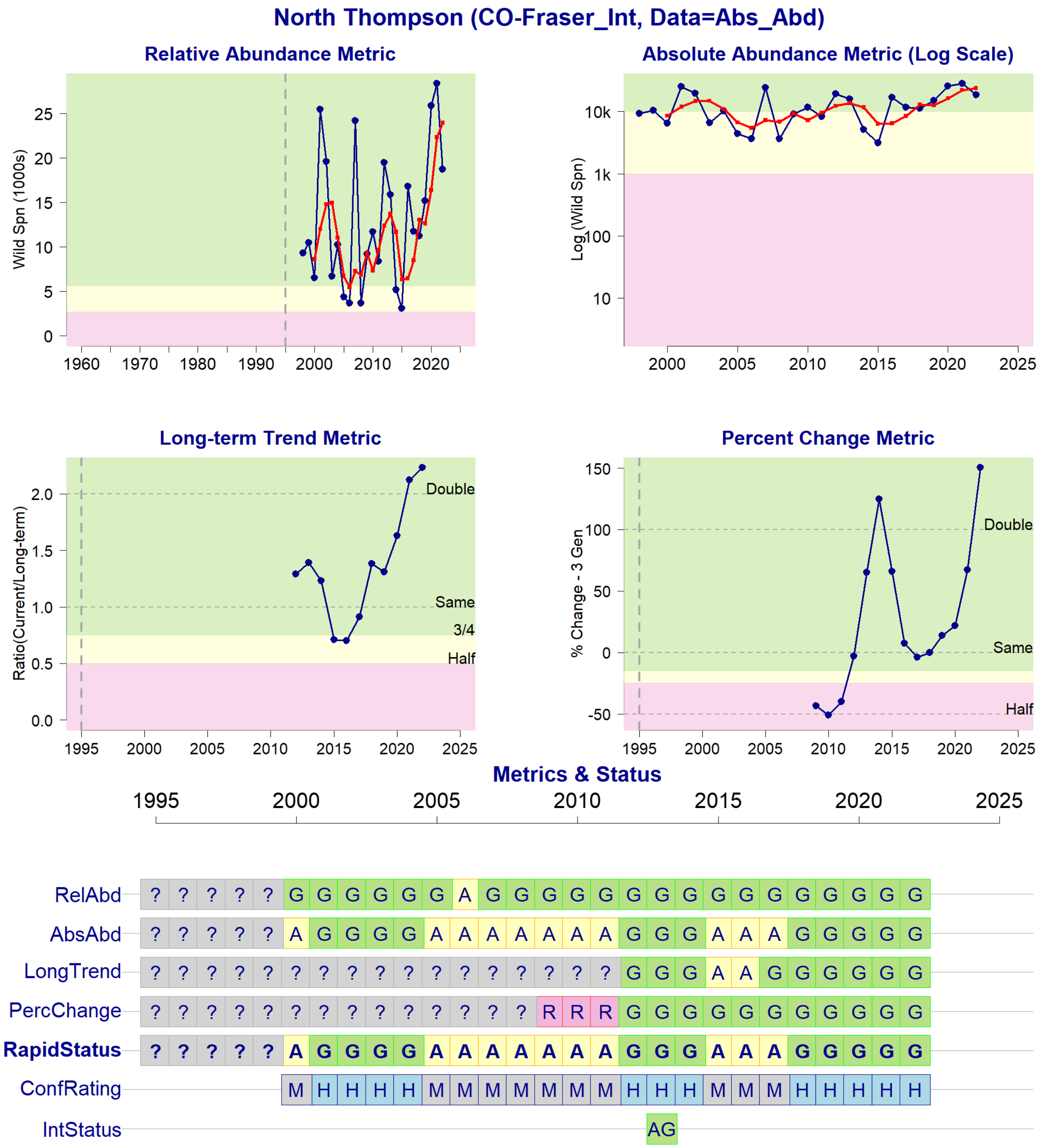

Figure A2.4. Metrics and Status for North Thompson Coho (CO-9). Panels on top show the four standard WSP metrics, calculated based on the available time series of spawner abundances. Bottom panel summarizes the status for each individual metric and shows the resulting rapid status for the CU with a confidence rating. If integrated WSP status assessments have been completed for this CU, they are shown on the last row (IntStatus). In the last integrated assessment, the North Thompson CU was assigned a status of 'Amber/Green'.

Middle Fraser Conservation Unit (CO-48)

In 2022, the Middle Fraser CU status was estimated as 'Green' with high-confidence by the Rapid Salmon Scanner (Figure A2.0, A2.5; Table A2.0). The recent generational average falls above the *absolute abundance* lower (1,500) threshold (node 1) and above the *absolute abundance* upper (10,000) threshold (node 2). Following algorithm Pathway 1, there is a *relative abundance* metric for this CU (node 4) and the recent generational average falls above the lower benchmark (S_{gen}) (node 9) and above the upper threshold of 1.1 (the upper benchmark for this metric (80% S_{MSY}). Status for this CU is therefore designated as 'Green' with High confidence at Node 36.

