

## 2022 PST Post-Season Coho Assessment

This 2022 post-season report includes three tables. Within the tables, pre-season estimates of Management Unit (MU) Exploitation Rate (ER) and escapements were generated with the Pacific Fishery Management Council - North of Falcon (PFMC-NOF) final Coho FRAM run (Fishery Regulation Assessment Model; bc-Coho2229). This model run contained planned US fisheries and anticipated Canadian fisheries. Canadian fisheries plans were developed within the Canadian domestic process, completed by June 2022. Since the planned Canadian fisheries were consistent with anticipated fisheries, the 2022 PFMC-NOF final Coho FRAM run was carried forward as representative of the set of planned fisheries for both countries.

Table 1 summarizes pre-season and post-season information on the abundance, escapement, status, status-specific ER caps and total ER for each MU included under Chapter 5 of the 2019 Pacific Salmon Treaty (PST). The ER cap for each MU was determined by MU status as defined under the PST agreement. In Canada, status and ER caps are only available for the Interior Fraser MU. ER caps for each of the Inside US MUs (Skagit, Stillaguamish, Snohomish, Hood Canal, and US Strait JDF) are based on MU status determined by cohort abundance. ER caps on each of the Outside US MUs (Quillayute Fall, Queets, Hoh, Grays Harbor) are based on cohort abundance and a pre-defined escapement goal range for each MU (with the lower limit of the escapement range determining MU status). The total model estimated ER reported for some MUs differs slightly from the sum of the component ERs of Canadian and southern United States fisheries in Table 1. These discrepancies are the result of not including Southeast Alaska (SEAK) fishery mortality of southern Coho MUs in the ER calculations. Estimates of ER for SEAK fisheries are included in Table 2.

Table 2 provides exploitation rates by country, presenting pre-season caps and planned ERs relative to post-season estimates for each MU in the US and Canada. This table was updated in response to a request from the Southern Panel, such that the table has two parts, one for Southern US and one for Canadian fisheries, arranged vertically. In addition, Table 2 now includes new information: the base ER caps (the ER cap before the intercepting country's unused portion is added to the cap) and the condition of each status, either normal or composite for US low or moderate MUs. The base ER cap for each country was calculated based on PST Coho Chapter 5 paragraph 9 (items b, c, and d). The difference between the ER cap and the modelled pre-season or estimated post-season ER is the unused portion for each country. In accordance with paragraph 9(f), the ER cap of the producing country includes the unused portion from the intercepting country. A negative unused ER means that the modelled or estimated ER exceeded the allowable ER cap for that country.

Table 3 summarizes the US and Canadian exploitation rates for each MU by fishery aggregate as requested by the Pacific Salmon Commission (PSC) Southern Panel.

## Methodology

The assessment of ERs and cohort abundance for PST Coho Salmon MUs for the 2022 return year was conducted using FRAM. The 2022 pre-season FRAM run used forecasts of stock abundance (modelled as recruit scalars) and anticipated total fishery mortality to calculate stock-specific exploitation rates (ERs). Pre-season fishing mortality for US fisheries is planned through the PFMC-NOF process, which occurs annually in March/April.

Post-season FRAM analysis uses observed stock escapements and fishing mortality to reconstruct total cohort abundances (via backwards FRAM), and then estimate MU-fishery-specific ERs. Area 10, 10E, and 11 escapements are preliminary pending final comanager agreement. In addition, stock-specific terminal fishery harvest rates are utilized for the Queets and Quillayute areas (via TAMM). Escapement values shown in the tables are model outputs and may differ slightly from the observed escapements due to the iterative nature of backwards FRAM calculations. For Canadian MUs without Table 1 escapement estimates, post-season abundance scalars were reconstructed using 2022 marine survival estimates from coded wire tag (CWT) indicator stocks. Differences exist in the way ER is estimated in the U.S. domestic planning processes and by the bilateral PSC Coho Technical Committee, including the method of accounting for natural mortality. These differences result in some of the ERs presented in Tables 1 and 2 to differ from values presented for domestic planning in the PFMC-NOF processes in the US.

Canada continues to improve catch monitoring. For the 2022 catch year, First Nations Food Social and Ceremonial (FSC) troll catch in West Coast Vancouver Island (WCVI) was included in the FRAM WCVI troll fisheries. In addition, catch estimates from East Coast Vancouver Island First Nations rod and reel, troll, and net fisheries were included in the appropriate FRAM fisheries.

