TCCHINOOK (25-01)

2024 Exploitation Rate Analysis

Prepared by the

CHINOOK TECHNICAL COMMITTEE

for the

PACIFIC SALMON COMMISSION

January 2025

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List of Acronyms and Abbreviations[1]

3YA	Running 3-year Calendar Year Exploitation Rate Average	**IM**	Incidental Mortality
AABM	Aggregate Abundance-Based Management	**ISBM**	Individual Stock-Based Management
ADF&G	Alaska Department of Fish & Game	**MSF**	Mark-Selective Fishery
AEQ	Adult Equivalent	**N**	Net
AWG	Analytical Working Group of the CTC	**NBC**	Northern BC Dixon Entrance to Kitimat including Haida Gwaii
BC	British Columbia	**NOAA**	National Oceanic and Atmospheric Administration
BY	Brood Year	**NWIFC**	Northwest Indian Fisheries Commission
BYER	Brood Year Exploitation Rate	**ODFW**	Oregon Department of Fish & Wildlife
CAS	Cohort Analysis System	**OR**	Oregon
CAMP	Chinook Analysis and Modelling Platform database	**PFMA**	Pacific Fishery Management Area
CBC	Central British Columbia	**PFMC**	Pacific Fishery Management Council
CETL	Chinook Extract, Transform, and Load Executable	**PSC**	Pacific Salmon Commission
CIG	Chinook Interface Group	**PST**	Pacific Salmon Treaty
CNR	Chinook Nonretention	**QIN**	Quinault Indian Nation
CRITFC	Columbia River Intertribal Fish Commission	**RM**	Release Mortality
CTC	Chinook Technical Committee	**RMIS**	Regional Mark Information System
CWT	Coded-wire Tag	**ROM**	Ratio of Means
CY	Calendar Year	**S**	Sport
CYER	Calendar Year Exploitation Rate	**SACE**	Stock Aggregate Cohort Evaluation
CYER WG	Calendar Year Exploitation Rate Work Group	**SEAK**	Southeast Alaska Cape Suckling to Dixon Entrance
CYM	Calendar Year Mortalities	**SFEC**	Selective Fishery Evaluation Committee
DFO	Department of Fisheries and Oceans Canada	**SIT**	Single Index Tag
DIT	Double Index Tag	**SPFI**	Stratified Proportional Fishery Index
EIS	Escapement Indicator Stock	**T**	Troll
ERA	Exploitation Rate Analysis	**TAM**	Terminal Adjustment Methods
ERIS	Exploitation Rate Indicator Stock	**TBD**	To Be Determined
ETD	Electronic tag detection	**TBR**	Transboundary Rivers
FI	Fishery indices	**UAF**	University of Alaska Fairbanks
FNC	First Nations Caucus	**U.S.**	United States
IDF&G	Idaho Department of Fish & Game	**USFWS**	U.S. Fish & Wildlife Service
IM	Incidental Mortality	**WA**	Washington
		WDFW	Washington Department of Fish & Wildlife

[1] Stock acronyms can be found in Table 2.1 and Appendix A.

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Executive Summary

Chapter 3 of the 2019 Pacific Salmon Treaty (PST) Agreement requires the Chinook Technical Committee (CTC) to report annual catches, harvest rate indices, estimates of incidental mortality (IM) and exploitation rates for all Chinook salmon fisheries and stocks harvested within the Treaty area. The CTC provides annual reports to the Pacific Salmon Commission (PSC) to fulfill this obligation under Chapter 3 of the Treaty. This report contains five sections: an introduction and description of the Chapter 3 2019 PST Agreement requirements related to the annual exploitation rate analysis (ERA) based on coded-wire tag (CWT) data (Section 1); a review of the ERA methods (Section 2); a presentation of the results from the annual ERA (Section 3); a performance evaluation of individual stock-based management (ISBM) fisheries (Section 4); and CWT analyses for mark-selective fisheries (MSFs; Section 5). This report includes the results of the 2024 annual ERA using CWT data through 2022 for Southern U.S. stocks and 2023 for Alaskan and Canadian stocks.

Paragraph 2(b)(vii) directs the CTC to provide stock-specific impacts for MSFs. For the first time, MSF algorithms have been incorporated into the ERA, which are a major update that allows the CTC to provide results based on unmarked (natural-origin) stocks as opposed to previous ERAs which produced results for the marked (hatchery-origin) stocks only.

Exploitation Rate Analysis

Section 2 of this report provides an overview of the ERA methodology. The CTC currently monitors 45 CWT ERA stocks, of which 31 are listed in Attachment I of Chapter 3 as calendar year exploitation rate (CYER) indicators of ISBM fishery performance. The ERA relies on cohort analysis of CWT recoveries, a procedure that reconstructs the cohort size and exploitation history of a given stock and brood year (BY) using representative CWT data as a proxy (CTC 1988). The ERA provides brood- and stock-specific estimates of total, age- and fishery-specific exploitation rates, maturation rates, smolt to age-2 or age-3 survival rates, annual distributions of fishery mortalities used to compute CYERs, and fishery indices for aggregate abundance-based (AABM) fisheries.

Estimates of age- and fishery-specific exploitation and maturation rates and adult equivalent estimates from the ERA are combined with data on catches, escapements, and incidental mortalities to complete the annual calibration of the PSC Chinook Model.

Section 3 of this report provides:

1) calendar year (CY) percent distribution of the total mortality that accrued to escapement, based on CWT data (Appendix C).
2) brood year exploitation rates (BYERs) based on total mortality of complete broods (Appendix D), and
3) cohort survival rates, calculated to age-2 for stocks that are released usually in the spring following spawning (subyearlings, or ocean type), and to age3 for stocks that are released in the spring in the year after spawning (yearlings or stream type) (Appendix E).

The most recent calendar year for percent distribution of total mortality in escapement is 2022 for Southern U.S. stocks and 2023 for Alaskan and Canadian stocks. However, because BYERs and survival rates use data for a fully returned cohort of fish, the most recent brood year of data reported for those statistics varies according to regional data availability and stock life history (yearling vs. subyearling).

Coastwide, BYERs generally showed declining trends compared to the long-term means. In Alaska, including transboundary rivers, all stocks showed a decrease in BYERs. In Canada, all stocks except Phillips River fall showed a decrease in BYERs. In the Southern U.S., all stocks showed a decrease in BYERs except for Grays Harbor fall, Quillayute fall, Hoh fall, Queets fall, and Lewis River Wild.

With regards to survival rates, changes compared to the long-term medians were highly variable. In Alaska, including transboundary rivers, all stocks showed declining trends in survival with the exception of Chilkat River, Stikine River, and Unuk River. More than half of Canadian stocks showed increases in survival. The highest percent changes in survival rates were for Nicola River spring, Harrison, and Chilliwack River fall. In the Southern U.S., just over half of the stocks showed decreases in survival. The largest increase was for Columbia summers, while the largest decrease was for Willamette spring.

Coastwide, calendar year percent escapement generally showed increasing trends when comparing the mean of available years during the 2019 PST Agreement to the mean from the 2009 PST Agreement. In Alaska, including transboundary rivers, Northern Southeast Alaska spring was the only stock that showed a decrease in calendar year percent escapement during the 2019 PST Agreement compared to the 2009 PST Agreement. In Canada, all stocks showed increasing calendar year percent escapement with the exception of Robertson Creek, Big Qualicum River, Quinsam River fall, East Vancouver Island North, and Chilliwack River fall. Similarly, in the Southern U.S., all stocks exhibited increasing or stable calendar year percent escapement, with the exception of Hoko Fall Fingerling, Queets fall, Hoh fall, Skagit Spring Fingerling, and South Umpqua.

Summary of statistics generated by the 2024 exploitation rate analysis. Statistics include brood year exploitation rates (BYERs), cohort survival rates (age 2 or 3), and calendar year (CY) percent distribution of total mortality in escapement for 2023 (in Alaska [Panel A] and Canada [Panel B]) and 2022 (in Southern U.S. stocks [Panel C]).

For each statistic, the values are heat mapped, with low to high BYERs ranging from green to red, respectively, and low to high survival rates and % to escapement ranging from red to green, respectively. Relative changes between the longer-term averages and last full broods (or all years available since 2019 in the case of % escapement) are shown by tertile class symbols, where red diamonds indicate the largest relative increases for BYERs, and largest relative decreases for survival rates and % escapement, yellow triangles indicate intermediate changes, and green circles indicate the largest relative decreases for BYERs, and largest relative increases for survival rates and % escapement.

A) Southeast Alaska and Transboundary Stocks

Region	Indicator Stock ID/Name		BYER (total mortality)			Age 2 or 3 Survival Rate			Calendar Year % Escapement		
			Mean	Last Full Brood[1]	Points Change	Median	Last Full Brood[1]	% Change	Mean % 2009-18	Mean % 2019-Last	Points Change
SEAK/TBR	SSA	Southern SEAK Spring[2]	38%	26%	▲ -12	5.5%	3.8%	↘ -31%	47%	54%	→ 7
	NSA	Northern SEAK Spring[2]	36%	20%	▲ -17	2.8%	2.8%	↘ -2%	51%	43%	↓ -8
	CHK	Chilkat River	18%	4%	▲ -13	7.5%	7.5%	↘ 0%	80%	96%	↗ 16
	STI	Stikine River	34%	22%	▲ -12	3.8%	7.2%	↗ 90%	72%	88%	↗ 16
	TAK	Taku River	17%	7%	▲ -10	6.3%	4.3%	↘ -32%	79%	94%	↗ 15
	TST	Taku and Stikine Rivers	20%	9%	▲ -11	5.6%	5.1%	↘ -9%	75%	91%	↗ 16
	UNU	Unuk River	30%	28%	▲ -1	6.9%	12.1%	↗ 76%	62%	76%	↗ 14

B) Canadian Stocks

Region	Indicator Stock ID/Name		BYER (total mortality)			Age 2 or 3 Survival Rate			Calendar Year % Escapement		
			Mean	Last Full Brood[1]	Points Change	Median	Last Full Brood[1]	% Change	Mean % 2009-18	Mean % 2019-Last	Points Change
Northern BC	KLM	Kitsumkalum	45%	38%	▲ -7	0.6%	0.2%	↓ -65%	59%	72%	↗ 13
	ATN	Atnarko	39%	27%	▲ -12	1.9%	1.2%	↘ -35%	59%	71%	↗ 12
WCVI	RBT	Robertson Creek Fall[2, 3]	42%	30%	▲ -12	4.1%	5.4%	→ 31%	43%	32%	↓ -11
	NWVI	Northwest Vancouver Island (RBT adj.)[2]	46%	33%	▲ -12	4.1%	5.4%	→ 31%	61%	69%	→ 8
	SWVI	Southwest Vancouver Island (RBT adj.)[2]	46%	33%	▲ -12	4.1%	5.4%	→ 31%	61%	69%	→ 8
Strait of Georgia	BQR	Big Qualicum River Fall	58%	53%	▲ -4	0.7%	1.3%	↗ 93%	57%	56%	↘ -1
	COW	Cowichan River Fall	65%	29%	● -36	1.3%	1.5%	→ 16%	36%	58%	↑ 22
	PPS	Puntledge River Summer	50%	30%	● -20	0.8%	0.5%	↘ -31%	60%	70%	↗ 10
	QUI	Quinsam River Fall	55%	51%	▲ -3	1.2%	1.0%	↘ -16%	56%	50%	↘ -6
	EVIN	East Vancouver Island North (QUI adj.)[2]	52%	48%	▲ -4	1.2%	1.0%	↘ -16%	59%	53%	↘ -6
	PHI	Phillips River Fall	30%	31%	◆ 0	3.9%	3.7%	↘ -6%	67%	71%	→ 4
Fraser	CHI	Chilliwack River Fall	40%	39%	▲ -1	11.0%	11.5%	↘ 4%	69%	67%	↘ -2
	HAR	Harrison River	44%	25%	● -19	2.1%	5.2%	↑ 150%	73%	77%	→ 4
	NIC	Nicola River Spring	25%	5%	● -19	1.9%	4.7%	↑ 149%	78%	91%	↗ 13
	SHU	Lower Shuswap River Summer	50%	22%	● -28	2.9%	3.2%	↘ 11%	55%	75%	↑ 20

C) Southern U.S. Stocks

Region	Indicator Stock ID/Name		BYER (total mortality)				Age 2 or 3 Survival Rate				Calendar Year % Escapement			
			Mean	Last Full Brood[1]		Points Change	Median	Last Full Brood[1]		% Change	Mean % 2009-18	Mean % 2019-Last		Points Change
WA Coast	HOK	Hoko Fall Fingerling	32%	26%	▲	-6	1.3%	0.7%	↓	-44%	72%	71%	↘	-1
		Grays Harbor Fall (QUE adj.)[2]	63%	66%	▲	3	2.6%	2.7%	↘	2%	37%	37%	↘	0
	QUE	Queets Fall Fingerling	60%	78%	◆	18	2.6%	2.7%	↘	2%	37%	23%	↓	-14
		Quillayute Fall (QUE adj.)[2]	61%	67%	◆	6	2.6%	2.7%	↘	2%	29%	36%	→	7
	Hoh	Hoh Fall (QUE adj.)[2]	61%	73%	◆	12	2.6%	2.7%	↘	2%	38%	30%	↓	-8
	SOO	Tsoo-Yess Fall Fingerling	36%	24%	▲	-11	0.4%	0.2%	↓	-52%	72%	80%	→	8
	ELW	Elwha River[2]	48%	21%	●	-27	0.5%	0.6%	→	21%	67%	75%	→	8
Puget Sound	NSF	Nooksack Spring Fingerling[2]	38%	24%	●	-15	1.3%	1.8%	→	37%	56%	64%	→	8
	SAM	Samish Fall Fingerling[2]	42%	39%	▲	-2	1.3%	1.1%	↘	-21%	30%	31%	↘	1
	SKF	Skagit Spring Fingerling[2]	28%	18%	▲	-10	1.4%	1.3%	↘	-5%	57%	52%	↘	-5
	SSF	Skagit Summer Fingerling[2]	33%	22%	▲	-11	1.2%	1.3%	↘	8%	48%	70%	↑	22
	STL	Stillaguamish Fall Fingerling[2]	45%	21%	●	-23	1.5%	1.1%	↘	-25%	55%	65%	↗	10
	SKY	Skykomish Fall Fingerling[2]	29%	19%	▲	-10	0.9%	0.9%	↘	-4%	71%	71%	↘	0
	SPS	South Puget Sound Fall Fingerling[2]	41%	13%	●	-28	2.1%	1.0%	↓	-54%	71%	79%	→	8
	NIS	Nisqually Fall Fingerling[2]	38%	16%	●	-22	1.5%	0.4%	↓	-73%	53%	53%	↘	0
	GAD	George Adams Fall Fingerling[2]	45%	39%	▲	-6	1.4%	0.6%	↓	-54%	46%	50%	→	4
Columbia River	CWF	Cowlitz Fall Tule[2]	35%	23%	▲	-12	0.4%	0.4%	↘	0%	68%	73%	→	5
	HAN	Hanford Wild Brights	60%	52%	▲	-8	0.8%	0.8%	↘	1%	37%	54%	↑	17
	LRH	Lower River Hatchery Tule	58%	43%	●	-15	0.6%	0.5%	↘	-9%	37%	53%	↗	16
	LRW	Lewis River Wild	43%	50%	◆	6	1.5%	0.9%	↓	-41%	48%	50%	→	2
	LYF	Lyons Ferry Fingerling	42%	36%	▲	-6	1.0%	0.7%	↘	-30%	63%	76%	↗	13
	LYY	Lyons Ferry Yearling	55%	42%	●	-13	3.6%	0.6%	↓	-82%	47%	56%	↗	9
	SMK	Similkameen Summer Yearling	50%	37%	●	-13	3.0%	3.0%	↘	0%	37%	61%	↑	24
	SPR	Spring Creek Tule	75%	64%	▲	-11	1.3%	1.3%	↘	0%	28%	34%	→	6
	SUM	Columbia River Summers	58%	51%	▲	-7	1.4%	3.5%	↑	145%	43%	60%	↑	17
	URB	Columbia Upriver Bright	59%	44%	●	-15	1.7%	3.7%	↑	115%	46%	58%	↗	12
	WSH	Willamette Spring[2]	12%	8%	▲	-4	2.3%	1.2%	↓	-47%	81%	84%	→	3
Oregon Coast	ELK	Elk River[2]	22%	27%	◆	5	6.1%	5.1%	↘	-15%	52%	62%	↗	10
		South Umpqua (ELK adj.)[2]	39%	44%	◆	5	6.1%	5.1%	↘	-15%	55%	53%	↘	-2
		Coquille (ELK adj.)[2]	37%	29%	▲	-8	6.1%	5.1%	↘	-15%	58%	63%	→	5
	SRH	Salmon River[2]	37%	36%	▲	-1	5.2%	4.2%	↘	-20%	44%	53%	↗	9
		Nehalem (SRH adj.)[2]	48%	49%	▲	1	5.2%	4.2%	↘	-20%	54%	55%	↘	1
		Siletz (SRH adj.)[2]	49%	53%	◆	4	5.2%	4.2%	↘	-20%	49%	51%	→	2
		Siuslaw (SRH adj.)[2]	54%	55%	▲	1	5.2%	4.2%	↘	-20%	45%	50%	→	5

[1] For 2024, the most recent brood is 2018 for subyearling stocks in Canada, and 2017 for yearling stocks in Alaska and Canada (KLM, NIC) and all stocks in the southern US, except LYY, SMK, and WSH yearlings (2016).
[2] BYER is ocean exploitation rate only to better represent natural spawner BYER in the presence of terminal fisheries targeting hatchery fish.
[3] Terminal adjustments to CYER applied because fishing mortality on hatchery fish does not represent fishing mortality on wild fish.

ISBM Fisheries Performance Under the 2019 PST Agreement

Section 4 of this report provides an assessment of annual and multi-year ISBM fisheries performance. Attachment I of Chapter 3 identifies CYER limits applicable to ISBM obligations for 31 stocks; of these, CYER limits apply to 17 stocks for Canadian ISBM fisheries and 22 stocks for U.S. ISBM fisheries. The CTC has evaluated status towards achieving PSC-agreed management objectives for the 16 stocks in Attachment I with identified management objectives for which CYER limits are applicable (CTC 2020)[2]. In 2022, there were three stocks that did not achieve their management objectives (Queets fall, Nehalem, and Siuslaw), so CYER limits apply to them as per paragraph 5(a).

Annual Canadian ISBM obligations were met for 10 of the 15 stocks that could be evaluated; six met their management objectives and thus had no applicable CYER limits (Atnarko, Cowichan, Lower Shuswap, Harrison, Skagit spring, and Skagit summer/fall), and four had no management

[2] Attachment I of the 2019 PST Agreement has a total of 38 stocks of which 31 are subject to ISBM obligations. There are currently 22 stocks with management objectives and 16 of those are subject to ISBM obligations.

objectives but had CYERs below their limits. Annual CYER obligations were not met for five stocks— NWVI Natural Aggregate, SWVI Natural Aggregate, East Coast Vancouver Island North (EVIN), Phillips, and Snohomish.

Relative to U.S. ISBM fisheries annual performance for 2022, annual ISBM obligations were met for 19 of the 22 stocks listed in Attachment I; 11 that met their management objectives and thus had no applicable CYER limits, and eight that had CYERs that were below the applicable limits. Annual CYER obligations were not met for three stocks: Queets fall, Nehalem, and South Umpqua.

Review of annual performance in the Pacific Salmon Treaty Individual Stock-Based Management (ISBM) fisheries, 2022. NA indicates the obligation does not exist for that stock and country combination.

Attachment I Escapement Indicator Stock	Canadian Obligation Met?	U.S. Obligation Met?
Skeena	Yes	NA
Atnarko	Yes	NA
NWVI Natural Aggregate	No	NA
SWVI Natural Aggregate	No	NA
East Vancouver Island North	No	NA
Phillips	No	NA
Cowichan	Yes	Yes
Nicola	Yes	Yes
Chilcotin	NA	NA
Chilko	NA	NA
Lower Shuswap	Yes	NA
Harrison	Yes	Yes
Nooksack Spring	Yes	NA
Nooksack Spring	NA	Yes
Skagit Spring	Yes	Yes
Skagit Summer/Fall	Yes	Yes
Stillaguamish	Yes	Yes
Snohomish	No	Yes
Hoko	NA	Yes
Grays Harbor Fall	NA	Yes
Queets Fall	NA	No
Quillayute Fall	NA	Yes
Hoh Fall	NA	Yes
Upriver Brights	NA	Yes
Lewis River Fall	NA	Yes
Coweeman	NA	Yes
Mid-Columbia Summers	NA	Yes
Nehalem	NA	No
Siletz	NA	Yes
Siuslaw	NA	Yes
South Umpqua	NA	No
Coquille	NA	Yes

For each escapement indicator stock with a CYER limit identified in Attachment I, the CTC is reporting the running 3-year average (3YA) CYER for the first time as data from catch years 2020–2022 are available from both Parties' ISBM fisheries (Footnote 17, 2019 PST Agreement). For Attachment I stocks without a management objective, all years shall be used to calculate the running 3YA as per paragraph 7(c). For Attachment I indicator stocks with a management objective, three years of CYERs that meet the criteria for inclusion specified in paragraph 7(c) are used to calculate the running 3YA CYER as agreed to by the PSC.[3]

For the running 3YA CYER specified in paragraph 7(c) of the PST Agreement, Canadian ISBM obligations were met for 10 of the 12 stocks that could be evaluated; the 3YA CYER for EVIN and Harrison exceeded their limit by more than 10% (limit + 10% of the limit). Per the provisions of the 2019 PST Agreement, this requires further action, as identified in subparagraphs 7(c)(i) and 7(c)(ii).

Performance of Canadian ISBM fisheries relative to three-year average (3YA) CYERs, as specified in paragraph 7(c) in Chapter 3 of the 2019 PST Agreement. Note: The 'Paragraph 7(c) Obligation Met' column indicates whether the provisions of paragraph 7(c) were met for each stock, specifically whether the 3YA CYER for a given stock was less than (green) or exceeded (red) the CYER limit by more than ten percent.

Escapement Indicator	Years Included in 3YA	CYER 3YA	CYER Limit	Paragraph 7(c) Obligation Met?
Skeena	2020, 2021, 2022	0.062	0.147	Yes
Atnarko	2020, 2021, 2022	0.183	0.276	Yes
NWVI Natural	2020, 2021, 2022	0.088	0.091	Yes
SWVI Natural	2020, 2021, 2022	0.088	0.091	Yes
EVIN	2020, 2021, 2022	0.174	0.157	No
Phillips	2020, 2021, 2022	0.102	0.097	Yes
Cowichan	2020, 2021, 2022	0.304	0.419	Yes
Nicola	2020, 2021, 2022	0.119	0.167	Yes
Chilcotin	NA	NA	NA	NA
Chilko	NA	NA	NA	NA
Lower Shuswap	2020, 2021, 2022	0.174	0.200	Yes
Harrison	2020, 2021, 2022	0.157	0.109	No
Nooksack Spring	2020, 2021, 2022	0.103	0.149	Yes
Skagit Spring	2019	NA	0.079	NA
Skagit Sum/Fall	2019, 2021, 2022	0.050	0.088	Yes
Stillaguamish	2020, 2021, 2022	0.085	0.128	Yes
Snohomish	2020, 2021, 2022	0.123	0.092	No

[3] The Chinook Interface Group (CIG) will return to the discussion of options on how to deal with years with missing data for future years and make a recommendation to the PSC.

For the 3YA CYER in U.S. ISBM fisheries, paragraph 7(c) obligations were met for all stocks that could be evaluated; no stocks had 3YAs that exceeded the CYER limit by more than 10%. As a result, no further action is required per subparagraph 7(c) in Chapter 3 of the 2019 PST Agreement.

Performance of U.S. ISBM fisheries relative to three-year average (3YA) CYERs, as specified in paragraph 7(c) in Chapter 3 of the 2019 PST Agreement. Note: The 'Paragraph 7(c) Obligation Met' column indicates whether the provisions of paragraph 7(c) were met for each stock, specifically whether the 3YA CYER for a given stock was less than (green) or exceeded (red) the CYER limit by more than ten percent.

Escapement Indicator	Years Included in 3YA	CYER 3YA	CYER Limit	Paragraph 7(c) Obligation Met?
Cowichan	2020, 2021, 2022	0.019	0.080	Yes
Nicola	2020, 2021, 2022	0.006	0.036	Yes
Harrison	2020, 2021, 2022	0.035	0.059	Yes
Nooksack Spring	2020, 2021, 2022	0.081	0.081	Yes
Skagit Spring	2020, 2021	NA	0.252	NA
Skagit Sum/Fall	2019, 2020, 2021	0.071	0.147	Yes
Stillaguamish	2020, 2021, 2022	0.084	0.105	Yes
Snohomish	2020, 2021, 2022	0.100	0.108	Yes
Hoko	2020, 2021, 2022	0.023	0.100	Yes
Grays Harbor	2020, 2021, 2022	0.075	0.154	Yes
Queets	2022	NA	0.137	NA
Quillayute	2020, 2021, 2022	0.090	0.207	Yes
Hoh	2021, 2022	NA	0.148	NA
Upriver Brights (URB)	2020, 2021, 2022	0.215	0.274	Yes
Upriver Brights (HAN)	2020, 2021, 2022	0.220	0.288	Yes
Lewis	2019, 2020, 2021	0.063	0.190	Yes
Coweeman	2020, 2021, 2022	0.124	0.195	Yes
Mid-Columbia Summers	2020, 2021, 2022	0.226	0.304	Yes
Nehalem	2022	NA	0.130	NA
Siletz	2020, 2022	NA	0.171	NA
Siuslaw	2020, 2021, 2022	0.153	0.201	Yes
South Umpqua	2020, 2021, 2022	0.251	0.266	Yes
Coquille	2020, 2021, 2022	0.074	0.223	Yes

Mark-Selective Fisheries

Section 5 of this report contains harvest information by region from MSFs. MSFs occurred in the Columbia River, Puget Sound, and Canadian Strait of Juan de Fuca and Vancouver Island inside in 2022. The magnitude of impact of an MSF relative to the total exploitation of a stock can be measured using the percentage of the total landed catch in net, sport, and troll fisheries of tagged and marked PSC indicator stocks that occurs in MSFs. Traditionally, the CTC has used PSC indicator stocks that have been double index tagged (DIT) to evaluate the impact of MSFs on the unmarked stocks represented by the unmarked tag group in a DIT pair[4]; however, many CWT indicator stocks do not have a DIT pair. Additionally, coastwide application of electronic tag detection (ETD) and the associated recovery of DIT releases is inconsistent. Accordingly, an approach was applied to estimate mortality distributions for natural stocks that have single index tag (SIT) indicator stocks under conditions where the MSF impacts mainly occur on mature SIT fish proximal to their terminal area. Under MSFs, marked CWT release groups experience different patterns of fishing mortality than unmarked fish. This report is the first time that the CTC has incorporated estimation procedures for MSF impacts and includes results for marked and unmarked fish for the purpose of generating ERA metrics including estimates of BYERs, CYERs, and fishery indices.

[4] A DIT group consists of at least two paired CWT release groups, one with the mass mark (or adipose fin clip) and one without the mark. These 2 tag groups are supposed to be identical except for the mark, and differences in recoveries at escapement are assumed to be due to the MSFs—assuming there is no mark induced mortality occurring prior to recruitment to the fisheries.

1. Introduction

Chapter 3 of the 2019 Pacific Salmon Treaty (PST) Agreement requires the Chinook Technical Committee (CTC) to report catch and escapement data and modeling results used to manage Chinook salmon fisheries and stocks harvested within the Treaty area annually. To fulfill this obligation, the CTC provides a series of annual reports to the Pacific Salmon Commission (PSC). This annual report provides an overview of the annual exploitation rate analysis (ERA), the ERA results, and includes calendar year exploitation rates (CYER) which are the metric used to evaluate performance of individual stock-based management (ISBM) fisheries under the 2019 PST Agreement. The results of the ERA are relevant to the PSC's fishery management framework for ISBM fisheries and used as inputs to the PSC Chinook Model calibration (see CTC 2024 for details).

Paragraph 3(b) of the 2019 PST Agreement defines ISBM fisheries as "a regime that constrains the annual impacts within the fisheries of a jurisdiction for a naturally spawning Chinook salmon stock or stock group." Per paragraph 5(a) "ISBM fisheries shall be managed to limit the total adult equivalent mortality for stocks listed in Attachment I that are not meeting agreed biologically-based management objectives, or that do not have agreed management objectives, to no more than the limits identified in Attachment I." The CTC is tasked with evaluating ISBM fishery performance relative to the obligations set forth in paragraphs 5 and 7 annually using the CYER metric to monitor total mortality.

Section 2 of this report describes the methods used to perform the ERA using coded-wire tag (CWT) data provided by management agencies throughout the PST area. Section 3 contains the annual results of the ERA. The results of the 2024 ERA are based on CWT data through catch year 2023 for Alaskan and Canadian stocks and 2022 for southern U.S. stocks. As data are now available, Section 4 contains a performance evaluation of ISBM fisheries relative to the 2019 PST Agreement. Beginning with the 2024 ERA, mark-selective fishery algorithms have been incorporated per the methods and recommendations identified in CYER WG (2024), and ISBM performance is now assessed using the "unmarked" CYERs (i.e., for Chinook with an intact adipose fin) in order to best represent fishery impacts on the wild escapement indicator stocks. Section 5 is a summary of catch in mark-selective fisheries (MSFs) and methods used to evaluate their impacts.

Appendix A shows the relationship between the exploitation rate indicator stocks, escapement indicator stocks, model stocks, and PST Attachment I stocks. Appendix B provides a description of notations found throughout this report. Appendix C through Appendix H present additional output from the ERA beyond the summaries presented in the main body of the report. Appendix C provides information about the percent distribution of total mortality by catch year for exploitation rate indicator stocks and includes a link to this data set. Appendix D presents methods for estimating brood year exploitation rate (BYER) accompanied by BYER plots by stock. For Appendix D, only complete brood years are shown. Appendix E presents methods for estimating smolt-to-youngest age survival and associated plots by stock. Appendix F displays the data used to adjust ERA results for stocks where a terminal area adjustment was applied (see Section 2.1.4 for details). Appendix G shows exploitation rate indices by stock and age for each aggregate abundance-based management (AABM) fishery. CYERs for ISBM fisheries are provided in Appendix H. CWT data quality and ERA documentation are detailed in Appendix I. Appendix J describes the pseudo recovery inclusion assessment which was the process utilized to account for the untagged/unmarked Chinook released from seven Canadian indicator stocks in 2019.

2. Exploitation Rate Analysis Methods

The CTC currently monitors 45 CWT exploitation rate indicator stocks (Figure 2.1; Table 2.1). The ERA relies on cohort analysis, a procedure that reconstructs the age-specific cohort size and exploitation history of a given stock for each brood year (BY) using CWT release and recovery data (CTC 1988). The ERA provides stock-specific estimates of BY total, age- and fishery-specific exploitation rates, maturation rates, smolt-to-age-2 (falls) or age-3 (springs) survival rates, annual distributions of mortalities among fisheries and escapement, and separate fishery indices for AABM and ISBM fisheries (Table 2.2). Then, in Stock Aggregate Cohort Evaluation (SACE), age-specific CWT indicator stock estimates of pre-terminal fishing mortality rates from the ERA are combined with age-specific estimates of stock aggregate terminal return. SACE thus provides more realistic estimates of wild stock aggregates' age-specific cohorts, and maturation rates calculated from these are employed in the PSC Chinook Model. Finally, estimates of age- and fishery-specific exploitation and maturation rates from these cohort analyses are combined with data on catches, escapements, and incidental mortalities to complete the annual calibration of the PSC Chinook Model (CTC 2024a).

Indicator stocks used for the ERA and the estimates derived for each stock are shown in Table 2.2. Relationships between the exploitation rate indicator stocks, model stocks, and escapement indicator stocks are provided in Appendix A, as well as a list of historic indicator stocks. A list of CWT codes used in the 2024 ERA can be found on the PSC website: https://www.psc.org/publications/technical-reports/technical-committee-reports/chinook/ctc-data-sets/.

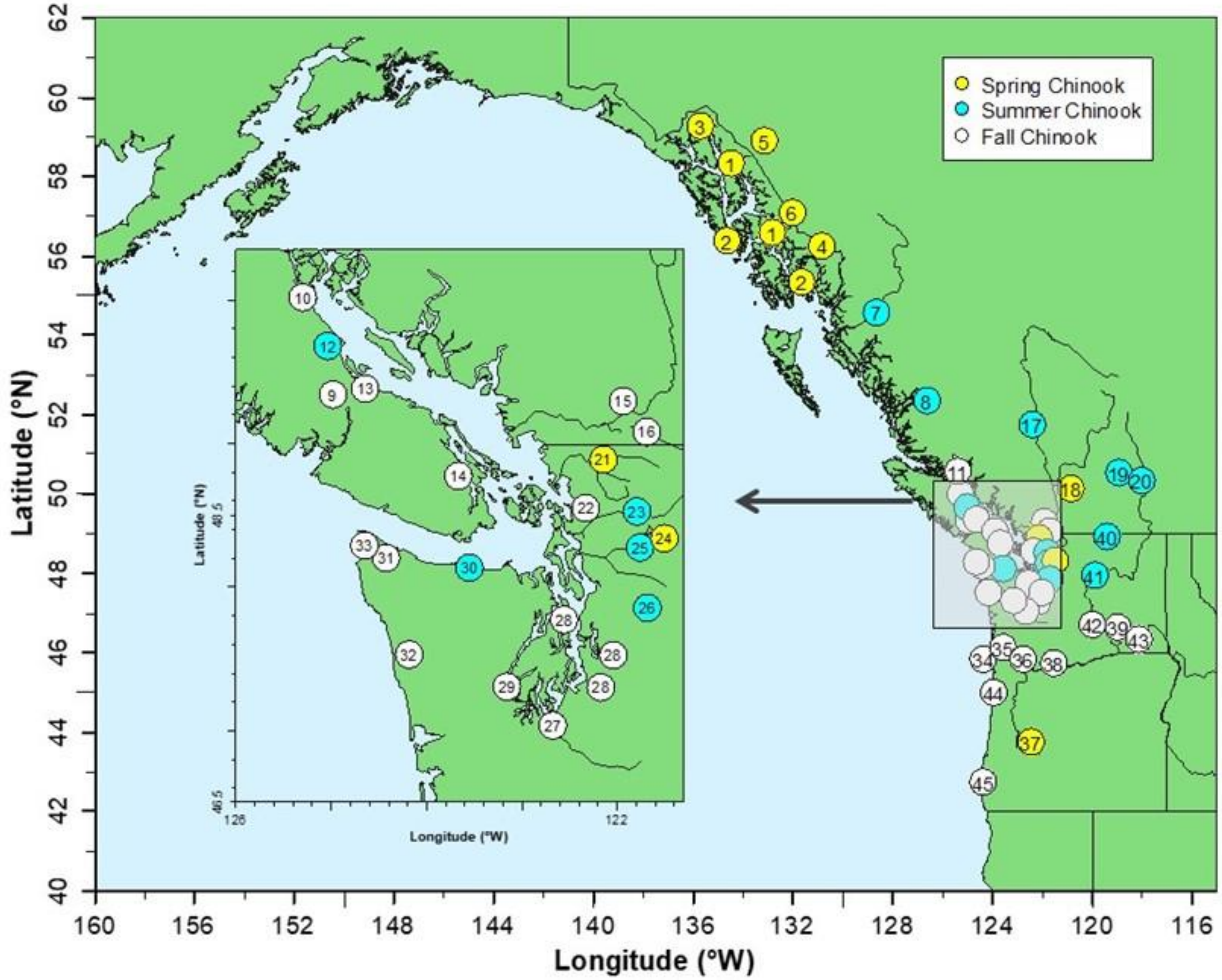

Figure 2.1—Geographical locations of current Chinook salmon coded-wire tag (CWT) exploitation rate indicator stocks.

Note: See Table 2.1 for the full stock names associated with each number. The southern BC and Puget Sound area, where concentration of the CWT indicators is greatest, is shown in the expanded view.

Table 2.1—Summary of current coded-wire tag (CWT) exploitation rate indicator stocks, location, run type, and smolt age.

Stock/Area	Exploitation Rate Indicator Stock	Hatchery	Run Type	Smolt Age	Map No.
Southeast Alaska	Northern Southeast Alaska (NSA)	Crystal Lake (ACI)	Spring	Age 1	1
	Southern Southeast Alaska (SSA)	Herring Cove (AHC), Little Port Walter (ALP), Deer Mountain (ADM), Neets Bay (ANB)	Spring	Age 1	2
	Chilkat (CHK)	Wild	Spring	Age 1	3
	Unuk (UNU)	Wild	Spring	Age 1	4
Transboundary Rivers	Taku and Stikine (TST)	Wild	Spring	Age 1	5,6
North/Central BC	Kitsumkalum (KLM)	Deep Creek	Summer	Age 1	7
	Atnarko (ATN)	Snootli	Summer	Age 0	8
WCVI	Robertson Creek (RBT)	Robertson Creek	Fall	Age 0	9
Strait of Georgia	Quinsam (QUI)	Quinsam	Fall	Age 0	10
	Phillips (PHI)	Gillard Pass	Summer/Fall	Age 0	11
	Puntledge (PPS)	Puntledge	Summer	Age 0	12
	Big Qualicum (BQR)	Big Qualicum	Fall	Age 0	13
	Cowichan (COW)[1]	Cowichan	Fall	Age 0	14
Fraser River	Harrison (HAR)	Chehalis	Fall	Age 0	15
	Chilliwack (CHI)[1]	Chilliwack	Fall	Age 0	16
	Chilko (CKO) - *In Development*	Spius Creek, Chehalis	Summer	Age 1	17
	Nicola (NIC)	Spius Creek	Spring	Age 1	18
	Lower Shuswap (SHU)[1]	Shuswap Falls	Summer	Age 0	19
	Middle Shuswap (MSH)	Shuswap Falls	Summer	Age 0	20
North Puget Sound	Nooksack Spring Fingerling (NSF)	Kendall Creek	Spring	Age 0	21
	Samish Fall Fingerling (SAM)[2]	Samish	Summer/Fall	Age 0	22
	Skagit Summer Fingerling (SSF)	Marblemount	Summer	Age 0	23
	Skagit Spring Fingerling (SKF)	Marblemount	Spring	Age 0	24
Central Puget Sound	Stillaguamish Fall Fingerling (STL)[3]	Stillaguamish Tribal	Summer/Fall	Age 0	25
	Skykomish Summer Fingerling (SKY)[2,3]	Wallace	Summer/Fall	Age 0	26
South Puget Sound	Nisqually Fall Fingerling (NIS)[2]	Clear Creek	Summer/Fall	Age 0	27
	South Puget Sound Fall Fingerling (SPS)[2]	Soos/Grovers/Issaquah creeks	Summer/Fall	Age 0	28
Hood Canal	George Adams Fall Fingerling (GAD)[2]	George Adams	Summer/Fall	Age 0	29
Juan de Fuca	Elwha Fall Fingerling (ELW)	Lower Elwha	Summer/Fall	Age 0	30
North Washington Coast	Hoko Fall Fingerling (HOK)	Hoko Makah National Hatchery	Fall	Age 0	31
	Queets Fall Fingerling (QUE)	Wild, Salmon River (WA)	Fall	Age 0	32
	Tsoo-Yess Fall Fingerling (SOO)	Makah National Fish Hatchery	Fall	Age 0	33
Lower Columbia River	Columbia Lower River Hatchery (LRH)[2]	Big Creek	Fall Tule	Age 0	34
	Cowlitz Tule (WA) (CWF)	Cowlitz	Fall Tule	Age 0	35
	Lewis River Wild (LRW)	Wild	Fall Bright	Age 0	36
	Willamette Spring (WSH)[1]	Willamette Hatcheries	Spring	Age 1	37
	Spring Creek Tule (WA) (SPR)[2]	Spring Creek National Hatchery	Fall Tule	Age 0	38
Upper Columbia River	Hanford Wild (HAN)	Wild	Fall Bright	Age 0	39
	Similkameen Summer Yearling (SMK)	Similkameen and Omak Pond	Summer	Age 1	40
	Columbia Summers (WA) (SUM)	Wells	Summer	Age 0/1	41

Stock/Area	Exploitation Rate Indicator Stock	Hatchery	Run Type	Smolt Age	Map No.
	Columbia Upriver Brights (URB)[2]	Priest Rapids	Fall Bright	Age 0	42
Snake River	Lyons Ferry Fingerling (LYF)[4]	Lyons Ferry	Fall Bright	Age 0	43
	Lyons Ferry Yearling (LYY)[2]	Lyons Ferry	Fall Bright	Age 1	
North Oregon Coast	Salmon (SRH)	Salmon	Fall	Age 0	44
Mid Oregon Coast	Elk River (ELK)	Elk River	Fall	Age 0	45

[1] Historical releases with double index tags (DIT); DIT component not currently maintained.
[2] DIT releases associated with this stock.
[3] Though stock is composed of both summer and fall-run components, references to both summer-run and fall-run stocks are used interchangeably throughout document.
[4] Subyearlings have been CWT-tagged since BY 1986, except for brood years 1993–1997.

Table 2.2—Coded-wire tag (CWT) exploitation rate indicator stocks used in the exploitation rate analysis (ERA) and data derived from them: fishery indices, individual stock-based management (ISBM) calendar year exploitation rates (CYER)—(ISBM CYER Limit), survival indices, brood year exploitation rates (BYER), and stock catch distribution (Dist) with escapement estimates (Esc) and base period (1979–1982) tag recoveries (Base Recoveries).