During an unpublished expert review (M. Arbeider, DFO, Fraser and Interior Stock Assessment, Kamloops, B.C., pers. comm), it was recorded: There were no dissenting experts on the status of Middle Fraser as 'Green'; however, it was stressed that this CU has *just* turned 'Green' based on the generational (three-year) geometric mean abundance being greater than 10,000 for the first time in the time series. Close observation of the percent change and relative distribution between the subpopulations and systems was recommended.

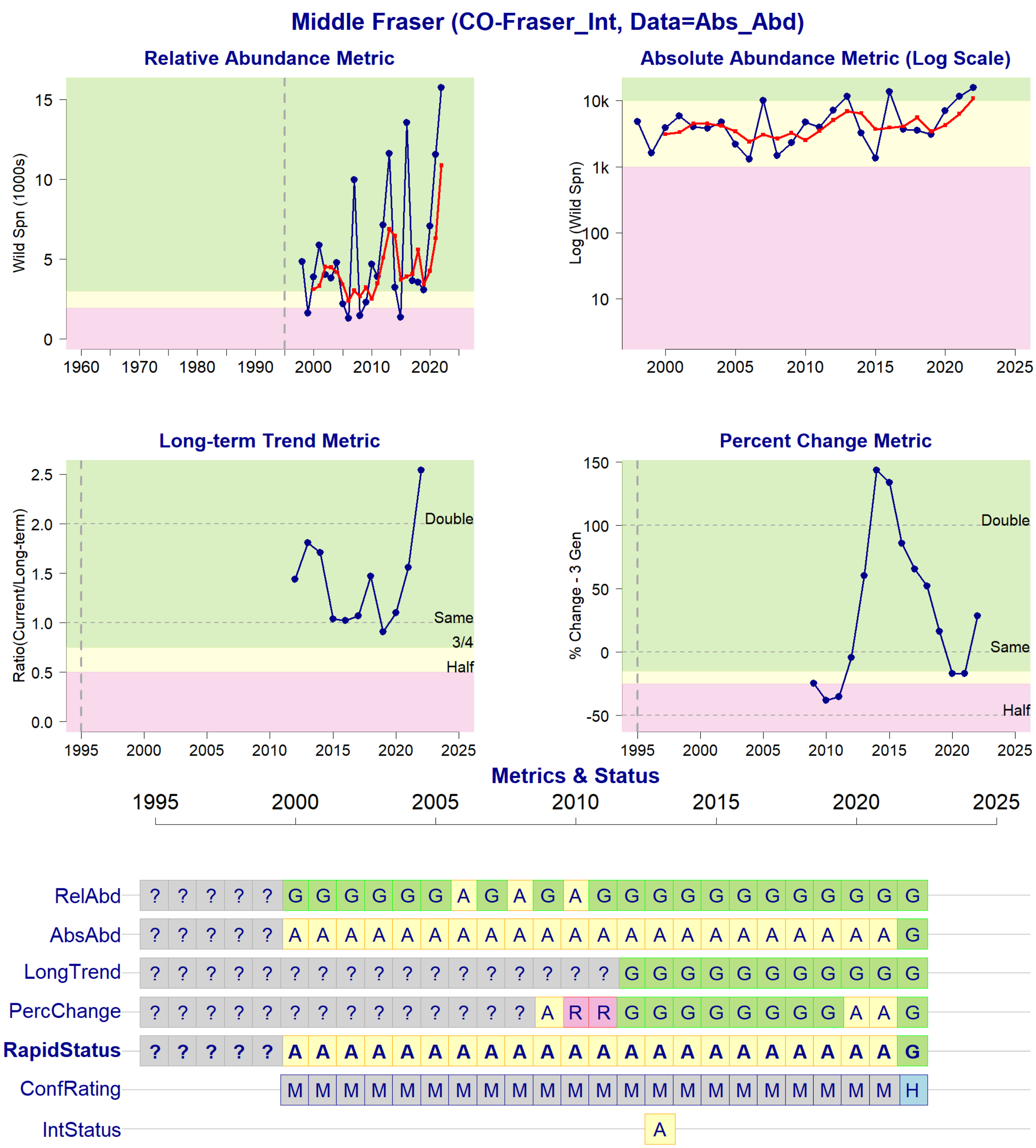

Figure A2.5. Metrics and Status for Middle Fraser Coho (CO-45). Panels on top show the four standard WSP metrics, calculated based on the available time series of spawner abundances. Bottom panel summarizes the status for each individual metric and shows the resulting rapid status for the CU with a confidence rating. If integrated WSP status assessments have been completed for this CU, they are shown on the last row (IntStatus). In the last integrated assessment, the North Thompson CU was assigned a status of 'Amber'.