## Uncertainties with FRAM analysis

Estimates of cohort abundances and ERs are reported as point estimates without explicit measures of uncertainty associated with them. Managers should consider the following data limitations and model assumptions when interpreting FRAM results:

- Cohort abundances and ERs are sensitive to the quality of escapement estimates, with estimation practices varying substantially among stocks. For example, Puget Sound net pens programs often lack escapement estimates. For these programs, pre-season abundances were used or were scaled to a nearby hatchery program using a pre-post ratio.
- Marine survival indices are used to estimate Canadian MU abundances, except for Interior Fraser, in both pre- and post-season FRAM runs because abundance forecasts and escapement estimates are highly uncertain or unavailable for the remaining two Canadian MUs (Lower Fraser and Georgia Strait).

- Average ocean distribution during the FRAM base period (derived using catch year 1986 to 1992 CWT data) may not reflect the true annual ocean distribution of Coho stocks in 2022; this leads to increased uncertainty in fishery-specific stock impacts.
- Complex regulations, such as fine-scale spatial/temporal and mixed retention limits for natural and hatchery Coho within a fishery, are difficult to represent and assess within FRAM and as a result, FRAM may not accurately represent stock-specific impacts within fisheries with these regulations.
- Spatial and temporal gaps in catch monitoring of some Canadian fisheries result in underestimation of catch.
- Uncertainty in mortality estimates arises from several sources, including incomplete creel census and inaccuracy of fisher reported data, as well as assumed non-retention mortality rates, which are used in the FRAM model.
- Natural mortality built into FRAM is constant and does not reflect inter-annual variability in survival during adult ocean residence (January Age-3 through FRAM's final time step).

#### Forecasts and fishery implementation

Coast-wide 2022 pre-season abundance forecasts varied across all MUs: two MUs were in the *Low* status category (Interior Fraser, US Strait of Juan de Fuca), two were in the *Moderate* status category (Snohomish, Hood Canal), and the remainder were in *Abundant* status including all of the outside MUs (Queets, Quillayute, Hoh, Grays Harbor), and Skagit, and Stillaguamish based on predictors of cohort success. The 2022 forecasts were informed by many factors including estimates of smolt abundance and environmental indicators.

In general, 2022 fisheries were constrained by the allowable ER Caps for MUs in *Low* status: US Strait of Juan de Fuca and the Interior Fraser MU in Canada. Canadian fisheries were managed for an exploitation rate of 3-5% on Interior Fraser Coho salmon, less than the 10% ceiling allowed under the PST. In the US, Coho salmon ocean fisheries were constrained by meeting conservation objectives for Interior Fraser Coho and rebuilding objectives for Snohomish, Queets, and the Strait of Juan de Fuca Coho MUs (PFMC 2023). In addition, conservation concerns for Chinook salmon caught in Coho fisheries and fine-scale distributional changes in fishing effort both resulted in reduced ERs for some Coho MUs.

Results of the post-season FRAM run show good forecast performance with all MUs remaining in the same status pre- and post-season except for US Juan de Fuca (Table 1). The US Juan de Fuca MU changed from *Low* pre-season status to *Moderate* in the post-season as a result of higher abundance than expected. While the Hood Canal MU remained in *Moderate* status, the post-season ER estimate exceeded the ER cap of 45% for this status.

The status of Interior Fraser Coho remains *Low* (Table 1) despite its relatively high abundance (80,317) because the reference management point under the PST includes abundance and survival metrics that need to be met in three consecutive years before

status may change. The aggregate abundance metric has been met in recent years, but the survival metric for *Moderate* status (> 3%) has been met only in 2021 (3.2%). The Interior Fraser Coho survival metric was 1.7% for return year 2022.

All MUs except Hood Canal had post-season exploitation rates below the ER caps based on post season abundance categories. Post season cohort abundances all exceeded preseason forecasts, except for Interior Fraser, Hood Canal, Queets, and Grays Harbor (Table 1). For the Stillaguamish, US JDF, and Hoh MUs, the post-season cohort abundance was roughly double that of the pre-season.

Unexpectedly large returns of Coho salmon in 2022 likely benefited from favorable ocean and freshwater conditions due to consecutive La Niñas in winters of 2020/2021 and 2021/2022, while escaping the worst impacts of the 2021 terrestrial heat wave and marine heat waves in 2021 and 2022. These favorable conditions included above average snowpack in the Pacific Northwest, high spring river flows, and exceptionally productive coastal waters during spring 2021, when the 2022 adult cohort entered marine waters. Most Coho smolts from the 2022 cohort were in the ocean when the record-shattering terrestrial heat wave occurred in late June 2021, and thus avoided many of the severe impacts to freshwater habitats. Although marine heat waves were present in the Northeast Pacific in summers of 2021 and 2022, the 2021 event was relatively small compared to previous heat waves, and both heat waves remained offshore for most of the summer, resulting in a coastal buffer from warm water.