Exploitation Rate Indicator Stock	Fishery Index	ISBM CYER Limit	Survival Index	BYER[1]	Dist	Esc	Base Recoveries
Northern Southeast Alaska (NSA)	Yes[2]	—	Yes	Ocean	Yes	Yes	Yes
Southern Southeast Alaska (SSA)	Yes[2]	—	Yes	Ocean	Yes	Yes	Yes
Chilkat (CHK)	—	—	Yes	Total	Yes	Yes	—
Taku and Stikine (TST)	—	—	Yes	Total	Yes	Yes	Yes
Unuk (UNU)	—	—	Yes	Total	Yes	Yes	—
Kitsumkalum (KLM/KLY)	—	Yes (KLM)	Yes	Total	Yes	Yes	—
Atnarko (ATN)	Yes	Yes	Yes	Total	Yes	Yes	Yes
Robertson Creek (RBT)	Yes	Yes[5]	Yes	Ocean	Yes	Yes	Yes
Quinsam (QUI)	Yes	Yes[5]	Yes	Total	Yes	Yes	Yes
Phillips River Fall (PHI)	—	Yes	—	—	Yes	—	—
Puntledge (PPS)	Yes	—	Yes	Total	Yes	Yes	Yes
Big Qualicum (BQR)	Yes	—	Yes	Total	Yes	Yes	Yes
Cowichan (COW)	Yes	Yes	Yes	Total	Yes	Yes	—
Chilliwack (CHI)	Yes	—	Yes	Total	Yes	Yes	—
Chilko (CKO)	—	—	—	Total	Yes	Yes	Yes
Harrison (HAR)	—	Yes	Yes	Total	Yes	Yes	—
Lower Shuswap (SHU)	Yes	Yes	Yes	Total	Yes	Yes	Yes
Middle Shuswap (MSH)	—	—	Yes	Total	Yes	Yes	—
Nicola (NIC)	—	Yes	Yes	Total	Yes	Yes	—
Nooksack Spring Fingerling (NSF)	—	Yes[5]	Yes	Ocean	Yes	Yes	Yes
Samish Fall Fingerling (SAM)[4]	Yes	—	Yes	Ocean	Yes	Yes[3]	Yes
Skagit Spring Fingerling (SKF)	—	Yes	Yes	Ocean	Yes	Yes	—
Skagit Summer Fingerling (SSF)	—	Yes	Yes	Ocean	Yes	Yes	—
Skykomish Summer Fingerling (SKY)	—	Yes	Yes	Ocean	Yes	Yes	—
Stillaguamish Summer Fingerling (STL)	—	Yes	Yes	Ocean	Yes	Yes	—
Nisqually Fall Fingerling (NIS)	—	—	Yes	Ocean	Yes	Yes	Yes
South Puget Sound Fall Fingerling (SPS)	Yes	—	Yes	Ocean	Yes	Yes[3]	Yes
George Adams Fall Fingerling (GAD)	Yes	—	Yes	Ocean	Yes	Yes[3]	Yes
Elwha Fall Fingerling (ELW)	—	—	Yes	Ocean	Yes	—	—
Hoko Fall Fingerling (HOK)	—	Yes	Yes	Total	Yes	Yes	—
Queets Fall Fingerling (QUE)	—	Yes[5]	Yes	Total	Yes	—	Yes
Tsoo-Yess Fall Fingerling (SOO)	—	—	Yes	Total	Yes	Yes	—

Exploitation Rate Indicator Stock	Fishery Index	ISBM CYER Limit	Survival Index	BYER[1]	Dist	Esc	Base Recoveries
Columbia Lower River Hatchery (LRH)[4]	Yes	—	Yes	Total	Yes	Yes	Yes
Cowlitz Tule (CWF)	Yes	Yes	Yes	Ocean	Yes	Yes	Yes
Lewis River Wild (LRW)	Yes	Yes	Yes	Total	Yes	Yes	Yes
Spring Creek Tule (SPR)[4]	Yes	—	Yes	Total	Yes	Yes	Yes
Willamette Spring (WSH)	Yes	—	Yes	Ocean	Yes	Yes	Yes
Columbia Summers (SUM)	Yes	Yes	Yes	Total	Yes	Yes	Yes
Columbia Upriver Brights (URB)	Yes	Yes	Yes	Total	Yes	Yes	Yes
Hanford Wild (HAN)	—	—	Yes	Total	Yes	Yes	—
Similkameen Summer Yearling (SMK)	—	—	Yes	Total	Yes	Yes	—
Lyons Ferry Fingerling (LYF)	—	—	Yes	Total	Yes	Yes	—
Lyons Ferry Yearling (LYY)	—	—	Yes	Total	Yes	Yes	—
Salmon River (SRH)	Yes	Yes[5]	Yes	Ocean	Yes	Yes	Yes
Elk River (ELK)	Yes	Yes[5]	Yes	Ocean	Yes	Yes	Yes

[1] For stocks of hatchery origin and subject to terminal fisheries directed at harvesting surplus hatchery production, ocean fisheries do not include terminal net fisheries. Otherwise, total fishery includes terminal net fisheries.
[2] Northern Southeast Alaska (NSA) and Southern Southeast Alaska (SSA) were used in the stratified proportional fishery index for the Phase II Pacific Salmon Commission Chinook Model.
[3] Only hatchery rack recoveries are included in escapement.
[4] Stock of hatchery origin not used to represent naturally spawning stock.
[5] The CYER limits includes terminal adjustments.

2.1 Overview of Coded-Wire Tag-Based Exploitation Rate Analyses

The ERA calculates several metrics to evaluate fishery and stock performance, including fishery indices, survival indices, CYERs, and BYERs. Details for calculating various fishery performance metrics are outlined in Appendix C, Appendix D, Appendix E, and Appendix F. Several key details of the ERA are described in the sections to follow.

2.1.1 Description of Incidental Mortality

Total mortality in a fishery is larger than the reported landed catch. The difference between total mortality and landed catch is the incidental mortality (IM), which can be separated into two components: release and drop-off mortality. Release mortality refers to landed encounters which are released and subsequently die from injury or stress. Drop-off mortality accounts for mortality among fish which encountered fishing gear, were not caught, yet died anyway due to the gear encounter.

Fisheries indices can be reported as either total mortality, or its components: landed catch and incidental mortality. Here we report total mortality for ISBM fisheries, but split total mortality into its individual components for AABM fisheries. Estimates of IM are essential for assessment of total fishery impacts, yet they cannot be determined directly from CWT recovery data. IM is estimated for both legal and sub-legal sized fish by accounting for each of the following: (1) drop-off mortality of legal-sized fish in retention fisheries (CTC 2022a), (2) mortality of legal-size fish in Chinook non-retention (CNR) fisheries, (3) mortality of sublegal-size fish in both retention and CNR fisheries, (4) mortality in mark-selective fisheries (starting with this year's report).

Additional details about the methods used to estimate IM have been described by the CTC Analytical Work Group (AWG) (CTC AWG Unpublished), CTC (2004), and CTC (2022a).

2.1.2 Calendar Year Exploitation Rates

The 2019 PST Agreement outlined a new metric for evaluating ISBM fisheries: the CYER. The CYER is used to monitor ISBM fisheries and for limiting adult equivalent (AEQ) total mortality (Chapter 3 paragraph 5(e)) on Attachment I stocks. The CYER is defined as the AEQ-adjusted total mortalities in ISBM fisheries of Canada or the U.S. summed across ages divided by the sum of AEQ-adjusted mortalities in all fisheries plus escapement for a single calendar year.

CYERs in all fisheries are reported in Appendix C, and ISBM-specific CYERs are reported in Appendix H.

Multiple adjustments are made to CYERs to ensure accuracy. Minimum data standards for calculating CYERs are applied and discussed in Appendix C. Accurate CYERs for some stocks may depend on adjustments to harvest rates in specific terminal fisheries (particularly in-river). Mark-selective fishery algorithms are used to calculate unmarked CYERs and to correct for the violation in the assumption of equal mortality in the marked and unmarked stock components introduced by mark-selective fishing (CYER WG 2024).

2.1.3 Mark-Selective Fishery Adjustments

Starting with the 2024 ERA, the CTC implemented algorithms to estimate incidental mortalities in MSFs. Prior to development of the MSF algorithms by the PSC's Calendar Year Exploitation Rate Working Group (CYER WG), unmarked release mortality in MSFs was unaccounted for in CYER estimates (CYER WG 2024). The MSF adjustment begins with a backwards cohort analysis of a marked single index tag group and proceeds with a forward cohort analysis that allows the ratio of unmarked to marked fish to change. The estimated ratio of unmarked to marked fish at the beginning of the forward cohort analysis is unknown and does not matter as long as results are converted to rates (i.e., CYERs, BYERs).

An ideal MSF is one in which all marked fish caught are kept and all unmarked fish caught are released; however, this assumption may be violated for a variety of different reasons. For example, in many cases a fishery may be subject to multiple different regulations in a calendar year. Furthermore, mixed-bag fisheries allow for a certain number of unmarked fish to be kept out of a total bag limit. Such situations can result in the number of marked releases and unmarked retentions to depart from that expected in an ideal MSF and therefore requires a mixed fishery adjustment. When accounting for differential impacts on marked and unmarked fish, it is not the specific regulation that matters but rather, the actual proportions of marked fish released and unmarked fish kept (Table 2.3). Values for marked release rate (MRRs) and unmarked kept rate (UKRs) used in the mixed fishery adjustment can either be assumed values (e.g., for an ideal MSF or non-selective fishery) or they can be calculated (e.g., using estimates of retentions and releases by mark status).

Table 2.3—Hypothetical marked release rate (MRR) and unmarked kept rate (UKR) values for different fishery types.

Fishery type	MRR	UKR
Non-selective	MRR = 0	UKR = 1
Mark-selective	MRR = 0	UKR = 0
Non-retention	MRR = 1	UKR = 0
Mixed fishery	0 < MRR < 1	0 < UKR < 1

2.1.4 Terminal Area Adjustments

Attachment I of Chapter 3 of the 2019 PST Agreement identifies 11 CWT exploitation rate indicator stocks that require adjustments to CWT recovery rates in terminal fisheries to accurately represent the fishery impacts on the associated escapement indicator stock. Terminal adjustment methods (TAMs) use auxiliary data to address situations in which terminal fishery impacts differ between CWT indicator stocks and the escapement indicator stocks they represent. Terminal harvest and escapement estimates for the escapement indicator stock are substituted for the CWT indicator stock and corrects for bias in the CYER estimates arising from differential harvest rates (CYER WG 2019; CYER WG 2021). Numerous factors can result in differential terminal harvest rates on CWT indicator stocks compared to their associated escapement indicator stocks such as differences in run timing, return locations, or mark-selective fishing (CTC 2019a). These terminal adjustments to CWT recoveries result in a more accurate reflection of the harvest rate on the associated escapement indicator stock (Appendix F).

2.1.5 Assumptions of the CWT Exploitation Rate Analyses

Assumptions for the procedures used in the ERA are summarized below and discussed in further detail in a previous publication (CTC 1988). Additional details regarding these assumptions are also available in CTC 2023e.

1. The temporal and spatial distribution of stocks in and between the fisheries are relatively stable from year to year.
2. The coded wire tagged fish behave in the same manner as the untagged stocks which they are intended to represent, termed the “gorilla assumption” by the CWT Expert Panel (Expert Panel 2005).
3. CWT recovery data are obtained in a consistent manner from year to year, or can be adjusted to be made comparable.
4. There are a number of assumptions about parameter values involved in the cohort analyses. For example, this includes assumptions of natural mortality, incidental mortality rates, and selectivity factors for estimating the mortality of legal-size CWT fish during periods of CNR.

3. Exploitation Rate Analysis Results

In this section, key ERA results are reviewed on a region-by-region basis and discussed briefly in terms of general patterns and trends at the stock and stock group level. Results are presented for the following ERA metrics: BYER (total or ocean, depending on stock), early marine survival rate, and mortality distribution. Although some of this content is germane to assessments of the effectiveness of the PST, such evaluations necessitate that other information also be considered (e.g., performance of escapement indicator stocks, AABM and ISBM fisheries, etc.). Thus, the emphasis of this section is on describing patterns and trends only, not on drawing inferences about cause-effect relationships due to changing management regimes.

3.1 Southeast Alaska and Transboundary Stocks

There are four wild, one wild aggregate, and two hatchery aggregate CWT indicator stocks in the SEAK and transboundary regions. The four wild stocks are the Chilkat River (CHK), Taku River (TAK), Stikine River (STI), and Unuk River (UNU). The one wild aggregate stock is the Taku and Stikine Rivers (TST), which is the CWT indicator stock used to represent the Taku and Stikine River model stock in the PSC Chinook Model. The CHK and UNU wild stocks are not currently used in the PSC Chinook Model but are used by the CTC to evaluate the efficacy of the hatchery indicator stock assumption. Southern Southeast Alaska Spring (SSA) is composed of CWT releases from three SEAK hatcheries (Little Port Walter, Deer Mountain, and Herring Cove) and Northern Southeast Alaska Spring (NSA) is composed of CWT releases from the Crystal Lake hatchery. The SSA and NSA hatchery stocks are used in the PSC Chinook Model. All SEAK and transboundary wild and hatchery indicators enter the ocean as yearlings and age 3 is the youngest age at which CWTs are recovered. The estimate of escapement for STI in 2023 was delayed and not available at the time of this report; therefore, results are restricted to STI escapement estimates through 2022.

3.1.1 Brood Year Exploitation Rates

The BYERs computed for the SEAK and transboundary wild stocks include recoveries from ocean and terminal fisheries. However, for the SEAK hatchery stocks, recoveries from intensive terminal fisheries are not included in the BYERs to more accurately represent SEAK wild stocks.

Average BYERs for the wild CWT indicator stocks have been 18% for CHK since BY 1999, 17% for TAK since BY 1975, 34% for STI since BY 1998, 30% for UNU since BY 1982, and 20% for TST since BY 1975. Average BYERs for the two hatchery aggregates have been 38% for SSA since BY 1976 and 36% for NSA since BY 1979 (*Table* 3.1; Appendix D1). Recent poor production has prompted conservative management actions in SEAK resulting in lower BYERs for CHK at 14%, TAK at 12%, and STI at 21% since BY 2008. However, the BYER for UNU has remained about average at 32% since BY 2008 (Appendix D2).

3.1.2 Survival Rates

Survival rates for the hatchery and transboundary stocks were computed at age 3 because these stocks enter the ocean predominantly as yearlings. For the wild CWT indicator stocks and the most recent complete BY (2017), survival rates were 7.5% for CHK, 7.2% for STI, 4.3% for TAK, and 12.1% for UNU. Rates ranged 3%–19% for CHK since BY 1999, 1%–29% for TAK since BY 1991, 1%–7% for STI since BY 1998, and 2%–15% for UNU since BY 1982 (Appendix E2). For the NSA hatchery stock and the most recent complete BY (2017), survival rates were 2.8% and ranged from 1%–24% since BY 1979 (Appendix E1). For the SSA hatchery stock and the most recent complete BY (2017), survival rates were 3.8% and ranged from 2%–26% since BY 1976 (Appendix E1).

3.1.3 Mortality Distributions

Distribution of mortalities for the SEAK and transboundary wild and SEAK hatchery stock groups in the 2009–2018 and 2019–present Treaty annex periods are provided in Table 3.1 and illustrated in Figure 3.1. The values for the mortality distributions are now available online on the PSC website in Appendix C. Overall, beginning with the 1999 Agreement, there was a high calendar year percent escapement for CHK (2004–2023 average 84%), STI (2003–2022 average 68%), TAK (1999–2023 average 83%), and UNU (1987–2023 average 71%), with other mortality mostly in SEAK AABM sport, troll, and net fisheries. Within the SEAK AABM fisheries in the 1999–2023 (2022 for STI) period, the SEAK troll fishery caught a higher percentage of STI fish (average 5% of total mortalities), TAK fish (average 4%), and UNU fish (average 14%), whereas the SEAK sport fishery caught a higher percentage of CHK fish (average 7%). Outside of the SEAK AABM fishery, a few STI and UNU mortalities have occurred in the NBC AABM fishery. Approximately 54% and 48% of NSA and SSA mortalities, respectively, occurred as escapement in the 1999–2023 period, with remaining mortalities occurring in the SEAK AABM and terminal fisheries. For the 1999–2023 period, the SEAK AABM troll fishery accounted for an average of 18% of the SSA total mortalities, followed by SEAK AABM net fisheries averaging 8%.; SEAK AABM troll averaged 19% of NSA mortality, and SEAK AABM net averaged 14%; SEAK AABM sport fisheries accounted for 5% and 7% of the NSA and SSA stock groups mortality, respectively. For the same time period, SEAK terminal fisheries combined (troll, net, sport) accounted for 8% of total NSA mortality and 16% of SSA total mortality.

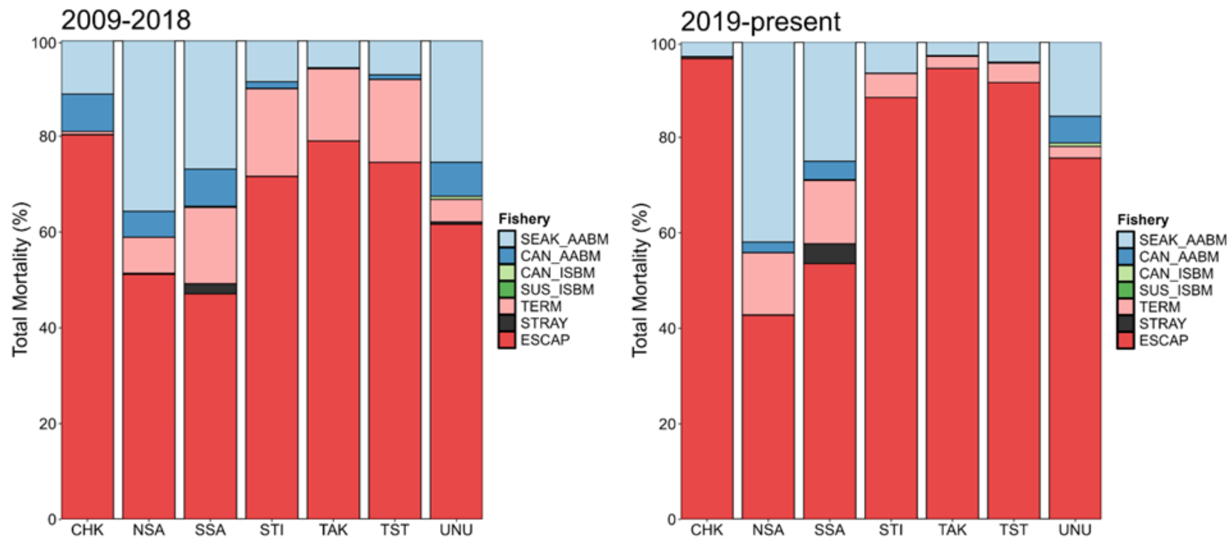

Figure 3.1—Distribution of total mortality for Southeast Alaska indicator stocks from the 2009 (2009–2018) and 2019 (2019–2028) Pacific Salmon Treaty Agreement periods.

3.1.4 Regional Summary for Southeast Alaska and Transboundary Stocks

Table 3.1—Summary of statistics generated by the 2024 coded-wire tag (CWT) cohort analysis for Southeast Alaska and transboundary river indicator stocks. Statistics include total mortality (catch plus incidental mortality), brood year exploitation rate (BYER), cohort survival rate to age 3, and calendar year (CY) percent distribution of the total mortality in escapement.

					CY % Escapement[1]		
	BYER (total mortality)		Survival rate		2009-2018	2019-current	
Indicator Stock Name	Mean (range)	Last complete BY	Median (range)	Last complete BY	Mean (range)	Mean (range)	Last CY (year)
Southern Southeast Alaska Spring (SSA)[2]	38% (23%-62%)	26% (2017)	5.53% (2.20-25.98%)	3.81% (2017)	47% (33-59%)	53% (41-64%)	64% (2023)
Northern Southeast Alaska Spring (NSA)[2]	36% (17%-65%)	20% (2017)	2.84% (0.67-23.99%)	2.78% (2017)	51 (32-72%)	43% (14-71%)	14% (2023)
Chilkat River (CHK)	18% (3%-42%)	5% (2017)	7.50% (2.93-18.73%)	7.50% (2017)	80% (70-95%)	97% (94-98%)	98% (2023)
Stikine River (STI)	34% (7%-80%)	22% (2016)	3.78% (1.28-7.26%)	7.19% (2017)	72% (56-92%)	88% (84-92%)	92% (2022)
Taku River (TAK)	17% (3%-41%)	7% (2017)	6.29% (1.48-28.68%)	4.28% (2017)	79% (54-96%)	94% (92-97%)	97% (2023)
Taku and Stikine Rivers (TST)	20% (4%-48%)	9% (2017)	5.55% (1.38-28.68%)	5.06% (2017)	75% (55-94%)	92% (90-94%)	90% (2023)
Unuk River (UNU)	30% (14%-58%)	28% (2017)	6.91% (1.78-15.19%)	12.13% (2017)	62% (38-85%)	76% (71-81%)	71% (2023)

[1] % Escapement is not a measure of performance for the escapement indicator stock(s) associated with a given CWT indicator stock.

[2] BYER is ocean exploitation rate only.

3.2 North and Central British Columbia Stocks

The North/Central BC Model stock (NTH) was split into North (NBC) and Central (CBC) Model stocks in the Phase II PSC Chinook Model. NBC includes Nass and Skeena escapements and is represented by the Kitsumkalum (KLM) hatchery CWT indicator stock, which is composed of tagged fish from the Deep Creek Hatchery. The CBC Model stock includes the Atnarko, Wannock, and Chuckwalla-Kilbella escapements, and this stock is represented by the hatchery CWT indicator Atnarko (ATN) stock, which is composed of tag recoveries from the Snootli Hatchery. Kitsumkalum Chinook enter the ocean as yearlings and age 3 is the youngest age at which CWTs are recovered, whereas Atnarko Chinook enter the ocean as subyearlings and age 2 is the youngest age recovered. The KLM time series begins in BY 1979, and the ATN time series begins in BY 1986. There were no KLM CWT releases in 1982 and 2019, and no ATN CWT releases in 2003, 2004 and 2019.

3.2.1 Brood Year Exploitation Rates

The BYERs computed for KLM and ATN include recoveries from both ocean and terminal fisheries. The total BYER for KLM has been generally decreasing from 69% in 1989 though there have been oscillations of varying length (Appendix D3). The total BYER for KLM was 38% for BY 2017, the last complete brood year and averaged 45% (Table 3.2). The BYER for ATN was 61% for BY 2006 and has generally declined since. It was 27% in 2018, the last complete brood year (Appendix D3). ATN total BYER averaged 39% (Table 3.2). Incidental mortalities within the total KLM BYER range from 4 to 13% and average 8%, and within the total ATN BYER range from 2 to 7% and average 4% (Appendix D3).

3.2.2 Survival Rates

The early marine survival rate of KLM is survival to age 3 because the fish enter the ocean as yearlings, whereas the early marine survival rate of ATN is survival to age 2 because the fish enter the ocean as subyearlings. Brood years included in the survival rate analyses of KLM were 1979 to 1981 and 1983 to 2017. Brood years included for the analyses of ATN were 1986 to 2002 and 2005 to 2018. The KLM survival rates have averaged 0.77% and ranged from 0.12–1.94% with a rate of 0.22% for the last complete BY, 2017 (Appendix E3; Table 3.2). The ATN survival rates have averaged 2.19% and ranged from 0.50–5.97% with a survival rate of 1.24% for the last complete BY, 2018 (Appendix E3; Table 3.2).

3.2.3 Mortality Distributions

Escapement accounted for an average of 55.7% of the KLM total mortality across the entire mortality distribution time series which began in catch year 1985. The percent attributable to escapement has increased through time overall. Average mortality in the escapement was 59.1% in KLM during 2009–2018 and 71.6% during 2019–2023. Catch and IM in NBC & CBC ISBM sport has historically been a large mortality component for KLM (2009–2018 average: 9.5%; 2019: 11.2%; 2020: 8.4%) but has decreased to 0% from 2021–2023. SEAK AABM troll mortality has declined (2009–2018 average: 11.7%; 2019–2022 average: 5.7%) but SEAK AABM net (2009–2018 average: 1.9%; 2019–2022 average: 6.5%) has increased and SEAK AABM mortality component averages 17.1% under the current agreement (18.4% in 2009–18). . No terminal sport mortality (0%) occurred for KLM from 2018–2023.

Escapement accounted for an average of 60.9% of the ATN total mortality across the entire mortality distribution time series which began in catch year 1990. Average mortality in the escapement was 58.5% for ATN during 2009–2018 and 71.3% during 2019–2023. Canadian ISBM (2019–2023 average: 14.4% made up of 9.7% net and 4.7% sport), terminal fisheries (2019–2023 average: 6.0% made up of 4.8% net and 1.2% sport) were the largest mortality components for ATN, followed by SEAK AABM (total mortality 5.4%; Figure 3.2).

There are essentially no strays for KLM and ATN.

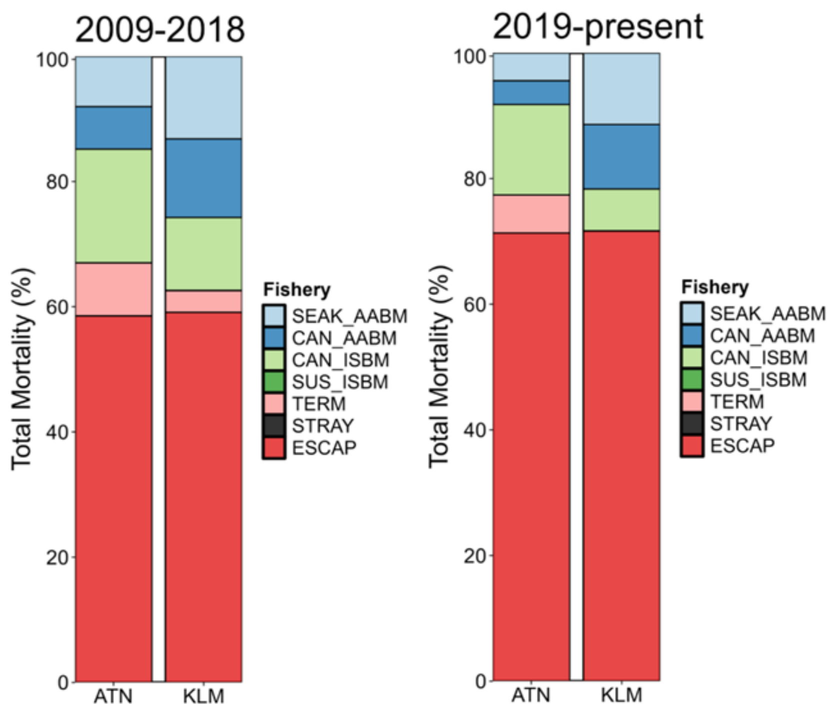

Figure 3.2—Distribution of total mortality for North (KLM) and Central (ATN) British Columbia indicator stocks from the 2009 (2009–2018) and 2019 (2019–2028) Pacific Salmon Treaty Agreement periods.

3.3 West Coast Vancouver Island Stocks

There is one hatchery CWT indicator stock to represent wild and hatchery WCVI Chinook. The Robertson Creek Fall (RBT) indicator stock is composed of tag recoveries from the Robertson Creek hatchery, and it is used to represent the WCVI model stocks WVH (hatchery) and WVN (natural). WCVI Chinook enter the ocean as subyearlings and age 2 is the youngest age recovered. The RBT time series begins in BY 1973 and the latest complete BY is 2018 (Appendix D4). RBT is used as an ocean exploitation rate indicator for two other WCVI escapement indicator stocks: Northwest Vancouver Island and Southwest Vancouver Island. Terminal adjustments are applied to these stocks for the CYER calculations in order to account for differential terminal fishery harvest rates (see section 3.3.4).

3.3.1 Brood Year Exploitation Rates

The BYER computed for RBT only includes recoveries from ocean fisheries. The total BYER for RBT has decreased from approximately 67% for BY 1973 to 30% for BY 2018, with an average of 42% over the entire time series (Appendix D4). Most of the BYER is attributed to landed catch (17% – 57%), with IM estimates ranging from only 2% to 30%. The exception was in BY 1991, when IM was higher than landed catch (30% versus 23%, respectively). The most recent complete BY (2018) had the fifth lowest landed catch in the time series at 21% and a moderate IM of 9%.

3.3.2 Survival Rates

The survival rate of RBT represents survival to age 2 because the juveniles enter the ocean as subyearlings and age 2 fish are the youngest recovered. RBT survival rates vary widely, but have generally declined over time, ranging from 20% for BY 1974 to 0.03% for BY 1992, and averaging 5%. The last complete BY (2018) has a survival rate of 5% (Appendix E4).

3.3.3 Mortality Distributions

Total mortality attributed to escapement for RBT declined from an average of 43% during 2009–2018 to 33% during 2019–2023; prior to 2009, average escapement mortality of the preceding four periods (1979–1984, 1985–1995, 1996–1998, and 1999–2008) averaged 37% (Figure 3.3).

Most of the total mortality for RBT during the recent 2019–2023 period is attributed to catch and IM in Canadian terminal fisheries (37%) which is a substantial increase from the previous period (19% during 2009–2018). Of the Canadian terminal fisheries, net fisheries accounted for most of the recent period total mortality (average 29% during 2019–2023), which increased from the previous period (average 10% during 2009–2018). Canadian terminal sport fisheries contribute a small amount to the total mortality for RBT and have been relatively consistent over both periods (average 9% during 2009–2018; average 7% during 2019–2023).

Total mortality attributed to all AABM fisheries declined slightly from 29% for 2009–2018 to 22% for 2019–2023. SEAK troll fisheries continue to make up the highest proportion of AABM mortality, though this proportion has declined on average from the previous period (10%) to the current (6%). SEAK net (averaging 3% during 2009–2018 and 4% during 2019–2023) and sport (averaging 5% during 2009–2018 and 3% during 2019–2023) fisheries account for a moderate amount of the RBT mortality. NBC AABM troll and sport fisheries accounted for similarly moderate portions of AABM mortalities, with sport (averaging 5% during 2009–2018 and 3% during 2019–2023) contributing slightly more than troll (averaging 2% during 2009–2018 and 2% during 2019–2023). WCVI AABM troll (averaging 1% during 2009–2018 and 2019–2023) and sport (averaging 3% during 2009–2018 and 2% during 2019–2023) fisheries account for a minimal portion of RBT total mortality.

RBT total mortality across all non-terminal ISBM fisheries declined slightly between the previous and current periods (averaging 10% during 2009–2018 and 9% during 2019–2023). Southern BC sport accounts for most of the non-terminal ISBM fisheries mortality, averaging 7% during 2009–2018 and 6% during 2019–2023, while NBC/CBC sport contribute moderately (averaging 3% during 2009–2018 and 2019–2023) and all other ISBM fisheries are negligible (<1%).

Observed strays make up a very small percentage of the total mortality for RBT (average 0.2% during 2009–2018; average 0.3% during 2019–2023). The largest percentage of the total mortality represented by strays in RBT was 1% in 2017 and again in 2020.

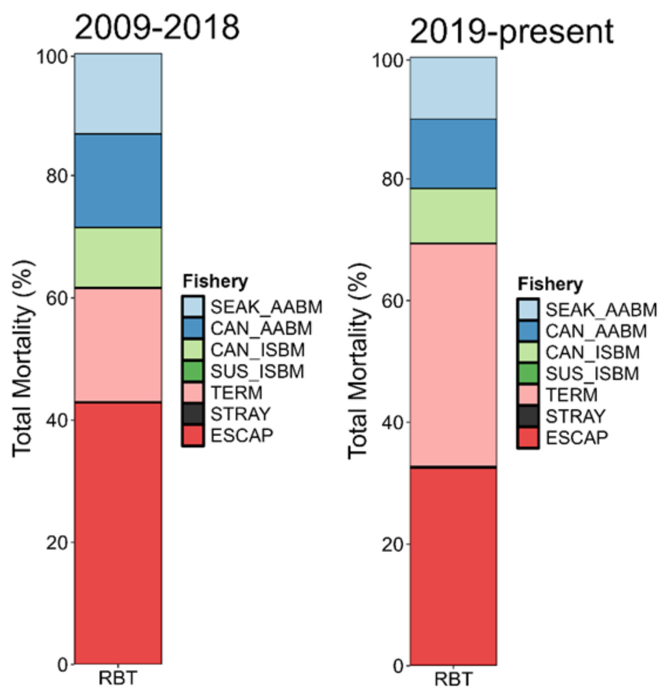

Figure 3.3—Distribution of total mortality for West Coast Vancouver Island indicator stock from the 2009 (2009–2018) and 2019 (2019–2028) Pacific Salmon Treaty Agreement periods.

3.3.4 Terminal Area Adjustments

Unadjusted and adjusted mortality estimates are given for the RBT CWT indicator to bound the likely range of ISBM (and other) fishery impacts applicable to the escapement indicator stocks comprising the aggregate. The adjusted estimates were obtained by subtracting the terminal fishery CWT estimates specific to RBT from the ISBM fishery total and adding them to the escapement. Recalculation of the percentage distribution of mortality results in some adjustment to each category. Recent WCVI terminal fishery assessments provide estimates of the catch of natural-origin stocks for a number of terminal fisheries along the WCVI (Luedke et al. 2019), however the analysis was not conducted at the scale of the Southwest Vancouver

Island (SWVI)and Northwest Vancouver Island (NWVI)escapement indicator stocks (Figure 3.4). Natural WCVI origin stocks are not targeted in the terminal areas.

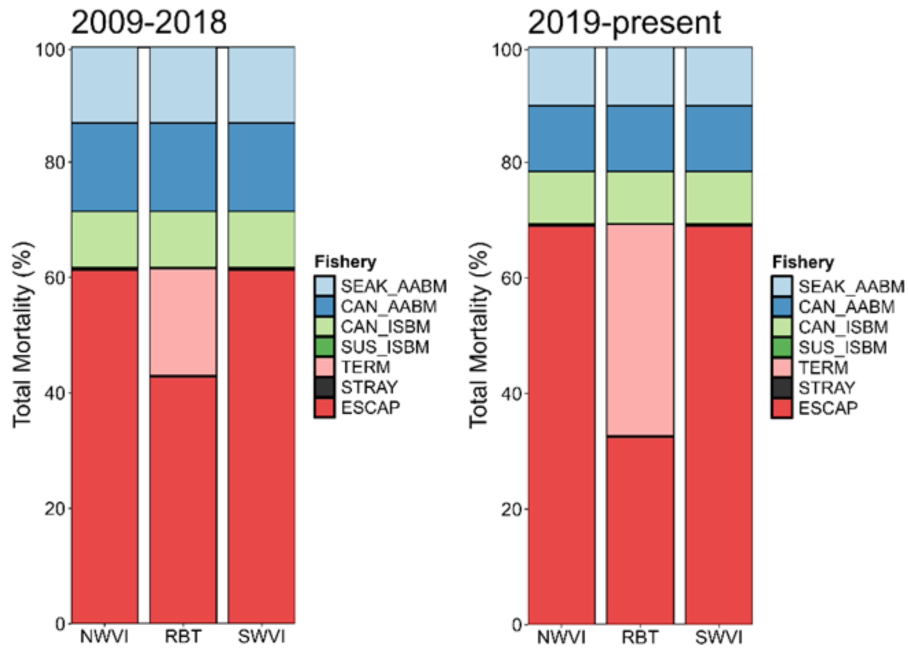

Figure 3.4—Distribution of total mortality for the West Coast Vancouver Island hatchery indicator stock before applying the terminal area adjustment (Robertson Creek Fall [RBT]) and after the terminal area adjustments for the escapement indicator stocks (Northwest Vancouver Island [NWVI] and Southwest Vancouver Island [SWVI]) for the 2009 (2009–2018) and 2019 (2019–2028) Pacific Salmon Treaty Agreement periods.

3.4 Strait of Georgia Stocks

The Strait of Georgia is segregated into two main regions: North Strait of Georgia and South Strait of Georgia. North Strait of Georgia has one hatchery CWT indicator stock (Quinsam [QUI]) which also represents the Upper Strait of Georgia in the PSC Chinook Model. The South Strait of Georgia includes Big Qualicum (BQR) and Cowichan (COW), which also represent Middle Strait of Georgia and Lower Strait of Georgia in the PSC Chinook Model, respectively. Additionally, there is also Puntledge (PPS) which also represents the PPS Model stock. QUI comprises tag recoveries from the Quinsam Hatchery. COW comprises tag recoveries from the Cowichan, whereas PPS and BQR comprise tag recoveries from the Puntledge and Big Qualicum hatcheries, respectively. Strait of Georgia Chinook enter the ocean as subyearlings and age 2 is the youngest age at which CWTs are recovered. The QUI time series begins in brood year 1974, COW in 1985, PPS in 1975, and BQR in 1973. QUI is also used as an ocean exploitation rate indicator for the Strait of Georgia escapement indicator stock East Vancouver Island North. Terminal adjustments are applied to this stock for the CYER calculations in order to account for differential terminal fishery harvest rates (see section 3.4.4).

3.4.1 Brood Year Exploitation Rates

The BYERs computed for Strait of Georgia stocks include recoveries from ocean fisheries and terminal fisheries. BYER figures for all Strait of Georgia stocks are provided in Appendix D5.

The total BYER for QUI (representing UGS) has generally decreased overall, from 71% in BY 1974 to 51% in BY 2018, averaging 55% over the entire time series and ranging from 29% for BY 1997 to 84% for BY 1977. After dropping to 29% in BY 1997, BYER remained relatively constant, averaging 44% (ranging from 31% for BY 2004 to 53% for BY 2005). IM accounts for, on average, 12% of the exploitation rate (from 5% in BY 1998 to 43% in BY 1991); the last complete brood year IM was 16% (2018). IM was only higher than landed catch exploitation rate in BY 1991 (43% versus 38%, respectively).

The total BYER for BQR (representing MGS) has generally decreased over the full time series, from 84% in BY 1974 to 53% in BY 2018. It has averaged 58%, ranging from 31% in BY 2014 to 85% in BY 1978. IM accounts for, on average, 15% of the exploitation rate (from 8% in BY 1974 to 28% in BY 1990); the last complete brood year IM was 31% (2018).

LGS has historically been represented by COW and Nanaimo (NAN). However, given that NAN has been discontinued as an exploitation rate indicator stock for LGS following the last complete BY of 2004, this section will focus on COW. The total BYER for COW has been variable across the time series, from 89% in BY 1985 to 29% in BY 2018. Over the time series it has averaged 65%, ranging from 29% in BY 2018 to 89% in BY 1985; note the most recent complete brood year (2018) has the lowest total mortality on record. IM accounts for, on average, 21% of the exploitation rate (ranging from 10% in BY 2003 to 31% in BY 1990); the last complete brood year IM was 15% (2018). Note that data are missing for BYs 1986 and 2004 for COW.

Finally, the total BYER for PPS declined from 85% in BY 1975 to 13% in BY 1998 but has increased moderately since then to 30% in BY 2018. Over the time series it has averaged 50%, ranging from 13% in BY 1998 to 88% in BY 1985. IM accounts for, on average, 11% of the exploitation rate (from 3% in BY 1998 to 24% in BY 1992). The last complete brood year IM was 20% (2018), and the exploitation rate for IM was higher than for landed catch in BY 2004 (9% versus 4%, respectively) and in 2018 (20% versus 11%, respectively). Note that data are missing for BY 1995 for PPS.

3.4.2 Survival Rates

The survival rates of Strait of Georgia (GST) CWT indicator stocks represent survival to age 2 because fish enter the ocean as subyearlings. All of these stocks show a clear declining trend in survival rates (Appendix E5). The QUI survival rates (representing UGS) have averaged 1.97% and ranged from 0.16% for BY 2006 to 9.11% for BY 1974. The survival rate for the last complete brood (2018) was 0.97%. In the case of the MGS CWT indicator stock, BQR survival rates have averaged 2.10% and ranged from 0.12% in BY 1992 to 25.14% for BY 1974 (the highest observed for GST stocks). The survival rate for the last complete brood year (2018) was 1.33%. LGS survival rates represented by COW have averaged 1.77% and ranged from 0.34% (BY 2002) to 6.82% (BY 1990). The survival rate for the last complete brood (2018) was 1.49%. NAN has been discontinued as an exploitation rate indicator stock for LGS following the last complete BY of 2004; see the 2021 ERA for NAN survival rate summary statistics (CTC 2022b). Finally, survival rates for the PPS indicator stock (representing the PPS Model stock) have averaged 1.15% and ranged from 0.10% (BY 1992) to 12.76% (BY 1976). The survival rate for the last complete brood year (2018) was 0.52%.

3.4.3 Mortality Distributions

Escapement contributes the majority of total mortality for all Strait of Georgia indicator stocks for the current period (2019–2023), ranging from 51% for QUI to 71% for PPS (Figure 3.5). This is largely unchanged from the previous period with the exception of COW which has seen an increase in escapement mortalities from 36% (2009–2018) to 58% (2019–2023). PPS has also seen a slight increase in escapement mortalities, from 60% (2009–2018) to 71% (2019–2023).

Total mortality attributed to Canadian AABM fisheries has declined for most stocks except QUI where it has remained fairly constant (approximately 3% of total mortality in both recent periods) and is largely driven by the NBC AABM sport fishery (2% of total mortality in both periods). SEAK AABM total mortalities have been constant for COW and QUI. For BQR they have declined from 7% during 2009–2018 to 4% in 2019–2023, primarily due to a reduction in troll fishery mortalities (5% during 2009–2018, 3% in 2019–2023). In contrast, they have increased for QUI from 20% during 2009–2018 to 21% in 2019–2023, primarily due to an increase in net fisheries mortalities (5% during 2009–2018, 8% in 2019–2023).

Total mortality attributed to Canadian ISBM fisheries has been variable between periods and among indicator stocks. The most notable change was for PPS, which exhibited a drop from 30% to 20% in the current period. This was primarily driven by a decrease in Southern BC ISBM sport fishery mortality (26% during 2009-2018, 14% during 2019-2023). Total mortalities in Southern U.S. ISBM fisheries have also varied between periods. The most notable change was for COW, for which total mortalities declined from 4% in the previous period to 1% in the current period, primarily due to a decline in Puget Sound ISBM sport fishery mortality (2.6% during 2009–2018, 0.5% during 2019–2023).

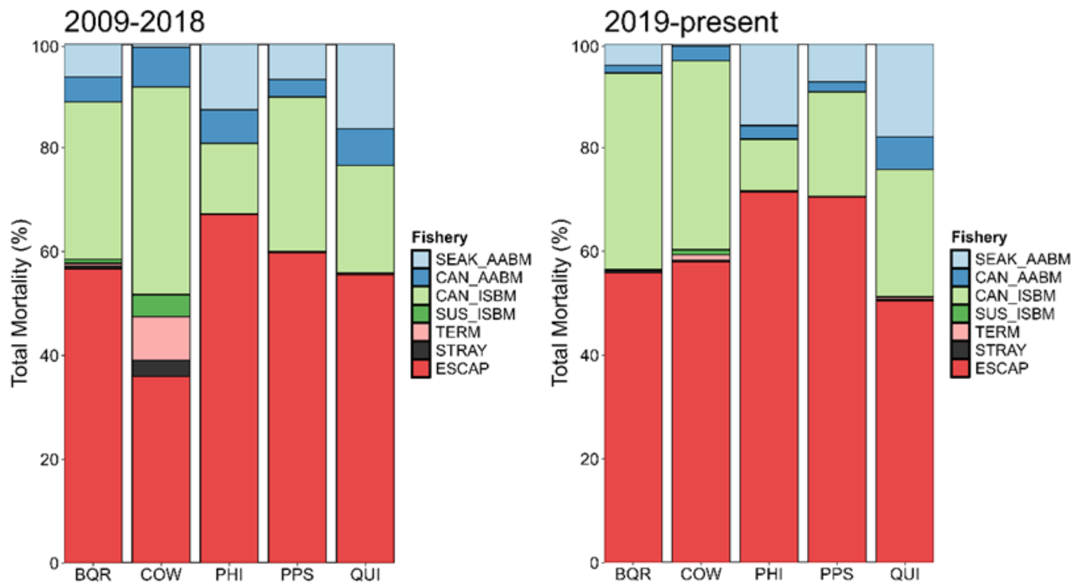

Figure 3.5—Distribution of total mortality for Strait of Georgia indicator stocks from the 2009 (2009–2018) and 2019 (2019–2028) Pacific Salmon Treaty Agreement (PST) periods.

3.4.4 Terminal Area Adjustments

Terminal area adjustments for the Strait of Georgia stocks only occur on the Quinsam stock to adjust for the East Vancouver Island North (EVIN) escapement indicator stock (Figure 3.6). Work is ongoing to identify the most suitable escapement indicator stock for the EVIN area.

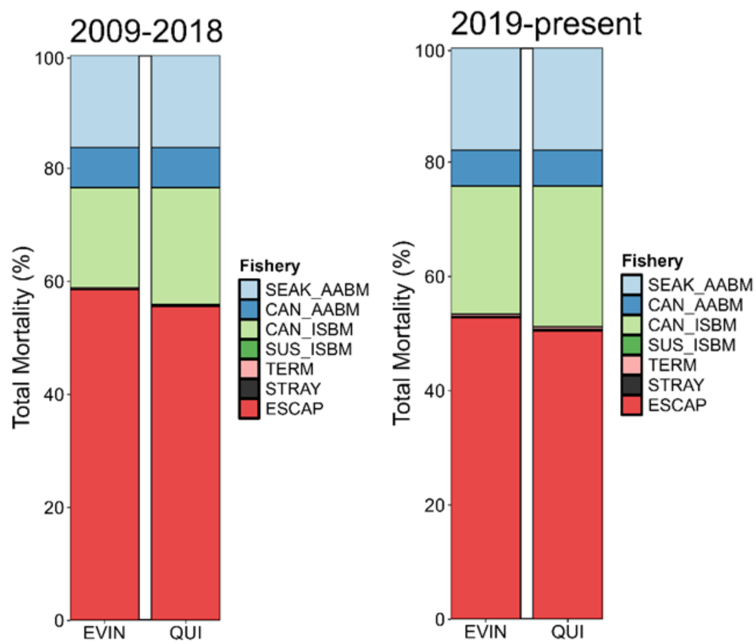

Figure 3.6—Distribution of total mortality for the Upper Strait of Georgia hatchery indicator stock before applying the terminal area adjustment (Quinsam [QUI]) and after the terminal area adjustments for the escapement indicator stock (East Vancouver Island North [EVIN]) for the 2009 (2009–2018) and 2019 (2019–2028) Pacific Salmon Treaty Agreement periods.