APPENDIX 3: ALTERNATE STOCK RECRUITMENT ANALYSIS RESULTS

IFC assessments have been limited to using data from 1998 onwards due to reliability/accuracy issues with older data (see Data section within Basis For Assessment). Given that IFC were much more abundant before the population crash in 1990, there is a concern that standard stock-recruitment analysis using a Ricker curve will underestimate the capacity of the population, and thus bias the results of the analysis. To account for reduced estimated capacity in standard analysis, authors of prior assessments combined the posteriors of two Ricker curves fit to IFC data (Arbeider et al. 2020; Holt et al. 2023b): the first is the standard curve without any strong priors, and the second is the same curve fit with strong CU-specific priors on capacity. The CU-specific priors violated an assumption of Bayesian statistics where priors cannot be derived from the data used to fit the model, and in this case the priors on capacity (S_{rep}) were the S_{rep} estimates from the baseline model multiplied by 1.4. Thus, the stock-recruitment based results reported in the main document (i.e., Table 3, the aggregate natural origin abundance targets (see “Ricker” column in Table 6 in Holt et al. 2023b), and the forward simulations that produce the ice cream plots) are derived solely from the baseline Ricker model. For comparison, we report the abundance-based benchmarks/reference points and ice cream plot results below using the previous methods and aggregate targets (see “Combined” column in Table 6 in Holt et al. 2023b).

Table A3.0. Interior Fraser Coho conservation unit (CU) specific abundance-based benchmarks and reference points with credible intervals using the Holt et al. (2023b) approach where the combined posteriors of the stock-recruit relationship with and without a prior on capacity are used to estimate the parameters below.

CU	Benchmark	Mean	2.5% CI	50% CI	97.5% CI
Fraser Canyon	S_{gen}	355	140	321	767
Fraser Canyon	80% S_{MSY}	1140	926	1117	1499
Fraser Canyon	U_{MSY}	0.62	0.41	0.63	0.78
Lower Thompson	S_{gen}	2828	1203	2496	5558
Lower Thompson	80% S_{MSY}	3931	2374	3868	5626
Lower Thompson	U_{MSY}	0.35	0.13	0.36	0.54
Middle Fraser	S_{gen}	1753	967	1633	3188
Middle Fraser	80% S_{MSY}	2688	1917	2604	3856
Middle Fraser	U_{MSY}	0.38	0.23	0.39	0.52
North Thompson	S_{gen}	2981	1526	2725	5655
North Thompson	80% S_{MSY}	5839	4367	5745	7743
North Thompson	U_{MSY}	0.47	0.31	0.48	0.60
South Thompson	S_{gen}	2800	1229	2568	5434
South Thompson	80% S_{MSY}	4277	2740	4282	6022
South Thompson	U_{MSY}	0.39	0.19	0.39	0.56

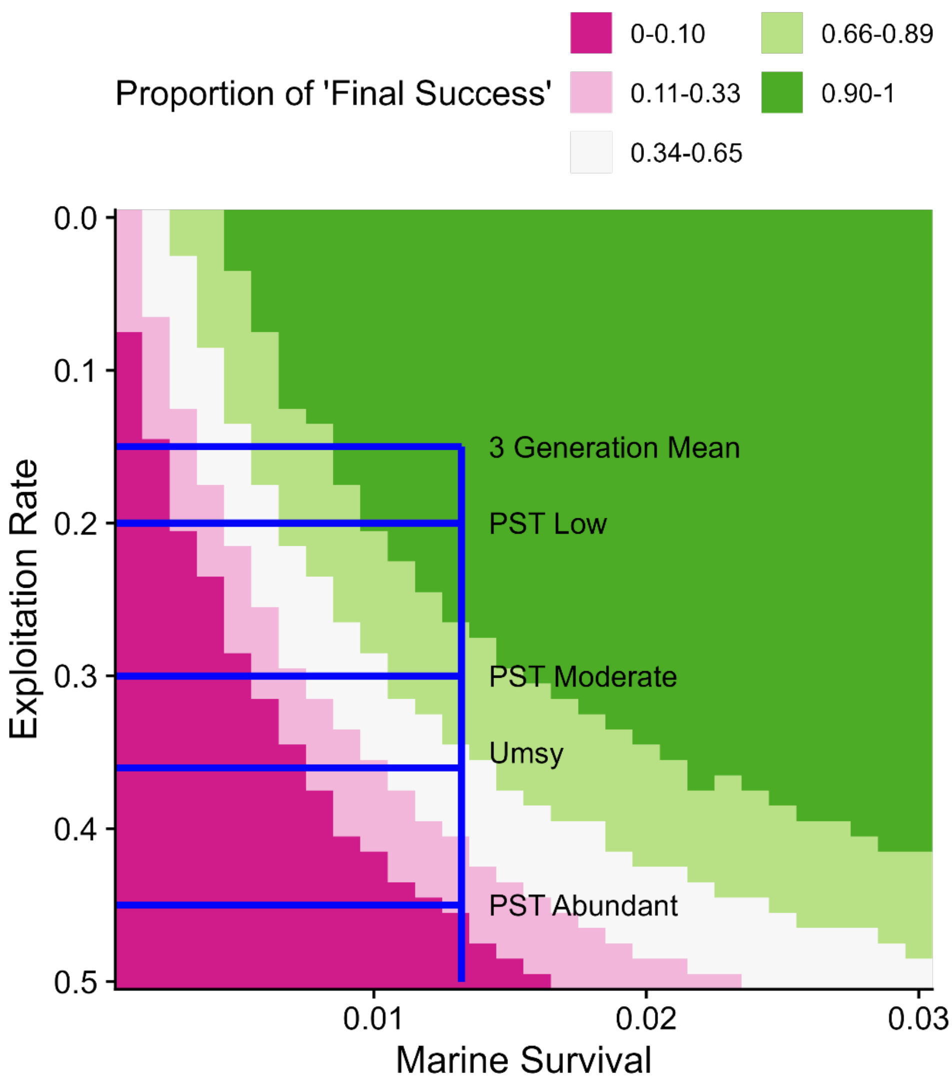

Figure A3.0. Proportion of simulation results where the final 3-year geometric mean was ≥ 33,500 natural origin spawners ('Final Success'). The blue lines intersect at the most recent 3-generation geometric mean smolt-to-adult survival (0.013; vertical blue line) and exploitation rates showing the current 3-generation average, Pacific Salmon Treaty (PST) rates based on IFC abundance, and U_{MSY} as calculated from stock recruit models (see Table 3).