#### Literature Cited

Pacific Fishery Management Council. 2023. Review of 2022 Ocean Salmon Fisheries: Stock Assessment and Fishery Evaluation Document for the Pacific Coast Salmon Fishery Management Plan. (Document prepared for the Council and its advisory entities).

**Pre-season DB:** PSC\_CoTC\_Preseason\_CohoFRAMDB\_thru2023\_050223.mdb, **Pre-season run name:** bc-Coho2229

**Post-season DB:** PSC\_CoTC\_PostSeason\_CohoFRAMDB\_thru2022\_02202024.mdb, **Post-season run name:** bc-bkFRAM\_a\_7\_b\_3

**Table 1: Summary of the 2022 return to natural spawning Coho Management Units.** Total exploitation rate (ER) represents the sum of US and Canadian exploitation rates on each Management Unit (MU). Status (i.e., “L”ow, “M”oderate, “A”bundant) is based on cohort abundance. Pre-season status is based on agency forecasts of MU cohort abundance and post-season status is based on backwards Coho FRAM run reconstruction of cohort abundances. The ER Cap on the Interior Fraser MU is 20% due to its Low MU status, which has a survival component in addition to escapement. ER Caps are not available for other Canadian MUs. ER Caps on each of the Inside US MUs (Skagit, Stillaguamish, Snohomish, Hood Canal, and US Strait JDF) are based on MU status, which is determined by cohort abundance. ER Caps on each of the Outside US MUs (Quillayute Fall, Queets, Hoh, Grays Harbor) are based on cohort abundance and the escapement goals for each MU. Outside US MUs are managed for an escapement range; the floor of the escapement range is used for MU status determination. Pre-season modelled ERs are the result of US and Canadian fishery planning processes. Post-season estimated ERs are generated from backwards Coho FRAM. Cohort abundance is the ocean age-3 abundance and represents escapement plus fishery mortality, but not natural mortality.

Management Unit	Pre-Season total ER			Post-Season total ER			Escapement		Abundance (Ocean Age-3)	
	Status	Cap	Model	Status	Cap	Model	Pre	Post	Pre	Post
Lower Fraser			16.0%			10.1%				
Interior Fraser	L	20.0%	14.4%	L	20.0%	12.2%	71,943	70,314	84,020	80,122
Georgia Strait			10.9%			8.1%				
Skagit	A	60.0%	43.2%	A	60.0%	25.6%	45,869	92,309	80,810	124,050
Stillaguamish	A	50.0%	36.1%	A	50.0%	9.9%	16,017	53,828	25,053	59,710
Snohomish	M	40.0%	33.7%	M	40.0%	8.1%	42,871	85,694	64,621	93,201
Hood Canal	M	45.0%	44.3%	M	45.0%	54.1%	11,350	9,190	20,368	20,007
US Strait JDF	L	20.0%	10.9%	M	40.0%	7.7%	6,519	16,976	7,319	18,396
Quillayute	A	49.7%	37.4%	A	61.3%	21.7%	7,842	12,744	12,525	16,266
Hoh	A	57.6%	53.6%	A	82.9%	30.4%	2,187	8,136	4,712	11,686
Queets	A	68.3%	36.3%	A	67.4%	32.0%	11,673	12,118	18,324	17,812
Grays Harbor	A	70.7%	50.2%	A	54.8%	28.9%	60,210	55,654	120,833	78,247

**Table 2: Exploitation rates by country for the 2022 return year.** US Exploitation Rates: For US ER on Canadian Management Units (MU), a 10% ER Cap for Interior Fraser Coho is allowable under the PSC Coho agreement based on Low status. ER Caps are not defined for other Canadian MUs because status is not available. Canadian Exploitation Rates: For Canadian ER Caps on US MUs, the pre-season ER Caps are the total allowable ER under the PSC Coho agreement. For Canadian ER Caps on Canadian MUs, a 10% ER Cap for Interior Fraser Coho is allowable under the PSC Coho agreement. Pre-season ERs reflect combined US and Canadian pre-season planning processes and do not include estimates of impacts in Canadian freshwater fisheries. Pre-season unused ERs are the difference between the ER Caps and modelled values. Post-season ER Caps and unused ERs are comparable to pre-season values except that they are based on post-season cohort abundance and associated MU status. Post-season estimated ERs are generated from backwards Coho FRAM. A negative value for unused ERs indicates that the post-season estimate exceeded the allowable ER Cap.