3.5 Fraser River Stocks

The Fraser CWT exploitation rate indicator stocks (ERIS) represent different combinations of Chinook run timing and life history; Nicola (NIC) represents the Fraser Spring 1.2 model stock (FS2), Lower Shuswap (SHU) represents the Fraser Summer Ocean-type 0.3 model stock (FSO), Harrison (HAR) represents the Fraser Harrison Fall model stock (FHF), and Chilliwack (CHI) represents the Fraser Chilliwack Fall Hatchery model stock (FCF). Currently, there is no CWT ERIS for the Fraser Summer Stream-type 1.3 (FSS) and Fraser Spring 1.3 (FS3) model stocks; however, the Chilko (CKO) and Lower Chilcotin (LCT) sites are being developed to represent these life history strategies, respectively. The Middle Shuswap (MSH) is another ERIS in the FSO model stock, but the SHU is used to represent the entire FSO model stock. The FCF, FHF, and FSO enter the ocean as subyearlings and age 2 is the youngest age at which CWTs are recovered, whereas the FS2, FS3, and FSS enter the ocean as yearlings with age 3 as the youngest age at which CWTs are recovered. The time series of recoveries for the CHI and HAR starts with BY 1981, NIC with BY 1985, SHU with BY 1984 and MSH with BY 1985. Since the 2020 ERA report (CTC 2021d), historic CWT data have been assembled, reviewed and standardized for MSH and 17 more brood years (1985–2001) were added to the ERA.

3.5.1 Brood Year Exploitation Rates

The BYERs computed for Fraser River stocks include recoveries from ocean fisheries and freshwater fisheries within the Fraser River and tributaries. The BYER plots for all Fraser stocks are available in Appendix D.

Since BY 1981, BYERs for the fall-run stocks have generally decreased to approximately 39% for CHI and 25% for HAR for BY 2018, the last complete BY (Appendix D6). CHI BYER averaged 40% and ranged from 23% for BY 1995 to 83% for BY 1982, whereas HAR BYERs averaged 44% and ranged from 20% for BY 1995 to 86% for BY 1982. Within BYERs, the percentage of the BYER comprised of IM for CHI averaged 24% over the entire time series, and increased during the first 15 years, reaching 31% for BY 1995, and then decreased substantially to average levels for subsequent BYs; however, BY 2015 onwards has seen the percentage of IM increase, averaging 42% for the 2015-2018 BYs. Similarly, the percentage of the HAR BYER that results from IM averaged 24% and also increased during the first 15 years of the time series, reaching 37% for BY 1995, followed by fluctuations around the average level ranging from 12% in 2001 to 32% in 1999. The last four BYs have seen an increase in the percentage of IM, averaging 42%, peaking for BY 2017 at 49%.

For the spring-run stocks, no clear trend in BYER is apparent for NIC (Appendix D7) and there is currently no indicator stock for the FS3 or FSS model stocks. NIC BYERs are the lowest among Fraser River and all other Canadian ERIS. Estimated BYERs for NIC averaged approximately 25% and ranged from 3% for BY 1992 to approximately 60% for BY 2003 (Appendix D7). The percentage of the NIC BYER that results from IM remained relatively stable, averaging approximately 11% for the entire time series, and ranging from 3% for BYs 2003 to 30% for BY 2015.

The BYER has been decreasing for the subyearling summer-run stocks since BY 2001 for SHU and since BY 2008 for MSH. Estimated BYERs for MSH averaged approximately 38% and ranged from 15% to 74% (Appendix D7). The percentage of MSH BYER attributed to IM averaged 15% and ranged from 8% to 28%, peaking in the early 1990s and then declining but remaining relatively consistent since then. Lastly, BYER for SHU averaged 50%, and ranged from 22% for BY 2016 to 81% for BY 1989. The proportion of the SHU BYER represented by IM has remained relatively stable, averaging 19% for the entire time series and ranging from 13% for BY 1990 and 2017 to 34% for BY 1992.

3.5.2 Survival Rates

Plots of early marine survival rate estimates by stock and year are available in Appendix E. Estimated survival rates for CHI, HAR, MSH and SHU represent survival to age 2 because juveniles from those stocks enter the ocean as subyearlings and age 2 is the youngest age recovered. Estimated survival rates for NIC represent survival to age 3 because smolts from this stock enter the ocean as yearlings and age 3 is the youngest age recovered.

For CHI, survival averaged 11.7%, with a range of 1.7% for BY 1991 to 30.5% for BY 1981 (the highest observed for any Fraser River stock). Estimated survival rates for HAR averaged 3.4% with a range of 0.4% for BY 1991 to 24.0% for BY 1981. NIC survival rates averaged 2.8% with a range of 0.1–12.5%. MSH survival rates averaged 2.9% with a range of 0.4–12.3%, and the SHU survival rates averaged 3.1% with a range of 0.7–8.1% (Appendix E7). The survival rate for the last completed brood of the time series was 11.5% for CHI, 5.2% for HAR, 4.7% for NIC, 1.5% for MSH and 3.2% for SHU

3.5.3 Mortality Distributions

For the fall-run ERIS, escapement represented an average of 62% of the CHI total mortality (Figure 3.7) and 58% of the HAR mortality (Figure 3.7) between 1985 and 2023 (mortality distribution time series for both stocks began in 1985). The CHI average mortality proportioned to escapement remained approximately the same from the 1999–2008 period (70%) and 2009–2018 period (70%) to the 2019–2023 period (67%). The HAR average mortality in the escapement increased from the 1999–2008 period (60%) to the 2009–2018 period (73%) and has remained similar in the 2019–2023 period (77%). For CHI, fishing mortality was attributed to catch and IM in the Canadian terminal sport (1999–2008 and 2009–2018 averages: 6% and 6% respectively; 2019–2023 average: 10%), the ISBM Southern BC sport (1999–2008 average: 5%; 2009–2018 average: 13%; 2019–2023 average: 16%), the ISBM North of Falcon troll (1999–2008 average: 6%; 2009–2018 average: 3%; 2019–2023 average: 1%), and the WCVI AABM troll (1999–2008 average: 6%; 2009–2018: 2%; 2019–2023 average: 1%) fisheries. Between 1985 and 1995, the ISBM Southern BC (Strait of Georgia) troll fishery was a large component of the total mortality for CHI (average 6%); however, that fishery for Chinook salmon ceased from 1996 onward. For HAR, most of the fishing mortality from 1999–2008 was associated with catch and IM in the WCVI AABM troll fishery (average: 13%), which declined to 2% during 2009–2018 period and to 1% in the 2019–2023 period; other large components of the total mortality were the North Falcon troll ISBM fishery (1999–2008 average: 10%; 2009–2018 average: 4%; 2019–2023 average: 2%) and the Southern BC sport ISBM fishery, which is a large mortality component for HAR (1999–2008 average: 6%; 2009–2018 average: 11%; 2019–2023 average: 16%). There is only limited terminal recreational fishing opportunity on HAR.

Among the ERIS for the spring- and summer-runs, escapement represented a larger amount of the total mortality distribution during the 2019–2023 period than the 2009–2018 and the 1999–2008 period for NIC (90% vs 78% and 74%, respectively; Figure 3.7), MSH (79% vs 54% and 68% respectively; Figure 3.7), and SHU total mortality (75% vs 55% and 53% respectively; Figure 3.7). During 2019 to 2023, the largest components of the total fishing mortality for SHU occurred in the terminal net fishery (average: 5%), followed by the ISBM Southern BC sport fishery (average: 5%), the SEAK AABM troll fishery (average: 4%) and the terminal sport fishery (average: 4%). MSH is part of the same stock group as SHU; however, for MSH the largest component of the total fishing mortality during 2019–2023 occurred in the terminal sport and net (average: 6% and 4% respectively), followed by the Southeastern Alaskan troll and sport fisheries (average: 1.8% and 1.5% respectively), and the NBC AABM sport fishery (average: 1.8%; Figure 3.7). During 2019 to 2023, the largest components of the total fishing mortality for NIC occurred in the terminal net and sport fisheries (average: 6% and 1% respectively), followed by the ISBM Southern BC sport (average: 1%).

Strays to other escapement locations made an average 1.0% of the total mortality for CHI during 1985–2023, with a high of 5.6% in 2003, and for HAR, strays made only 0.3% of the total mortality during 1985–2023 with a high of 4.6% in 1995. Strays also represented a very small percentage of the total mortality in NIC (average 0% during 1989–2023). The largest percentage of the total mortality represented by strays in NIC was 1.7% in 1990. Similarly, strays made up only a small percentage of the total mortality in SHU (1988–2023 average: 0.7%) and MSH

(2012–2023 average: 1.9%). The largest percentage of the total mortality represented by strays in SHU was 3% in 2021 and it was 5% for MSH in 2015, 2016 and 2019.

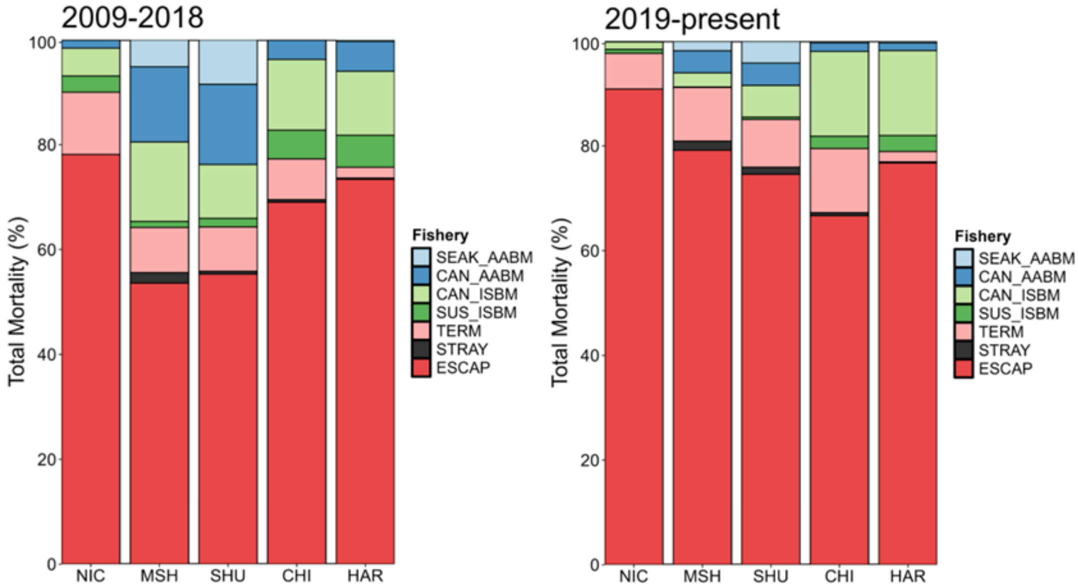

Figure 3.7—Distribution of total mortality for Fraser River indicator stocks from the 2009 (2009–2018) and 2019 (2019–2028) Pacific Salmon Treaty Agreement periods.

3.6 Regional Summary for Canada

With exception of the RBT indicator stock, for which BYER represents ocean fishing mortality, BYERs in Canadian indicator stocks represent fishing mortality in both ocean and terminal fisheries. BYERs of most Canadian indicator stocks have been generally declining. Strait of Georgia stocks have experienced the largest BYERs among Canadian indicator stocks with COW, a Lower Strait of Georgia natural stock, experiencing an average BYER greater than 60%. BYERs for the last complete BY of all Canadian stocks were lower than their long-term averages, except for PHI which had a 31% BYER in 2018 compared to 30% for its long-term average (Table 3.2).

Median survival rates to age 2 (to age 3 for KLM) are lower than 5% for all Canadian indicator stocks, except for CHI, which has the largest median survival rate at 11.04% (Table 3.2). CHI also experienced the largest estimated survival rate (30.6% in 1981) for any given BY among all Canadian stocks. Other stocks that have experienced BY survival rates greater than 20% earlier in the time series are RBT, BQR, and HAR. Survival rates for these stocks have decreased relative to those high values. The lowest survival rate for the last complete BY (2017 or 2018) among all Canadian indicator stocks was 0.22% for KLM. Survival rates for the last complete BY increased for 8 out of 14 Canadian stocks (RBT, RBT adj., BQR, COW, CHI, HAR, NIC, SHU).

In terms of calendar year statistics for the 2009–2018 and 2019–current PST Agreement periods, the average percentage of total mortality occurring in the escapement was greater than 50% for most Canadian indicator stocks. Differences in average escapement percentages of the total mortality between PST Agreement periods 2009–2018 and the current Agreement were small in most cases, although COW had a large increase from 36% to 58% (Table 3.2). Average escapement percentages increased for most stocks from the 2009–2018 to 2019–current except for RBT which decreased from 43% to 32%, BQR which decreased from 57% to 56%, QUI which decreased from 56% to 50%, QUI adj. which has decreased from 59% to 53%, and CHI which decreased from 69% to 67%. In 2009–2018, RBT and COW experienced average escapement percentages of the total mortality below 50% (43%and 36%, respectively). From 2019–current, only RBT had an average escapement percentage of total mortality below 50% (32%). Escapement percentages by calendar year lower than 20% have previously occurred in COW (2009). The largest escapement percentages of the total mortality in 2023 occurred in NIC (91%) and HAR (77%).

Table 3.2—Summary of statistics generated by the 2024 coded-wire tag (CWT) cohort analysis for Canadian indicator stocks by region. Statistics include total mortality (catch plus incidental mortality) brood year exploitation rate (BYER), cohort survival rate to age 2 (age 3 for Kitsumkalum), and calendar year (CY) percent distribution of the total mortality and the escapement.

Region	Indicator Stock Name	BYER (total mortality)		Survival rate		CY % Escapement[1]		
						2009-2018	2019-current	
		Mean (range)	Last complete BY	Median (range)	Last complete BY	Mean (range)	Mean (range)	Last CY (year)
North/ Central BC	Kitsumkalum River Summer (KLM)	45% (25%-69%)	38% (2017)	0.62% (0.12-1.94%)	0.22% (2017)	59% (48-85%)	72% (58-85%)	73% (2023)
	Atnarko River (ATN)	39% (27%-61%)	27% (2018)	1.90% (0.50-5.97%)	1.24% (2018)	59% (36-74%)	71% (60-79%)	79% (2023)
WCVI	Robertson Creek Fall (RBT)[2,3,4]	42% (23%-67%)	30% (2018)	4.14% (0.03-20.10%)	5.41% (2018)	43% (27-62%)	32% (23-51%)	51% (2023)
	Northwest Vancouver Island (RBT adj.)[3]	46% (23%-83%)	33% (2018)	4.14% (0.03-20.10%)	5.41% (2018)	61% (51-68%)	69% (58-80%)	80% (2023)
	Southwest Vancouver Island (RBT adj.)[3]	46% (23%-83%)	33% (2018)	4.14% (0.03-20.10%)	5.41% (2018)	61% (51-68%)	69% (58-80%)	80% (2023)
Strait of Georgia	Big Qualicum River Fall (BQR)	58% (31%-85%)	53% (2018)	0.69% (0.12-25.14%)	1.33% (2018)	57% (41-73%)	56% (39-77%)	68% (2023)
	Cowichan River Fall (COW)	65% (29%-89%)	29% (2018)	1.28% (0.34-6.82%)	1.49% (2018)	36% (16-48%)	58% (30-77%)	65% (2023)

	Puntledge River Summer (PPS)	50% (13%-88%)	30% (2018)	0.75% (0.10-12.76%)	0.52% (2018)	60% (40-73%)	70% (46-80%)	79% (2022)
	Quinsam River Fall (QUI)[4]	55% (29%-84%)	51% (2018)	1.15% (0.16-9.11%)	0.97% (2018)	56% (47-67%)	50% (44-59%)	50% (2023)
	East Vancouver Island North (QUI adj.)[3]	52% (26%-84%)	48% (2018)	1.15% (0.16-9.11%)	0.97% (2018)	59% (51-68%)	53% (45-64%)	50% (2023)
	Phillips River Fall (PHI)	30% (19%-39%)	31% (2018)	3.94% (1.03-10.36%)	3.72% (2018)	67% (61-72%)	71% (62-81%)	63% (2022)
Fraser River	Chilliwack River Fall (CHI)	40% (23%-83%)	39% (2018)	11.04% (1.68-30.54%)	11.52% (2018)	69% (56-80%)	67% (59-75%)	60% (2023)
	Harrison River (HAR)	44% (20%-86%)	25% (2018)	2.08% (0.40-23.96%)	5.20% (2018)	73% (54-84%)	77% (66-90%)	80% (2023)
	Middle Shuswap River Summer (MSH)	38% (15%-74%)	18% (2018)	2.56% (0.42-12.27%)	1.46% (2018)	54% (35-66%)	79% (69-85%)	85% (2023)
	Nicola River Spring (NIC)	25% (3%-60%)	5% (2017)	1.88% (0.10-12.51%)	4.69% (2017)	78% (46-90%)	91% (71-97%)	96% (2023)
	Lower Shuswap River Summer (SHU)	50% (22%-81%)	22% (2018)	2.85% (0.73-8.12%)	3.15% (2018)	55% (49-65%)	75% (68-81%)	81% (2023)

[1] % Escapement is not a measure of performance for the escapement indicator stock(s) associated with a given CWT indicator stock.

[2] Does not include BY 1992 from which there were no CWT recoveries in the catch due to extremely low survival rates.

[3] BYER is ocean exploitation rate only.

[4] Terminal adjustments to CYER applied because fishing mortality on the hatchery stock does not represent fishing mortality on wild stocks.

3.7 WASHINGTON COAST STOCKS

The CTC uses coded-wire tag data from three facilities on the Washington Coast to represent natural fall Chinook salmon production in the rivers between the Columbia River in the south to the Strait of Juan de Fuca in the north. These indicator stocks include the Queets River (QUE, released from Quinault Division of Natural Resources Salmon River Hatchery) and Tsoo-Yess River (SOO, released from the U.S. Fish and Wildlife Service Makah National Fish Hatchery) on the coast, and the Hoko River at the western end of the Strait of Juan de Fuca (HOK, released from Makah's Hoko Falls Hatchery). Queets, Tsoo-Yess, and Hoko indicator stocks share a common life history; they are ocean type (subyearling fingerling releases), fall-timed fish with a maximum age at maturity of 6. These 3 stocks also have extensive historical tagging and recovery coverage (30+ completed BYs), with Queets records starting in 1977 and Hoko and Tsoo-Yess records starting in 1985. Queets is used as an ocean exploitation rate indicator for three other Washington Coastal escapement indicator stocks: Grays Harbor, Quillayute, and Hoh. Terminal adjustments are applied to these three escapement indicator stocks for the CYER calculations to account for terminal fishery harvest rates that differ from those in the Queets (see section 3.7.4).

3.7.1 Brood Year Exploitation Rates

Patterns for all stocks BYER are considered in terms of total exploitation on unmarked fish (ocean and terminal; Table 3.3; Appendix D8). Average exploitation rates are in the 60-65% range for Queets, Quillayute, Hoh and Grays Harbor, and much lower (30-40% range) for Hoko and Tsoo-Yess.

Table 3.3—Summary of statistics generated by the 2024 coded-wire tag (CWT) cohort analysis for Washington Coast indicator stocks. Statistics include total mortality (catch plus incidental mortality), brood year exploitation rate (BYER), cohort survival rate to age 2, and calendar year (CY) percent distribution of the total mortality in the escapement.

					CY % Escapement[1]		
	BYER (total mortality)		Survival rate		2009-2018	2019-current	
Indicator Stock	**Mean (range)**	**Last complete BY**	**Median (range)**	**Last complete brood year**	**Mean (range)**	**Mean (range)**	**Last CY % (year)**
Hoko Fall Fingerling (HOK)	32% (14-56%)	26% (2017)	1.31% (0.17-3.25%)	0.74% (2017)	72% (54-91%)	71% (53-86%)	79% (2022)
Tsoo-Yess Fall Fingerling (SOO)	36% (10-64%)	24% (2017)	0.44% (0.01-1.97%)	0.21% (2017)	72% (62-83%)	80% (59-98%)	81% (2022)
Quillayute Fall (QUE adj.)	61% (47%-79%)	67% (2017)	2.61% (0.57-5.66%)	2.66% (2017)	29% (20-42%)	36% (32-39%)	37% (2022)
Hoh Fall (QUE adj.)	61% (47%-75%)	73% (2017)	2.61% (0.57-5.66%)	2.66% (2017)	38% (16-52%)	30% (26-35%)	35% (2022)
Queets Fall Fingerling (QUE)	60% (37-81%)	78% (2017)	2.61% (0.57-5.66%)	2.66% (2017)	37% (19-50%)	23% (14-27%)	14% (2022)
Grays Harbor Fall (QUE adj.)	63% (40%-78%)	66% (2017)	2.61% (0.57-5.66%)	2.66% (2017)	37% (23-51%)	37% (32-41%)	39% (2022)

[1] % Escapement is not a measure of performance for the escapement indicator stock(s) associated with a given CWT indicator stock. See CTC (2013) for these details.

3.7.2 Survival Rates

CWT data indicate that release-to-age-2 survival for Chinook salmon on the Washington Coast indicator stocks is highly variable across stocks and years (Appendix E8; Table 3.3). Tsoo-Yess Chinook salmon, for instance, consistently experience some of the lowest survivals of any CWT indicator stock evaluated by the CTC. The series-wide median survival from release to age 2 for this stock is 0.44%, but it has ranged more than 2 orders of magnitude (0.01–1.97%). There are no clear long-term or short-term trends in survival rates for any of the Washington Coast stocks (Appendix E8).

3.7.3 Mortality Distributions

Washington Coast indicator stocks exhibit a mortality distribution consistent with a far north migration pattern. Most fishery-related mortality occur in the SEAK and NBC AABM troll fisheries (Figure 3.8; Appendix C). While the stocks are caught in similar fisheries, a greater proportion of Queets and associated stocks are caught in the AABM and terminal fisheries than Hoko and Tsoo-Yess. Escapement recoveries are consistently higher for Hoko and Tsoo-Yess than for Queets (Table 3.3)

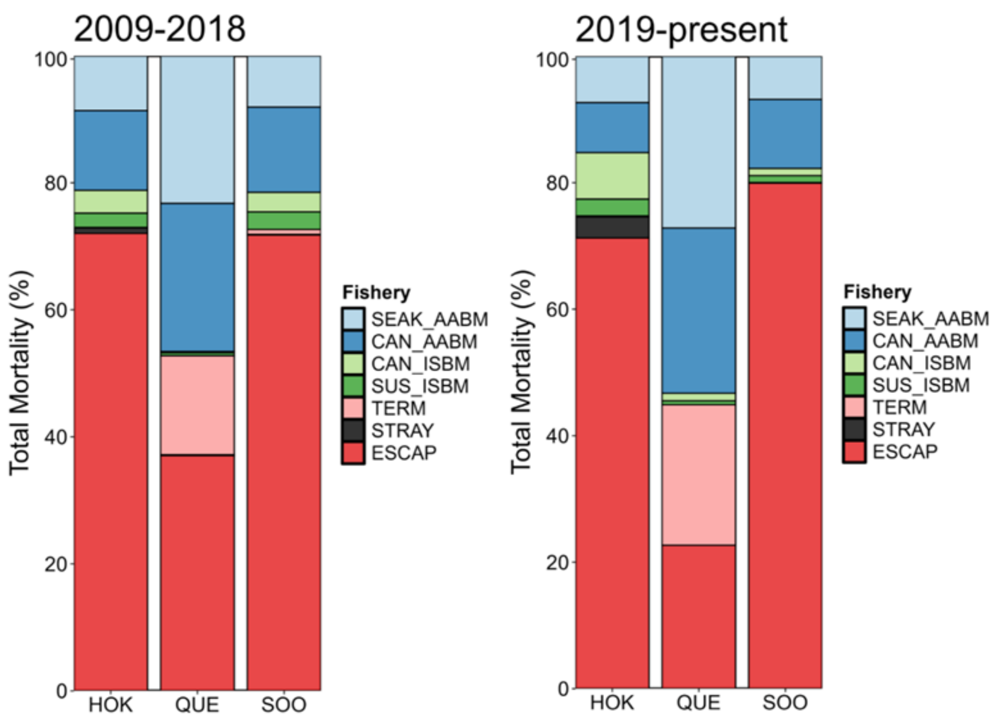

Figure 3.8—Distribution of total mortality for Washington Coast indicator stocks from the 2009 (2009–2018) and 2019 (2019–2028) Pacific Salmon Treaty Agreement periods. The figure on the right contains data from 2019 through 2022.

3.7.4 Terminal Area Adjustments

The terminal harvest rate for Queets River is adjusted to account for differential harvest rates that occur on the Grays Harbor, Hoh, and Quillayute Fall Chinook escapement indicator stocks (Appendix F3). For Grays Harbor, the terminal harvest rates on naturally spawning fish are calculated using the co-manager (Quinault Indian Nation and WDFW) run reconstruction and represent all net and sport fisheries in the Grays Harbor basin. For Hoh and Quillayute, terminal harvest rates are calculated for naturally spawning fish from data in Tables B-33 and B-36 in the Pacific Fishery Management Council's annual Review of Ocean Salmon Fisheries document

(PFMC 2024). Between 2009–2018 the proportion of total mortality occurring in terminal fisheries was similar in the Queets, Grays Harbor, and Hoh basins, averaging around 16% (Figure 3.9) and slightly higher in the Quillayute basin, averaging around 25% (Appendix C).

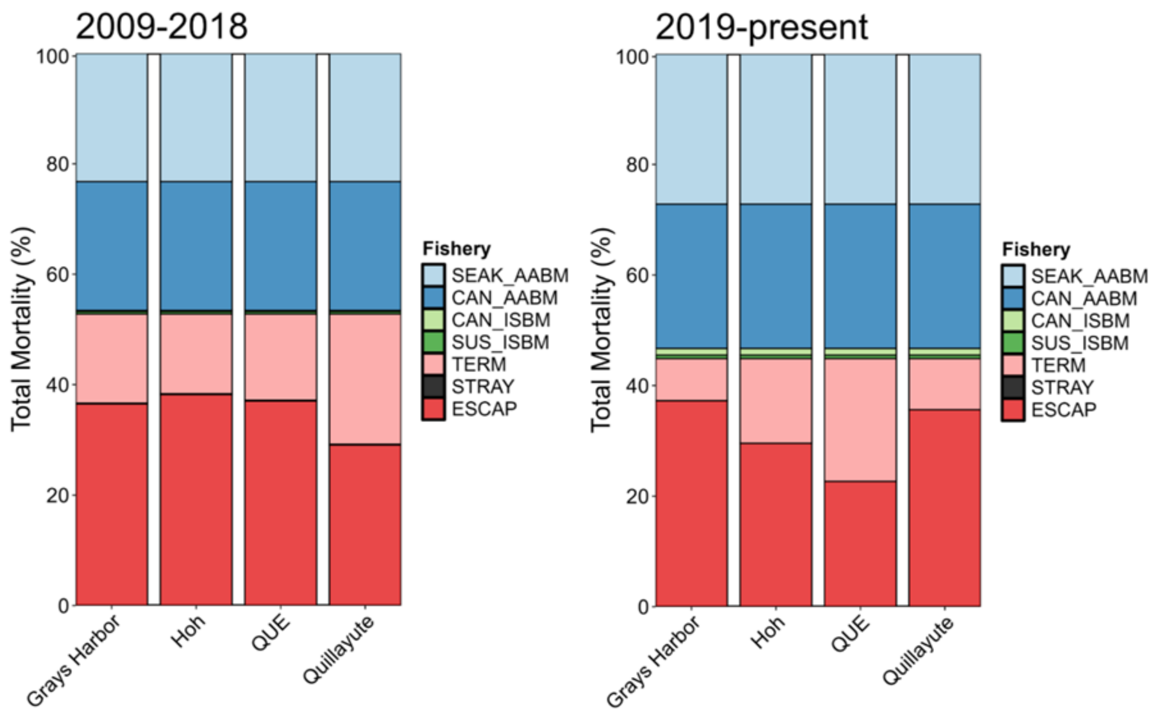

Figure 3.9—Distribution of total mortality for the Washington Coastal hatchery indicator stock before applying the terminal area adjustment (Queets [QUE]) and after the terminal area adjustments for the escapement indicator stocks (Grays Harbor, Hoh, and Quillayute) for the 2009 (2009–2018) and 2019 (2019–2028) Pacific Salmon Treaty Agreement periods. The figure on the right contains data from 2019 through 2022.

3.8 Salish Sea Stocks

There are currently 10 CWT indicator stocks within the Washington Salish Sea that are analyzed on an annual basis. The indicator stocks are a mixture of traditional hatchery production for harvest purposes and natural stock supplementation programs from brood stock collected on the spawning grounds. Current non-tribal sport fisheries for Chinook salmon within marine waters of Puget Sound are almost exclusively under MSF regulations. This, in turn, can result in fishery mortality rates that differ notably between the adipose-clipped (marked) and adipose-intact (unmarked) components for some stocks. With the incorporation of MSF algorithms into the ERA, results are now available for both the marked and unmarked components of each stock. Below we present “unmarked” results from the ERA in an effort to best represent the conditions experienced by the natural-origin components of each stock. Mark-selective fisheries or directed fisheries on hatchery surplus in terminal areas may create a differential terminal fishery structure for these indicator groups compared to the natural stocks they are intended to represent; hence, BYERs are expressed in terms of ocean fisheries in these cases. Details on the CWT indicator stock groups and influence of mark-selective and terminal fisheries on the estimates are presented in the regional subsections below.

Four other Salish Sea CWT indicator stocks that have previously been discontinued are no longer included in this report: Nooksack River Spring Yearling (NKS), Skagit River Spring Yearling (SKS), South Puget Sound Fall Yearling (SPY), and White River Spring Yearling (WRY). Information on these stocks and final analysis results are included in the CTC's 2021 ERA Report (CTC 2022b).

3.8.1 North Puget Sound

Indicator stocks in North Puget Sound include spring fingerling tag groups from the Nooksack (NSF) and Skagit (SKF) rivers and summer/fall fingerling tag groups from the Samish (SAM) and Skagit (SSF) rivers. The Nooksack Spring (NSF), Skagit Spring (SKF), and Skagit Summer/Fall (SSF) stocks are included in Chapter 3 Attachment I of the 2019 PST Agreement, each of which have associated ISBM fishery limits. The primary purpose of the Nooksack Spring hatchery program is natural supplementation and supporting a small tribal subsistence fishery in the river. The SAM indicator does not represent an associated natural production but is important for evaluating the large hatchery production program from the Samish Hatchery. The primary purpose of the Skagit Spring program is harvest augmentation; the returning fish are subjected to terminal net fisheries and a mark-selective sport fishery in the area near the hatchery. The goal of the Skagit Summer/Fall group is evaluation of fishery impacts to the natural stock in the system. Spawning ground recoveries are the source of brood stock for the SSF program. Releases of Nooksack and Skagit River Spring Yearling stocks were discontinued following the 1996 and 2010 BY, respectively.

3.8.2 Central Puget Sound

Indicator stocks in Central Puget Sound, from north to south, include fingerling tag groups from the Stillaguamish River (STL) and the Skykomish River (SKY), a tributary in the Snohomish Basin. The Stillaguamish and Snohomish stocks are listed as indicator stocks with ISBM fishery limits in Chapter 3 Attachment I of the 2019 PST Agreement. The primary purposes of the Stillaguamish Fall CWT program are the evaluation of fishery impacts, and natural supplementation. Brood stock for this program is captured on the spawning grounds. The primary purpose of the Skykomish program, which uses returns of summer-run fish to the Wallace Salmon Hatchery for brood stock, is for fishery evaluation, and it also provides limited harvest in the in-river mark-selective sport fishery when abundance is favorable.

3.8.3 South Puget Sound

The indicator stocks in Southern Puget Sound are South Puget Sound Fall Fingerling (SPS) and Nisqually Fall Fingerling (NIS). The SPS indicator group is an aggregate of several CWT indicator programs, currently composed of tag releases from Soos Creek Hatchery in the Green River Basin and Grovers Creek Hatchery on the western shore of Puget Sound across from Seattle. The SPS indicator is intended to represent mixed stock fishery impacts that occur on the Green

River and Lake Washington stocks. However, it should not be used to represent terminal fisheries due to the varying intensity with which they occur on stocks within the SPS aggregate and on those the aggregate is intended to represent. Because stocks originating in South Puget Sound are exposed to a number of MSFs, exploitation rates can vary considerably between the marked and unmarked components. The NIS stock is the southernmost indicator tag group in Puget Sound. Releases of South Puget Sound Fall Yearlings and White River Spring Yearlings were discontinued following the 2013 and 2015 BY, respectively.

3.8.4 Juan de Fuca and Hood Canal

Chinook salmon releases from the Washington Department of Fish and Wildlife (WDFW) Elwha Hatchery (ELW) are used in the annual ERA, but releases of adipose-clipped and CWT Chinook salmon were insufficient for analysis between BYs 1994 and 2011. Tagging of adipose-clipped Elwha River Fall Fingerling stock in the Strait of Juan de Fuca was discontinued with the 1994 BY. Between 1994 and 2011, a hatchery program continued using brood stock collected from the spawning grounds and from the hatchery rack. The Elwha Hatchery program has now shifted to a stock restoration and recovery program with the removal of the Elwha River dams that began in September 2011. Marking and tagging of this stock resumed with the 2012 BY as part of monitoring and evaluation of the restoration project. The George Adams (GAD) indicator stock is used to represent fishery and escapement distribution of natural fall fingerlings in Hood Canal tributaries, primarily the Skokomish River at the southern end of the Hood Canal.

3.8.5 Regional Summary for Washington Salish Sea Stocks

For Washington Salish Sea stocks, the BYERs presented here represent only ocean mortality because terminal fisheries may not properly reflect the impacts on the natural stock(s) represented by the CWT indicator. Some terminal fisheries are designed as hatchery fish target zones which would exceed the impacts on any natural stocks in the basin. Additionally, some river sport fisheries are now managed under MSF regulations that may overestimate impacts on natural stocks. The ocean fishery BYERs presented here represent those on unmarked fish and include IM associated with releases in Puget Sound marine area MSFs, which have grown significantly since 2003.

Summaries of Washington Salish Sea stock-specific BYERs are presented in Table 3.4, with more detail available in Appendix D. The ocean BYERs for Washington Salish Sea Stocks have averaged 40% (per stock average range of 29–48%) for the fall stocks (SAM, SSF, STL, SKY, SPS, NIS, ELW, and GAD) and 33% (range 28–38%) for the spring stocks (NSF, SKF; Figure 3.10) over the long term. Relative to the long term, ocean BYERs for the most recent complete brood year are lower, averaging 24% for the fall stocks and 21% for the spring stocks.

Summaries of Washington Salish Sea stock-specific survival rates are presented in Table 3.4, with more detail available in Appendix E, all of which depict survival to age 2. Median survival rates for Washington Salish Sea fall and spring fingerling stocks ranged from 0.5–2.1%, which is similar to the rates commonly observed for fingerling type stocks. The trend in survival rates for those stocks with a long continuous time series of analysis (e.g., SAM, SPS, GAD) shows the lowest survival rates occurring for the late 1980s to early 1990s broods, with somewhat improved survivals beginning in the early 2000s.

The distribution of total AEQ mortality across fisheries and escapement for Washington Salish Sea stocks is presented in Figure 3.10, with more detailed information available in Appendix C. The distribution across fisheries varies by stock, with stocks from Central and North Puget Sound tending to have higher interception rates in Alaskan and Canadian fisheries. The proportion of total mortality that has occurred in fisheries since 2009 differs by stock, averaging 54% for stocks exposed to notable terminal fisheries (SAM, SKF, NIS, GAD) and 34% for stocks where terminal fishery impacts are lower (NSF, SSF, STL, SKY, SPS, ELW).

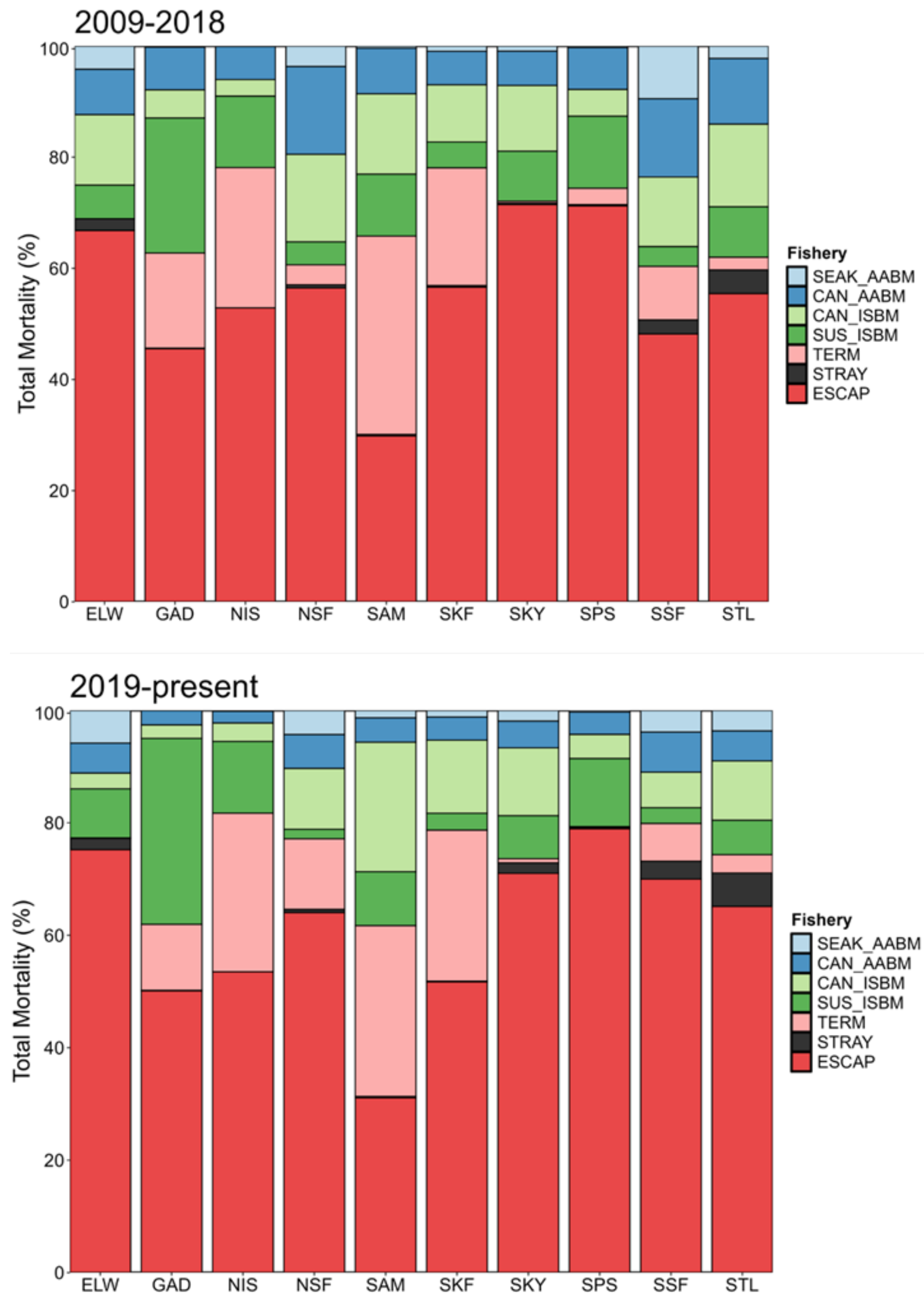

Figure 3.10—Distribution of total mortality for Puget Sound indicator stocks from the 2009 (2009–2018) and 2019 (2019–2028) Pacific Salmon Treaty Agreement periods. The figure on the right contains data from 2019 through 2022.

Table 3.4—Summary of statistics generated by the 2024 coded-wire tag (CWT) cohort analysis for Washington Salish Sea indicator stocks by region. Statistics include brood year exploitation rate (BYER), cohort survival rate to age 2 (age 3 for yearling stocks), and calendar year (CY) percent of total mortality in escapement.

Subregion	Indicator Stock	BYER (total mortality)		Survival rate		CY % Escapement[1]		
						2009-2018	2019-current	
		Mean (range)	Last complete BY	Median (range)	Last complete BY	Mean (range)	Mean (range)	Last CY % (year)
North Puget Sound	Nooksack Spring Fingerling (NSF)[2]	38% (22-63%)	24% (2017)	1.30% (0.27-4.65%)	1.78% (2017)	56% (37-72%)	64% (56-71%)	63% (2022)
	Samish Fall Fingerling (SAM)[2]	42% (25-67%)	39% (2017)	1.33% (0.31-14.47%)	1.05% (2017)	30% (19-41%)	31% (30-33%)	31% (2022)
	Skagit Spring Fingerling (SKF)[2]	28% (13-60%)	18% (2017)	1.39% (0.62-4.10%)	1.32% (2017)	57% (47-71%)	52% (47-59%)	47% (2022)
	Skagit Summer Fingerling (SSF)[2]	33% (21-53%)	22% (2017)	1.19% (0.22-3.34%)	1.28% (2017)	48% (32-72%)	70% (61-77%)	68% (2022)
Central Puget Sound	Stillaguamish Fall Fingerling (STL)[2]	45% (16-91%)	21% (2017)	1.51% (0.28-6.97%)	1.13% (2017)	55% (31-71%)	65% (56-73%)	69% (2022)
	Skykomish Fall Fingerling (SKY)[2]	29% (15-42%)	19% (2017)	0.89% (0.44-3.03%)	0.85% (2017)	71% (64-82%)	71% (55-80%)	71% (2022)
South Puget Sound	South Puget Sound Fall Fingerling (SPS)[2]	41% (13-74%)	13% (2017)	2.11% (0.37-9.51%)	0.98% (2017)	71% (61-82%)	79% (72-84%)	72% (2022)
	Nisqually Fall Fingerling (NIS)[2]	38% (16-84%)	16% (2017)	1.50% (0.11-4.26%)	0.41% (2017)	53% (41-75%)	53% (36-76%)	36% (2022)
Juan de Fuca/ Hood Canal	Elwha (ELW)[2]	48% (0-100%)	21% (2017)	0.47% (0.01-2.33%)	0.57% (2017)	67% (54-74%)	75% (60-87%)	60% (2022)
	George Adams Fall Fingerling (GAD)[2]	45% (21-83%)	39% (2017)	1.40% (0.04-5.86%)	0.64% (2017)	46% (24-55%)	50% (31-69%)	69% (2022)

[1] % Escapement is not a measure of performance for the escapement indicator stock(s) associated with a given CWT indicator stock.

[2] BYER is ocean exploitation rate only.

3.8.6 Terminal Area Adjustments

Terminal area adjustments are applied to NSF to account for MSFs occurring in the terminal area, as well as differential terminal fishery impact rates that occur on the north/middle fork versus the south fork components of the stock. Currently, information for calculating these adjustments is only available for the years in which CYERs are used to assess ISBM fishery performance (2009–2015 and 2019 onward, Figure 3.11).

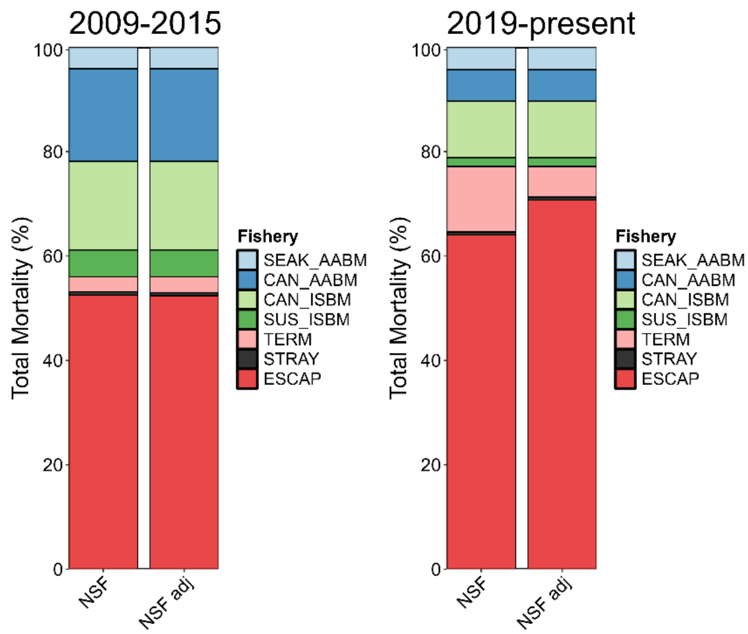

Figure 3.11—Distribution of total mortality for the Nooksack Spring indicator stock before (NSF) and after (NSF_adj) applying the terminal area adjustments for the CYER base period of 2009–2015 (left) and for 2019–2022.