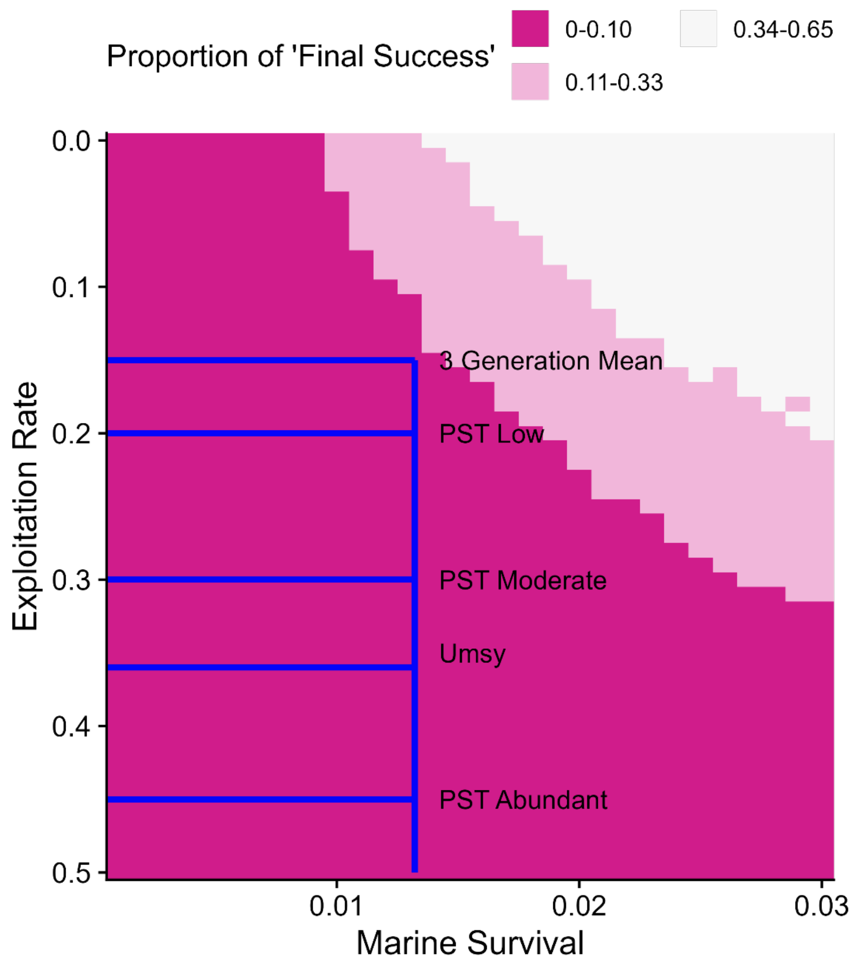

Figure A3.1. Proportion of simulation results where the final 3-year geometric mean was ≥ 65,300 natural origin spawners ('Final Success'). The blue lines intersect at the most recent 3-generation geometric mean smolt-to-adult survival (0.013; vertical blue line) and exploitation rates showing the current 3-generation average, Pacific Salmon Treaty (PST) rates based on IFC abundance, and U_{MSY} as calculated from stock recruit models (see Table 3).