Exploitation Rate for Southern U.S.* Fisheries												
Management Unit	Pre-Season						Post-Season					
	Status <sup>§</sup>	Base Cap <sup>†</sup>	CDN unused	Cap + Unused <sup>‡</sup>	Model	Unused	Status <sup>§</sup>	Base Cap <sup>†</sup>	CDN Unused	Cap + Unused <sup>‡</sup>	Model	Unused
Lower Fraser					11.2%							5.7%
Interior Fraser	L	10.0%			9.5%	0.5%	L	10.0%			6.4%	3.6%
Georgia Strait					3.9%						2.3%	
Skagit	A	34.8%	23.5%	58.3%	41.5%	16.8%	A	34.8%	22.1%	56.9%	22.5%	34.4%
Stillaguamish	A	27.6%	21.3%	48.9%	35.0%	13.9%	A	27.6%	20.6%	48.2%	8.1%	40.1%
Snohomish	NM	22.4%	16.5%	38.9%	32.6%	6.3%	NM	22.4%	15.8%	38.2%	6.3%	31.9%
Hood Canal	NM	26.7%	16.3%	43.0%	42.3%	0.8%	NM	26.8%	14.8%	41.5%	50.6%	-9.1%
US Strait JDF	CL	7.0%	11.5%	18.5%	8.9%	9.6%	NM	22.4%	15.5%	37.9%	5.3%	32.6%
Quillayute	A	28.4%	20.6%	49.0%	36.6%	12.4%	A	35.6%	24.6%	60.2%	20.5%	39.7%
Hoh	A	33.3%	21.8%	55.1%	50.7%	4.4%	A	49.0%	30.5%	79.5%	26.8%	52.7%
Queets	A	40.0%	26.3%	66.2%	34.0%	32.2%	A	39.4%	24.5%	63.9%	28.4%	35.6%
Grays Harbor	A	41.4%	28.1%	69.5%	48.5%	21.0%	A	31.6%	21.7%	53.2%	27.1%	26.1%

Exploitation Rate for Canadian Fisheries												
Management Unit	Pre-Season						Post-Season					
	Status <sup>§</sup>	Base Cap <sup>†</sup>	US unused	Cap + Unused <sup>‡</sup>	Model	Unused	Status <sup>§</sup>	Base Cap <sup>†</sup>	US Unused	Cap + Unused <sup>‡</sup>	Model	Unused
Lower Fraser					4.8%							4.4%
Interior Fraser	L	10.0%	0.5%	10.5%	4.6%	5.8%	L	10.0%	3.6%	13.6%	5.7%	7.9%
Georgia Strait					6.6%						5.5%	
Skagit	A	25.2%			1.7%	23.5%	A	25.2%			3.1%	22.1%
Stillaguamish	A	22.4%			1.1%	21.3%	A	22.4%			1.8%	20.6%
Snohomish	NM	17.6%			1.1%	16.5%	NM	17.6%			1.8%	15.8%
Hood Canal	NM	18.2%			2.0%	16.3%	NM	18.2%			3.5%	14.8%
US Strait JDF	CL	13.0%			1.5%	11.5%	NM	17.6%			2.1%	15.5%
Quillayute	A	21.3%			0.7%	20.6%	A	25.7%			1.1%	24.6%
Hoh	A	24.3%			2.5%	21.8%	A	33.9%			3.4%	30.5%
Queets	A	28.4%			2.1%	26.3%	A	28.0%			3.5%	24.5%
Grays Harbor	A	29.3%			1.2%	28.1%	A	23.2%			1.5%	21.7%

\*Southern U.S. is limited to US fisheries south of the Canadian border.

<sup>§</sup>Southern US MUs that are in Low or Moderate status are assigned a "N"ormal or "C"omposite condition. See PST (<https://www.psc.org/about-us/history-purpose/pacific-salmon-treaty/>) chapter 5 paragraphs 9 (b) and (c).

<sup>†</sup>The base ER cap before the unused portion from the intercepting party is included. See PST chapter 5 paragraphs 8 through 9.

<sup>‡</sup>Contains the treaty ER cap plus the unused portion of the intercepting party's ER. For example, in the pre-season, Skagit includes US share plus the unused 23.5% Canadian allocation, totaling 58.3% total US allocation.