3.9 Columbia River Stocks

The Columbia River CWT ERA indicator stocks come from the Willamette River tributary, the Lower Columbia, the Upper Columbia, and the Snake River tributary. The Willamette River Spring Chinook CWT indicator (WSH) is an aggregation of yearling releases from several Willamette basin hatcheries. Lower Columbia CWT stocks include three tule fall Chinook CWT indicator stocks from hatcheries, and one wild bright stock below Bonneville Dam. The three tule indicator stocks are Lower River Hatchery (LRH), Cowlitz Hatchery (CWF), and Spring Creek Hatchery (SPR). LRH are released at dispersed lower Columbia River estuary sites near the river mouth including directly from Big Creek Hatchery as well as from Bonneville Hatchery, whereas CWF are released directly from the hatchery/very nearby sites and SPR are released directly from the hatchery. Tule Chinook are distinguished by their dark coloration and advanced stage of maturation upon entering the Columbia River. The Lewis River Wild (LRW) indicator stock is a bright stock and is one of few wild stock tagging programs. Bright Chinook typically have a later freshwater entry and are bright in color within the river, like ocean caught fish. Upper Columbia CWT indicator stocks include two bright fall and two summer Chinook stocks: Columbia Upriver Brights (URB, from Priest Rapids Hatchery), Hanford Wild Upriver Brights (HAN, from Hanford Reach), Columbia Summers (SUM, from Wells Hatchery, including subyearling and yearling releases), and Similkameen (SMK, summers from the Okanogan watershed). For the Snake River, Lyons Ferry Hatchery releases both subyearling (LYF) and yearling (LYY) CWT indicators, but only the subyearlings are representative of the natural production. Long term mean, range and most recent BYERs, long-term median, range and most recent brood year survival rates, and means, ranges and most recent calendar year of the percentage of total mortality accruing to escapement for these stocks are in Table 3.5.

3.9.1 Brood Year Exploitation Rates

For each of the CWT indicator stocks BYERs are calculated. For WSH and CWF, ocean-only BYER is reported, since the wild components that these stocks represent experience terminal MSFs targeting marked hatchery production. Over the last ten years analyzed, total ocean BYERs have averaged about 10% for WSH, and 21% for CWF.

Three tule fall Chinook hatchery stocks in the lower Columbia River (CWF, LRH, and SPR) showed a decline in BYERs from high levels during the late 1970s (over 65%) to lower levels since the early to mid–1990s (Appendix D13). Over the last 10 years, BYERs for LRH and SPR averaged 55–65%, and IM averaged 6–9%.

Over the last ten years, average BYER was 55% for LRH and 65% for SPR (see above for average CWF ocean BYER). The other lower river stock, LRW, which is a bright stock, has averaged a 45% BYER over the last ten years.

The summer river stocks – SUM and SMK – have experienced lower average BYERs during the most recent 5 years (40% and 50%, respectively) than the 10 previous years (60% and 62%). The bright fall Chinook stocks from the upper Columbia River – URB and HAN – have also experienced lower average BYERs during the most recent 5 years (45% and 48%) relative to the previous 10 (59% and 67%). In contrast, the bright fall Chinook from the Snake River – LYF & LYY – have not exhibited a trend in BYERs over the last fifteen brood years analyzed, averaging 35% and 50%, respectively. IM for all stocks except WSH and SMK has averaged 5–10%. WSH ocean IM is lower at 2% and SMK IM is higher at 13%.

3.9.2 Survival Rates

Survival rate for WSH (to age 3 as a spring stock) was characterized by a high degree of variability from 1975 through 1989 (Appendix E13). From 1990 through 1995 survival remained relatively stable and low (between 1% and 2%), followed by an increase to roughly 6% in 1998. Survival has fluctuated between 0.5% and 4% since 1999, with 2015 BY the lowest on record and most recent (2016 BY) survival of 1.23% (Table 3.5).

Lower Columbia River stocks, specifically both CWF and LRH, have suffered from persistently low survival throughout the time series available for CWT survival analysis (1977–1978 through 2018). Recent survival rates remain well below 1%. Survival rates for SPR were 0–1% for 17 of 18 broods before 1998. Since 1998, 9 of the next 14 broods had improved survivals, including 6 broods (1998–2001, 2007 and 2011) with rates of 3–4%, however recent survival rates have declined to under 2%. Survival rates for LRW declined from an average of 2.8% for the 1982–1992 broods, to under 2% for all but 1 of the next 23 broods.

In the Upper Columbia River, SUM had survival rates less than 1.3% until 1997, except for 1985 (2.2%), averaging only 0.7%. Since then, survival rates improved to 1.0–5.4%. A 5.4% survival for 2011 is the highest value for SUM, while it was the 2010 brood that excelled for URB (7.9%), HAN (5.8%) and LYY (5.9%). URB survival rates were 2–7% for 1975–1985 broods (averaging 4%), below 3% from 1986–2008 (averaging 1%), improved to 3–8% from 2009–2012 (averaging 5%), dropped to less than 2% from 2013-2016, and increased to 3.7% in 2017. HAN survival rates were 0–2% for 20 of 21 broods from 1986–2006, averaging 1%, and then averaged 3% for 6 broods, before declining to well under 1% for recent broods. LYF and SMK have data gaps through the 2002 brood, and highly variable survival since 2003. The most recent 5 broods (2013—2017) for LYF are all under 2% survival, with the latest 3 complete broods at only about 0.5%. Survival for the most recent three complete SMK brood years were near average at 3–4%. LYY, which are yearlings, had 4–5% survival rates for 12 of 16 broods (averaging 5%), before decreasing to about 2–3%, and with the latest 2 complete broods (2015—2016) dropping to 1.3% and 0.6%, respectively.

3.9.3 Mortality Distributions

The distribution of mortality for each stock are in Figure 3.12 and Appendix C. For Columbia River stocks, sport data take two years to complete, thus the most recent numbers are for 2022. For most far-north migrating stocks (LRW, URB, HAN, SUM, and SMK), average total mortality in AABM fisheries was about 20–30% for 2009-2018, occurring primarily in SEAK. For the current annex period, average AABM percent total mortality has decreased to about 10–20% for URB, HAN, SUM and SMK. WSH and CWF are also northern migrating and have most AABM fishery impacts in SEAK troll, but at lower levels of 5–10%. SPR and LRH AABM fishery impacts are primarily in the WCVI AABM fishery. Average AABM total mortality impacts have decreased substantially since the last annex period for SPR (7 to 5%) and LRH (13 to 8%) tule Chinook, and for SUM (23 to 16%) and SMK (24 to 11%) summer Chinook, primarily due to decreases in WCVI harvest but for SUM and SMK, decreases in NBC also.

Figure 3.12 demonstrates changes in the proportion of CY total mortality in fisheries and escapement. Impacts in Southern U.S. ISBM fisheries since 2018 were lower than during the previous 10 years for most Columbia River stocks, and correspondingly, the recent average proportion passing through to escapement for most Columbia River stocks has increased from the 2009–2018 average.

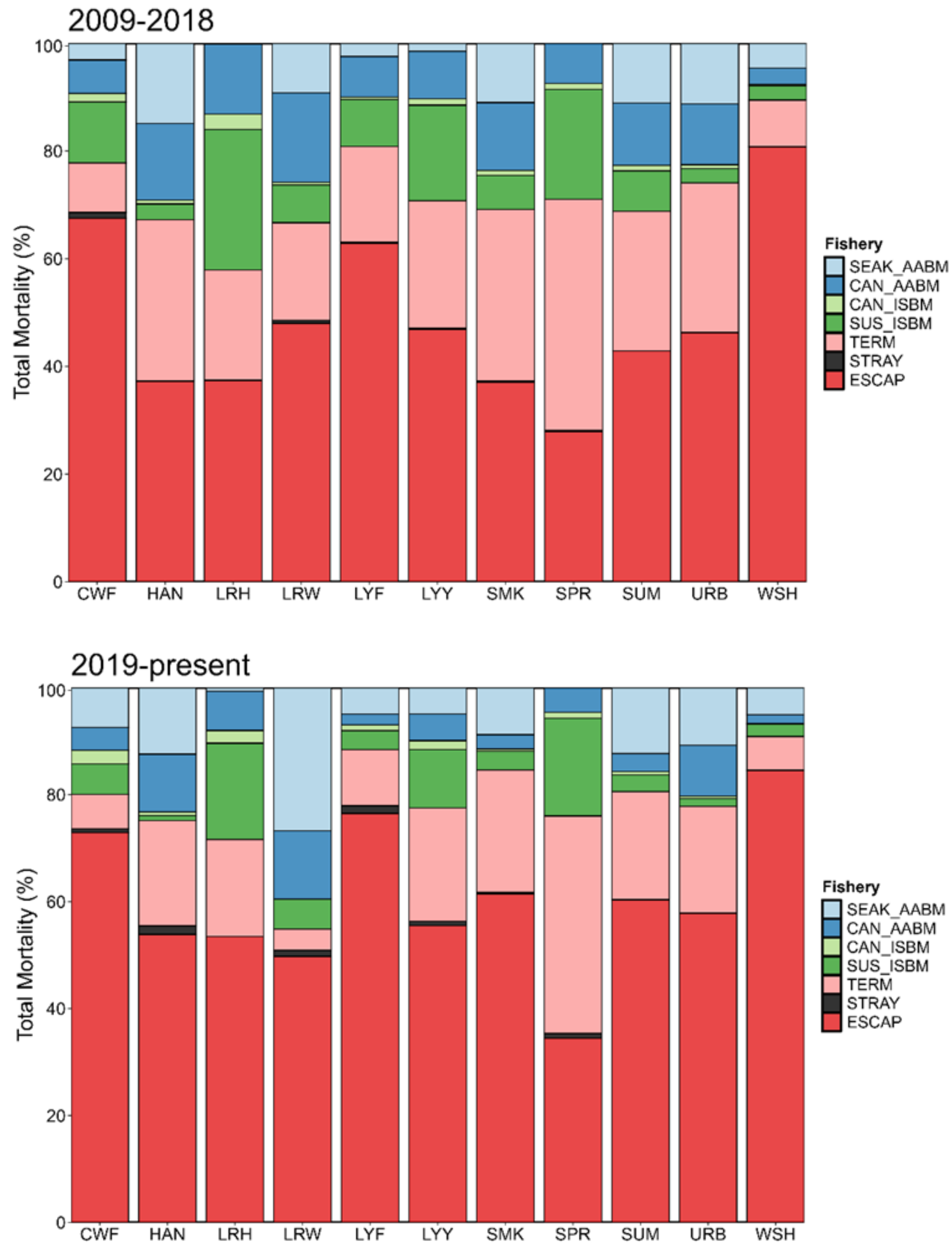

Figure 3.12—Distribution of total mortality for Columbia River and tributaries indicator stocks from the 2009 (2009–2018) and 2019 (2019–2028) Pacific Salmon Treaty Agreement periods. The figure on the bottom contains data from 2019 through 2022.

3.9.4 Regional Summary for Columbia River Stocks

Most Columbia River stocks typically have survival rates from 0–3%, with more successful broods surviving at 6–8% (Appendix E13). Currently, recent survival rates are showing substantial declines to well under 2% for all stocks except SUM and SMK Summer Chinook, which currently have 3–5% survival, and URB Fall Chinook (3.6% for 2017 BY).

Except for WSH, averaging a BYER of 12%, and LRH (58%) and SPR (75%), Columbia River stocks had BYERs of about 35–50% (Table 3.5). BYERs for WSH and CWF are ocean exploitation rates that do not include terminal harvest impacts. Percent escapement has been higher since 2019 than during the 2009—2018 period for all Columbia River stocks.

Table 3.5—Summary of statistics generated by the 2024 coded-wire tag (CWT) cohort analysis for Columbia River indicator stocks. Statistics include total mortality (catch plus incidental mortality), brood year exploitation rate (BYER), cohort survival rate to age 2, and calendar year (CY) percent distribution of the total mortality in the escapement.

	BYER (total mortality)		Survival rate		CY % Escapement[1]		
					2009-2018	2019-current	
Indicator Stock	Mean (range)	Last complete BY	Median (range)	Last complete BY	Mean (range)	Mean (range)	Last CY % (year)
Cowlitz Fall Tule (CWF)[2]	35% (11%-68%)	23% (2017)	0.40% (0.06-3.54%)	0.40% (2017)	68% (49-90%)	73% (62-82%)	62% (2022)
Hanford Wild Brights (HAN)	60% (39%-82%)	52% (2017)	0.77% (0.14-5.77%)	0.78% (2017)	37% (10-57%)	54% (49-56%)	49% (2022)
Lower River Hatchery Tule (LRH)	58% (20%-82%)	43% (2017)	0.56% (0.02-9.58%)	0.51% (2017)	37% (28-49%)	53% (39-61%)	61% (2022)
Lewis River Wild (LRW)	43% (17%-69%)	50% (2017)	1.51% (0.23-6.91%)	0.89% (2017)	48% (30-67%)	50% (39-68%)	39% (2022)
Lyons Ferry Fingerling (LYF)	42% (16%-81%)	36% (2017)	1.04% (0.06-6.25%)	0.73% (2017)	63% (40-82%)	76% (62-83%)	81% (2022)
Lyons Ferry Yearling (LYY)	55% (35%-86%)	42% (2016)	3.57% (0.64-11.69%)	0.64% (2016)	47% (32-62%)	56% (49-65%)	52% (2022)
Similkameen Summer Yearling (SMK)	50% (21%-74%)	37% (2016)	3.02% (0.09-9.17%)	3.02% (2016)	37% (27-44%)	61% (57-71%)	60% (2022)
Spring Creek Tule (SPR)	75% (56%-97%)	64% (2017)	1.29% (0.12-7.84%)	1.29% (2017)	28% (19-44%)	34% (32-37%)	36% (2022)
Columbia Summer (SUM)	58% (23%-81%)	51% (2017)	1.41% (0.01-5.44%)	3.46% (2017)	43% (35-52%)	60% (48-69%)	48% (2022)
Columbia River Upriver Brights (URB)	59% (31%-83%)	44% (2017)	1.70% (0.08-7.75%)	3.65% (2017)	46% (28-60%)	58% (54-63%)	56% (2022)
Willamette Spring Hatchery (WSH)[2]	12% (2%-32%)	8% (2016)	2.31% (0.53-6.34%)	1.23% (2016)	81% (70-88%)	84% (79-90%)	79% (2022)

[1] % Escapement is not a measure of performance for the escapement indicator stock(s) associated with a given CWT indicator stock.

[2] BYER is ocean exploitation rate only.

3.10 Oregon Coast Stocks

There are two hatchery-origin CWT ERISs representing exploitation and survival of Chinook salmon on the Oregon coast, the Salmon River Hatchery (SRH) release group and the Elk River Hatchery (ELK) release group. Both groups are fall ocean type sub-yearling stocks with earliest recoveries at the total age of 2. The SRH release group represents the Northern Oregon Coast (NOC) aggregate, and the ELK release group represents the Mid-Oregon Coast (MOC) aggregate. The SRH has consistently released CWT groups every year since 1976, with the exception of 1981. Releases from SRH have averaged 197,000 over the past 10 years and 196,000 over the past 20 years. There have been consistent, although sometimes small (prior to 1989), releases from the ELK since 1977. Average CWT release group size for ELK between 1977 and 1989 was approximately 37,000, and between 1990 and 2007 this increased to an average of approximately 184,000. Since 2007, after a two-year decline of coded-wire tagged ELK releases in 2008–2009 (average 40,000), the release size increased to an average of 284,000 in 2010–2016. SRH is used as an ocean exploitation rate indicator for three other escapement indicator stocks (EIS); Nehalem, Siletz and Siuslaw. ELK is used as the ocean exploitation rate indicator for both the South Umpqua and Coquille EIS. Terminal adjustments are applied to these EIS stocks for CYER calculations to account for different terminal exploitation (Figure 3.14; Figure 3.15).

3.10.1 Brood Year Exploitation Rates

BYERs for both the SRH and ELK ERISs include only those mortalities attributable to ocean fisheries, excluding the Port Orford bubble fishery (Appendix D14; Table 3.6). The BYER has averaged 37% (range 24–63%) for the SRH releases. BYER for the ELK has averaged 22% (range 10–31%) for the time series, excluding brood years 1977 and 1978. There is no discernible trend through time regarding the percentage of IM occurring in ocean fisheries for either SRH or ELK hatchery releases. For the last complete brood year, SRH (36%) showed greater ocean BYER compared to ELK (27%). In general, the SRH stock has displayed higher ocean exploitation rate than the ELK stock throughout the observed time series.

3.10.2 Survival Rates

Survival rates for both SRH and ELK hatchery stocks are to age 2. Generally, survival rates for ELK have been variable, yet robust, with a median of 6% (range of 1–33%; Appendix E14; Table 3.6). From 2015–2017 (the last year with complete broods from which survival can be calculated), survival has been below average. Brood years 2018 and 2019 are represented by incomplete brood data but continue to exhibit lower than average survival. Survival rates for SRH generally increased through 2012 with a long-term median of 5%. Recently, the survival of the SRH stock has declined from a historic high of 19% in 2012 to a historic low of 1% during the 2013–2015 brood years. Available (yet incomplete) information on the 2018 and 2019 brood years indicate there has been an increase in survival following the prior 3-year decline (Appendix E14).

3.10.3 Mortality Distributions

An average of 53% of SRH mortality and 62% of the ELK mortality is attributed to escapement for the 2019–present time series (Table 3.6). Both stocks exhibit variation in the proportion which escapes to spawn through the time series, and, for years with at least 3 ages reported (SRH since 1980, ELK since 1983) both have shown significant trend to higher proportion in escapement (SRH: p=0.003, ELK: p=0.038). According to the 2019–2022 CY data, the largest harvest mortality on the SRH stock occur in terminal sport (17%), SEAK troll fisheries (13%), NBC troll (9%), and WCVI Troll (2%). During the same time period, the largest impacts on the ELK stock occur in SEAK troll (10%), terminal troll fisheries (9%) and NBC troll (5%). Recent impact distributions are displayed in Figure 3.13.

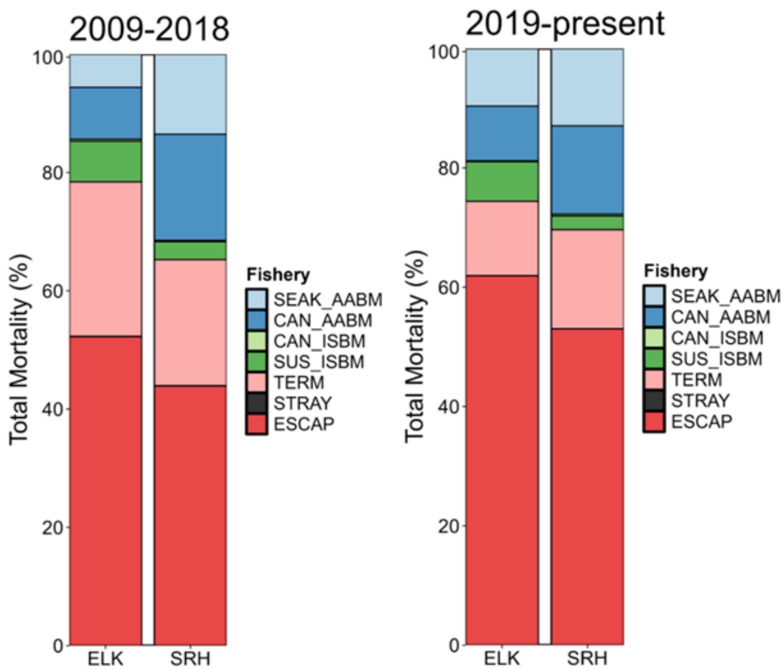

Figure 3.13—Distribution of total mortality for Oregon Coast indicator stocks from the 2009 (2009–2018) and 2019 (2019–2028) Pacific Salmon Treaty Agreement periods. The figure on the right contains data from 2019 through 2022.

3.10.4 Terminal Area Adjustments

Terminal area adjustments are needed to adequately depict the harvest in the rivers of the escapement indicator stocks, as there are often intensive terminal fisheries focused on the ERIS hatchery stocks (SRH, ELK) that are not representative of the terminal fisheries on their natural counterparts within their modeled aggregate (NOC and MOC). The terminal harvest rate for the SRH stock (NOC ERIS) is adjusted to account for differential harvest rates that occur on the Nehalem, Siletz, and Siuslaw rivers. As seen in Figure 3.14 the total harvest mortality of the terminal fishery on these stocks during the 2009–2018 period was generally similar, but lower than that experienced by SRH. More recently (2019 to present) terminal harvest mortality was more variable among the EIS stocks. The ELK stock (MOC ERIS) is adjusted to account for the differential harvest rates that occur in the Umpqua (South Umpqua) and Coquille river basins (Figure 3.15). There currently is no directed harvest in the South Umpqua basin and has not been in decades. All of the harvest in the Umpqua basin occurs in the full basin drainage. In recent years the spawning escapement in the Coquille river has been quite depressed, leading to the closure of the terminal fishery on naturally produced fish. Reductions to terminal harvest are seen between the 2009 and 2018 vs the 2019 to present periods in both the Elk and Coquille basins, with the harvest in the Umpqua basin remaining similar between the two periods (Figure 3.15).

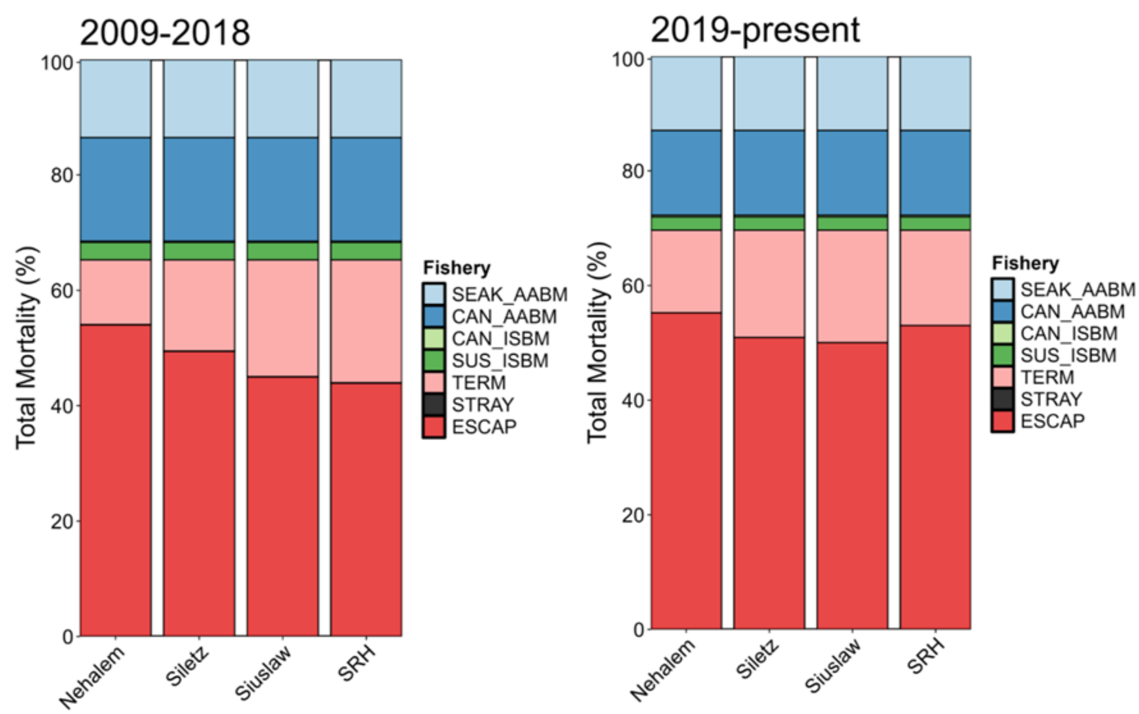

Figure 3.14—Distribution of total mortality for the North Oregon Coast hatchery indicator stock before applying the terminal area adjustment (Salmon River [SRH]) and after the terminal area adjustments for the escapement indicator stocks (Siletz, Siuslaw, and Nehalem) for the 2009 (2009–2018) and 2019 (2019–2028) Pacific Salmon Treaty Agreement periods. The figure on the right contains data from 2019 through 2022.

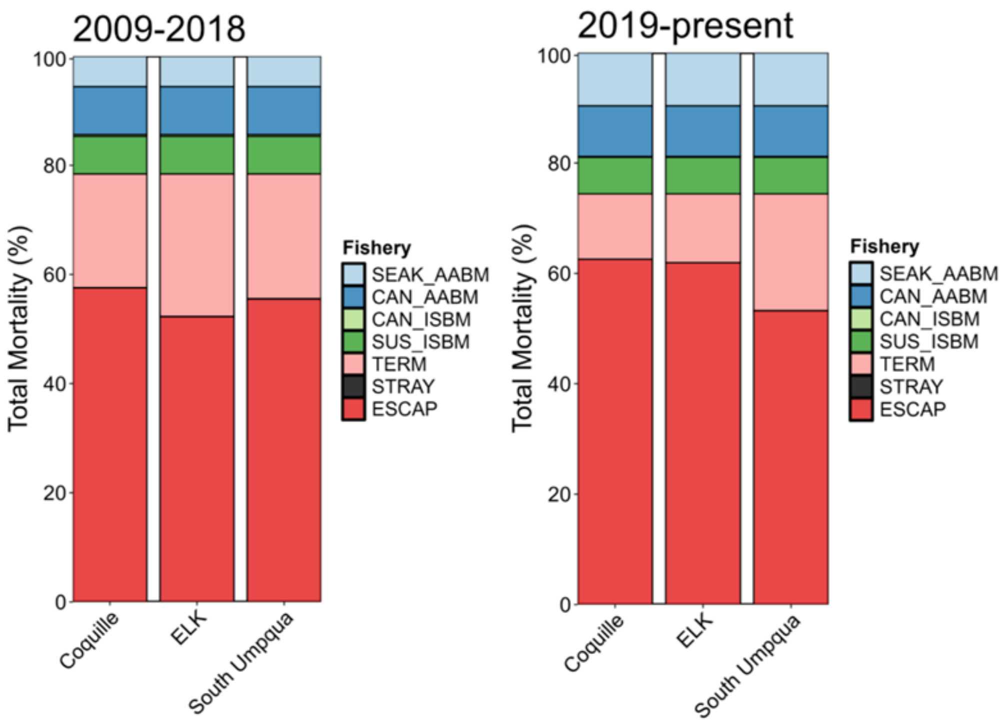

Figure 3.15—Distribution of total mortality for the Mid-Oregon Coast hatchery indicator stock before applying the terminal area adjustment (Elk River [ELK]) and after the terminal area adjustments for the escapement indicator stocks (Coquille and South Umpqua) for the 2009 (2009–2018) and 2019 (2019–2028) Pacific Salmon Treaty Agreement periods. The figure on the right contains data from 2019 through 2022.

3.10.5 Regional Summary for Oregon Coast Stocks

There are dynamic changes that have occurred to both NOC and MOC stocks, and those fisheries which capitalize upon them, through the period of observation and reporting for this document (2009 to present). Both aggregates have experienced survival declines recently (Appendix E14). Survival has fluctuated more for SRH than for ELK, SRH varying from the highest survival to the worst survival observed in recent years (Appendix E14). Not surprisingly, NOC stocks have experienced a patchwork of escapement goal attainment and failure over the same period: in the 15 years from 2009-2023 Nehalem has met goal in 10 years with failure interspersed, Siletz has met goal every year except 2009, Siuslaw has met goal in 9 years but only once after 2016. MOC stocks do not have CTC-approved escapement goals but have exhibited similar variability of escapement. Escapement performance most likely cannot be well attributed to one fishery's exploitation over another in consideration of reductions to AABM catches, particularly for WCVI. Nevertheless, over the full time series of PST management, increasing trends of the total mortality proportion in terminal sport fisheries have occurred for Nehalem ($p=0.001$), closed to wild harvest in 2009, for Siletz ($p=3.9E-6$), for Siuslaw ($p=0.001$), closed to wild harvest in 2022, and for Umpqua ($p=1.1E-5$); Coquille has been greatly reduced in returns since 2018 and has been closed to wild harvest since 2020, which will very likely continue until returns rebound. In accordance, terminal fisheries have become considerably more closely managed during the 2009-2023 period, and this will continue, as it is recognized that doing so is crucial to meeting escapement goals.

Table 3.6—Summary of statistics generated by the 2024 coded-wire tag (CWT) cohort analysis for Oregon Coast indicator stocks. Statistics include total mortality (catch plus incidental mortality) brood year exploitation rate (BYER), cohort survival rate to age 2, and calendar year (CY) percent distribution of the total mortality.

	BYER (total mortality)		Survival rate		CY % Escapement[1]		
					2009-2018	2019–present	
Indicator Stock	**Mean (range)**	**Last complete BY**	**Median (range)**	**Last complete BY**	**Mean (range)**	**Mean (range)**	**Last CY % (year)**
Elk River (ELK)[2]	22% (10%-31%)	27% (2017)	6.06% (1.04-32.90%)	5.14% (2017)	52% (42-65%)	62% (56-65%)	56% (2022)
South Umpqua (ELK adj.)[2]	39% (21%-55%)	44% (2017)	6.06% (1.04-32.90%)	5.14% (2017)	55% (47-72%)	53% (47-59%)	48% (2022)
Coquille (ELK adj.)[2]	37% (25%-66%)	29% (2017)	6.06% (1.04-32.90%)	5.14% (2017)	58% (27-77%)	63% (32-77%)	69% (2022)
Salmon River (SRH)[2]	37% (24%-63%)	36% (2017)	5.21% (0.64-18.77%)	4.18% (2017)	44% (21-57%)	53% (46-60%)	47% (2022)
Nehalem (SRH adj.)[2]	48% (36%-67%)	49% (2017)	5.21% (0.64-18.77%)	4.18% (2017)	54% (23-68%)	55% (40-68%)	40% (2022)
Siletz (SRH adj.)[2]	49% (36%-69%)	53% (2017)	5.21% (0.64-18.77%)	4.18% (2017)	49% (21-70%)	51% (44-62%)	49% (2022)
Siuslaw (SRH adj.)[2]	54% (44%-73%)	55% (2017)	5.21% (0.64-18.77%)	4.18% (2017)	45% (16-58%)	50% (40-61%)	61% (2022)

[1] % Escapement is not a measure of performance for the escapement indicator stock(s) associated with a given CWT indicator stock.

[2] BYER is ocean exploitation rate only.

4. ISBM Fishery Performance

4.1 ISBM Management Framework under 2019 PST Agreement

Under the 2019 PST Agreement Chapter 3, paragraph 5(a), "*U.S. and Canadian ISBM fisheries shall be managed to limit the total adult equivalent mortality for stocks listed in Attachment I that are not meeting agreed biologically-based management objectives, or that do not have agreed management objectives, to no more than the limits identified in Attachment I.*" The CYER is the metric the PSC uses to monitor total mortality in ISBM fisheries and for limiting total AEQ mortality (paragraph 5(e)). The CTC is tasked with evaluating ISBM fishery performance relative to the obligations set forth in paragraphs 5 and 7 annually.

Paragraph 5(d) of Chapter 3 of the 2019 PST Agreement requires that *"actual ISBM fishery performance relative to the obligations set out in this paragraph shall be evaluated by the CTC and reported annually to the Commission. Because the performance analysis is dependent on recovery of CWT, the CTC shall provide the evaluation for ISBM fisheries on a post-season basis.*" Thus, the CTC is required to annually compute and report the CYERs for ISBM fisheries and using *"the best available post-season data and analysis, report performance to the Commission of those metrics and the obligations set out in this Chapter*."

The CTC interprets "*best available post-season data and analysis*" to mean that escapement, annual CYER, and base period CYER values used to evaluate ISBM obligations are updated annually based on results from the most current ERA and reported in Appendix H. A retrospective evaluation of CYER values from the 2017–2022 ERA (CTC 2018, CTC 2019a, CTC 2021d, CTC 2021e, CTC 2022b) showed that annual and base period CYER values change over time. This year, MSF algorithms were incorporated into the ERA and those results are reported in the following sections (referred to as the unmarked results). Other major changes to CYER data are documented in Appendix H. For ISBM fishery evaluation, Attachment I ISBM indicator stocks, management objectives, and CYER limits are shown in Table 4.1; the steps to evaluate the ISBM management framework are diagrammed in Figure 4.1. SEAK stocks are excluded because they are not subject to ISBM fishery provisions. ISBM fisheries subject to the Treaty are listed in Table 4.2.

Table 4.1—Attachment I individual stock-based management (ISBM) indicator stocks, management objectives, and calendar year exploitation rate (CYER) limits as percentages of the 2009–2015 average CYER. To represent naturally spawning stocks, some exploitation rate indicators require adjustment for impacts of terminal fisheries targeting hatchery-origin fish.

Escapement Indicator	Management Objective[1]	Exploitation Rate Indicator	ISBM CYER Limits (%)	
			Canadian	U.S.
Skeena	TBD	KLM	100%	
Atnarko	5,009[3,4]	ATN	100%	
NWVI Natural Aggregate[7]	TBD	RBT adj.[5]	95%	
SWVI Natural Aggregate[8]	TBD	RBT adj.[5]	95%	
E. Vancouver Island North	TBD	QUI adj.[5] (TBD)[2]	95%	
Phillips	TBD	PHI	100%	
Cowichan	6,500	COW	95%	95%
Nicola	TBD	NIC	95%	95%
Chilcotin	TBD	LCT (TBD)[2]	95%	
Chilko	TBD	CKO (TBD)[2]	95%	
Lower Shuswap	12,300[3]	SHU	100%	
Harrison	75,100	HAR	95%	95%
Nooksack Spring	TBD	NSF	87.5%	100%
Skagit Spring	690[3]	SKF	87.5%	95%
Skagit Summer/Fall	9,202[3]	SSF	87.5%	95%
Stillaguamish	TBD	STL	87.5%	100%
Snohomish	TBD	SKY	87.5%	100%
Hoko	TBD	HOK		10% CYER[6]
Grays Harbor Fall	13,326	QUE adj.[5]		85%
Queets Fall	2,500	QUE		85%
Quillayute Fall	3,000	QUE adj.[5]		85%
Hoh Fall	1,200	QUE adj.[5]		85%
Upriver Brights	40,000	HAN/URB		85%
Lewis River Fall	5,700	LRW		85%
Coweeman	TBD	CWF		100%
Mid-Columbia Summers	12,143	SUM		85%
Nehalem	6,989	SRH adj.[5]		85%
Siletz	2,944	SRH adj.[5]		85%
Siuslaw	12,925	SRH adj.[5]		85%
South Umpqua	TBD	ELK adj.[5]		85%
Coquille	TBD	ELK adj.[5]		85%

[1] TBD = to be determined after review specified in paragraph 2(b)(iv) of Chapter 3 of 2019 Pacific Salmon Treaty.
[2] TBD = to be determined because the requisite data are not available; in development.
[3] Agency escapement goal has the same status as Chinook Technical Committee agreed-to escapement goal for implementation of Chapter 3.
[4] Natural origin spawners.
[5] Coded-wire tag stocks and adjustments described in CTC (2016), CTC (2019b), CYER WG (2021).
[6] ISBM limit set at 10% in recognition of closure of the Hoko River to Chinook salmon fishing in 2009–2015.
[7] NWVI Natural Aggregate consists of Colonial-Cayeagle, Tashish, Artlish, and Kaouk.
[8] SWVI Natural Aggregate consists of Bedwell-Ursus, Megin, and Moyeha.

Table 4.2—Chinook Technical Committee (CTC) exploitation rate analysis fisheries included in individual stock-based management (ISBM) metrics by country.

Canada	United States
Troll	
Central BC Troll Georgia Strait Troll	North of Falcon Troll South of Falcon Troll Oregon Coast (Port Orford) Terminal Troll
Net	
North BC Net North BC Terminal Net Central BC Net Central BC Terminal Net West Coast Vancouver Island Terminal Net West Coast Vancouver Island Net Strait of Georgia Net North BC Terminal Freshwater net Central BC Freshwater Net Georgia Strait Freshwater Net Fraser Freshwater Net Johnstone Strait Net BC Juan de Fuca Net Fraser Net Fraser Terminal Net	Puget Sound North Net Puget Sound North Terminal Net U.S. Juan de Fuca Net Puget Sound Other Net Puget Sound Other Terminal Net Washington Coast Net Columbia River Net Puget Sound Freshwater Net Washington Coast Freshwater Net
Sport	
Central BC Sport Central BC Terminal Sport North BC ISBM Sport North BC Terminal Sport West Coast Vancouver Island ISBM Sport West Coast Vancouver Island Terminal Sport Johnstone Strait Sport Johnstone Strait Terminal Sport Georgia Strait Sport Georgia Strait Terminal Sport BC Juan de Fuca Sport BC Juan de Fuca Terminal Sport North BC Freshwater Sport Central BC Freshwater Sport West Coast Vancouver Island Freshwater Sport Fraser River Freshwater Sport Georgia Strait Freshwater Sport	North of Falcon Sport North of Falcon Terminal Sport South of Falcon Sport South of Falcon Terminal Sport Puget Sound North Sport Puget Sound North Terminal Sport Puget Sound Other Sport Puget Sound Other Terminal Sport Columbia River Sport Puget Sound Freshwater Sport South of Falcon Freshwater Sport

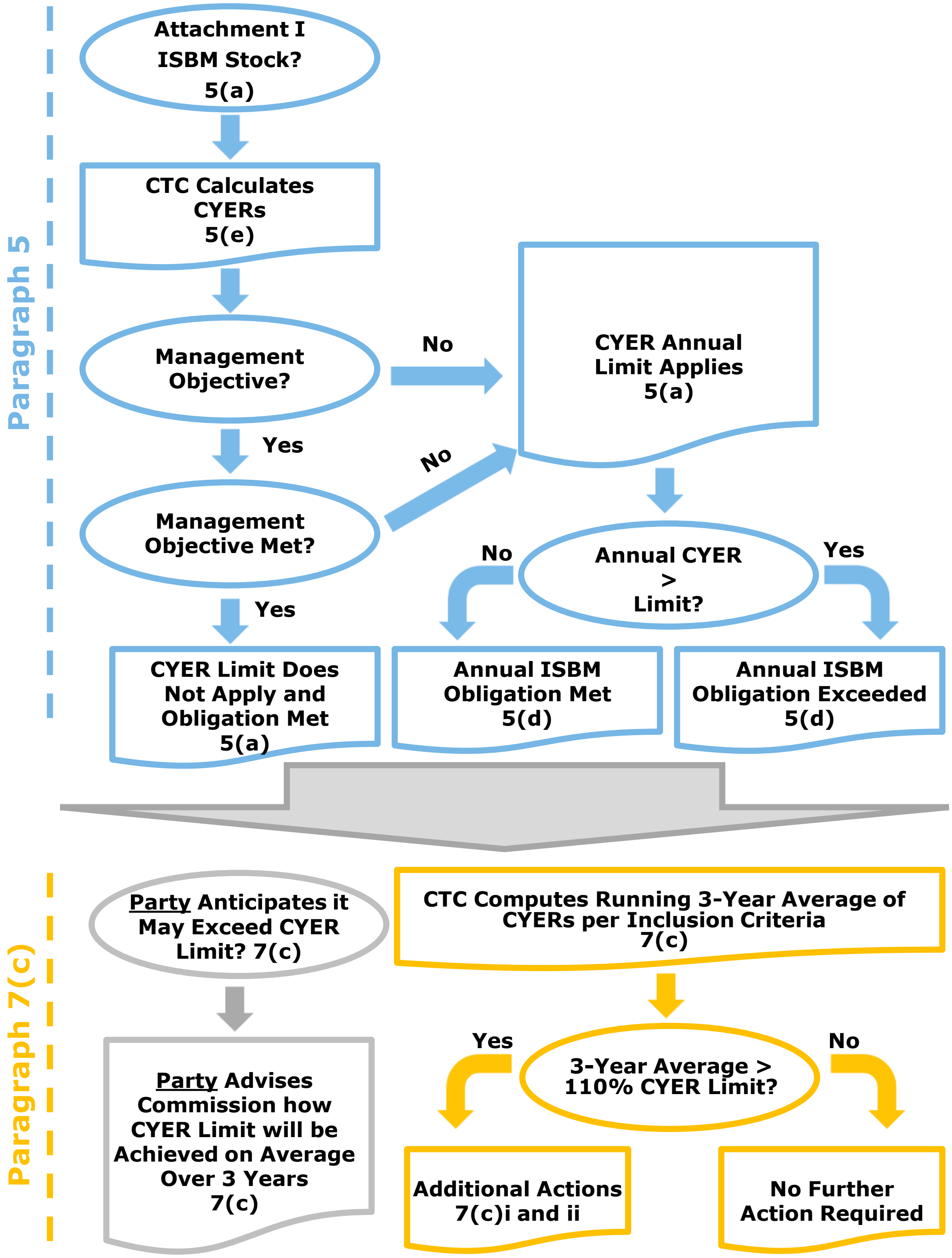

Figure 4.1—Flow diagram depicting the sequence of steps for individual stock-based management (ISBM) fisheries management framework under the 2019 Pacific Salmon Treaty Agreement.

Effective in 2023, the CTC is now reporting annual CYERs (Chapter 3, paragraph 5) and the running 3-year average (3YA) CYER as data are now available from both Parties' ISBM fisheries (Chapter 3, Footnote 17). The 3YA was calculated for the 2024 ERA based on the most recent three years of CYERs that meet the criteria for inclusion specified in paragraph 7(c) as agreed to by the PSC. For stocks in Attachment I without agreed-to management objectives, paragraph 7(c) specifies that all years shall be used to calculate the running 3YA. For stocks in Attachment I with an agreed-to management objective, the 3YA will include "*all years in which the management objective is not achieved, and the years in which the management objective is achieved with a CYER that is less than or equal to the ISBM obligation identified in paragraph 5.*" At their October 2022 meeting, the Commission provided guidance that the 3YA must include three years of CYERs that meet the criteria for inclusion specified in paragraph 7(c). Thus, in cases where there are years that do not meet the criteria for inclusion in the 3YA, the running 3YA will span a time frame greater than three years.

For stocks that have a running 3YA of CYERs that exceeds 110% of the CYER limit, the Commission "*shall request that the management entities responsible for the management of the ISBM fishery take necessary actions to minimize the deviation between the three-year CYER average and the CYER limits in Attachment I*" (Chapter 3, subparagraph 7(c)(i)). The Commission will discuss proposals from the management entities regarding actions that will be taken and expected outcomes prior to implementation. Meanwhile, the CTC "*shall provide to the Commission a plan to improve the performance of pre-season, in-season and other management tools so that the deviations between the CYERs and the CYER limits are narrowed to a maximum level of 10% when limits apply (Attachment I)*" (Chapter 3, subparagraph 7(c)(ii)).

The PSC will review the CYER metric per paragraph 5(e) "*to make a decision on its continued application or the use of an alternative metric. In the absence of a Commission decision to use an alternative metric, the use of the CYER metric continues*."

4.2 ISBM Performance Evaluation for 2022

Implementation of the newly revised PST Agreement began with fishing year 2019. Attachment I identifies CYER limits applicable to ISBM obligations for 31 stocks. Of those, 15 do not have management objectives so the annual CYER limit automatically applies to this subset of stocks as per paragraph 5(d). The remaining 16 stocks have management objectives[5] and for these stocks, the annual CYER limit only applies when the management objective is not met (Table 4.1).