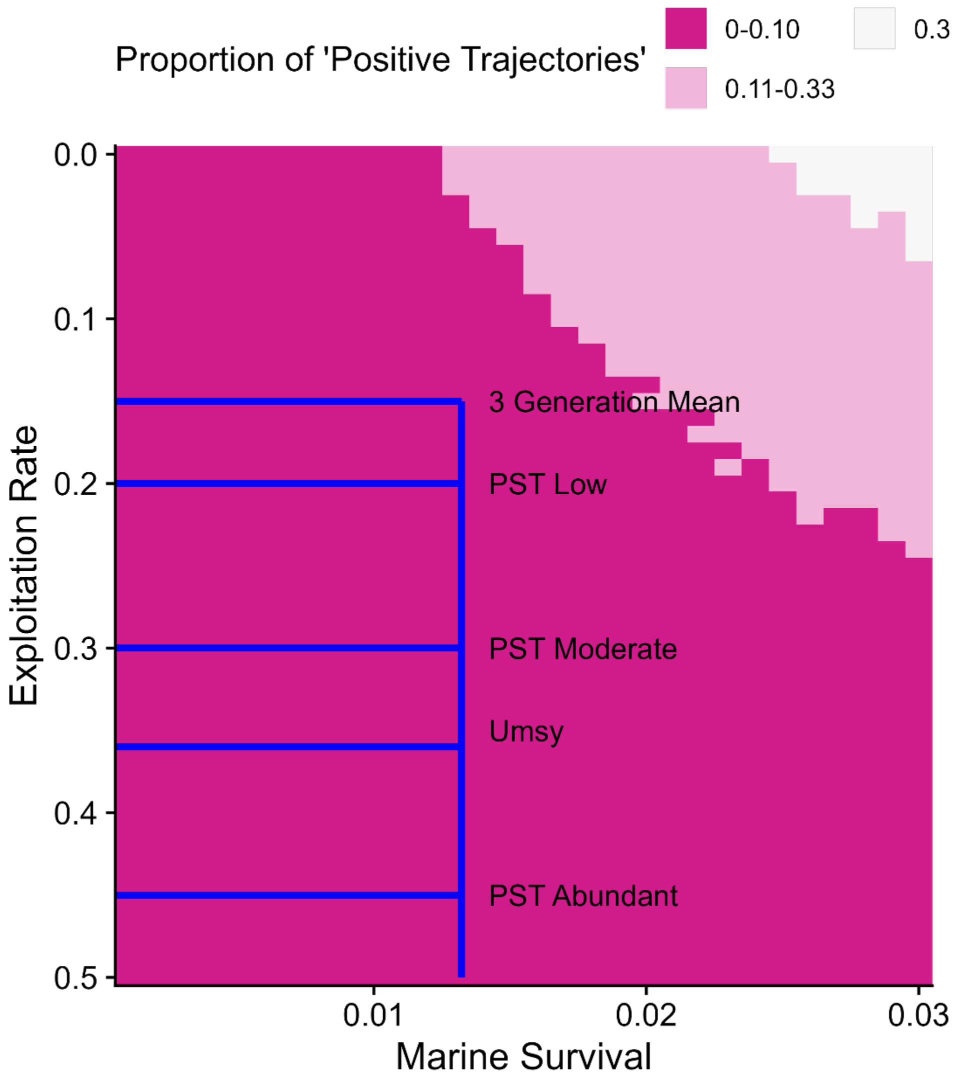

Figure A3.2. Proportion of simulation results where the population trajectory was positive ('Positive Trajectory'). The blue lines intersect at the most recent 3-generation geometric mean smolt-to-adult survival (0.013; vertical blue line) and exploitation rates showing the current 3-generation average, Pacific Salmon Treaty (PST) rates based on IFC abundance, and U_{MSY} as calculated from stock recruit models (see Table 3). Note that simulated abundances at the beginning of simulations are relatively high due to recently high IFC abundances, and thus negative population trajectories are likely.

APPENDIX 4: EXPLOITATION RATE UPDATE

Interior Fraser Coho Exploitation Rates (ER) have been calculated in a variety of ways through time (see Data Section in Basis For Assessment; Tompkins et al. 2013). The most recent methodology, FRAM (Fisheries Regulatory Assessment Model) provides the most consistent estimates of IFC ER, which have been recently validated (Hagen-Breaux et al. 2022). Previously, FRAM was used to estimate IFC ER as far back as 2013 in the dataset. However, in January of 2024 Chuck Parken and Michael Arbeider (DFO, Fraser and Interior Stock Assessment, Kamloops, B.C.) identified that FRAM estimates of ER were available as far back as 2004 (see Tompkins et al. 2013), and updated estimates were available for 2013 – 2016 (M. Arbeider 2024, DFO, Fraser and Interior Stock Assessment and Coho Tech. Comm.; see Tables A4.0-A4.1 for a comparison of previous and current ER estimates). These adjustments were made a) because FRAM is the bilaterally agreed to method for estimating IFC ER to meet Pacific Salmon Treaty requirements, and b) to reduce inconsistency in methods used to estimate IFC ER.

Table A4.0. Comparison of the original ER estimates based on the Canadian Spreadsheet model, and the updated ER estimates based on FRAM. Difference is arithmetic, whereas the absolute percent difference is the arithmetic difference divided by the average of the original and FRAM ERs.

Return Year	Original ER	FRAM ER	Difference	Absolute Percent Difference
2004	13.1%	10.6%	-2.5%	21.4%
2005	13.0%	9.3%	-3.7%	33.1%
2006	9.4%	10.5%	1.1%	10.9%
2007	11.2%	11.9%	0.7%	6.1%
2008	9.8%	9.6%	-0.2%	2.1%
2009	11.5%	14.0%	2.5%	19.6%
2010	10.4%	10.8%	0.4%	3.7%
2011	12.6%	14.2%	1.6%	12.3%
2012	11.2%	14.4%	3.2%	25.1%
Average	11.4%	11.7%	0.3%	3.0%

Table A4.1. Comparison of the original FRAM ER estimates based on year-specific estimates calculated with the data available at the time, and updated FRAM estimates . Difference is arithmetic, whereas the absolute percent difference is the arithmetic difference divided by the average of the original and FRAM ERs.