Table 3: Post-season summary exploitation rates, escapements, and cohort abundances for naturally spawning Coho MUs in 2022.

Fishery Name	Lower Fraser	Interior Fraser	Georgia Strait	Skagit	Stillaguamish	Snohomish	Hood Canal	US Strait JDF	Quillayute	Hoh	Queets	Grays Harbor
<b>BC No/Cent Troll</b>	0.1%	0.1%	0.3%	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%	0.3%	0.3%	0.3%
<b>BC No/Cent Net</b>	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
<b>BC No/Cent Sport</b>	0.1%	0.1%	0.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%
<b>BC WCVI Troll</b>	1.1%	1.2%	0.4%	0.6%	0.4%	0.4%	1.2%	0.8%	0.7%	1.3%	1.0%	0.4%
<b>BC WCVI Net</b>	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
<b>BC WCVI Sport</b>	1.3%	1.3%	2.8%	2.0%	1.2%	1.2%	1.7%	0.9%	0.2%	1.7%	2.2%	0.8%
<b>BC JnstStr Sport</b>	0.1%	0.1%	0.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
<b>BC GeoStr Spt &amp; Trl</b>	0.4%	0.2%	0.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
<b>BC GeoStr Net</b>	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
<b>BC JDF Sport</b>	1.1%	0.7%	0.6%	0.5%	0.2%	0.2%	0.5%	0.3%	0.1%	0.0%	0.0%	0.0%
<b>BC Fraser FW &amp; Spt</b>	0.4%	2.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
<b>BC</b>	4.4%	5.7%	5.5%	3.1%	1.8%	1.8%	3.5%	2.1%	1.1%	3.4%	3.5%	1.5%
<b>WA Ocn Troll</b>	1.0%	2.4%	0.4%	1.9%	1.4%	1.4%	1.7%	1.6%	1.7%	4.8%	3.9%	2.8%
<b>WA Ocn Sport</b>	0.1%	0.3%	0.1%	0.3%	0.2%	0.2%	0.4%	0.2%	0.4%	1.5%	2.4%	1.8%
<b>SOF All</b>	0.0%	0.1%	0.0%	0.1%	0.1%	0.1%	0.1%	0.3%	0.2%	0.6%	1.0%	0.6%
<b>US JDF All</b>	0.6%	0.6%	0.3%	0.9%	0.6%	0.6%	1.4%	2.7%	0.1%	0.3%	0.2%	0.1%
<b>SanJnIsl Net</b>	3.9%	2.7%	1.5%	0.7%	0.1%	0.1%	0.1%	0.1%	0.0%	0.0%	0.1%	0.0%
<b>SanJnIsl Sport</b>	0.0%	0.2%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
<b>PS Sport (8-13)</b>	0.0%	0.1%	0.1%	2.6%	1.1%	1.2%	11.5%	0.1%	0.0%	0.1%	0.0%	0.0%
<b>PS Net (8-13)</b>	0.0%	0.0%	0.0%	0.9%	2.5%	2.7%	27.0%	0.2%	0.0%	0.0%	0.1%	0.0%
<b>FW Net &amp; Sport</b>	0.0%	0.0%	0.0%	15.2%	2.1%	0.1%	8.4%	0.0%	18.0%	19.5%	20.7%	21.9%
<b>Southern U.S.</b>	5.7%	6.4%	2.3%	22.5%	8.1%	6.3%	50.6%	5.3%	20.5%	26.8%	28.4%	27.1%
<b>SEAK All</b>	0.0%	0.1%	0.3%	0.0%	0.0%	0.0%	0.0%	0.3%	0.0%	0.2%	0.1%	0.2%
<b>TOTAL</b>	10.1%	12.2%	8.1%	25.6%	9.9%	8.1%	54.1%	7.7%	21.7%	30.4%	32.0%	28.9%
<b>escapement</b>	70,195 <sup>*</sup>	70,314	118,038 <sup>‡</sup>	92,309	53,828	85,694	9,190	16,976	12,744	8,136	12,118	55,654
<b>cohort</b>	78,084 <sup>†</sup>	80,122	128,394 <sup>†</sup>	124,050	59,710	93,201	20,007	18,396	16,266	11,686	17,812	78,247

\*Modelled values of terminal run size occurring after lower Fraser in river fisheries.

†Modelled values of terminal run size that are not directly estimated.

‡Modelled values that are not directly estimated.