The CTC evaluated whether management objectives were achieved for the 16 stocks in Attachment I with identified management objectives (Table 2.1). In 2022 three stocks did not achieve their management objectives (Queets Fall, Nehalem and Siuslaw), so the relevant CYER limits will apply for these stocks.

[5] Attachment I of the 2019 PST Agreement has a total of 38 stocks of which 31 are subject to ISBM obligations. There are currently 22 with management objectives and 16 of those are subject to ISBM obligations.

4.2.1 Canadian ISBM Fisheries Performance

There are 17 Attachment I indicator stocks subject to Canadian ISBM fisheries performance evaluation. Of those, 11 stocks do not have management objectives listed in Attachment I and exploitation rate indicators for two stocks (Chilcotin and Chilko) are currently under development and cannot be evaluated; therefore, CYER limits apply to nine of the 11 stocks without management objectives. For Canadian ISBM obligations, there are six stocks with management objectives listed in Attachment I and CYER limits apply when these management objectives are not met. In 2022, all applicable stocks had escapements above their management objectives. Thus for 2022, CYER limits apply to nine stocks without management objectives for which CYERs can be evaluated (Table 4.3).

Annual Canadian ISBM obligations were met for 10 of the 15 stocks that could be evaluated; six met their management objectives and thus had no applicable CYER limits (Atnarko, Cowichan, Lower Shuswap, Harrison, Skagit Spring, and Skagit Summer/Fall) and 4 had no management objectives but had CYERs below their limits. Annual CYER obligations were not met for five stocks— NWVI Natural Aggregate, SWVI Natural Aggregate, East Coast Vancouver Island North (EVIN), Phillips, and Snohomish.

Table 4.3—Review of annual performance in the Canadian individual stock-based management (ISBM) fisheries for the unmarked stocks, 2022.

Note: Grey shaded cells indicate that the calendar year exploitation rate (CYER) qualifies for inclusion in the running 3-year average (3YA) per paragraph 7(c). Green/red shaded cells indicate whether annual CYER obligations were met for a particular stock. NA = No or insufficient data available.

Escapement Indicator	Mgmt. Obj.	2022 Escape-ment	Mgmt. Obj. Met?	CYER Limit	2022 CYER	Annual CYER Obligation Met?
Skeena	NA	24,724		0.147	0.028	Yes
Atnarko	5,009	5,139	Yes	0.276	0.116	Yes
NWVI Natural Aggregate	NA	2,588		0.091	0.150	No
SWVI Natural Aggregate	NA	331		0.091	0.150	No
East Coast Vancouver Island North	NA	NA		0.157	0.203	No
Phillips	NA	2,070		0.097	0.104	No
Cowichan	6,500	17,574	Yes	0.419	0.393	Yes
Nicola	NA	7,438		0.167	0.024	Yes
Chilcotin	NA	4,126		NA	NA	NA
Chilko	NA	13,532		NA	NA	NA
Lower Shuswap	12,300	33,914	Yes	0.200	0.191	Yes
Harrison	75,100	81,649	Yes	0.109	0.062	Yes
Nooksack Spring	NA	4,246		0.149	0.078	Yes
Skagit Spring	690	3,487	Yes	0.079	0.121	Yes
Skagit Summer/Fall	9,202	17,323	Yes	0.088	0.041	Yes
Stillaguamish	NA	1,407		0.128	0.088	Yes
Snohomish	NA	5,635		0.092	0.120	No

For the running 3YA specified in paragraph 7(c) of the 2019 PST Agreement, Canadian ISBM obligations were met for 11 of the 14 stocks that could be evaluated; EVIN, Harrison, and Snohomish exceeded their 3YA limit by more than 10%. Per the provisions of the 2019 PST Agreement this exceedance stipulates further action, as identified in Chapter 3, subparagraphs 7(c)(i) and 7(c)(ii).

Table 4.4—Review of performance in the Canadian individual stock-based management (ISBM) fisheries relative to three-year average (3YA) calendar year exploitation rates (CYERs), as specified in paragraph 7(c) in Chapter 3 of the 2019 Pacific Salmon Treaty Agreement for the unmarked stocks.

Note: Green/red shaded cells indicate whether 3YA CYER obligations were met for a particular stock. NA = No or insufficient data available.

Escapement Indicator	Years Included in 3YA	CYER 3YA	CYER Limit	Paragraph 7(c) Obligation Met?
Skeena	2020, 2021, 2022	0.062	0.147	Yes
Atnarko	2020, 2021, 2022	0.183	0.276	Yes
NWVI Natural	2020, 2021, 2022	0.088	0.091	Yes
SWVI Natural	2020, 2021, 2022	0.088	0.091	Yes
EVIN	2020, 2021, 2022	0.174	0.157	No
Phillips	2020, 2021, 2022	0.102	0.097	Yes
Cowichan	2020, 2021, 2022	0.304	0.419	Yes
Nicola	2020, 2021, 2022	0.119	0.167	Yes
Chilcotin	NA	NA	NA	NA
Chilko	NA	NA	NA	NA
Lower Shuswap	2020, 2021, 2022	0.174	0.200	Yes
Harrison	2020, 2021, 2022	0.157	0.109	No
Nooksack Spring	2020, 2021, 2022	0.103	0.149	Yes
Skagit Spring	2019	NA	0.079	NA
Skagit Sum/Fall	2019, 2021, 2022	0.050	0.088	Yes
Stillaguamish	2020, 2021, 2022	0.085	0.128	Yes
Snohomish	2020, 2021, 2022	0.123	0.092	No

4.2.2 U.S. ISBM Fishery Performance

There are 22 Attachment I indicator stocks, including three of Canadian origin, that are subject to U.S. ISBM fisheries performance evaluation. Of the 22 Attachment I indicator stocks, eight stocks do not have management objectives listed in Attachment I, and therefore, annual CYER limits apply to them. The remaining 14 stocks have PSC agreed management objectives and annual CYER limits only apply when these management objectives are not met. For 2022, CYER limits apply to eleven stocks— three stocks that did not meet their management objectives (Queets Fall, Nehalem, and Siuslaw) and eight stocks without management objectives (Table 4.5).

For 2022, annual U.S. ISBM obligations were met for 19 of the 22 stocks listed in Attachment I; 11 that met their management objectives and thus had no applicable annual CYER limits, and eight that had CYERs below the Attachment I limits. Treaty obligations were not met for three stocks— Queets Fall, Nehalem, and South Umpqua.

Table 4.5—Review of annual performance in the United States individual stock-based management (ISBM) fisheries, 2022.

Note: Grey shaded cells indicate that the calendar year exploitation rate (CYER) qualifies for inclusion in the running 3-year average (3YA) per paragraph 7(c). Green/red shaded cells indicate whether annual CYER obligations were met for a particular stock.

Escapement Indicator	Mgmt. Obj.	2022 Escape-ment	Mgmt. Obj. Met?	CYER Limit	2022 CYER	Annual CYER Obligation Met?
Cowichan	6,500	17,574	Yes	0.080	0.017	Yes
Nicola	NA	7,438		0.036	0.004	Yes
Harrison	75,100	81,649	Yes	0.059	0.022	Yes
Nooksack Spring adj	NA	4,246		0.081	0.077	Yes
Skagit Spring	690	3,487	Yes	0.252	0.333	Yes
Skagit Summer/Fall	9,202	17,323	Yes	0.147	0.168	Yes
Stillaguamish	NA	1,407		0.105	0.042	Yes
Snohomish	NA	5,635		0.108	0.090	Yes
Hoko	NA	917		0.100	0.056	Yes
Grays Harbor Fall	13,326	14,259	Yes	0.154	0.066	Yes
Queets Fall	2,500	1,643	No	0.137	0.319	No
Quillayute Fall	3,000	6,761	Yes	0.207	0.082	Yes
Hoh Fall	1,200	1,866	Yes	0.148	0.109	Yes
Upriver Brights (URB)[1]	40,000	95,558	Yes	0.274	0.201	Yes
Upriver Brights (HAN)[1]				0.288	0.249	Yes
Lewis River Fall	5,700	11,504	Yes	0.190	0.193	Yes
Coweeman	NA	789		0.195	0.161	Yes
Mid-Columbia Summers	12,143	64,497	Yes	0.304	0.292	Yes
Nehalem	6,989	4,434	No	0.130	0.239	No
Siletz	2,944	4,694	Yes	0.171	0.146	Yes
Siuslaw	12,925	7,394	No	0.201	0.027	Yes
South Umpqua	NA	1,922		0.266	0.268	No
Coquille	NA	NA		0.223	0.057	Yes

[1]Attachment I to Chapter 3 of the 2019 PST Agreement identifies two exploitation rate indicator stocks to represent the Upriver Bright escapement indicator stock (URB, HAN). In the event the Upriver Bright management objective is not met in a given year, the URB CYER will be used to assess U.S. ISBM fishery performance.

For the 3YA as specified in Paragraph 7(c) of the PST Agreement, U.S. ISBM obligations were met for all stocks that could be evaluated; no stocks had 3YAs that exceeded the CYER limit by more than 10%. As a result, no further action is required per subparagraph 7(c) in Chapter 3 of the 2019 PST Agreement.

Table 4.6—Review of performance in the United States individual stock-based management (ISBM) fisheries relative to three-year average (3YA) calendar year exploitation rates (CYERs), as specified in paragraph 7(c) in Chapter 3 of the 2019 Pacific Salmon Treaty Agreement for unmarked stocks.

Note: Green/red shaded cells indicate whether 3YA CYER obligations were met for a particular stock. NA = No or insufficient data available.

Escapement Indicator	Years Included in 3YA	CYER 3YA	CYER Limit	Paragraph 7(c) Obligation Met?
Cowichan	2020, 2021, 2022	0.019	0.080	Yes
Nicola	2020, 2021, 2022	0.006	0.036	Yes
Harrison	2020, 2021, 2022	0.035	0.059	Yes
Nooksack Spring	2020, 2021, 2022	0.081	0.081	Yes
Skagit Spring	2020, 2021	NA	0.252	NA
Skagit Sum/Fall	2019, 2020, 2021	0.071	0.147	Yes
Stillaguamish	2020, 2021, 2022	0.084	0.105	Yes
Snohomish	2020, 2021, 2022	0.100	0.108	Yes
Hoko	2020, 2021, 2022	0.023	0.100	Yes
Grays Harbor	2020, 2021, 2022	0.075	0.154	Yes
Queets	2022	NA	0.137	NA
Quillayute	2020, 2021, 2022	0.090	0.207	Yes
Hoh	2021, 2022	NA	0.148	NA
Upriver Brights (URB)	2020, 2021, 2022	0.215	0.274	Yes
Upriver Brights (HAN)	2020, 2021, 2022	0.220	0.288	Yes
Lewis	2019, 2020, 2021	0.063	0.190	Yes
Coweeman	2020, 2021, 2022	0.124	0.195	Yes
Mid-Columbia Summers	2020, 2021, 2022	0.226	0.304	Yes
Nehalem	2022	NA	0.130	NA
Siletz	2020, 2022	NA	0.171	NA
Siuslaw	2020, 2021, 2022	0.153	0.201	Yes
South Umpqua	2020, 2021, 2022	0.251	0.266	Yes
Coquille	2020, 2021, 2022	0.074	0.223	Yes

5. Coded-Wire Tag Analysis and Mark-Selective Fisheries

Chinook salmon released from Puget Sound hatcheries and spring-run hatchery Chinook salmon in the Columbia River have been mass marked since BY 1998. Mass marking of Columbia River Fall Chinook salmon started with BY 2005, and for BY 2009 onwards most of the Chinook salmon production intended for harvest released in Washington and Oregon has been mass marked (Selective Fisheries Evaluation Committee [SFEC] 2009). Mark-selective fisheries have been in place on the Columbia River since 2001, in Puget Sound (including U.S. Strait of Juan de Fuca) since 2003, in some terminal fishing areas along the Oregon coast between 2002 and 2018 and Washington coast since 2006, and in BC Strait of Juan de Fuca since 2008. Additionally, small mark-selective Chinook salmon fisheries occurred in the ocean sport fishery off the Washington Coast (Areas 1–4) between 2010 and 2015 and in the Alaska troll fishery (during periods that would have otherwise been non-retention) during 2016 and 2017.

5.1 Catch in Mark-Selective Fisheries

Regulations for MSFs require a differential retention and release of salmon missing a fin (i.e., fish that are marked; usually the adipose fin is clipped to identify marked hatchery fish) and fish with an intact adipose fin (i.e., fish that are unmarked). As a consequence, exploitation rates from MSFs are different between marked and unmarked Chinook salmon. The benefits of MSF regulations to reduce impacts on unmarked (e.g., natural) stocks relative to a non-selective fishery of equivalent effort depend on the proportion of the total number of fish available to the fishery that are marked (though not necessarily tagged).

Coded-wire tag analysis based on recoveries of marked and tagged Chinook salmon will only reflect the exploitation on the marked fish in an MSF. Because unmarked fish are not retained, and their CWTs not recovered, the exploitation rate of this group must be inferred using other analytical techniques. One method of estimating exploitation rates on unmarked fish is to express it as a function of the release mortality (RM) rate and encounter events of adipose fin clipped CWT fish in an MSF. As a stock is exposed to more MSFs, the difference in exploitation rate between marked and unmarked fish increases, and CWT analysis of marked Chinook salmon recoveries will likely overestimate the exploitation rate on the unmarked fish. Consequently, the assumption that marked and tagged hatchery fish can properly represent the exploitation rate on associated natural stocks has an increasing amount of error as the MSF exploitation rate increases on marked fish. Differences in return-to-escapement proportions between marked and unmarked components of a double index tag (DIT) release group can be tested for significance for stocks susceptible to all MSFs in aggregate.

Details on proposed MSFs for 2022 can be found in SFEC's "Review of Mass Marking and Mark-Selective Fishery Activities Proposed to Occur in 2022" (SFEC 2023a). Information on whether the proposed fishery occurred can be found in the following year's report (SFEC 2023b). Here, we summarize the extent of the MSFs on Chinook salmon in areas governed by the PST.

As mass marking of hatchery production increased in Washington and Oregon, so did the gradual implementation of MSFs. Implementation of MSF regulations began in 2001 on the Columbia River. Landed catch in sport fisheries during the spring run migration period are now almost entirely under MSF regulations, with a lower proportion during the summer and fall run migrations (Figure 5.1). In 2012, the first fall period MSF occurred in the mainstem Columbia River sport fishery, although MSFs occurred in the tributaries prior to 2012. MSFs have gradually increased during the summer/fall fisheries on the Columbia River, though the majority of the catches still occur under non-selective regulations.

Puget Sound sport fisheries (including U.S. Strait of Juan de Fuca) began implementing MSF regulations in 2003. Since then, the landed catch under MSF regulations has increased to equal nearly all the total landed catch of Chinook salmon in Puget Sound marine sport fisheries and sometimes a majority in freshwater fisheries (Figure 5.2).

In Oregon, a Chinook salmon MSF restriction occurred within the 15-fathom curve off of Tillamook Bay from March through July. There were concurrent non-selective Chinook salmon seasons open in adjacent ocean waters that allowed vessels to fish both areas on the same trip as long as no unmarked Chinook were retained or in possession while gear was deployed within the restricted area. The sport MSF in this area began in 2002 and the commercial MSF began in 2011. These limitations ended after 2018. At time of landing, catch from both the mark-selective “Tillamook bubble” fishery and the nonselective fishery outside of the bubble is combined. Therefore, although numbers of landed catch and released Chinook are recorded, they cannot be assigned specifically to the individual MSFs occurring within the bubble. In response to continued conservation concerns for naturally spawning Chinook in the Elk River, an ERIS for the MOC aggregate, an MSF in the terminal freshwater sport fishery was initiated in 2019. This MSF has continued each year since 2019 and is likely to be in place until observations of sustainable natural production from this stock have been made.

In Canada beginning in 2019, significant changes were made to Chinook fisheries in Canada (long periods of non-retention and reduced annual limits) to address conservation concerns for wild Southern BC (including Fraser River) Chinook salmon. As a result Canada started to explore expansion of MSF as a management tool for Chinook fisheries.

The Strait of Juan de Fuca MSF occurred from approximately early-March to mid-June from 2008 to 2018, and opened again March 1st, 2019. Effective April 2019, this area became a Chinook non-retention fishery and from 2020 to present was only open in March, except for a portion of Area 20-5 (Beecher Bay) which remained open from April 1st to July 31st. Waters included in this fishery are those near Victoria, as well as Pacific Fishery Management Area (PFMA) Subareas 19–1 to 19–4 (excluding 19-2 since 2016) and 20–4 to 20–7. Typically, the regulations in this MSF allow retention of both marked and unmarked Chinook between 45 and 67 cm in length, but only marked fish over 67 cm (with a minimum size limit of 45 cm). In 2020, Chinook MSFs (mixed-bag and size) were also applied to some mainland inlets and portions of Areas 12, 13, 15, and in 2021 and 2022 portions of Area 16 were also included.

In 2023, two new MSFs were approved in Canada near the city of Victoria, BC, in portions of PFMAs 17, 18 and 19. All opportunities were pure MSF, where only hatchery-marked Chinook could be retained, and in effect until May 31 (Subareas 19-1, 19-3 to 19-6, western portion of Subarea 18-6, and Subarea 18-10); July 14 (Subareas 17-6 and 17-9); or July 31 (Subareas 18-7, 19-7, 19-8, and eastern portion of Subarea 18-6). The MSF in Area 16 was also modified from mixed-bag and size regulations to pure MSF for its opening April 1 through July 14.

Beginning in 2010 and continuing through 2015, small-scale MSF fisheries for Chinook salmon on the Washington and Oregon coast (north of Cape Falcon, Oregon) occurred prior to the traditional summer period sport fishery. These 2-week sport MSFs north of Cape Falcon have started as early as May 30 and as late as June 18. From 2010–2015, landed catch was highest in 2012, with 7,382 hatchery Chinook salmon landed in Washington, and 290 landed in Oregon. Catch was lowest in 2015, with 1,135 hatchery Chinook salmon landed in Washington, and 36 landed in Oregon. In Washington, the number of released Chinook ranged from a low of 1,361 in 2015 to a high of 7,852 in 2012. In Oregon, the number of released Chinook ranged from a low of 11 in 2015 to a high of 1,039 in 2011. No Washington or Oregon coastal mark-selective Chinook fisheries have occurred north of Cape Falcon since 2015.

Alaska held its first experimental Chinook MSF in a coho-directed troll fishery from September 4–30, 2016. During this fishery, 457 marked Chinook salmon were retained. In 2017, Alaska conducted a second experimental MSF from July 5–21, also occurring during a coho-directed troll fishery. In 2017, 2,680 marked Chinook salmon were retained. No MSFs have occurred in Alaska since 2017.

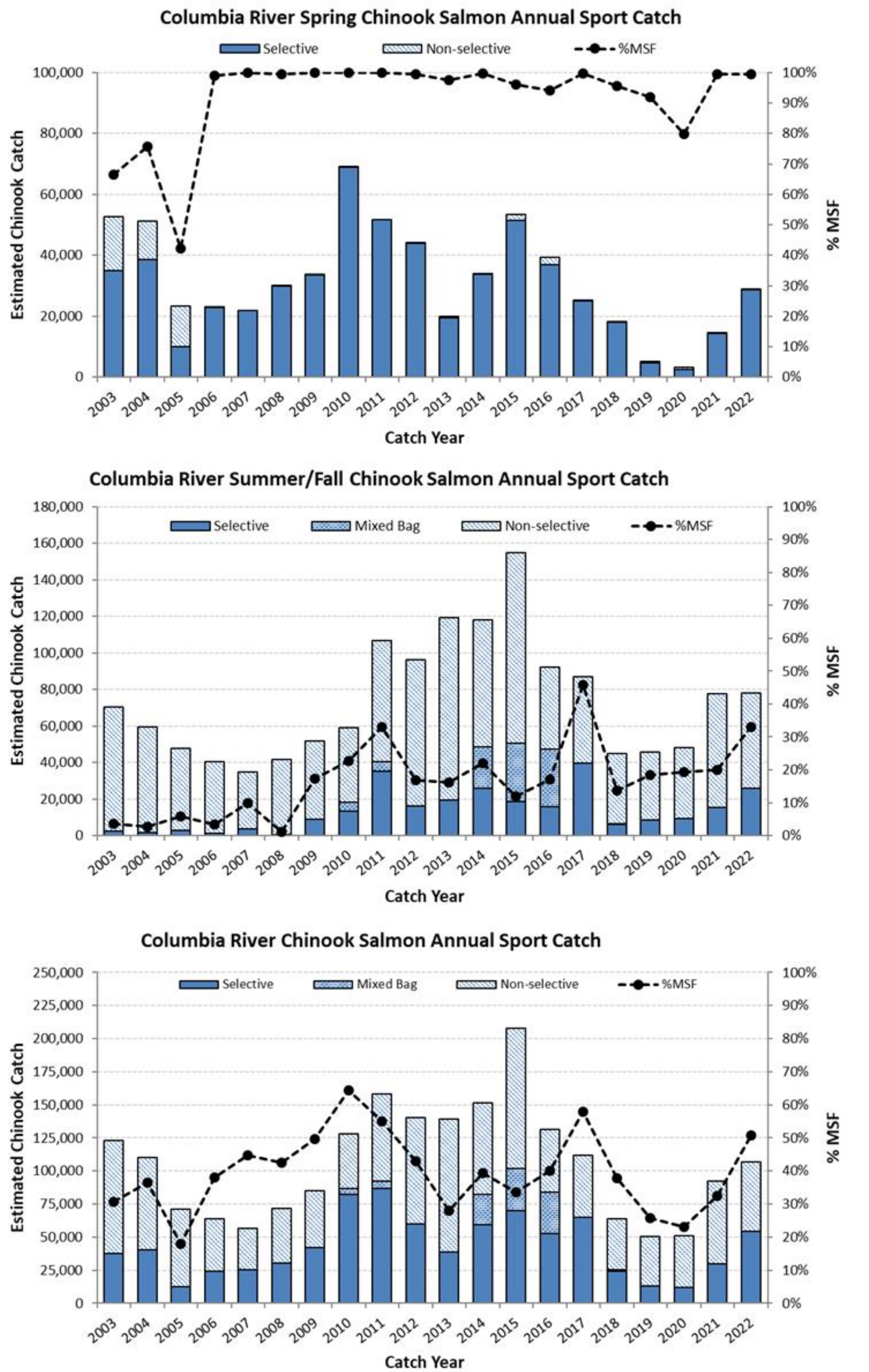

Figure 5.1—Estimated total Chinook catch in Columbia River mark-selective and non-selective sport fisheries during Spring (May–Jun) and summer–fall (Jul–Dec) seasons (left y-axis) and percent of catch in mark-selective fisheries (MSFs) (right y-axis) for catch years 2003–2022.

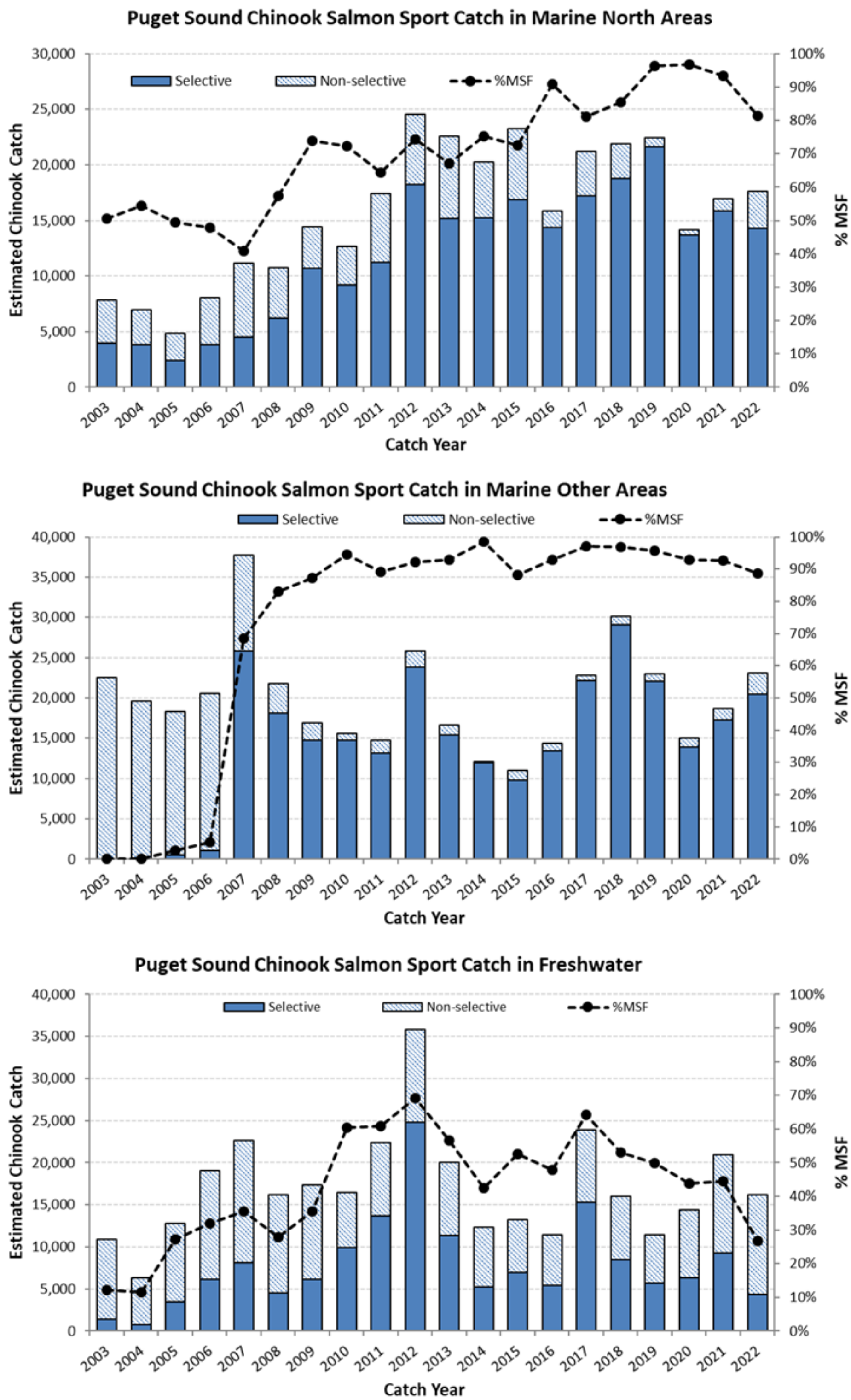

Figure 5.2—Estimated total Chinook catch in mark-selective and non-selective Puget Sound sport fisheries (left y-axis) and percent of catch in mark-selective fisheries (MSFs) (right y-axis) for catch years 2003–2022.

As an alternative to pure MSFs, some agencies have implemented "mixed" bag limit regulations whereby different proportions of marked to unmarked fish are allowed in the landed catch. In the most common configuration, mixed bag limits allow no more than 1 unmarked fish to be retained as part of the total bag limit. Since 2006, mixed bag MSFs have occurred in some terminal fishing areas along the Oregon and Washington coasts and in the BC portion of the Strait of Juan de Fuca. In 2011 and 2013, sport fisheries in the upper Columbia River for summer Chinook salmon were implemented under mixed-bag limit regulations. In recent years, Canada has implemented a variation of mixed bag limits in the marine areas around the southern tip of Vancouver Island by allowing only hatchery-marked fish to be retained above a certain fork length measurement. The benefits of reduced exploitation on unmarked (e.g., natural) stocks is usually minor (e.g., Figure 5.3) for mixed bag limit fisheries but mixed bag limits do allow for additional retention of hatchery origin fish (R. Houtman, DFO, personal communication, August 16, 2021).

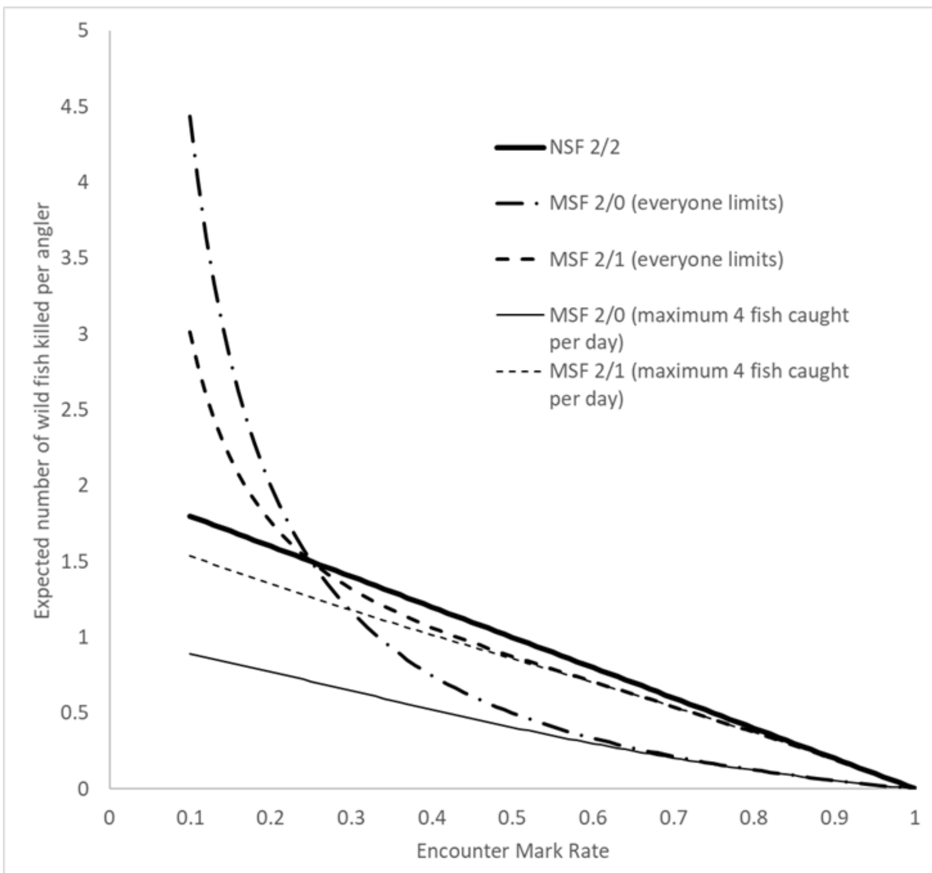

Figure 5.3—Average number of wild fish killed under alternative mark-selective fishery (MSF) regulations, with release mortality rate equal to 0.25.

Note: Regulation notations show total Chinook daily bag limits / total daily limit of wild Chinook (i.e., unmarked). For example, a notation of 2/1 means fishers can retain up to 2 Chinook of which a maximum of 1 can be unmarked. Lines described as "limit out" are for cases when fishers keep fishing until their bag limit is reached. Lines described as "max 4 fish" are for cases where fishers encounter four fish maximum and end their fishing trip, regardless of meeting bag limits.

5.2 Methods to Estimate the Impact of Mark-Selective Fisheries on Unmarked Chinook Salmon Stocks

In ISBM fisheries, the CYER metric is used to monitor fishery related mortalities. The Parties are held to CYER limits in ISBM fisheries on certain naturally spawning escapement indicator stocks of Chinook salmon, which may or may not also have an agreed biologically-based escapement goal. Assessment of performance in ISBM fisheries is reliant on accurate estimates of CYERs, which may be influenced by MSFs.

Where MSF regulations are implemented, the exploitation rates of hatchery- and natural-origin salmon may differ, which violates a key assumption that a CWT indicator stock of hatchery-origin accurately represents fishery impacts on the escapement indicator stocks (ASFEC 1995; Expert Panel 2005; CYER WG 2024). The CTC worked in conjunction with the CYER WG on the development of analytical methods to account for this difference in exploitation between hatchery- and natural-origin salmon. The details of the methodologies that were applied are documented in CYER WG (2024).

5.2.1 Comparison of marked vs unmarked CYERs for Attachment I stocks

This section provides a comparison of marked and unmarked CYERs for escapement indicator stocks with ISBM fishery limits identified in Attachment I to Chapter 3 of the 2019 PST Agreement. CYERs are presented for 2009 to present to align with the CYER base period (2009–2015) used for ISBM fishery evaluations.

Relatively small changes between marked and unmarked CYERs were noted for escapement indicator stocks in Canadian ISBM fisheries (*Figure 5.4*), likely due to limited implementation of MSF regulations in Canada. However, some instances of regulations resulting in differential retention and release between marked and unmarked Chinook were accounted for in areas of southern BC. Starting in 2020, Chinook MSF (mixed-bag and slot) regulations were accounted for in some mainland inlets, specifically portions of Areas 12, 13, 15 and 16. While Vancouver Island stocks (EVIN, NWVI and SWVI) had the most noticeable changes between marked and unmarked CYERs, particularly in recent years, southern BC (including Fraser River) Chinook salmon are the most likely to experience MSF impacts. This is because the majority of MSF regulations along with Chinook non-retention measures are being implemented in BC's South Coast Areas, yet Fraser stocks have a lower mark rate compared to Vancouver Island stocks. The purpose of these regulations is to lower impacts on stocks of concern such as Fraser River stocks, while still allowing some Chinook fishing opportunities.

Larger differences in CYERs were observed for some escapement indicator stocks in U.S. ISBM fisheries due to the larger presence of MSF regulations in those regions. Starting in the early 2000's, when the first MSFs in Washington state were implemented, most Washington Puget Sound marine area and many Washington freshwater recreational fisheries progressively shifted from NSFs to MSFs. Beginning in 2010, several early season MSFs occurred in the recreational fishery off the Washington coast, however, these fisheries were generally small in scale and have not occurred since 2015. There are also some instances of net MSFs in Washington State, most notably in Willapa Bay, the Columbia River system, Nooksack River, and Nisqually River. The greater usage of MSFs in Washington State, particularly inside Puget Sound and in some freshwater fisheries in the Columbia River, explains why there are greater differences in marked versus unmarked CYERs for U.S. ISBM fisheries compared to Canadian ISBM fisheries. Since MSFs have been utilized at varying spatio-temporal stratifications in the U.S., however, differences vary by stock.

Several stocks that would commonly be encountered in Puget Sound marine area U.S. ISBM MSFs displayed notably lower unmarked CYERs compared to marked CYERs over the time series examined including Cowichan, Harrison, Nicola, Hoko, Stillaguamish, and Skagit Summer/Falls (Figure 5.5). As these fish are migrating back to their natal rivers, U.S. ISBM fishery impacts would primarily take place in recreational MSFs occurring in the Strait of Juan de Fuca, San Juan Islands, and northern Puget Sound. Additionally, there are some escapement indicator stocks originating from Puget Sound that are commonly encountered in U.S. ISBM MSFs within both freshwater and marine areas, including Nooksack Springs, Skagit Springs, and Snohomish, with these stocks also showing moderate decreases in unmarked CYERs relative to marked CYERs.

Patterns in U.S. ISBM CYERs for Washington and Oregon Coastal and Columbia River Chinook escapement indicator stocks (Figure 5.6, Figure 5.7) differ from those originating from Puget Sound, as these stocks generally don’t pass through Puget Sound MSFs and there have not been coastal marine MSFs in Washington or Oregon for most years. Additionally, the Washington and Oregon Coastal escapement indicator stocks are not subjected to any freshwater MSFs in their rivers of origin. The Columbia River stocks do encounter freshwater MSFs, notably in the spring and summer management period. Accordingly, the Washington and Oregon Coast stocks examined (Quillayute, Hoh, Queets, Grays Harbor, Nehalem, Siletz, Siuslaw, South Umpqua, Coquille) displayed minimal differences between marked and unmarked CYERs for the entire time series, whereas the unmarked and marked CYERs for Columbia River stocks are slightly (Coweeman, Lewis, Upriver Brights) to moderately (Mid-Col Summers) different, reflecting the differing freshwater regulations across management periods.

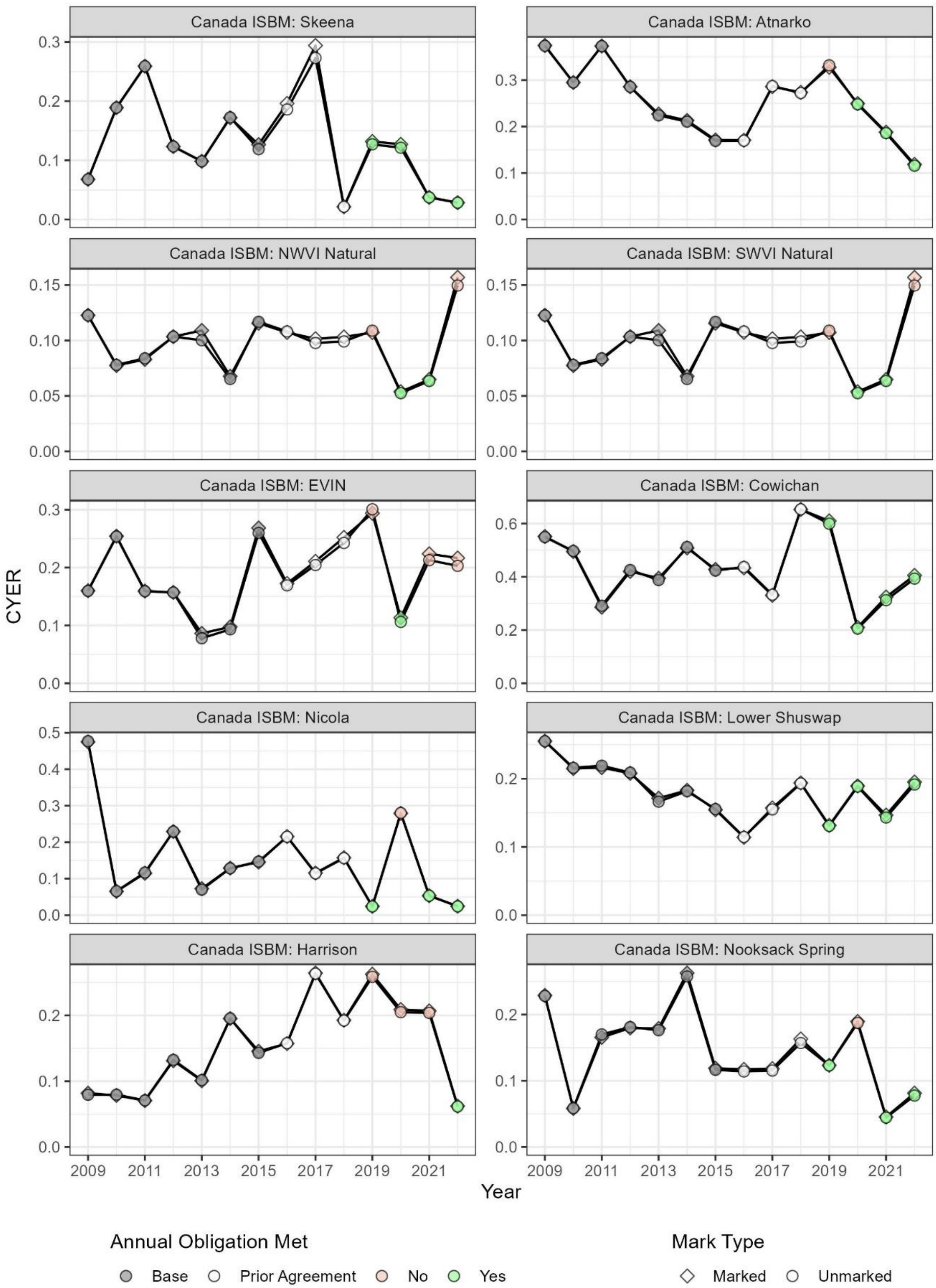

Figure 5.4—Comparison of marked and unmarked CYERs in ISBM fisheries by country for each Attachment I indicator stock.

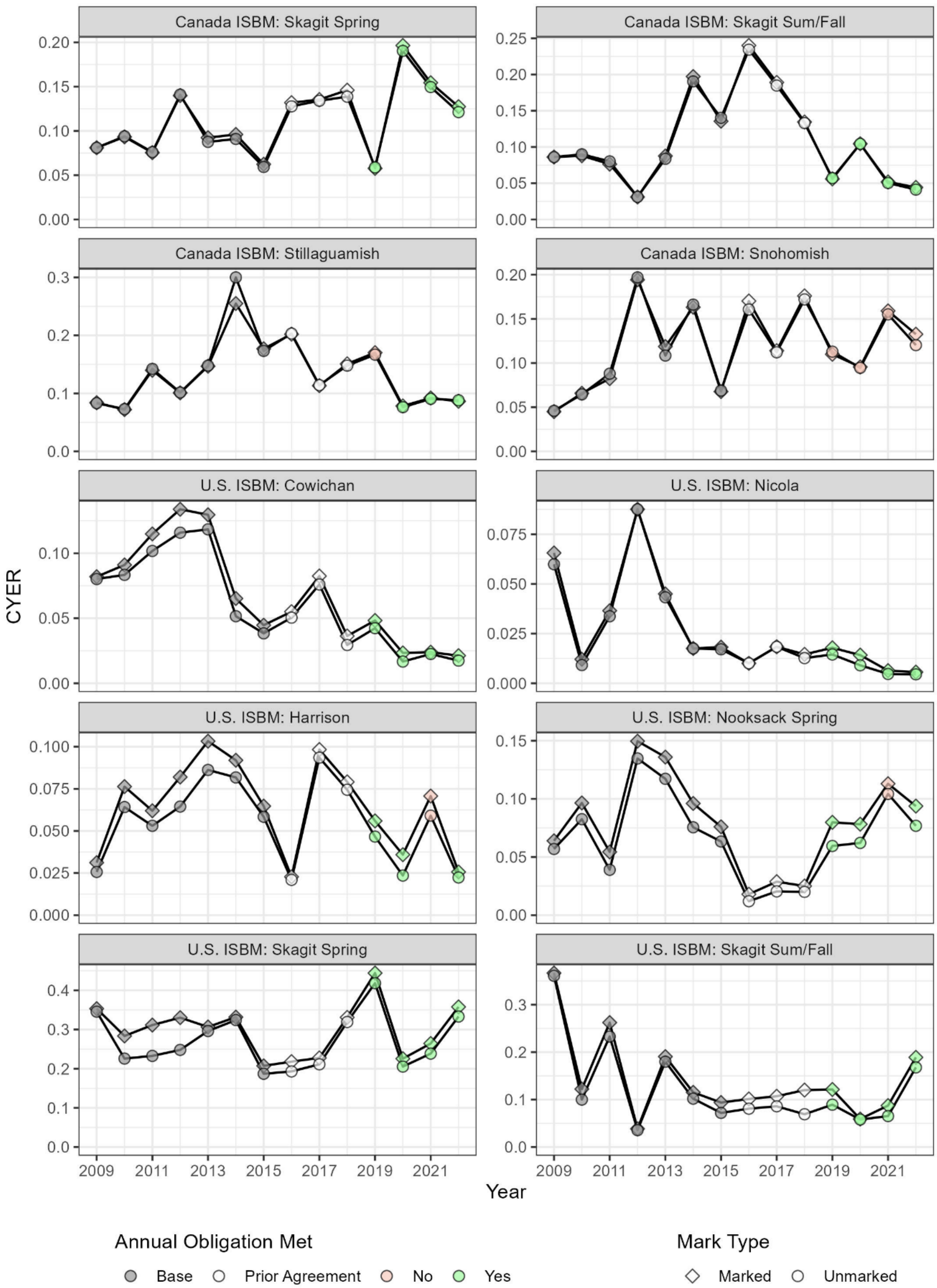

Figure 5.5—Comparison of marked and unmarked CYERs in ISBM fisheries by country for each Attachment I indicator stock.