Return Year	Original ER	Updated FRAM ER	Difference	Absolute Percent Difference
2013	16.2%	20.5%	4.3%	23.3%
2014	31.8%	35.8%	4.0%	11.8%
2015	17.8%	24.0%	6.2%	29.7%
2016	7.3%	9.2%	1.9%	23.0%
Average	18.3%	22.4%	4.1%	20.1%

APPENDIX 5: ASSESSMENT

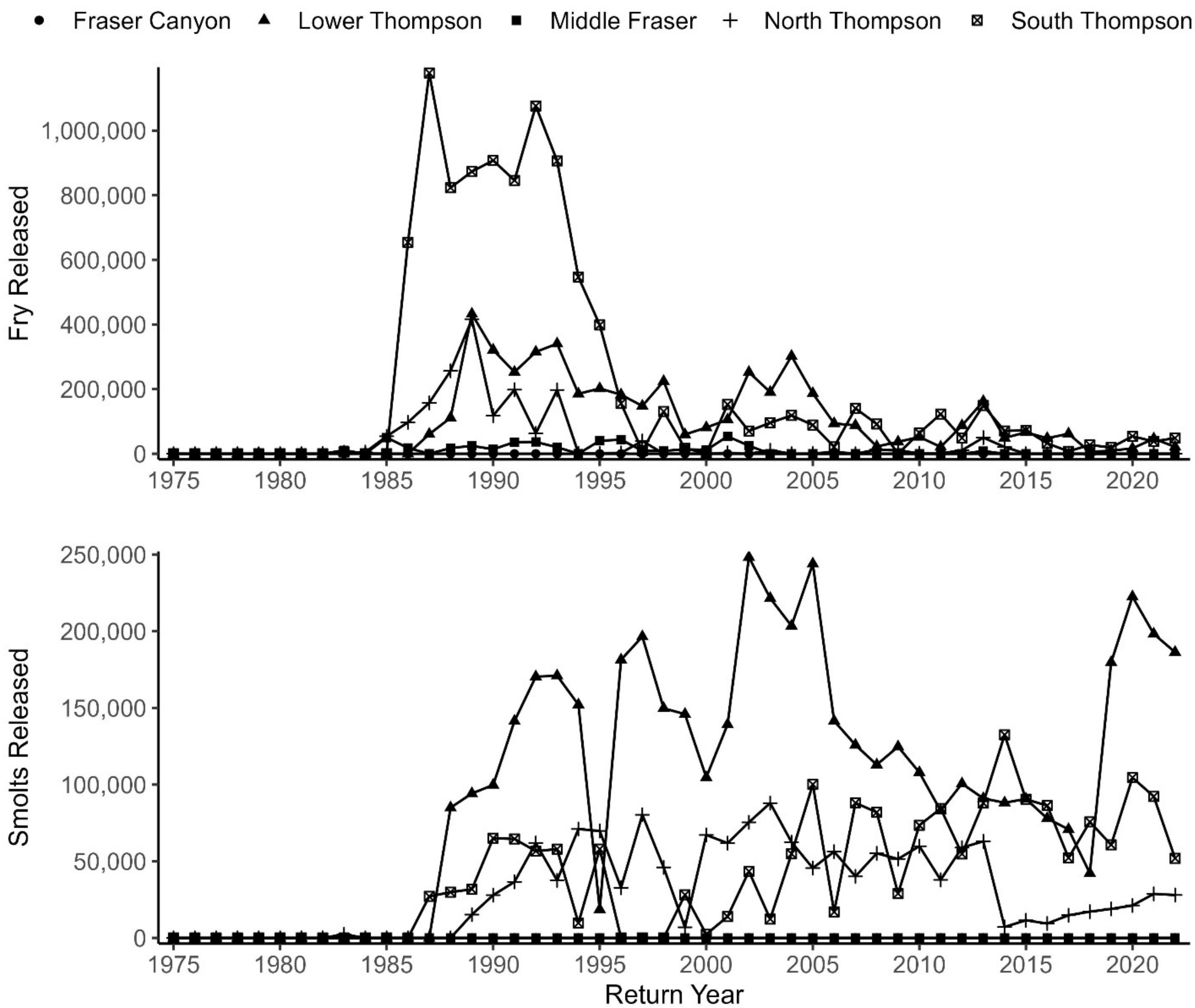

Figure A5.0. Interior Fraser Coho smolt and fry releases within each conservation units (Fraser Canyon, Middle Fraser, Lower Thompson, South Thompson, and North Thompson) from 1975-2022.

Table A5.0. Interior Fraser Coho CU-level natural recruit abundance, and natural spawner abundance for return years 1984 – 2022. Note that data prior to 1998 were not used for stock recruit analysis due to low reliability (see the Data section of Basis For Assessment and Sources Of Uncertainty for details).