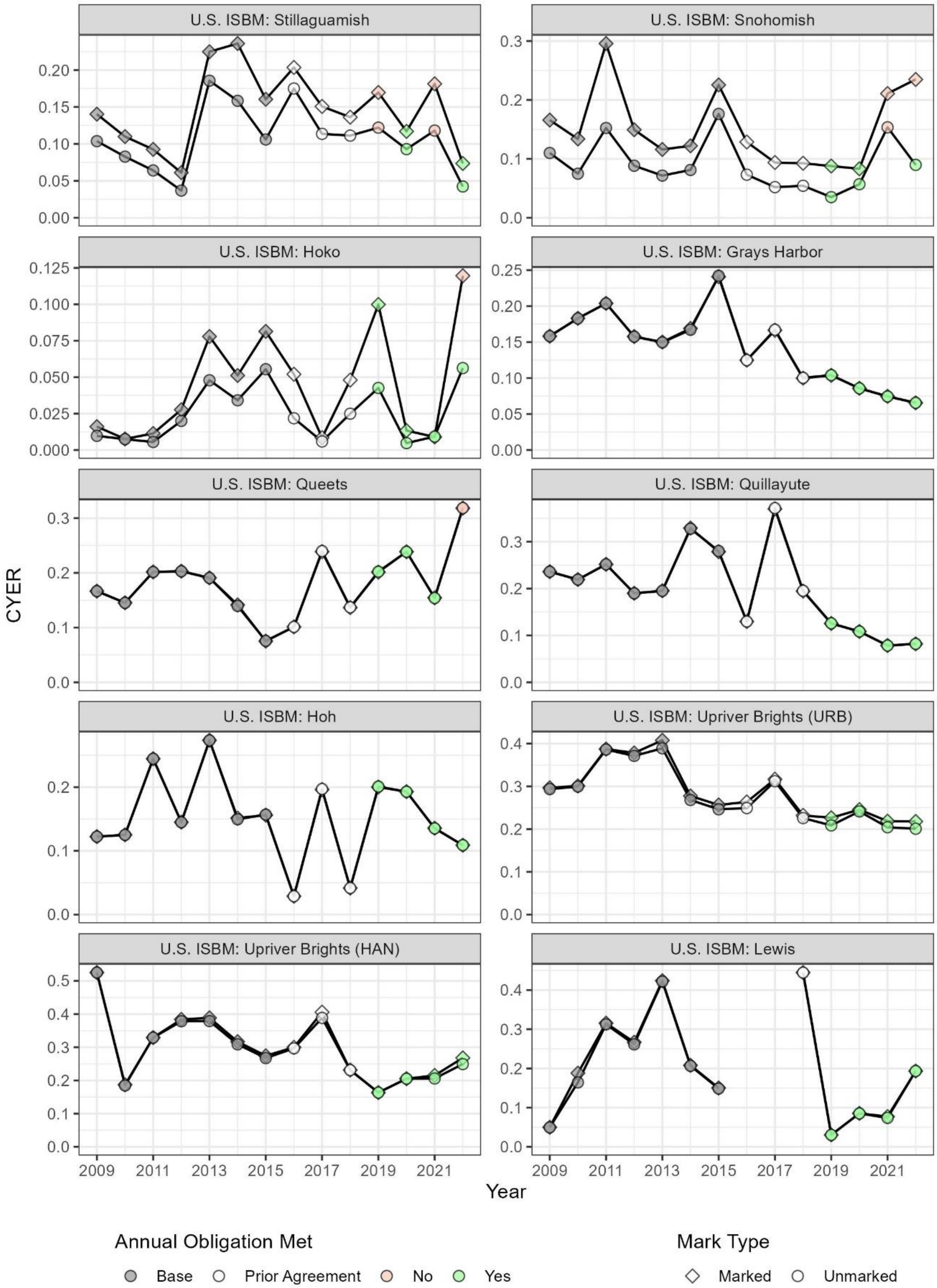

Figure 5.6—Comparison of marked and unmarked CYERs in ISBM fisheries by country for each Attachment I indicator stock.

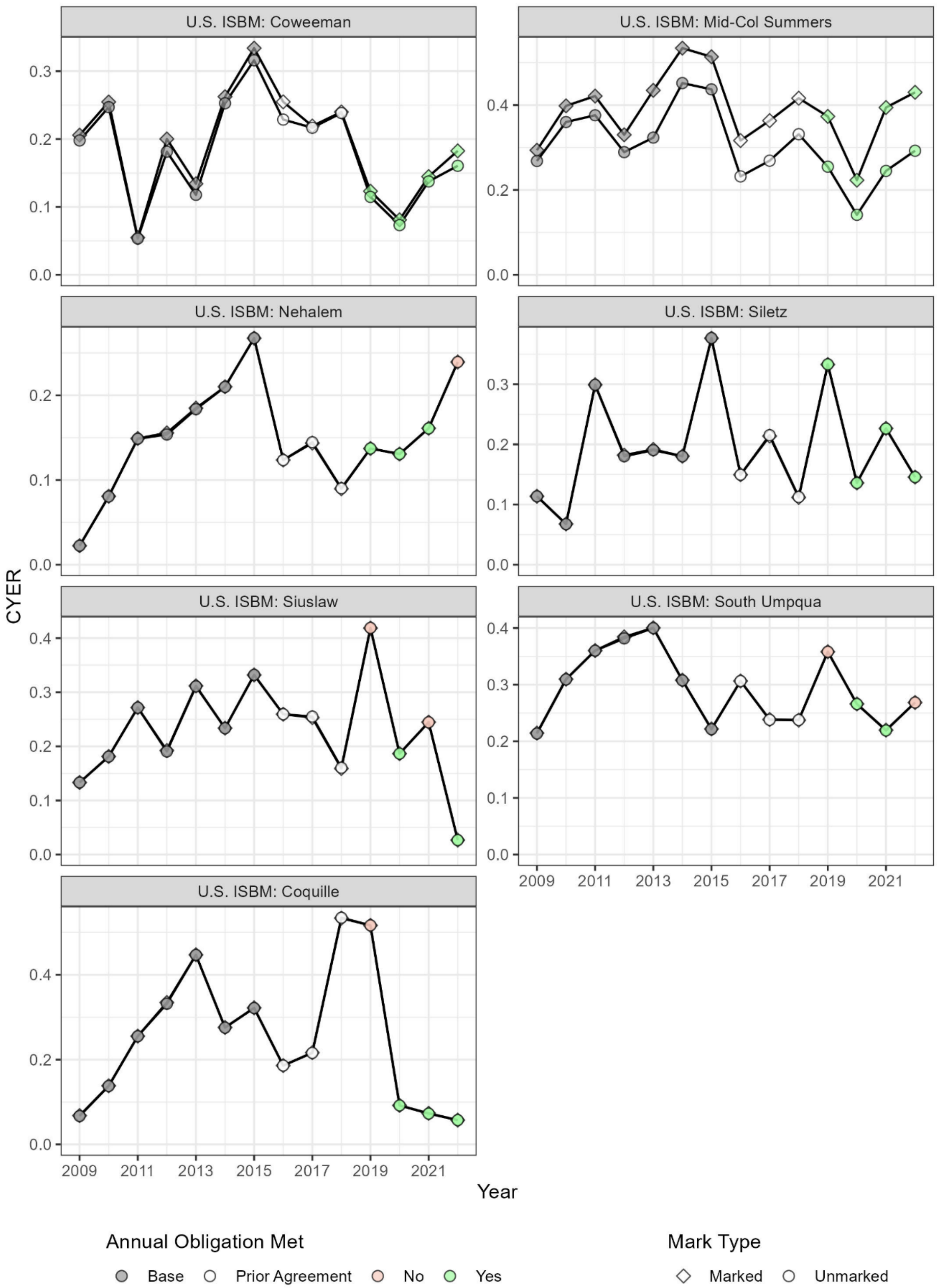

Figure 5.7—Comparison of marked and unmarked CYERs in ISBM fisheries by country for each Attachment I indicator stock.

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LIST OF APPENDICES

APPENDIX A: RELATIONSHIP BETWEEN EXPLOITATION RATE INDICATOR STOCKS, ESCAPEMENT INDICATOR STOCKS, AND MODEL STOCKS IN THE PACIFIC SALMON TREATY

LIST OF APPENDIX A TABLES

Appendix A1– Indicator stocks for Transboundary (TBR) Rivers and Southeast Alaska (SEAK).

Region	Run	Attachment I stock	Escapement Indicator (PSC Management Objective)	Exploitation Rate Indicator/Acronym		Model Stock/Acronym	
Transboundary Rivers (TBR)	Spring	Yes	Taku (19,000–36,000)	Taku Taku and Stikine	TAK TST[1]	Taku and Stikine	TST
		Yes	Stikine (14,000–28,000)	Stikine Taku and Stikine	STI TST[1]		
		Yes	Alsek (3,500–5,300)	TBD	NA	Alsek	ALS
Southeast Alaska (SEAK)		Yes	Situk (500–1,000)	TBD	NA	Yakutat Forelands	YAK
		Yes	Chilkat (1,750–3,500)	Chilkat Northern Southeast Alaska	CHK NSA[2]	Northern Southeast Alaska	NSA
		Yes	Unuk (1,800–3,800)	Unuk Southern Southeast Alaska	UNU SSA[3]	Southern Southeast Alaska	SSA

[1] TST is an aggregate of the Taku (TAK) and Stikine (STI) exploitation rate indicator stocks and is used by the PSC Chinook Model to represent the TST Model Stock aggregate.
[2] NSA is an aggregate of Crystal Lake (ACI) and Douglas Island Pink and Chum (DIPAC)/Macaulay (AMC) hatcheries and is used by the PSC Chinook Model to represent the NSA Model Stock aggregate.
[3] SSA is an aggregate of Little Port Walter (ALP), Neets Bay (ANB), Whitman Lake (AHC), and Deer Mountain (ADM) hatcheries and is used by the PSC Chinook Model to represent the SSA Model Stock aggregate.

Appendix A2– Indicator stocks for Northern British Columbia (NBC), Central British Columbia (CBC), and West Coast Vancouver Island (WCVI).

Region	Run	Attachment I stock	Escapement Indicator (PSC Management Objective)	Exploitation Rate Indicator/Acronym		Model Stock /Acronym	
Northern BC (NBC)	Summer	No	Nass	Kitsumkalum (Deep Creek Hatchery)	KLM	Northern BC	NBC
Northern BC (NBC)	Summer	Yes	Skeena (TBD)	Kitsumkalum (Deep Creek Hatchery)	KLM	Northern BC	NBC
Northern BC (NBC)	Summer	No	Kitsumkalum	Kitsumkalum (Deep Creek Hatchery)	KLM	NA	NA
Northern BC (NBC)	Spring	No	NA	Kitsumkalum Yearling	KLY	NA	NA
Central BC (CBC)	Fall	No	Wannock	Atnarko (Snootli Hatchery)	ATN	Central BC	CBC
Central BC (CBC)	Summer	No	Chuckwalla and Killbella	Atnarko (Snootli Hatchery)	ATN	Central BC	CBC
Central BC (CBC)	Summer	Yes	Atnarko (5,009)	Atnarko (Snootli Hatchery)	ATN	Central BC	CBC
West Coast Vancouver Island (WCVI)	Fall	Yes	NWVI Natural Aggregate (Colonial-Cayeagle, Tashish, Artlish, Kaouk) (TBD)	Robertson Creek Hatchery[1]	RBT (adj)	West Coast Vancouver Island Natural	WVN
West Coast Vancouver Island (WCVI)	Fall	Yes	SWVI Natural Aggregate (Bedwell/Ursus, Megin, Moyeha) (TBD)	Robertson Creek Hatchery[1]	RBT (adj)	West Coast Vancouver Island Natural	WVN
West Coast Vancouver Island (WCVI)	Fall	No	West Coast Vancouver Island Aggregate (14 Streams)	Robertson Creek Hatchery[1]	RBT	West Coast Vancouver Island Hatchery	WVH

[1] Coded-wire tag indicator stocks and fishery adjustments described in CYER WG 2021.

Appendix A3– Indicator stocks for Fraser River and Strait of Georgia.

Region	Run	Attachment I stock	Escapement Indicator (PSC Management Objective)	Exploitation Rate Indicator/Acronym		Model Stock /Acronym	
Fraser River	Spring	Yes	Nicola (TBD)	Nicola (Spius Creek Hatchery)	NIC	Fraser Spring 1.2	FS2
		No	Fraser Spring 1.2				
		Yes	Chilcotin (TBD)	Lower Chilcotin (in development)	LCT	Fraser Spring 1.3	FS3
	Summer	Yes	Lower Shuswap (12,300)	Lower Shuswap (Shuswap Falls Hatchery)	SHU	Fraser Summer Ocean-type 0.3	FSO
		No	NA	Middle Shuswap (Shuswap Falls Hatchery)	MSH		
		Yes	Chilko (TBD)	Chilko (in development)	CKO	Fraser Summer Stream-type 1.3	FSS
	Fall	No	NA	Chilliwack Hatchery	CHI	Fraser Chilliwack Fall Hatchery	FCF
		Yes	Harrison (75,100)	Harrison (Chehalis Hatchery)	HAR	Fraser Harrison Fall	FHF
North Strait of Georgia	Fall	Yes	East Vancouver Island North (TBD)	Quinsam Hatchery[1]	QUI (adj)	Upper Strait of Georgia	UGS
		Yes	Phillips (TBD)	Phillips (Gillard Pass Hatchery)[2]	PHI		
South Strait of Georgia	Fall	No	NA	Big Qualicum Hatchery	BQR	Middle Strait of Georgia	MGS
		Yes	Cowichan (6,500)	Cowichan Hatchery	COW	Lower Strait of Georgia	LGS
	Summer	No	NA	Puntledge Hatchery	PPS	Puntledge Hatchery	PPS

[1] Coded-wire tag indicator stocks and fishery adjustments described in CYER WG 2021.

[2] PHI will be discontinued as an exploitation rate indicator stock once all age classes from the 2019 brood have been recovered (i.e., 2024). A new exploitation rate indicator is TBD.

Appendix A4– Indicator stocks for Puget Sound.

Region	Run	Attachment I stock	Escapement Indicator (PSC Management Objective)	Exploitation Rate Indicator/Acronym		Model Stock /Acronym	
Northern Puget Sound	Spring	Yes	Nooksack Spring (TBD)	Nooksack Spring Fingerling (Kendall Creek Hatchery)	NSF	Nooksack Spring	NKS
		Yes	Skagit Spring (1,024)	Skagit Spring Fingerling (Marblemount Hatchery)	SKF	NA	NA
	Fall	No	NA	Samish Fall Fingerling (Samish Hatchery)	SAM	Nooksack Fall	NKF
	Summer/ Fall	Yes	Skagit Summer/Fall (8,201)	Skagit Summer Fingerling (Marblemount Hatchery)	SSF	Skagit Summer/Fall	SKG
	Fall	Yes	Stillaguamish (TBD)	Stillaguamish Fall Fingerling (Whitehorse Hatchery)	STL	Stillaguamish	STL
	Summer	Yes	Snohomish (TBD)	Skykomish Fingerling (Wallace Hatchery)	SKY	Snohomish	SNO
Central and Southern Puget Sound	Fall	No	Green	SPS Fall Fingerling[1]	SPS	Puget Sound Hatchery Fingerling & Puget Sound Natural Fingerling	PSF & PSN
		No	Lake Washington				
		No	NA	Nisqually Fall Fingerling (Clear Creek Hatchery)	NIS		
Hood Canal		No	NA	George Adams Hatchery Fall Fingerling	GAD		

[1] SPS is aggregate from Soos Creek (Green River), Grovers, and Issaquah hatcheries. The Soos Creek (Green tag group) are included in the SPS exploitation rate indicator.

Appendix A5– Indicator stocks for the Washington Coast.

Region	Run	Attachment I stock	Escapement Indicator (PSC Management Objective)	Exploitation Rate Indicator/Acronym		Model Stock /Acronym	
Juan de Fuca	Fall	No	NA	Elwha Fall Fingerling (Lower Elwha Hatchery)	ELW	NA	NA
Washington Coast (WAC)	Fall	Yes	Hoko (TBD)	Hoko Fall Fingerling (Hoko Falls Hatchery)	HOK	NA	NA
		Yes	Queets Fall (2,500)	Queets Fall Fingerling (Salmon River brood stock)	QUE	WA Coastal Wild	WCN
		Yes	Grays Harbor Fall (13,326)		QUE (adj)[1]		
		Yes	Quillayute Fall (3,000)				
		Yes	Hoh Fall (1,200)				
		No	NA			WA Coastal Hatchery	WCH
		No	NA	Tsoo-Yess Fall Fingerling (Makah National Fish Hatchery)	SOO	NA	NA
	Spring	No	Grays Harbor Spring	NA	NA	NA	NA
	Spring/ Summer	No	Queets Spring/Summer (700)	NA	NA	NA	NA
	Summer	No	Quillayute Summer	NA	NA	NA	NA
	Spring/ Summer	No	Hoh Spring/Summer (900)	NA	NA	NA	NA

[1] Coded-wire tag indicator stocks and fishery adjustments described in CYER WG 2021.

Appendix A6– Indicator stocks for Columbia River and Oregon Coast.

Region	Run	Attachment I stock	Escapement Indicator (PSC Management Objective)	Exploitation Rate Indicator/Acronym		Model Stock /Acronym	
Columbia River	Spring	No	NA	Cowlitz/Kalama/Lewis Springs	CWS	Cowlitz Spring Hatchery	CWS
		No	NA	Willamette Spring (Hatchery Complex)	WSH	Willamette River Hatchery	WSH
	Summer	Yes	Mid-Columbia Summers (12,143)	Columbia Summers (Wells Hatchery)	SUM	Columbia River Summers	SUM
		No	Canadian Okanagan[1]	Similkameen Summer Yearling	SMK	NA	NA
	Fall	No	NA	Columbia Upriver Brights (Priest Rapids Hatchery)	URB	Mid-Columbia Brights	MCB
		Yes	Upriver Brights (40,000)			Columbia Upriver Brights	URB
				Hanford Wild	HAN		
		No	NA	Lyons Ferry Fingerling	LYF	Lyons Ferry Hatchery	LYF
		No	NA	Lyons Ferry Yearling	LYY	NA	NA
		Yes	Lewis (5,700)	Lewis River Wild	LRW	Lewis River	LRW
		Yes	Coweeman (TBD)	Cowlitz Hatchery Fall Tule	CWF	Cowlitz Hatchery	CWF
		No	NA	Spring Creek National Fish Hatchery	SPR	Spring Creek	SPR
		No	NA	Lower River Hatchery (Big Creek Hatchery)	LRH	Bonneville Hatchery	BON
North Oregon Coast (NOC)	Fall	Yes	Nehalem (6,989)	Salmon River Hatchery (adj)[2]	SRH (adj)	North Oregon Coast	NOC
		Yes	Siletz (2,944)				
		Yes	Siuslaw (12,925)				
Mid-Oregon Coast (MOC)	Fall	Yes	South Umpqua (TBD)	Elk River Hatchery (adj)[1]	ELK (adj)	Mid-Oregon Coast	MOC
		Yes	Coquille (TBD)				

[1] Pending the review specified in paragraph 5(b) of Chapter 3 and a subsequent Commission decision.

[2] Coded-wire tag indicator stocks and fishery adjustments described in CYER WG 2021.

Appendix A7– Historic exploitation rate indicator stocks that are no longer reported.

Region	Historic exploitation rate indicator (Acronym)	Model stock (Acronym)	Last year in ERA	Reason stock is no longer reported
Southeast Alaska	Alaska Spring (AKS)	NA	2020	Stratified into Southern Southeast Alaska (SSA) and Northern Southeast Alaska (NSA)
Southeast Alaska	Chickamin (CHM)	Southern Southeast Alaska (SSA)	2020	Tagging discontinued
Central BC	Atnarko Yearling (ATS)	NA	2014	Tagging discontinued (2011)
Fraser River	Dome -Penny Creek Hatchery (DOM)	Fraser Spring 1.3 (FS3)	2021	Tagging discontinued
South Strait of Georgia	Nanaimo (NAN)	Lower Strait of Georgia (LGS)	2021	Tagging discontinued
Northern Puget Sound	Nooksack Spring Yearling (NKS)	Nooksack Spring (NKS)	2021	Tagging discontinued
Northern Puget Sound	Skagit Spring Yearling (SKS)	NA	2021	Reduced hatchery production
Central and Southern Puget Sound	Stillaguamish Summer Fingerling	Stillaguamish (STL)	2012	Subsumed into Stillaguamish Fall Fingerling (STL)
Central and Southern Puget Sound	White River Spring Yearling (WRY)	NA	2021	Tagging discontinued
Central and Southern Puget Sound	South Puget Sound Fall Yearling (SPY)	Puget Sound Hatchery Yearling (PSY)	2021	Tagging discontinued
Central and Southern Puget Sound	Squaxin Net Pens Fall (SQP)	Puget Sound Hatchery Yearling (PSY)	2021	Tagging discontinued
Central and Southern Puget Sound	Green River Fingerling (GRN)	Puget Sound Hatchery Fingerling (PSF) & Puget Sound Natural Fingerling (PSN)	2016	Stock is a part of South Puget Sound (SPS) indicator stock
Central and Southern Puget Sound	University of Washington Accelerated (UWA)	Puget Sound Hatchery Yearling (PSY)	2021	Tagging discontinued

APPENDIX B: PARAMETERS USED IN THE 2024 EXPLOITATION RATE ANALYSIS

The following two tables summarize the notations used throughout this report.

LIST OF APPENDIX B TABLES

Appendix B1— Parameter definitions for all equations except those used for the Stratified Proportional Fishery Index (SPFI).

Parameter	Description
a	age class
A	set of all ages that meet selection criteria
$AEQ_{BY,a,f}$ $AEQ_{BY,Maxage,f}$=1.0	adult equivalent factor in brood year *BY*, age *a*, and fishery *f* (for terminal fisheries, AEQ = 1.0 for all ages)
$AEQ_{s,BY,a,f}$	adult equivalent factor for stock *s*, brood year *BY*, age *a*, and fishery *f*
$AvgMatRte_a$	average maturation rate for age *a*
$BPYR$	base period year
$BYER_{BY,f}$	brood year exploitation rate in adult equivalents for brood year *BY* and fishery *f*
BY	brood year
$Cohort_{BY,a}$	cohort by brood year *BY* and age *a* (*where stock is implied from context*)
$Cohort_{s,BY,a}$	cohort by stock *s*, brood year *BY* and age *a* (*where stocks are defined explicitly in a summation*)
$CohSurv_{BY,a=2or3}$	cohort survival of CWT fish to age 2 or 3 for brood year *BY*
CY	calendar year
$CYDist_{CY,F}$	proportion of total stock mortality (or escapement) in a calendar year *CY* attributable to a fishery or a set of fisheries *F*
$d_{t,s,a}$	distribution parameter for time step *t*, stock *s*, and age *a*
$Esc_{Y,a}$	escapement past all fisheries for either brood year *BY* or calendar year *CY* and age *a*
$ER_{s,a,f,CY}$	exploitation rate at age *a* divided by cohort size at age *a* for stock *s* in fishery *f* in year *CY*
$EV_{n,BY}$	the stock productivity scalar for iteration *n* and brood year *BY*
f	a single fishery or escapement
$f \in \{F\}$	a fishery *f* within the set of fisheries *F = Preterminal or Terminal*
$f \in \{F_{p,ISBM}\}$	a fishery *f* within the set of each party's (*p)* ISBM fisheries *F*
$FI_{f,CY}$	fishery exploitation rate index for fishery *f* in year *CY*

Parameter	Description
$MatRte_{BY,a}$	maturity rate of age *a* for brood year *BY*
Maxage	maximum age of stock (generally age 6 for stream type stocks, age 5 for ocean type stocks)
Minage	minimum age of stock (generally age 3 for stream type stocks, age 2 for ocean type stocks)
$Morts_{Y,a,f}$	landed or total fishing-related mortality for brood year *BY* or calendar year *CY,* age *a*, and fishery *f*
NM_a	annual natural mortality prior to fishing on age *a* cohort
Numfisheries	total number of fisheries
s	a particular stock
S	set of all stocks that meet selection criteria
$Surv_a$	survival rate (1-NM_a) by age
$TotCWTRelease_{BY}$	total number of fish released with coded-wire tags for a given brood year
$TotMorts_{s,Y,a,f}$	total fishing related mortality for stock *s*, brood year *BY* or calendar year *CY*, age *a*, and fishery *f*
$RepMorts_{BY,a,f}$	reported fishing-related mortality for brood year *BY* or calendar year *CY* or during the base period BPER and age *a* in fishery *f*

Appendix B2— Parameter descriptions for equations used for the stratified proportional fishery index (SPFI).

Parameter	Description
$A_{t,CY}$	Alaska hatchery origin catch by fishery strata *t*, year *CY*
$c_{t,CY,s,a}$	adult equivalent CWT catch by fishery strata *t*, year *CY*, stock *s* and age *a*
$C_{t,CY}$	catch by fishery strata *t*, year *CY*
$d_{t,s,a}$	distribution parameter by fishery strata *t*, stock *s* and age *a*
$h_{t,CY}$	CWT harvest rate by fishery strata *t*, year *CY*
H_{CY}	harvest rate by year *CY*
$H_{t,CY}$	harvest rate by fishery strata *t*, year *CY*
$n_{CY,s,a}$	CWT cohort size by year *CY*, stock *s* and age *a*
$r_{t,CY,s,a}$	CWT recoveries by fishery strata *t*, year *CY*, stock *s* and age *a*
S_{CY}	SPFI by year *CY*
$S_{t,CY}$	SPFI by fishery strata *t*, year *CY*

Appendix C: Percent distribution of landed catch and total mortality and escapement for exploitation rate indicator stocks by calendar year

Mortality distribution tables show the percent of estimated landed catch or total mortality for individual stocks attributed to specific fisheries (T = troll, N = net, S = sport) for both marked and unmarked stocks. Landed catch mortalities are calculated from catch estimation and CWT sampling programs. Total mortality includes landed catch and incidental mortality (i.e., release mortality) which occurs in both retention and non-retention fisheries. Incidental mortalities are estimated based on sampling data and/or algorithms within the ERA (i.e., size-at-age vulnerability algorithms and gear-specific mortality rates). Mortality distribution within a calendar year sums to 100%.

For mortality distribution among fisheries, calendar years that do not meet the minimum criteria of at least 3 age classes and 105 estimated CWT recoveries were shaded or, in some cases, omitted. If only 1 age class was present in a calendar year, data from that year were omitted. If 2 age classes or less than 105 estimated CWTs were present in a calendar year, data from that year were shaded, but excluded from the calculation of the time period averages found at the bottom rows of the table. Where relevant, escapement included inter-dam loss mortalities (i.e., Columbia River stocks). Complete time series of mortality distributions, as well as tables of landed catch mortalities, can be found on the PSC website: https://www.psc.org/publications/technical-reports/technical-committee-reports/chinook/ctc-data-sets/.

The distributions of mortalities (reported catch and total) among fisheries and escapement in a catch year were calculated for each stock to determine the exploitation patterns. The distributions were computed if at least two BYs contributed to the CWT recoveries for a catch year. Distributions were computed for each fishery across all ages present in the catch year as:

$$CYDist_{CY,F} = \frac{\sum_{a=Minage}^{Maxage} \sum_{f\epsilon\{F\}} Morts_{CY,a,f} * AEQ_{BY=CY-a,a,f}}{\sum_{a=Minage}^{Maxage} \sum_{f=1}^{Numfisheries} Morts_{CY,a,f} * AEQ_{BY=CY-a,a,f} + Esc_{CY,a}}$$

Equation C.1

Calculated mortality distributions may not indicate the true geographic distribution of an indicator stock. For example, no CWTs will be recovered if a fishery area is closed but this would not necessarily indicate zero abundance of a given stock in that fishing area.

Mortality distribution tables for stocks with terminal area adjustments are also included in the excel file posted on the PSC website (https://www.psc.org/publications/technical-reports/technical-committee-reports/chinook/ctc-data-sets/).

APPENDIX D: BROOD YEAR EXPLOITATION RATE PLOTS

The brood year exploitation rate measures the cumulative impact of fisheries on all ages for a given stock and brood year. The BYER is computed by dividing AEQ total fishing mortality by AEQ total fishing mortality plus escapement.

$$BYER_{BY,f} = \frac{\sum_{a=Minage}^{Maxage} \sum_{f \in \{F\}} Morts_{BY,a,f} * AEQ_{BY,a,f}}{\sum_{a=Minage}^{Maxage} \sum_{f=1}^{Numfisheries} Morts_{BY,a,f} * AEQ_{BY,a,f} + Esc_{BY,a}}$$

Equation D.1

All terms are defined in Appendix B. The AEQ factor represents the proportion of fish of a given age that would, in the absence of fishing, leave the ocean to return to the terminal area. The AEQ factor is calculated as:

$$AEQ_{BY,a,f} = \begin{cases} MatRte_{BY,a} + \left(1 - MatRte_{BY,a}\right) * Surv_{a+1} * AEQ_{BY,a+1,f}, a < \text{Maxage} \\ 1, a = \text{Maxage} \end{cases}$$

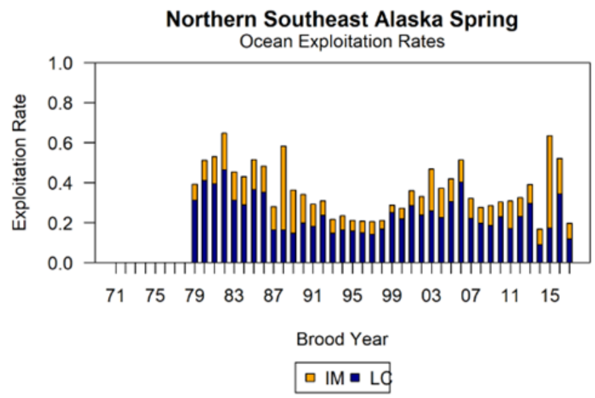
Equation D.2

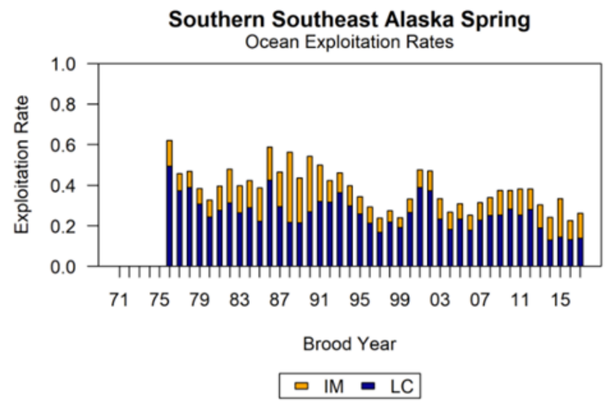
The AEQ factor is equal to 1 for the oldest age and for all ages in terminal fisheries. The BYER is further partitioned into AEQ landed catch and incidental mortality. BYERs are not reported for incomplete BYs.

If a hatchery indicator stock is subject to directed terminal fisheries, its BYER will no longer equal the BYER of the corresponding wild stock it's supposed to represent (i.e., a violation of the indicator stock assumption). This issue is addressed by reporting the BYER in the ocean fisheries (i.e., excludes the terminal fishery impacts). The type of BYER statistic reported for each exploitation rate indicator stock are described in Table 2.2 and in the subtitles of the following figures.

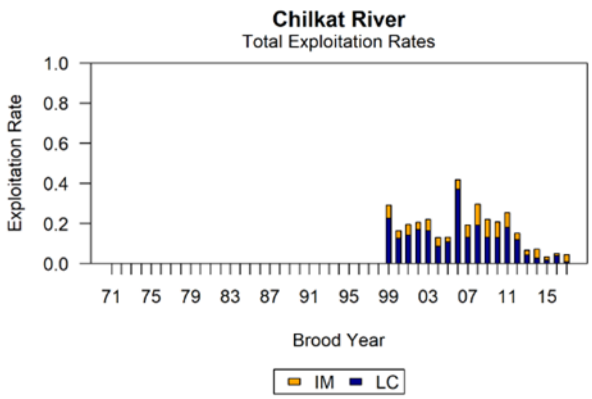
LIST OF APPENDIX D TABLES

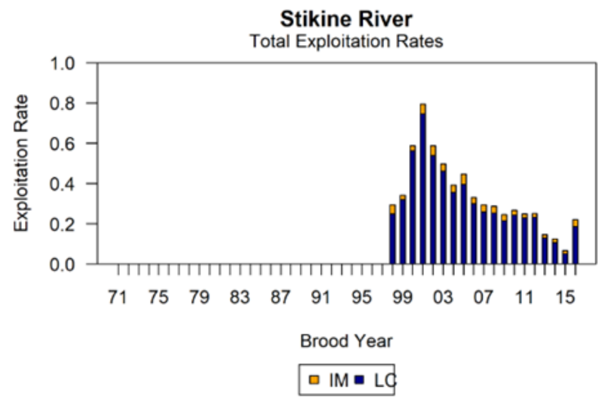
Appendix D1— Brood year exploitation rates for Southeast Alaska hatchery indicator stocks. Catch and incidental mortality are shown. Only completed brood years are included.

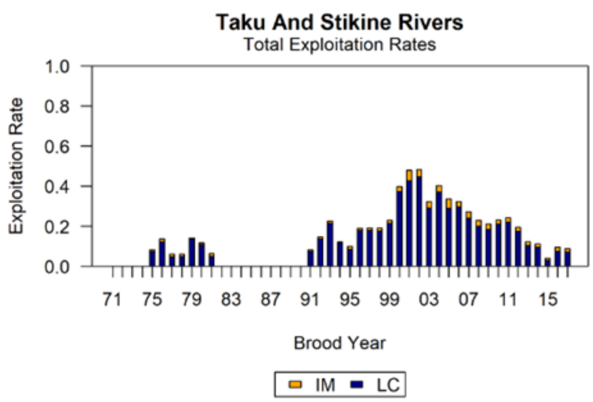


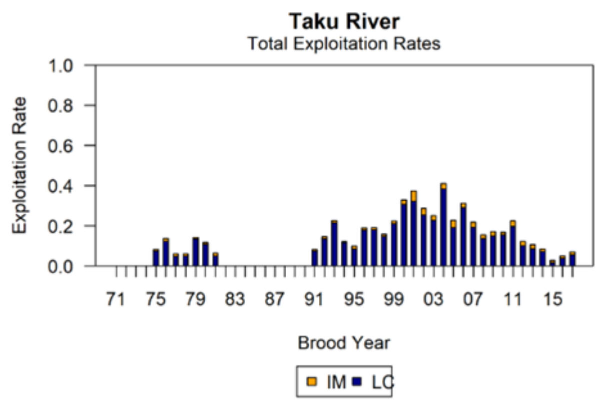


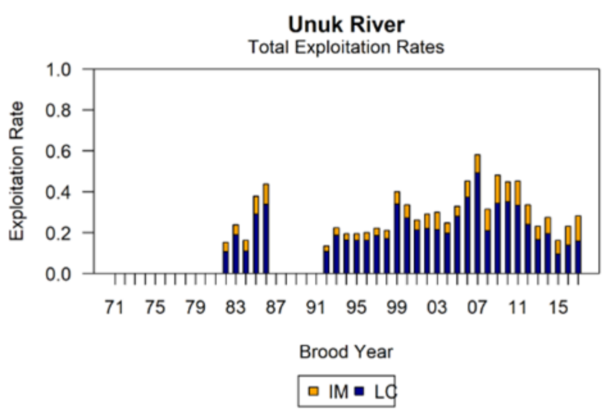
Appendix D2— Brood year exploitation rate for Southeast Alaska and transboundary wild indicator stocks. Catch and incidental mortality are shown. Only completed brood years are included.



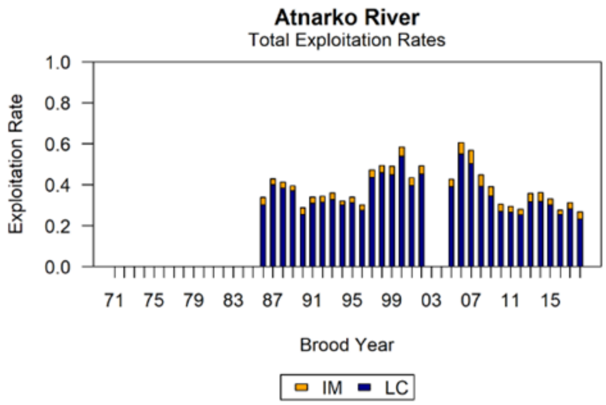


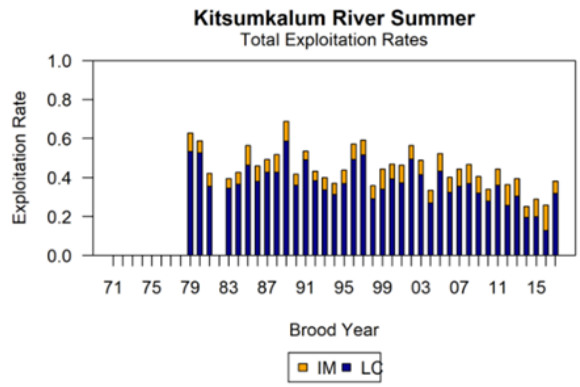




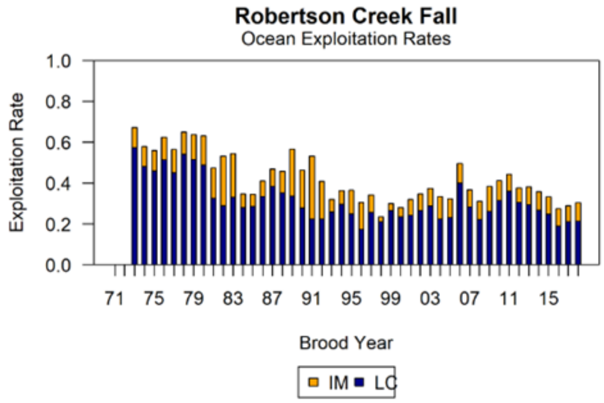


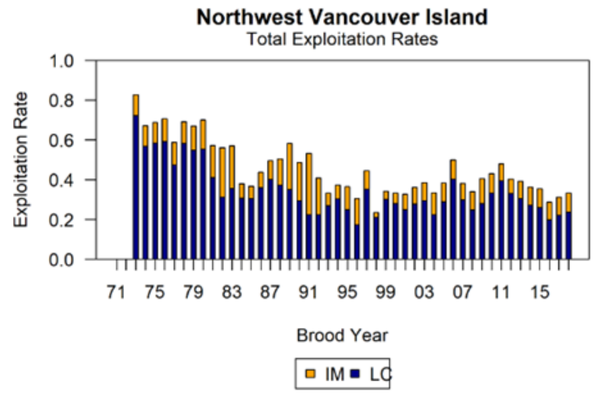
Appendix D3— Brood year exploitation rate for North and Central British Columbia stocks. Catch and incidental mortality are shown. Only completed brood years are included.

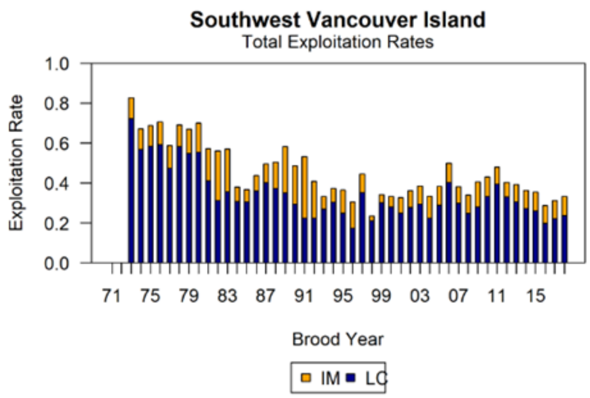




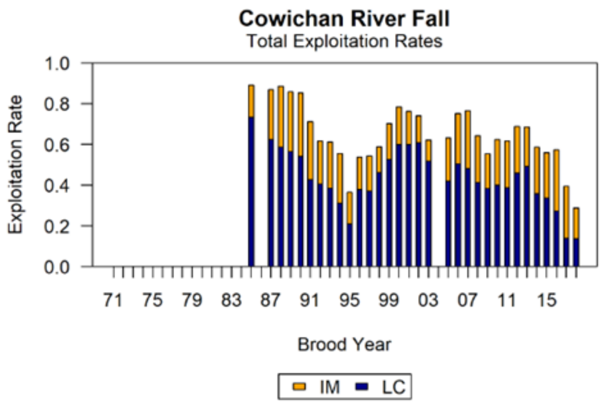
Appendix D4— Brood year exploitation rates for West Vancouver Island stocks. Catch and incidental mortality are shown. Only completed brood years are included.

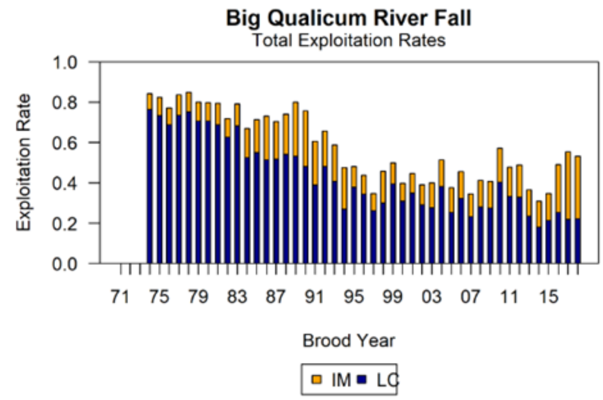


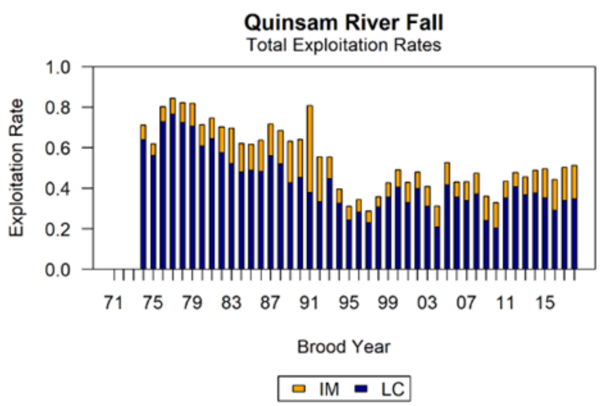


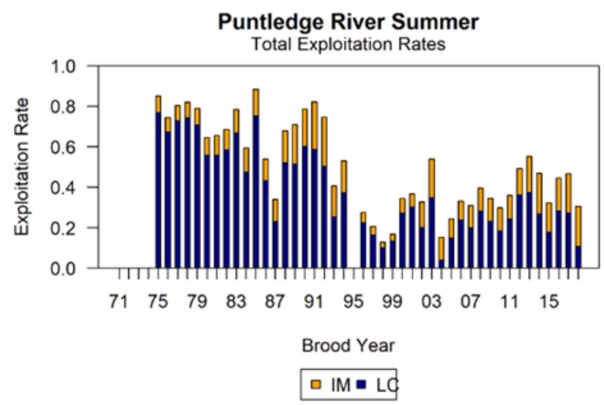


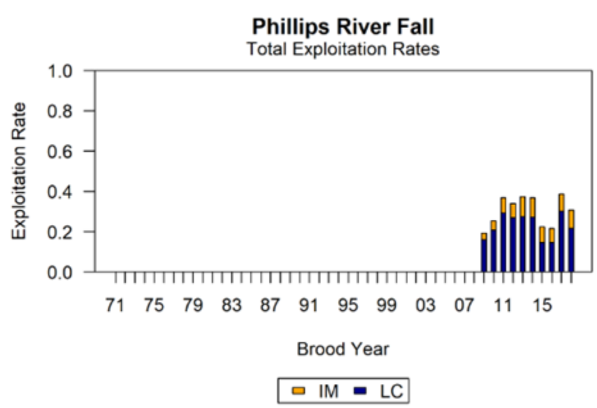
Appendix D5— Brood year exploitation rate for the Strait of Georgia indicator stocks. Catch and incidental mortality are shown. Only completed brood years are included.

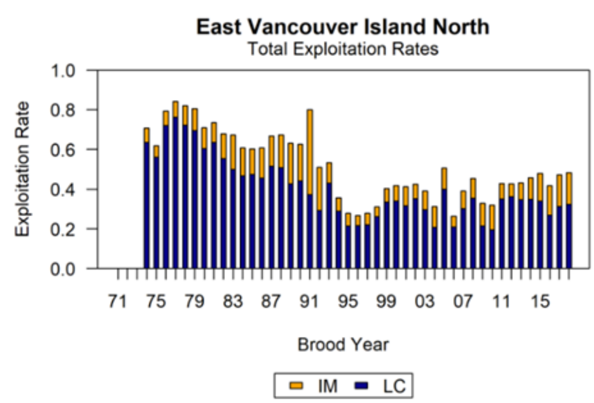




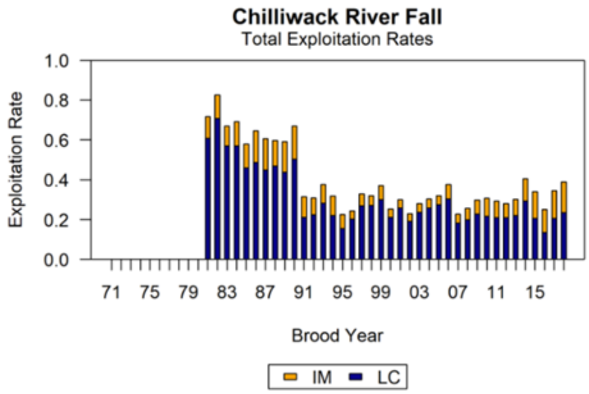


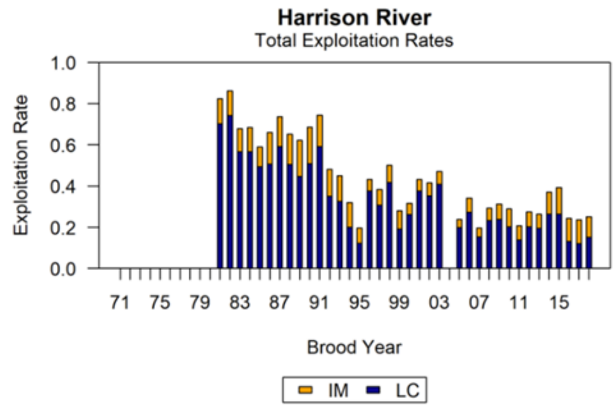




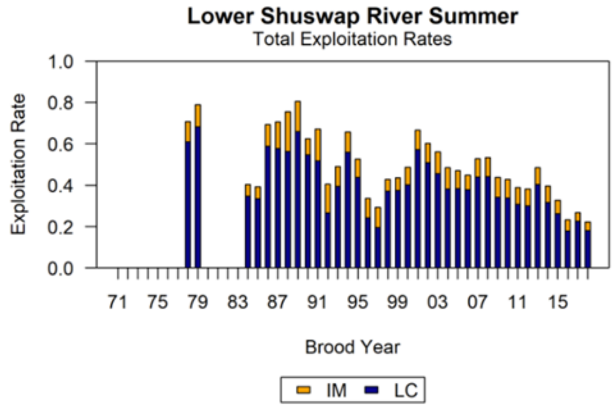


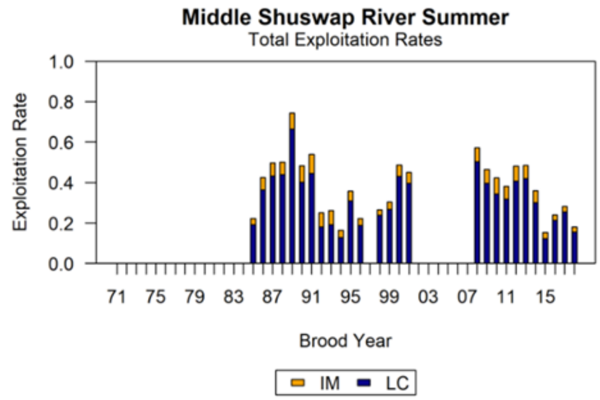
Appendix D6— Brood year exploitation rate for Fraser fall-run stocks. Catch and incidental mortality are shown. Only completed brood years are included.

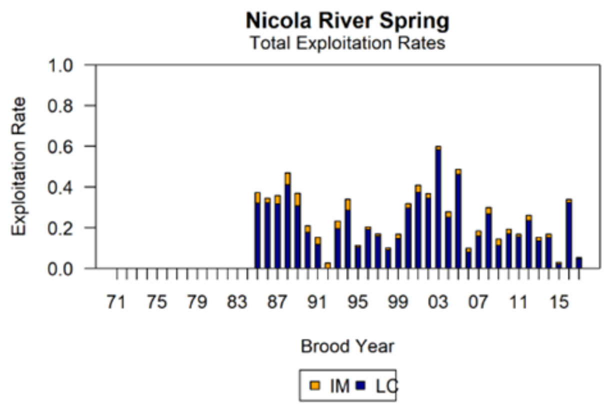




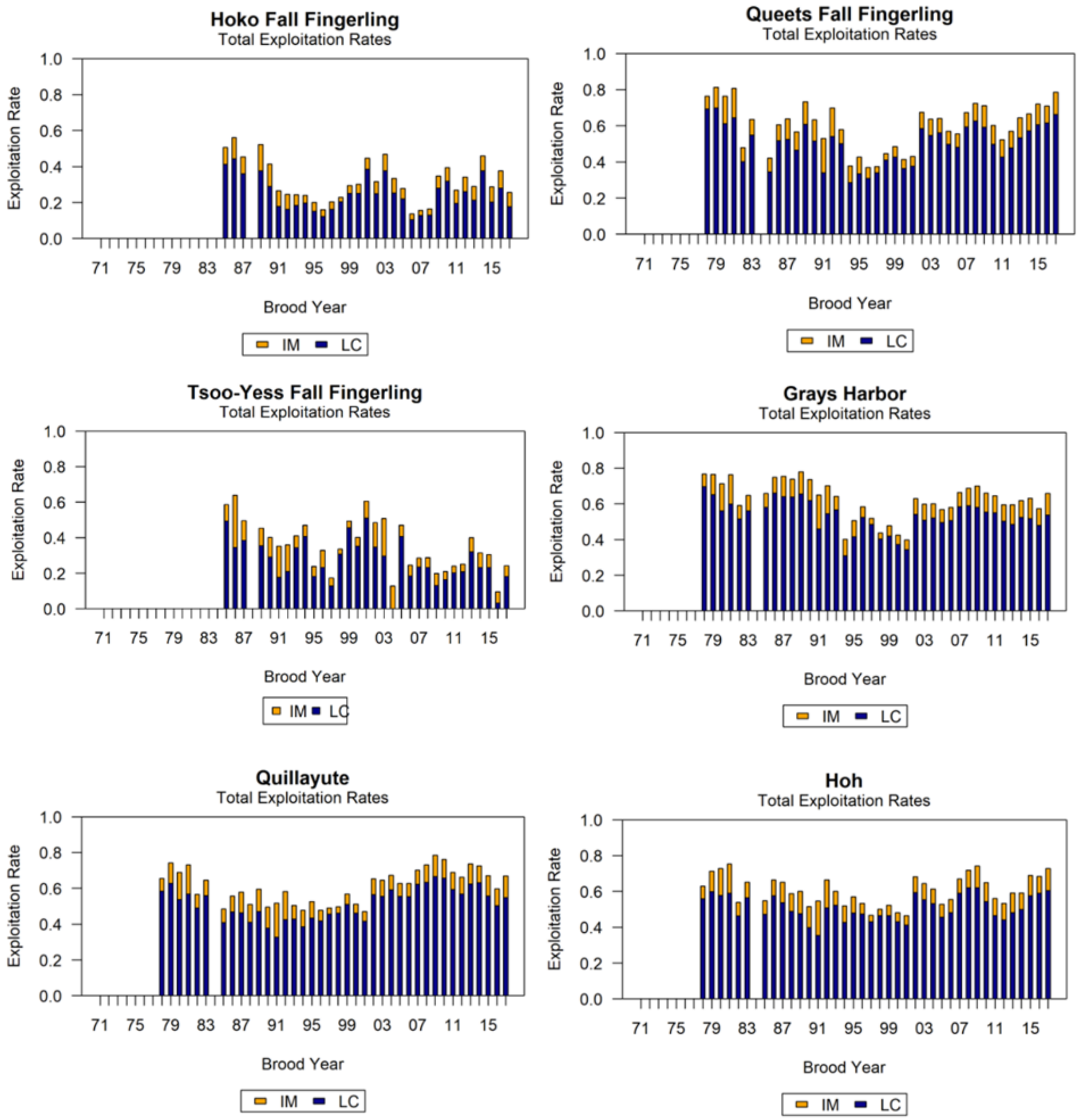
Appendix D7— Brood year exploitation rate for Fraser spring- and summer-run stocks. Catch and incidental mortality are shown. Only completed brood years are included.



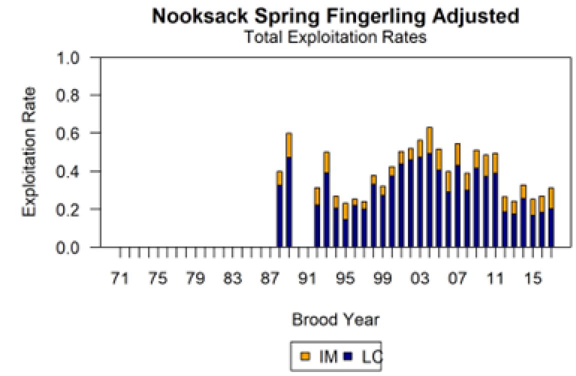


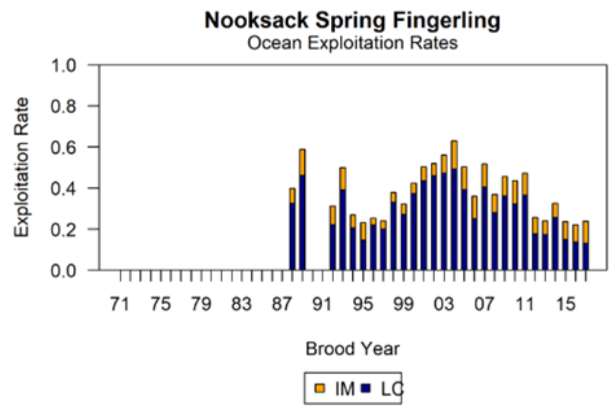


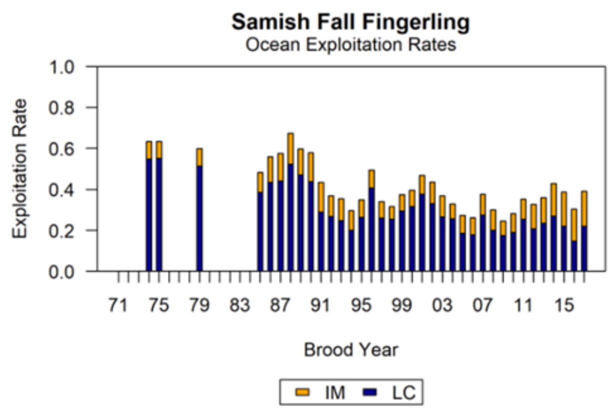
Appendix D8— Brood year exploitation rate in terms of landed catch and incidental mortality for Washington Coast indicator stocks.

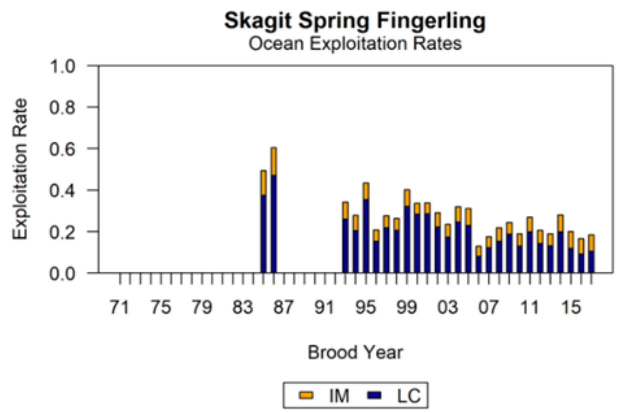


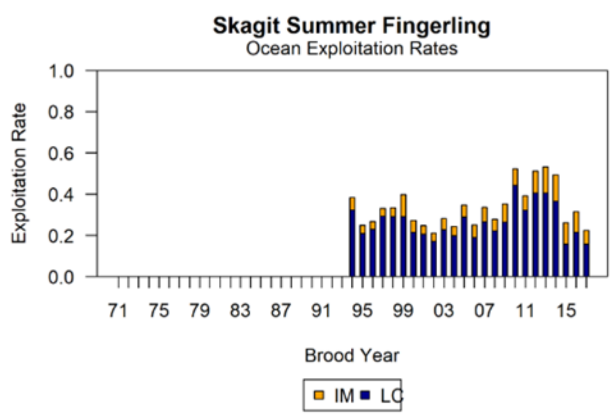
Appendix D9— Brood year exploitation rate in terms of landed catch and incidental mortality for Northern Puget Sound coded-wire tag indicator stocks.



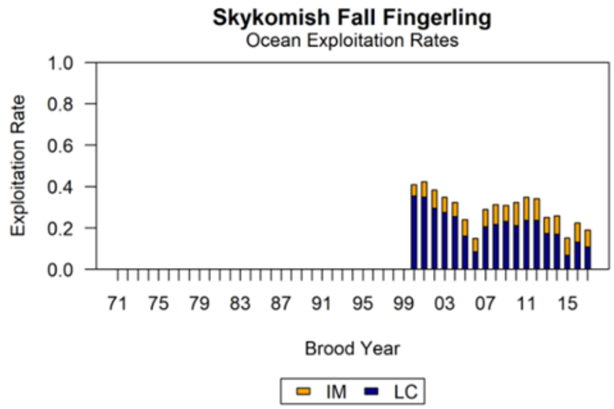


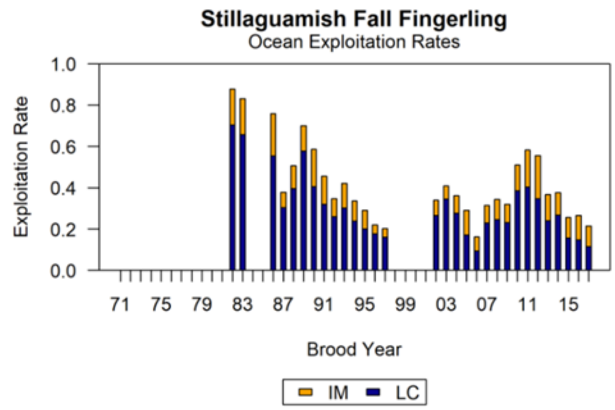




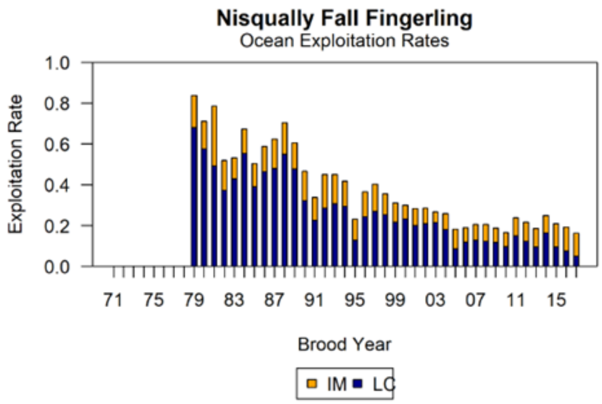


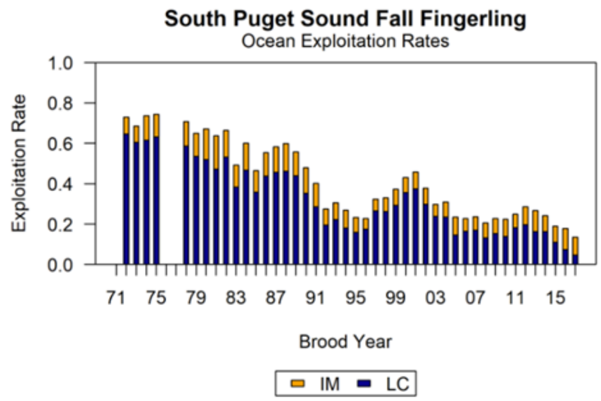
Appendix D10— Brood year exploitation rate in terms of landed catch and incidental mortality for Central Puget Sound coded-wire tag indicator stocks Stillaguamish Fall and Skykomish Summer Fingerling.



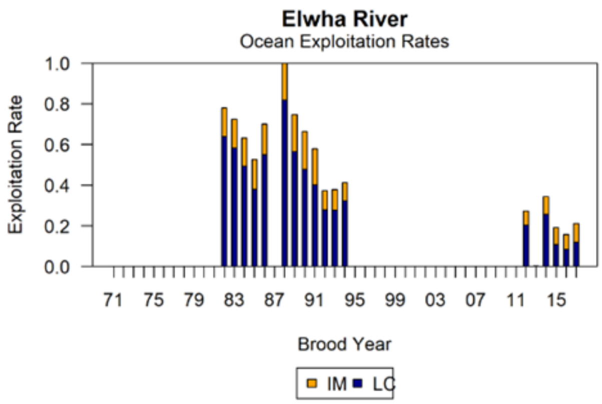


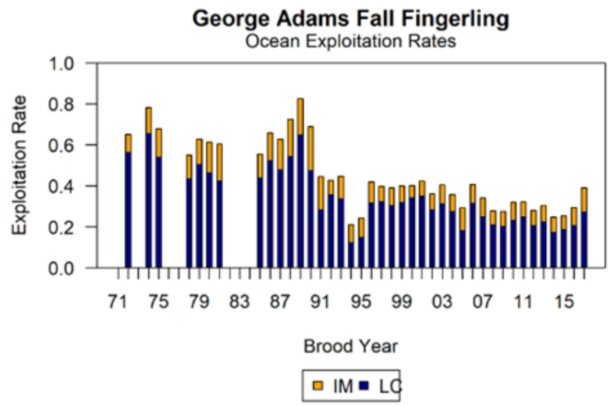
Appendix D11— Brood year exploitation rate in terms of landed catch and incidental mortality for Southern Puget Sound coded-wire tag indicator stocks.



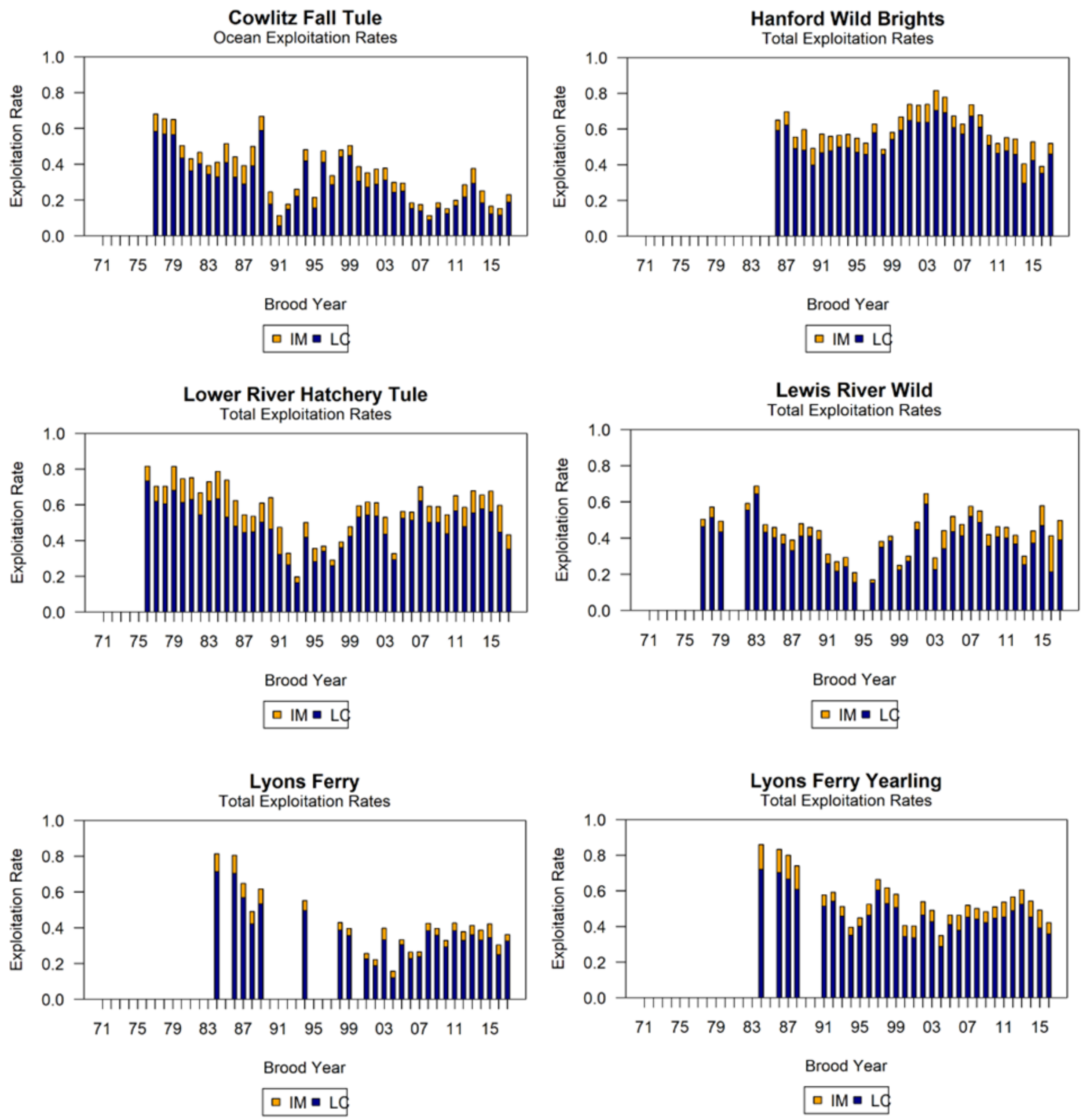


Appendix D12— Brood year exploitation rate in terms of landed catch and incidental mortality for Juan de Fuca and Hood Canal coded-wire tag indicator stocks Elwha and George Adams (Skokomish River) Fall Fingerling.





Appendix D13— Brood year exploitation rate for summer and fall Columbia River coded-wire tag indicator stocks, including Willamette and Snake River Chinook. Catch and incidental mortality are shown. Only completed brood years are included.



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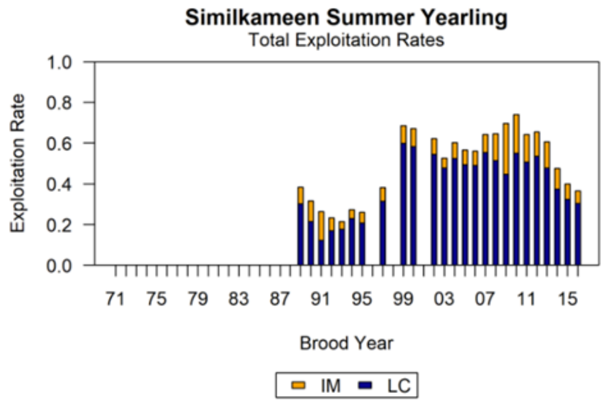
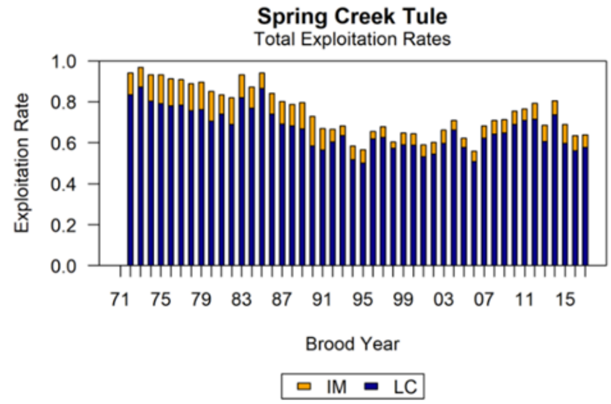
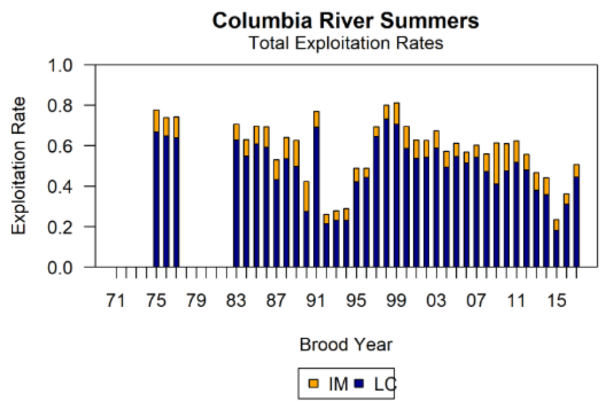
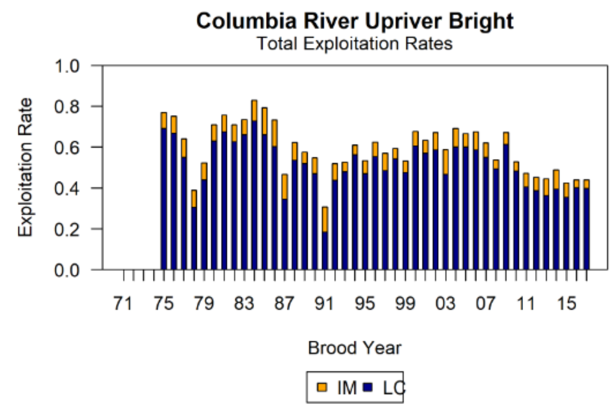
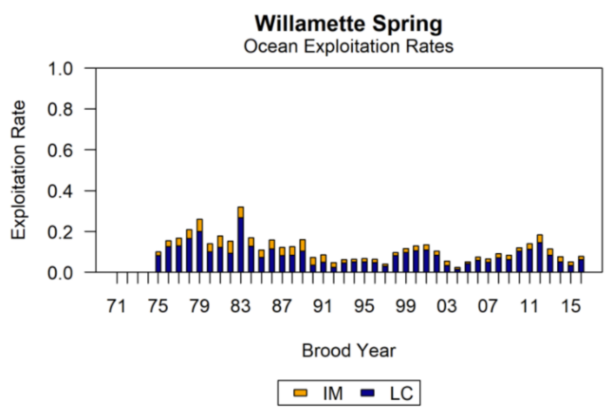


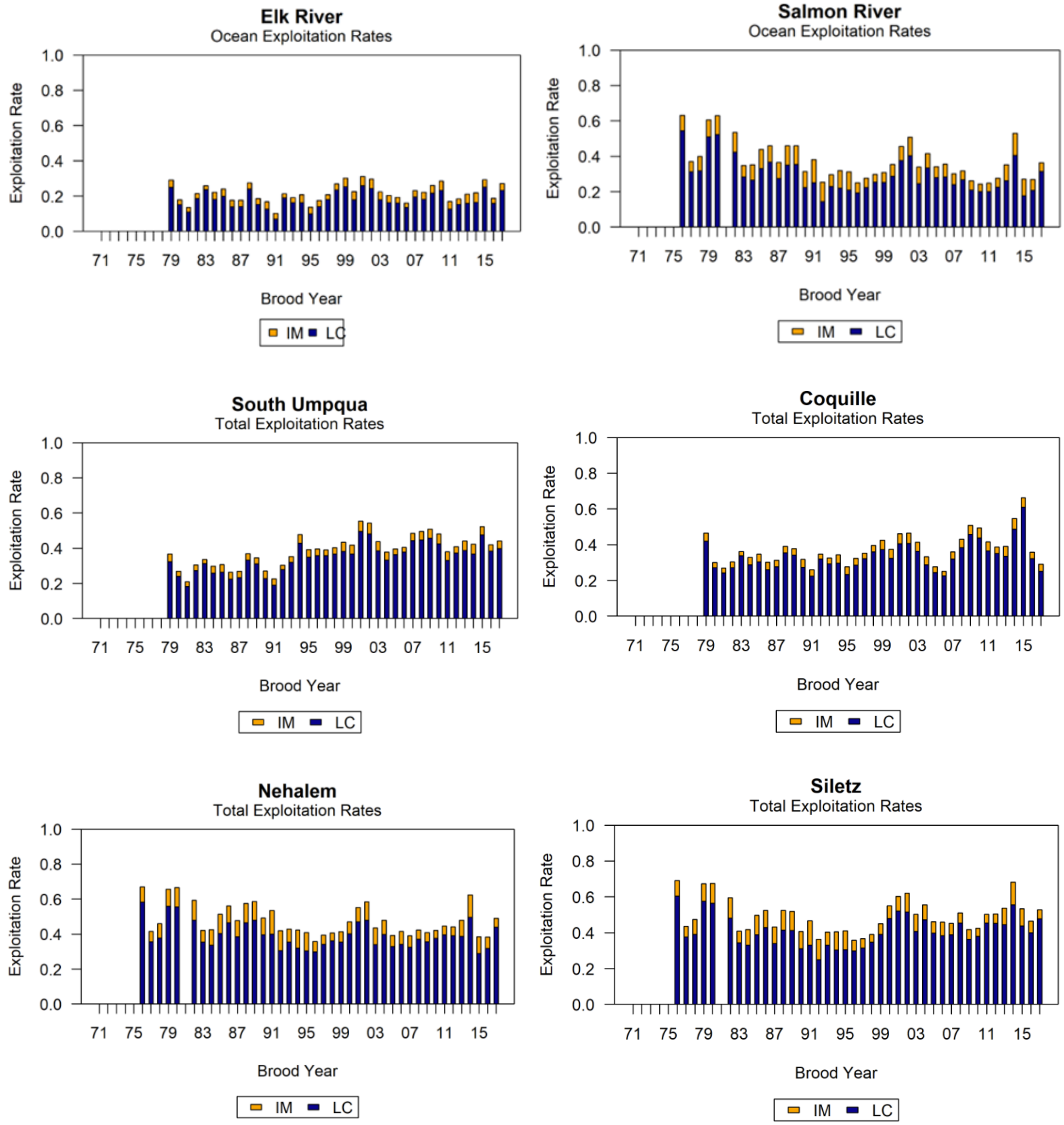








Appendix D14— Brood year exploitation rate (ocean only) for Oregon Coast coded-wire tag indicator stocks. Catch and incidental mortality are shown. Only completed brood years are included.



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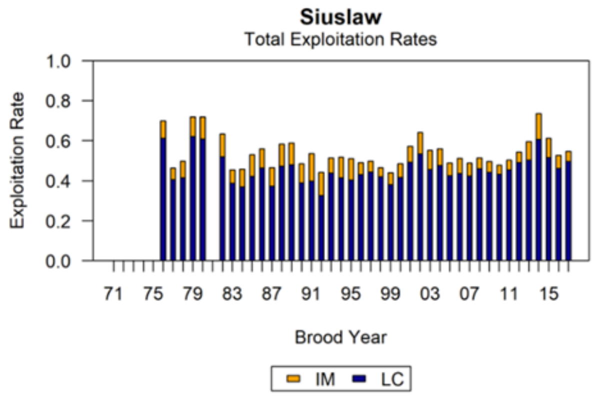


APPENDIX E: SURVIVAL RATE PLOTS

The BY smolt-to-age 2 or 3 survival of CWT-tagged juveniles after release is calculated for most exploitation rate indicator stocks (*Table 2.2*). This survival rate is frequently referred to as the early marine survival of the tag group and is calculated using the youngest age's cohort size before fishing and maturation or escapement mortality processes begin; for subyearling stocks, this is age 2 and for yearling stocks this is age 3. The CWT-based estimate is our most direct measure of early marine survival and is not final until all ages from that brood have returned to spawn. Preliminary estimates are generated using available CWT data and average maturation rates and are displayed in figures Appendix E1–Appendix E14 but are not included in average survival estimates.

The BY survival rate for a fingerling stock is the estimated age 2 cohort (determined from the cohort analysis) divided by the number of CWT fish released; for yearling stocks, BY survival rate is calculated using the estimated age 3 cohort:

$$CohSurv_{BY,a=Minage} = \frac{Cohort_{BY,a=Minage}}{TotCWTRelease_{BY}} \qquad \textit{Equation E.1}$$

where $\text{Cohort}_{BY,a}$ is calculated recursively from the oldest age to the youngest age using:

$$Cohort_{BY,a} = \frac{\sum_{f=1}^{Numfisheries} TotMorts_{BY,a,f} + Esc_{BY,a} + Cohort_{BY,a+1}}{1 - NM_a} \qquad \textit{Equation E.2}$$

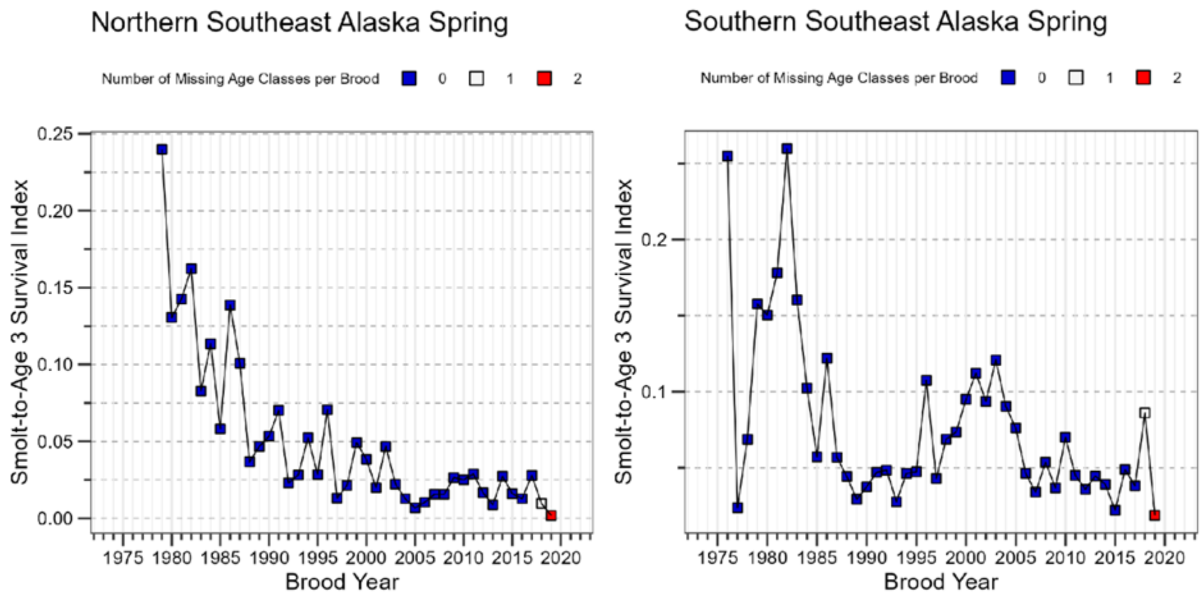
If there are no CWT recoveries for the oldest ocean age of a stock, the next youngest cohort size is estimated using:

$$Cohort_{BY,Maxage-1} = \frac{\sum_{f \in Preterminal} TotMorts_{BY,Maxage-1,f} + \frac{Esc_{BY,Maxage-1} + \sum_{f \in Terminal} TotMorts_{BY,Maxage-1,f}}{AvgMatRte_{Maxage-1}}}{1 - NM_{Maxage-1}}$$

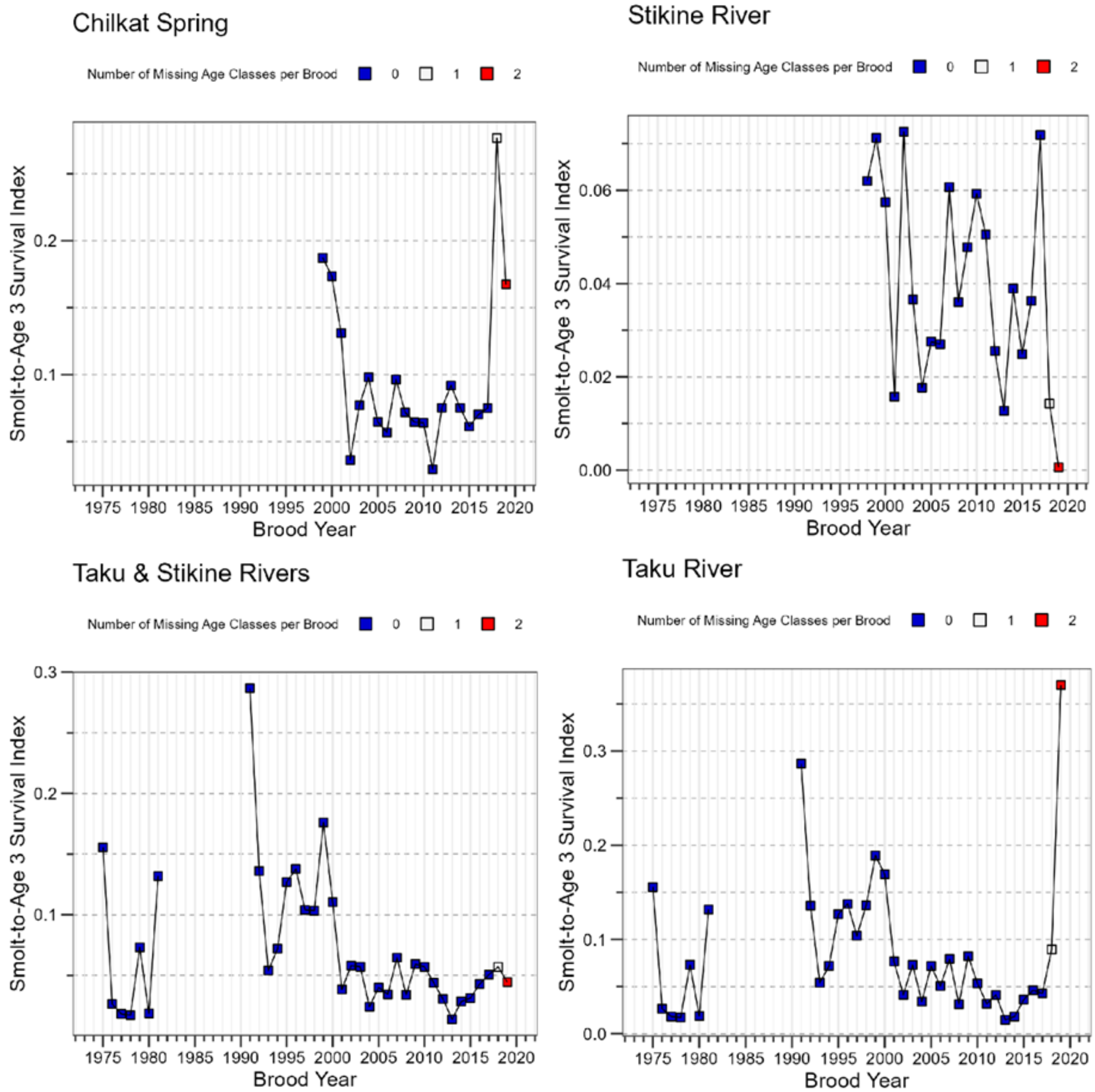
Equation E.3

LIST OF APPENDIX E FIGURES

Appendix E1— Smolt-to-youngest age survival rates for the Southeast Alaska hatchery indicator stocks.



Appendix E2— Smolt-to-youngest age survival rates for Southeast Alaska *and transboundary wild indicator stocks*.



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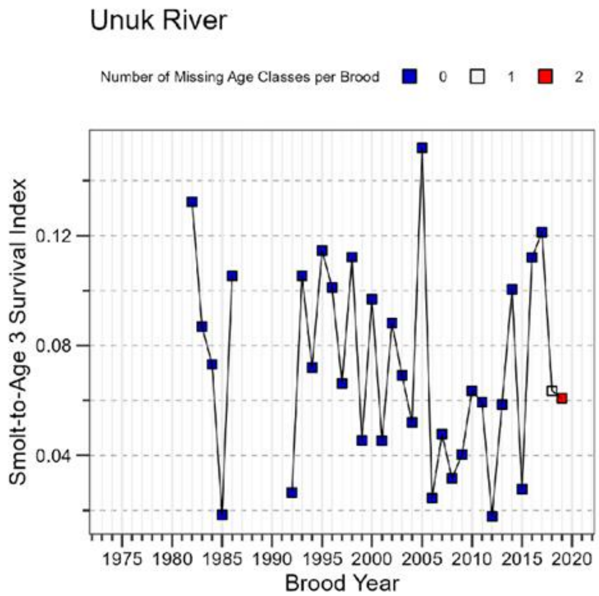
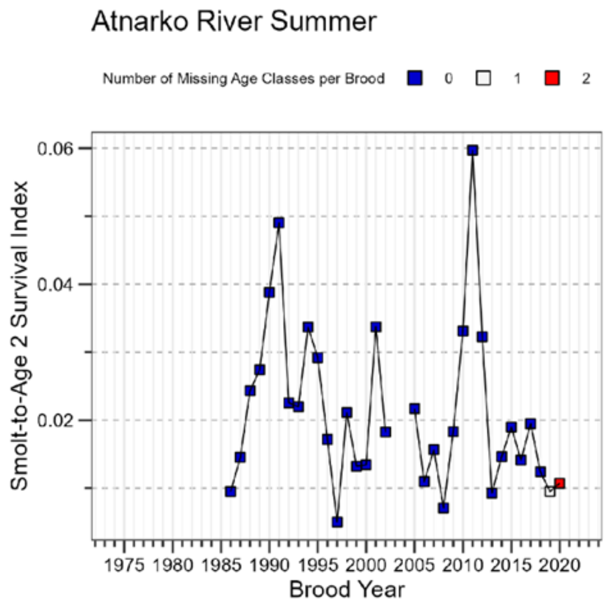
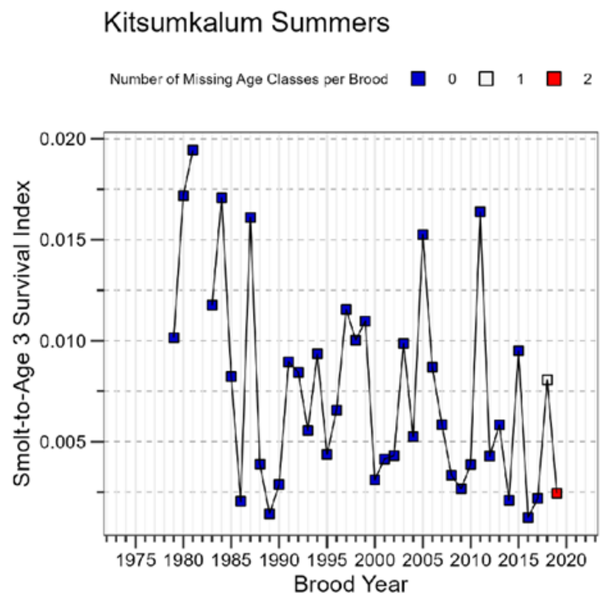
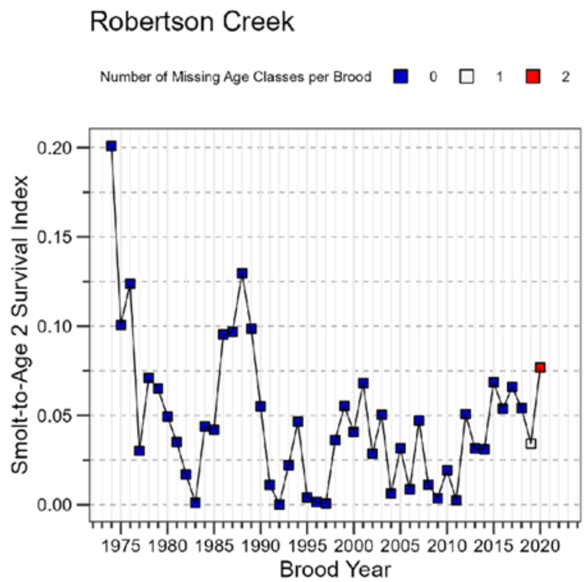


Appendix E3— Smolt-to-age 3 survival rates for Northern and Central British Columbia stocks.