Return Year	Conservation Unit	Spawner Abundance	Recruit Abundance
1984	Fraser Canyon	14925	46713
1984	Lower Thompson	6894	21578
1984	Middle Fraser	4726	14792
1984	North Thompson	41654	130374
1984	South Thompson	16946	53040
1985	Fraser Canyon	10084	31561
1985	Lower Thompson	4534	14192
1985	Middle Fraser	5038	15768
1985	North Thompson	18226	57047
1985	South Thompson	18294	57259
1986	Fraser Canyon	11403	33258
1986	Lower Thompson	4819	14056
1986	Middle Fraser	1827	5330
1986	North Thompson	31123	90774

Return Year	Conservation Unit	Spawner Abundance	Recruit Abundance
1986	South Thompson	16786	48958
1987	Fraser Canyon	13187	28495
1987	Lower Thompson	6547	14146
1987	Middle Fraser	3546	7663
1987	North Thompson	30970	66920
1987	South Thompson	17131	37017
1988	Fraser Canyon	16060	55758
1988	Lower Thompson	5176	17969
1988	Middle Fraser	7956	27623
1988	North Thompson	33938	117826
1988	South Thompson	23949	83145
1989	Fraser Canyon	11206	31582
1989	Lower Thompson	3816	10753
1989	Middle Fraser	6651	18745
1989	North Thompson	23496	66219
1989	South Thompson	15194	42821

Return Year	Conservation Unit	Spawner Abundance	Recruit Abundance
1990	Fraser Canyon	7110	26987
1990	Lower Thompson	7277	27622
1990	Middle Fraser	2620	9944
1990	North Thompson	16939	64297
1990	South Thompson	8406	31907
1991	Fraser Canyon	4674	14492
1991	Lower Thompson	5885	18246
1991	Middle Fraser	2842	8811
1991	North Thompson	10639	32983
1991	South Thompson	3179	9857
1992	Fraser Canyon	7506	40498
1992	Lower Thompson	6194	33419
1992	Middle Fraser	6122	33027
1992	North Thompson	14839	80060
1992	South Thompson	12073	65135
1993	Fraser Canyon	2406	19325

Return Year	Conservation Unit	Spawner Abundance	Recruit Abundance
1993	Lower Thompson	14557	116936
1993	Middle Fraser	7600	61047
1993	North Thompson	6438	51718
1993	South Thompson	1949	15657
1994	Fraser Canyon	4348	7673
1994	Lower Thompson	5830	10289
1994	Middle Fraser	1912	3373
1994	North Thompson	14364	25348
1994	South Thompson	4074	7190
1995	Fraser Canyon	3519	8026
1995	Lower Thompson	6104	13924
1995	Middle Fraser	2342	5342
1995	North Thompson	12535	28594
1995	South Thompson	3200	7298
1996	Fraser Canyon	1473	8926
1996	Lower Thompson	1557	9433

Return Year	Conservation Unit	Spawner Abundance	Recruit Abundance
1996	Middle Fraser	1162	7039
1996	North Thompson	5915	35837
1996	South Thompson	1368	8286
1997	Fraser Canyon	1964	3300
1997	Lower Thompson	6473	10877
1997	Middle Fraser	1654	2779
1997	North Thompson	8030	13493
1997	South Thompson	1438	2416
1998	Fraser Canyon	5460	5874
1998	Lower Thompson	2165	595
1998	Middle Fraser	4851	5243
1998	North Thompson	9786	10172
1998	South Thompson	5155	5680
1999	Fraser Canyon	4096	4502
1999	Lower Thompson	3992	2032
1999	Middle Fraser	1652	1768

Return Year	Conservation Unit	Spawner Abundance	Recruit Abundance
1999	North Thompson	10696	11711
1999	South Thompson	3137	3638
2000	Fraser Canyon	2719	2819
2000	Lower Thompson	4739	2537
2000	Middle Fraser	3920	4015
2000	North Thompson	8054	6879
2000	South Thompson	3307	3509
2001	Fraser Canyon	5971	6427
2001	Lower Thompson	9522	5415
2001	Middle Fraser	6162	6334
2001	North Thompson	27238	27553
2001	South Thompson	13063	12641
2002	Fraser Canyon	3817	4141
2002	Lower Thompson	16053	6583
2002	Middle Fraser	4170	4366
2002	North Thompson	22083	21395

Return Year	Conservation Unit	Spawner Abundance	Recruit Abundance
2002	South Thompson	10544	9927
2003	Fraser Canyon	4552	5227
2003	Lower Thompson	2933	2221
2003	Middle Fraser	3809	4374
2003	North Thompson	7211	7840
2003	South Thompson	3422	3701
2004	Fraser Canyon	5872	6568
2004	Lower Thompson	4304	3092
2004	Middle Fraser	4760	5324
2004	North Thompson	10661	11549
2004	South Thompson	15850	17301
2005	Fraser Canyon	2269	2502
2005	Lower Thompson	2614	2289
2005	Middle Fraser	2189	2413
2005	North Thompson	4518	4999
2005	South Thompson	2302	2337

Return Year	Conservation Unit	Spawner Abundance	Recruit Abundance
2006	Fraser Canyon	1605	1793
2006	Lower Thompson	1082	1349
2006	Middle Fraser	1301	1453
2006	North Thompson	3670	4223
2006	South Thompson	2003	2256
2007	Fraser Canyon	2739	3109
2007	Lower Thompson	10169	10360
2007	Middle Fraser	9958	11303
2007	North Thompson	24500	27689
2007	South Thompson	12345	13380
2008	Fraser Canyon	1138	1259
2008	Lower Thompson	3800	3875
2008	Middle Fraser	1464	1619
2008	North Thompson	3849	4127
2008	South Thompson	6688	7213
2009	Fraser Canyon	2308	2684

Return Year	Conservation Unit	Spawner Abundance	Recruit Abundance
2009	Lower Thompson	4768	4630
2009	Middle Fraser	2306	2681
2009	North Thompson	9631	10851
2009	South Thompson	3821	4353
2010	Fraser Canyon	2227	2496
2010	Lower Thompson	12217	12709
2010	Middle Fraser	4689	5257
2010	North Thompson	12159	13231
2010	South Thompson	8946	9537
2011	Fraser Canyon	3189	3717
2011	Lower Thompson	7289	7608
2011	Middle Fraser	3920	4574
2011	North Thompson	8803	9814
2011	South Thompson	4771	4545
2012	Fraser Canyon	5134	5998
2012	Lower Thompson	11559	12506

Return Year	Conservation Unit	Spawner Abundance	Recruit Abundance
2012	Middle Fraser	7126	8325
2012	North Thompson	20058	22836
2012	South Thompson	13303	15057
2013	Fraser Canyon	5398	6790
2013	Lower Thompson	11887	14399
2013	Middle Fraser	11625	14612
2013	North Thompson	16271	20073
2013	South Thompson	13132	15046
2014	Fraser Canyon	1048	1633
2014	Lower Thompson	7447	10212
2014	Middle Fraser	3243	5042
2014	North Thompson	5252	8301
2014	South Thompson	2284	3200
2015	Fraser Canyon	352	463
2015	Lower Thompson	5182	6190
2015	Middle Fraser	1354	1782

Return Year	Conservation Unit	Spawner Abundance	Recruit Abundance
2015	North Thompson	3178	4241
2015	South Thompson	2392	2661
2016	Fraser Canyon	1160	1277
2016	Lower Thompson	18389	19377
2016	Middle Fraser	13540	14982
2016	North Thompson	16914	18555
2016	South Thompson	15206	14892
2017	Fraser Canyon	1657	1835
2017	Lower Thompson	4103	4304
2017	Middle Fraser	3645	4036
2017	North Thompson	11908	13183
2017	South Thompson	2794	2685
2018	Fraser Canyon	4916	5800
2018	Lower Thompson	7152	8141
2018	Middle Fraser	3544	4182
2018	North Thompson	11429	13361

Return Year	Conservation Unit	Spawner Abundance	Recruit Abundance
2018	South Thompson	6141	6854
2019	Fraser Canyon	3259	4162
2019	Lower Thompson	13217	14308
2019	Middle Fraser	3076	3897
2019	North Thompson	15405	19466
2019	South Thompson	8313	9712
2020	Fraser Canyon	5311	6154
2020	Lower Thompson	18406	17803
2020	Middle Fraser	7046	8164
2020	North Thompson	26239	30364
2020	South Thompson	15187	10824
2021	Fraser Canyon	2372	2621
2021	Lower Thompson	23377	19146
2021	Middle Fraser	11555	12768
2021	North Thompson	29189	31121
2021	South Thompson	20280	15452

Return Year	Conservation Unit	Spawner Abundance	Recruit Abundance
2022	Fraser Canyon	6420	7254
2022	Lower Thompson	19647	19051
2022	Middle Fraser	15726	17569
2022	*North Thompson*	*19107*	*20968*
2022	South Thompson	11152	8829

Table A5.1. Interior Fraser Coho Stock Management Unit (SMU)-level smolt-to-adult survival (SAS) and exploitation rate (ER) from return year 1988-2022.

Return Year	Smolt-to-Adult Survival	Exploitation Rate
1988	0.063	0.71
1989	0.059	0.65
1990	0.063	0.74
1991	0.066	0.68
1992	0.072	0.81
1993	0.056	0.88
1994	0.034	0.43
1995	0.008	0.56
1996	0.017	0.83
1997	0.012	0.40
1998	0.012	0.07
1999	0.020	0.09

Return Year	Smolt-to-Adult Survival	Exploitation Rate
2000	0.025	0.04
2001	0.031	0.07
2002	0.036	0.08
2003	0.008	0.13
2004	0.008	0.11
2005	0.003	0.09
2006	0.0001	0.11
2007	0.009	0.12
2008	0.004	0.10
2009	0.009	0.14
2010	0.009	0.11
2011	0.014	0.14
2012	0.011	0.14
2013	0.007	0.21
2014	0.011	0.36
2015	0.007	0.24
2016	0.013	0.09
2017	0.010	0.10
2018	0.014	0.15
2019	0.016	0.22
2020	0.019	0.14
2021	0.032	0.10
2022	0.021	0.15

APPENDIX 6: BYCATCH

Table A6.0. Pacific Salmon bycatch within the Pacific Region groundfish trawl fishery in British Columbia (adapted from Table 2 in Lagasse et al. 2025).

Year	Coho catch	Total salmon catch abundance	Unidentified salmon catch
2008	26	3,209	102
2009	121	9,646	83
2010	65	7,582	151
2011	242	11,081	282
2012	378	8,299	217
2013	289	4,681	567
2014	247	7,299	360
2015	211	8,171	234
2016	400	3,157	200
2017	129	6,839	240
2018	119	9,218	196
2019	146	7,328	294
2020	83	10,002	254
2021	697	14,270	0
2022	613	24,457	122
2023	511	31,941	73

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