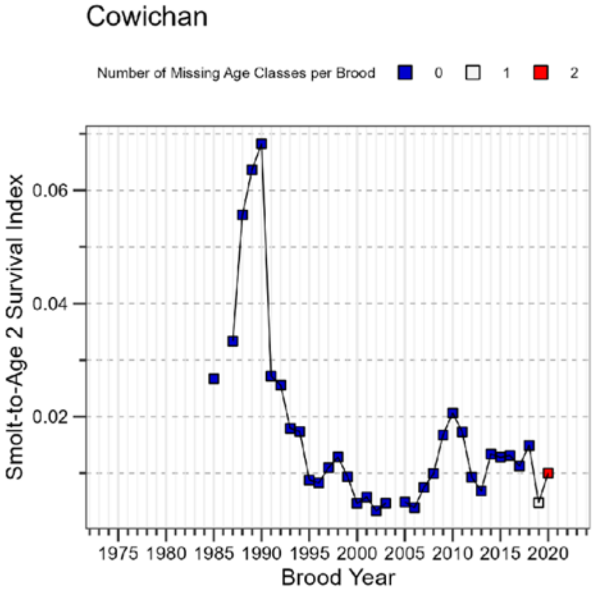


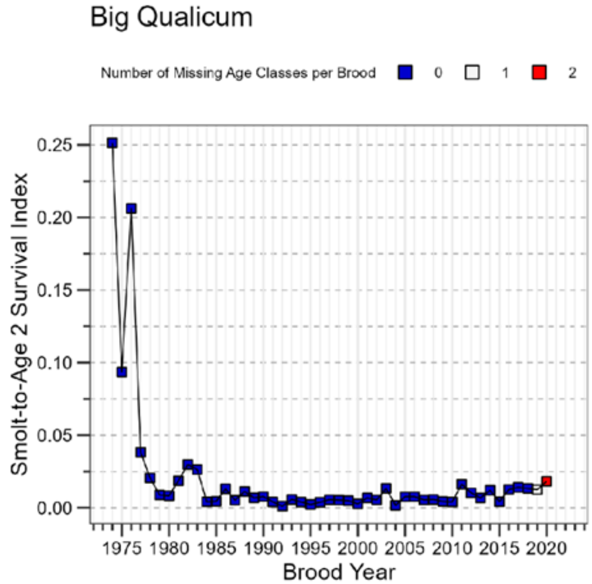


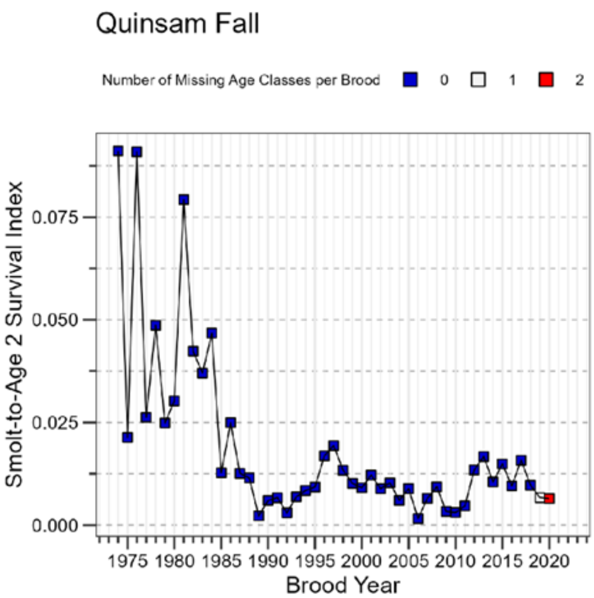
Appendix E4— Smolt-to-age 2 survival rates for Robertson Creek Fall.

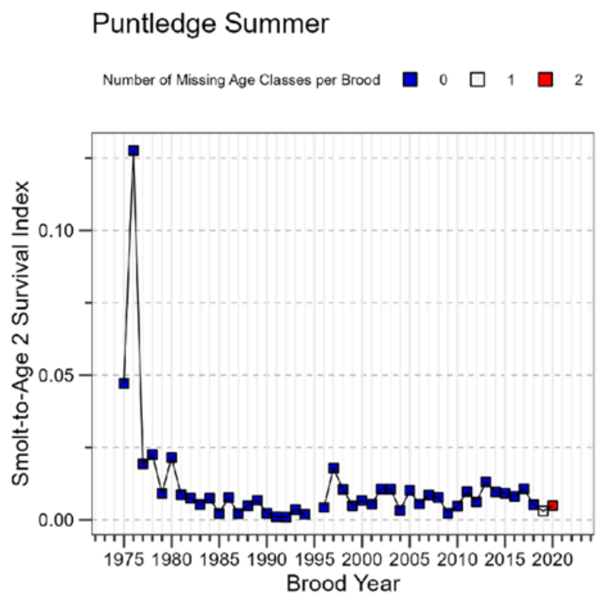


Appendix E5— Smolt-to-age 2 survival rates for Strait of Georgia stocks.









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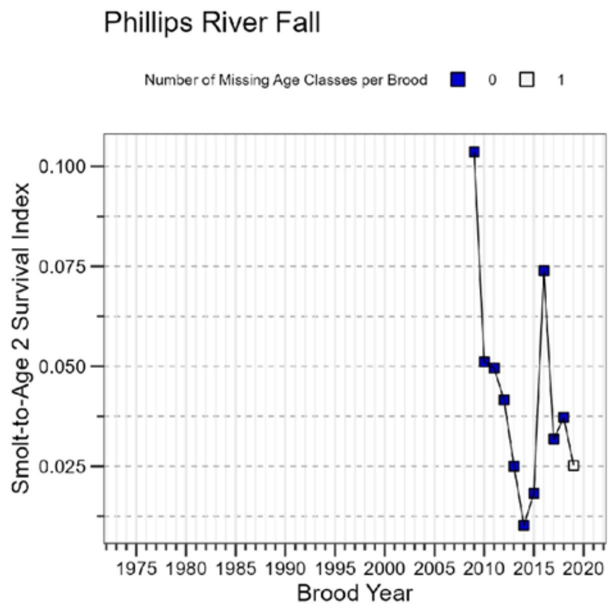
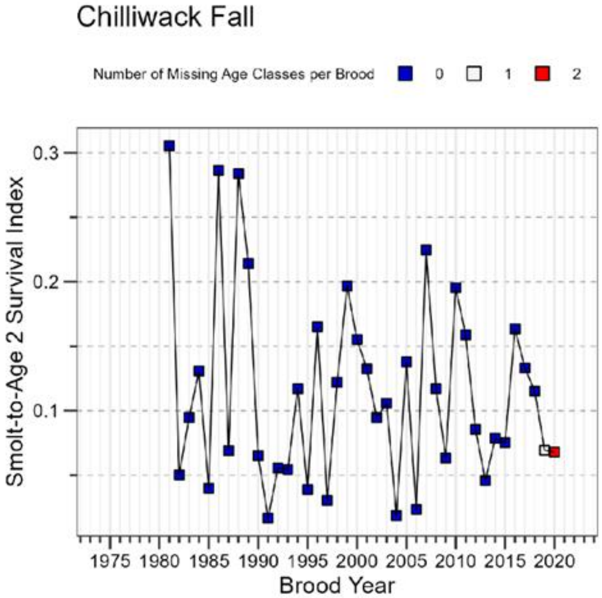
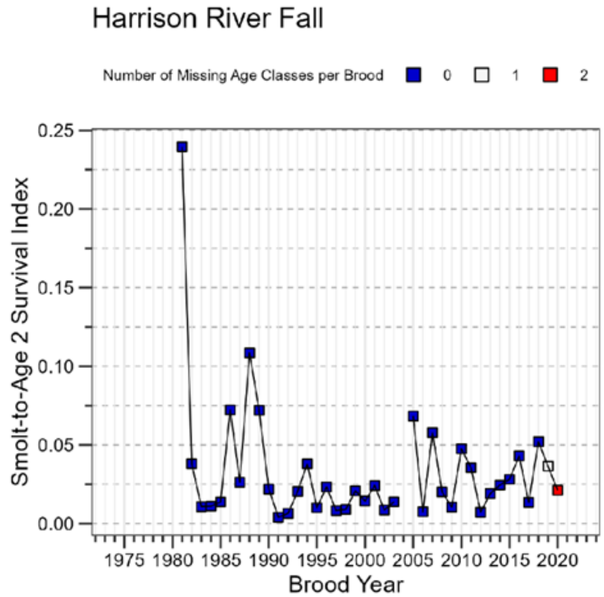
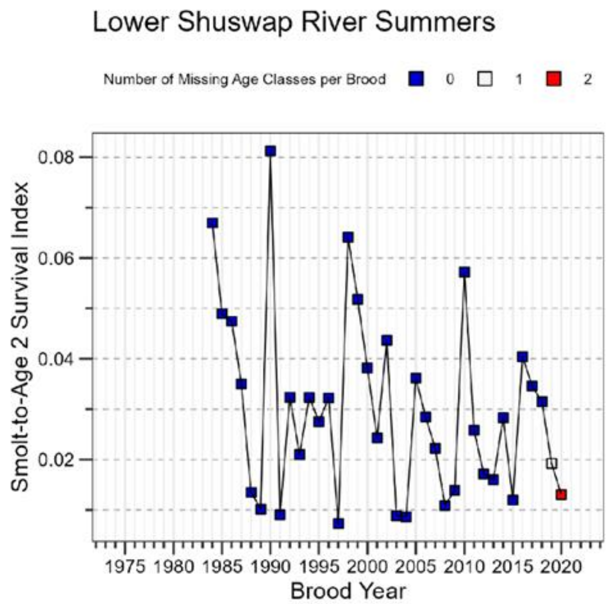


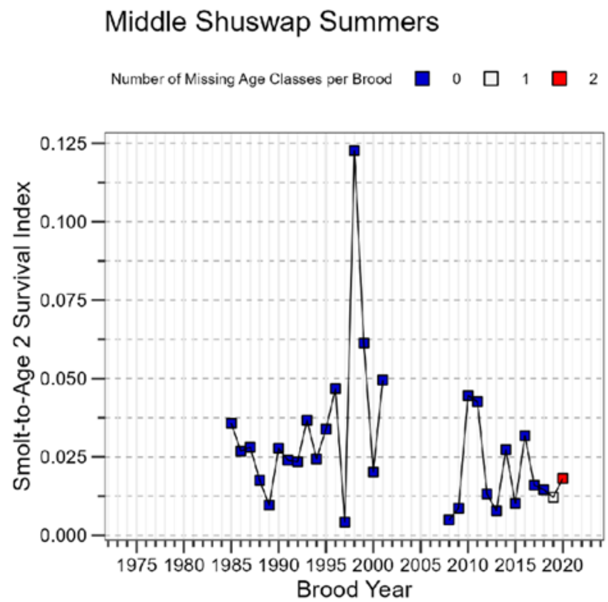
Appendix E6— Smolt-to-youngest age survival rates for Fraser fall-run stocks.

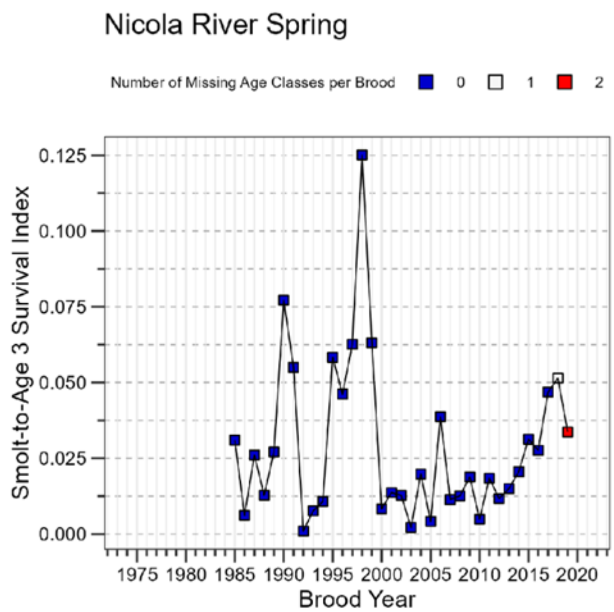




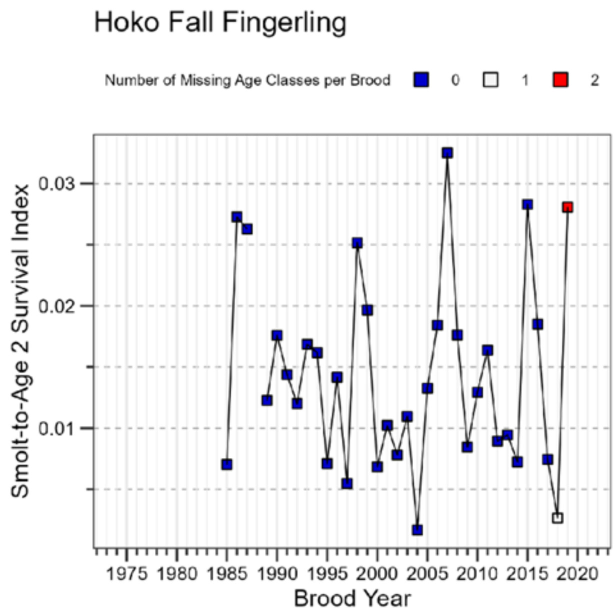
Appendix E7— Smolt-to-youngest age survival rates for Fraser spring- and summer-run stocks.

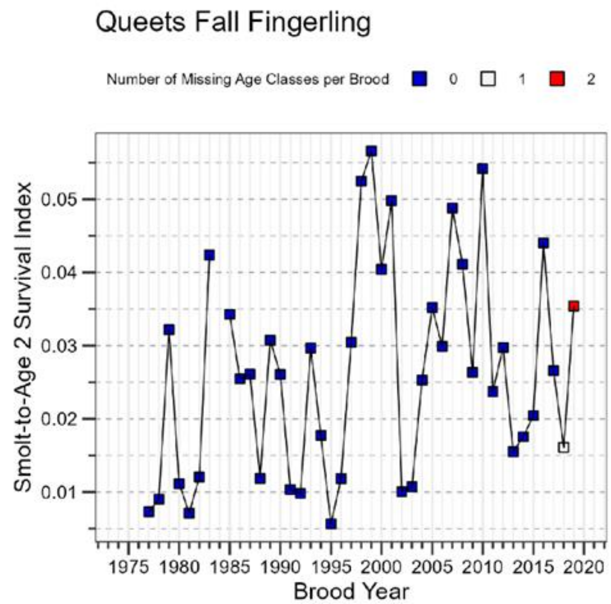


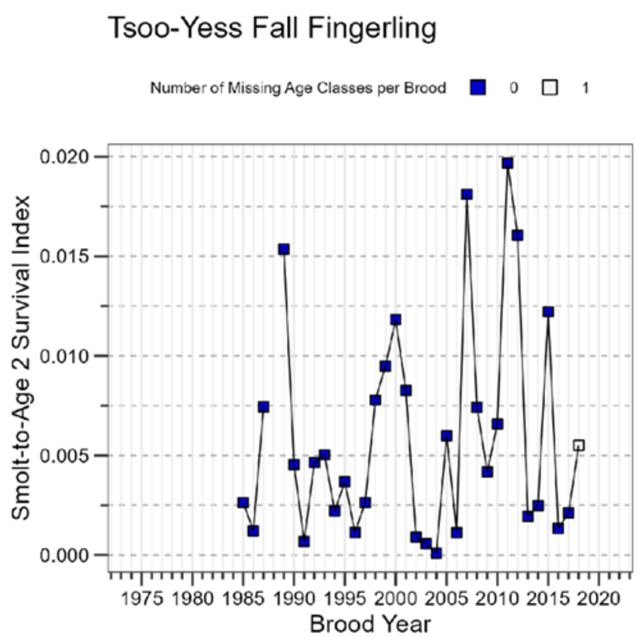




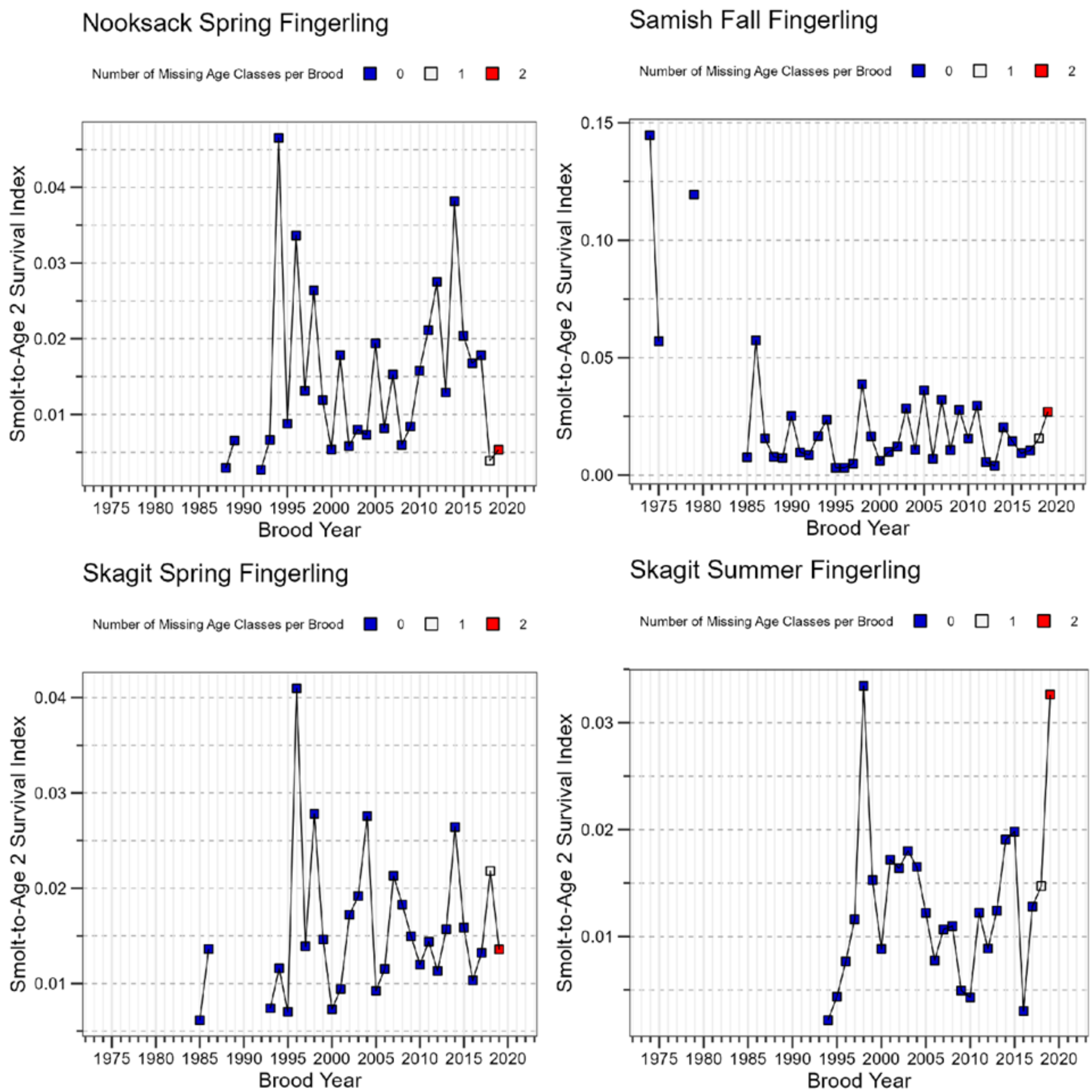
Appendix E8— Smolt-to-youngest age survival rates for Washington Coast coded-wire tag indicator stocks of Hoko, Queets, and Tsoo-Yess Fall Fingerling.



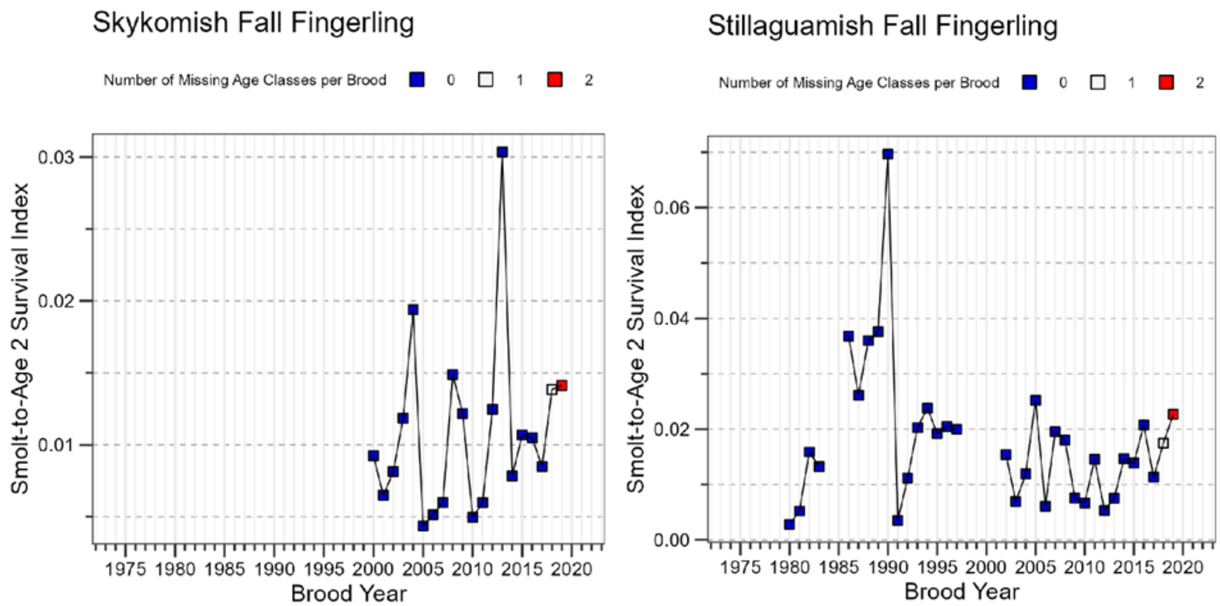




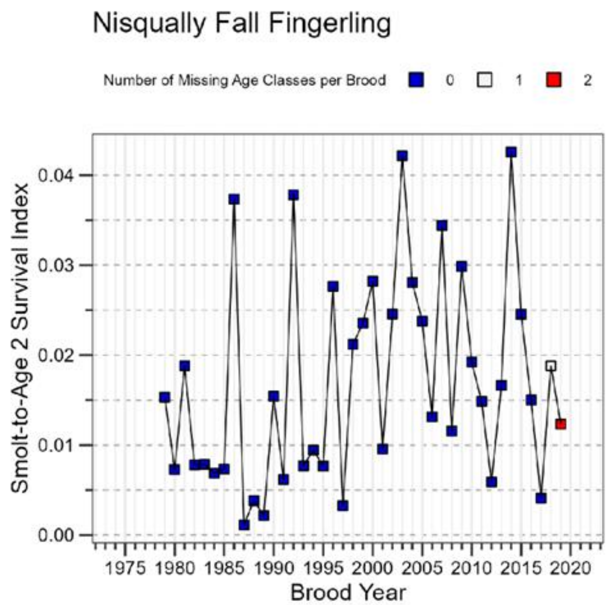
Appendix E9— Smolt-to-youngest age survival rates for Northern Puget Sound coded-wire tag indicator stocks.

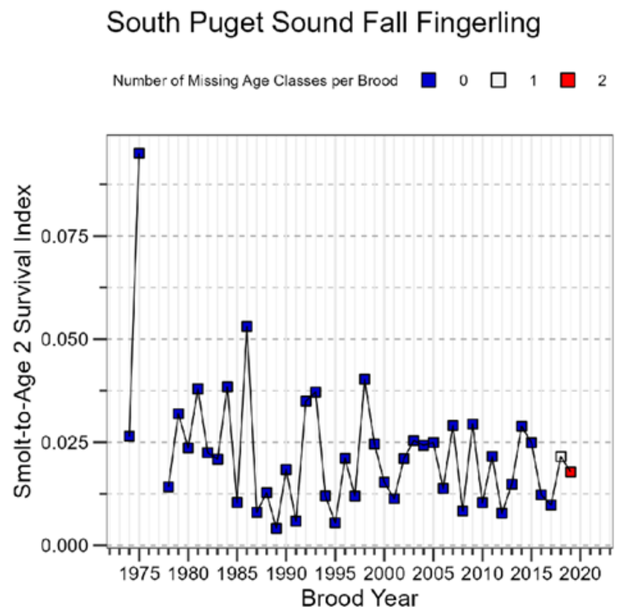


Appendix E10— Smolt-to-youngest age survival rates for Central Puget Sound coded-wire tag indicator stocks Stillaguamish Fall Fingerling and Skykomish Fall Fingerling.

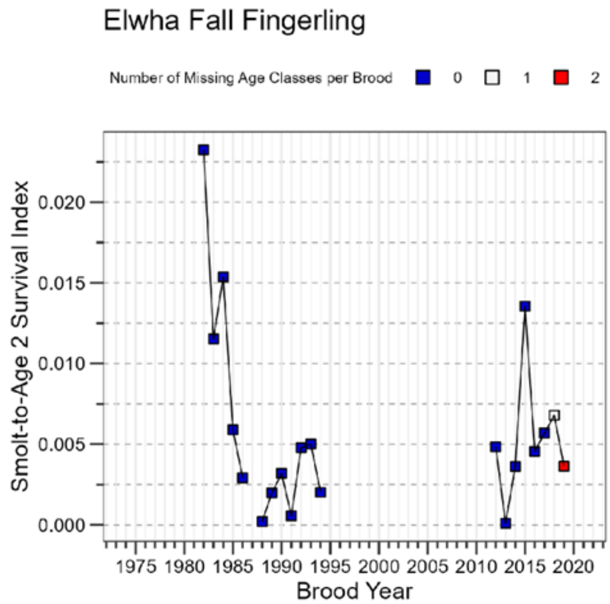


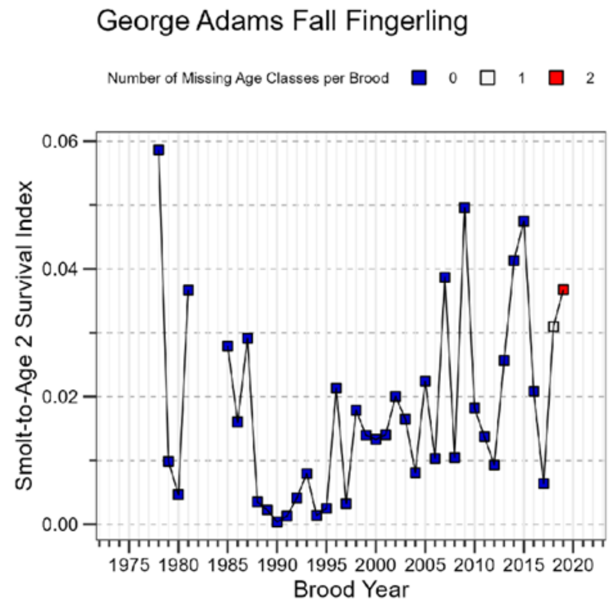
Appendix E11— Smolt-to-youngest age survival rates for Southern Puget Sound coded-wire tag indicator stocks.



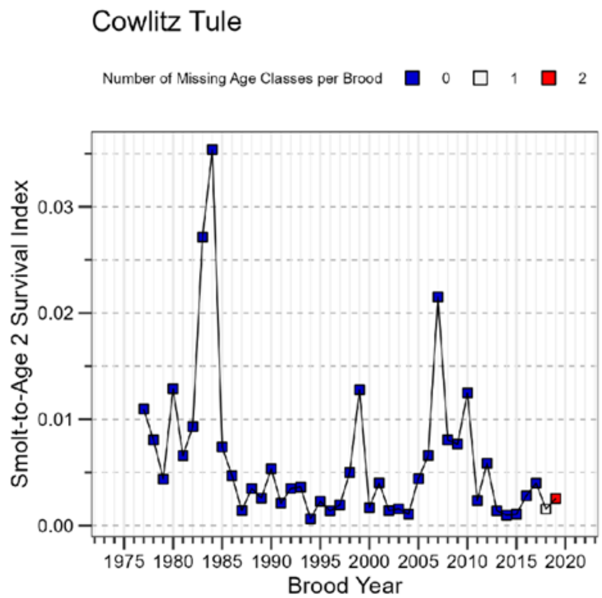


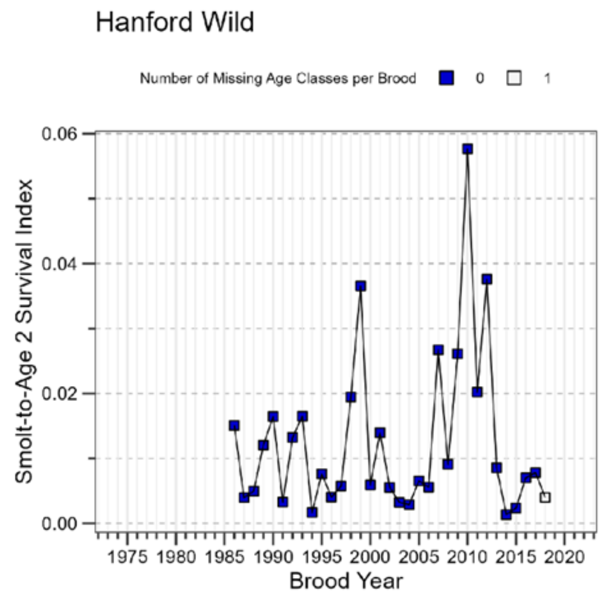
Appendix E12— Smolt-to-youngest age survival rates for Juan de Fuca and Hood Canal coded-wire tag indicator stocks Elwha River and George Adams (Skokomish River) Fall Fingerling.

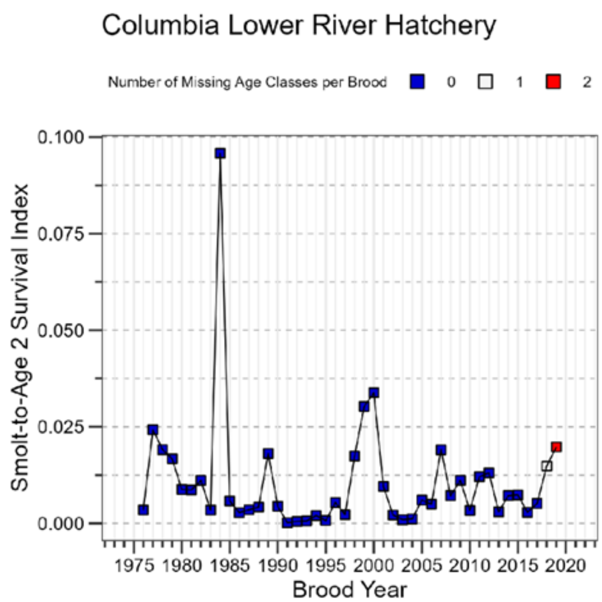


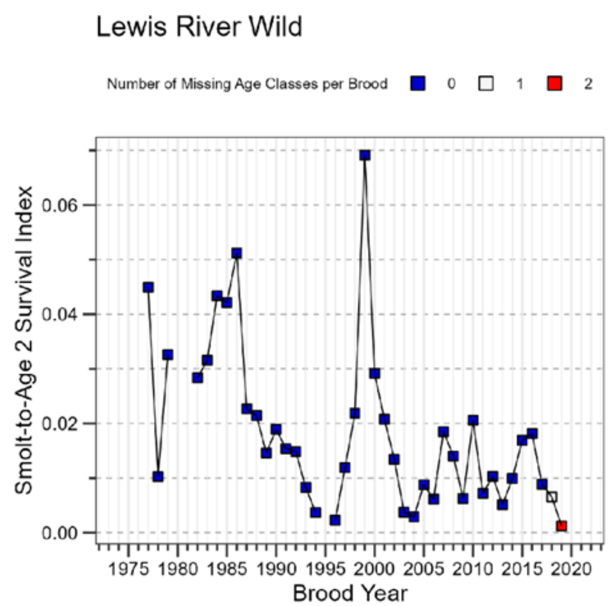


Appendix E13— Smolt-to-youngest age survival rates for summer and fall Columbia River, including Willamette Spring, Chinook coded-wire tag indicator stocks.



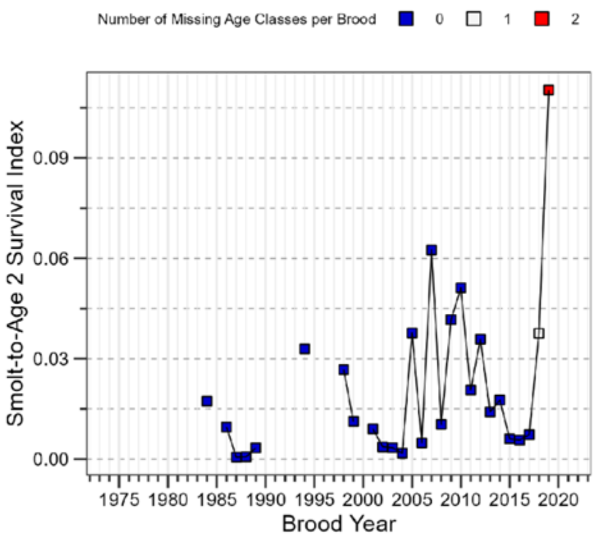




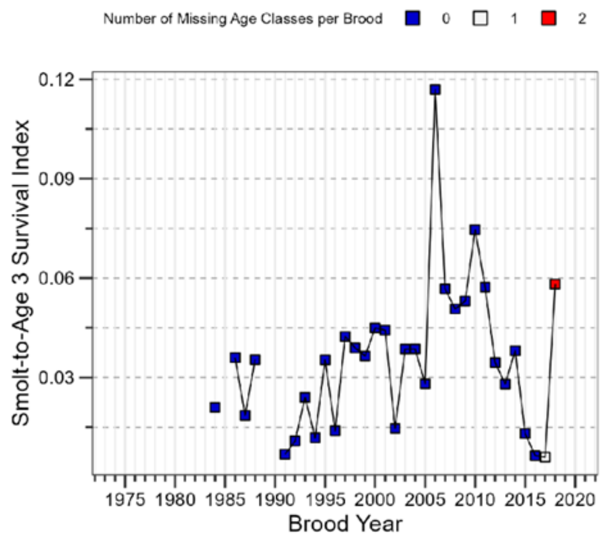


Appendix E13 continued.

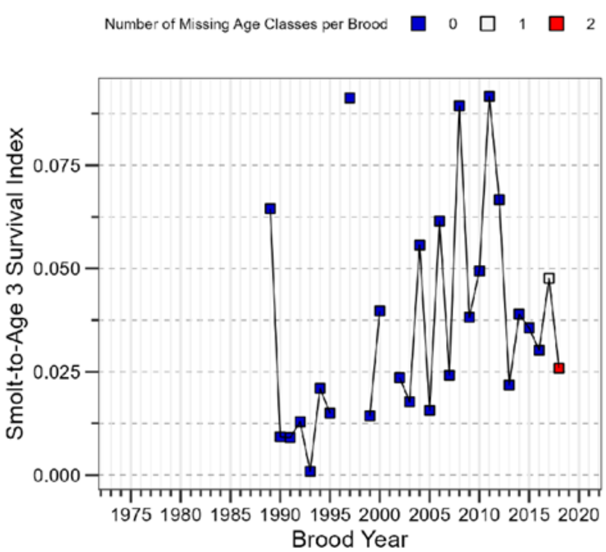
Lyons Ferry Fingerling



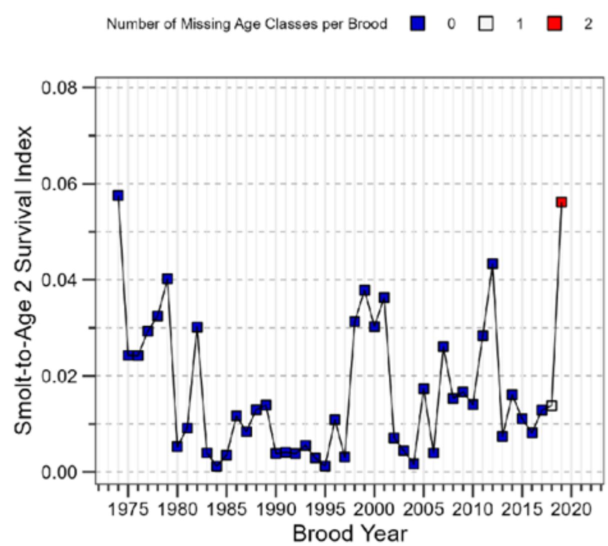
Lyons Ferry Yearling



Similkameen Summer Yearling

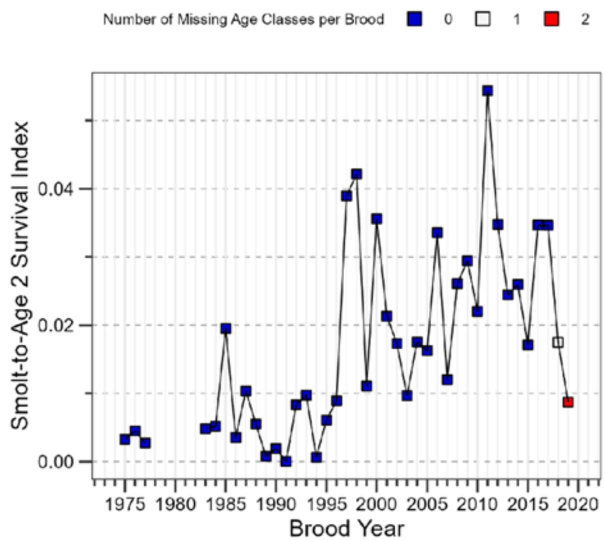


Spring Creek Tule

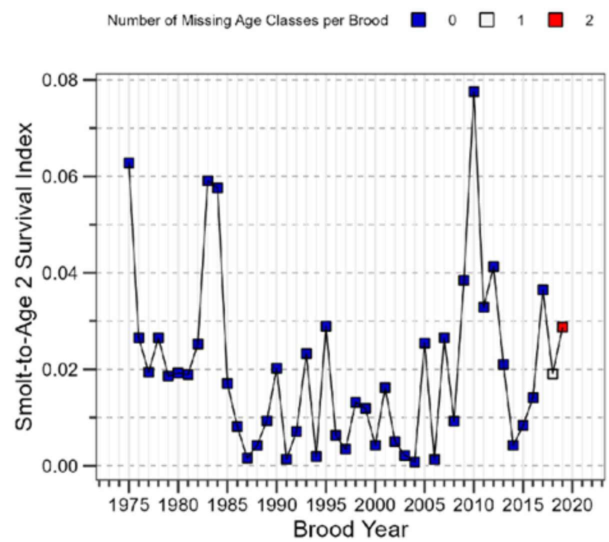


Appendix E13 continued.

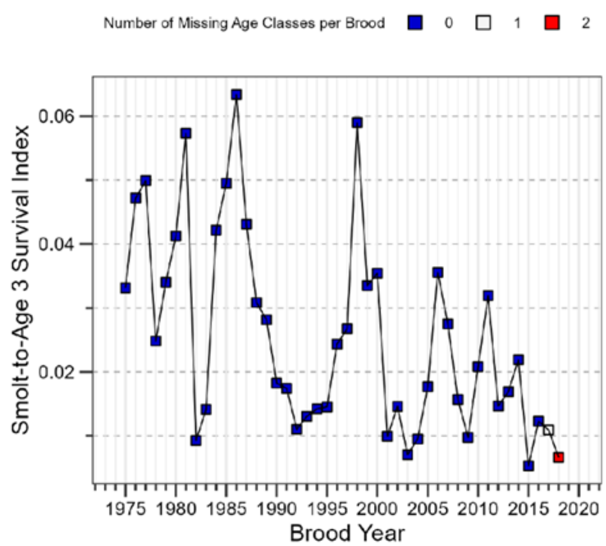
Columbia Summers



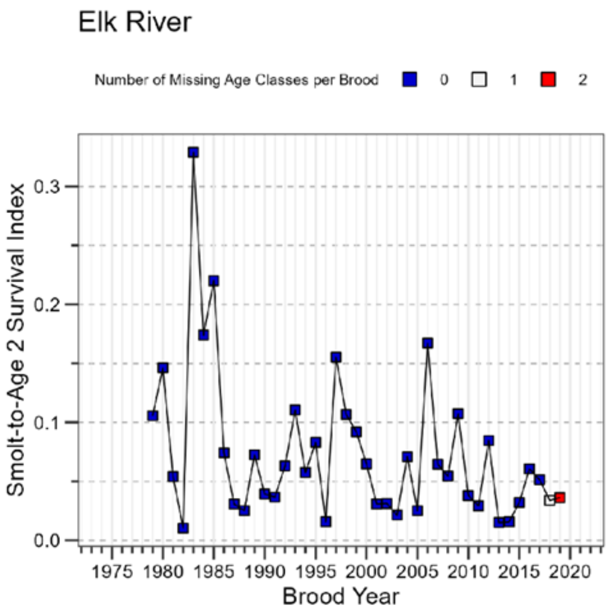
Upriver Bright

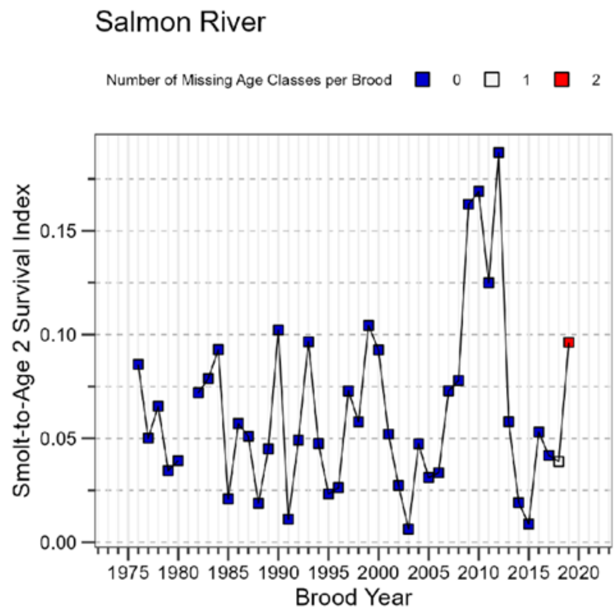


Willamette Spring



Appendix E14— Smolt-to-youngest age survival rates for North Oregon Coast coded-wire tag indicator stocks.





APPENDIX F: TERMINAL AREA ADJUSTMENT DATA

Attachment I of Chapter 3 of the 2019 PST Agreement identifies 11 escapement indicator stocks (EIS) that require terminal area adjustments (TAA) to CWT recovery rates of corresponding exploitation rate indicator stocks (ERIS). Terminal area adjustments ensure that CWT recovery rates from terminal fisheries accurately reflect fishery impacts on the associated escapement indicator stock. Beginning with the 2024 ERA, a new terminal area adjustment for Nooksack Spring Fingerlings (NSF) was added as part of a management response to subparagraph 7(c) of the PST, bringing the total number of TAAs in the ERA up to 12. Details of terminal adjustment methodologies are available in CYER WG (2021).

Each table in this appendix presents the terminal harvest rates for a given ERIS (left-most stock in the table) and the corresponding EIS. Terminal harvest rates are defined as terminal catch in a terminal fishery divided by the sum of terminal catch and escapement of the basin. For ERISs the terminal harvest rates are derived directly from results of the CWT cohort analysis. For EISs, terminal harvest rates are derived externally and provided by the relevant management entities.

Fishery Acronym	**ERA Fishery**
TWCVI TERM N	West Coast Vancouver Island Terminal Net
TWCVI TERM S	West Coast Vancouver Island Terminal Sport
TWCVI FS	West Coast Vancouver Island Terminal Freshwater Sport
TJNST TERM S	Johnstone Strait Terminal Sport
TGS FS	Strait of Georgia Terminal Freshwater Sport
WA CST N	Washington Coast Net
TWAC FN	Washington Coast Terminal Freshwater Net
TPS FN	Terminal Puget Sound Freshwater Net
TPS FS	Terminal Puget Sound Freshwater Sport
TNF TERM S	North of Falcon Terminal Sport
TSF TERM FS	South of Falcon Terminal Freshwater Sport
TOR TERM FS	Oregon Terminal Freshwater Sport

LIST OF APPENDIX F TABLES

Appendix F1— Robertson Creek Fall (RBT) harvest rate and terminally adjusted harvest rates for the Northwest Vancouver Island (NWVI) and Southwest Vancouver Island (SWVI) escapement indicator stocks, 1979–2023.

Year	Robertson Creek Fall			Northwest Vancouver Island			Southwest Vancouver Island		
	TWCVI TERM N	TWCVI TERM S	TWCVI FS	TWCVI TERM N	TWCVI TERM S	TWCVI FS	TWCVI TERM N	TWCVI TERM S	TWCVI FS
1979	0%	14%	1%	0%	0%	0%	0%	0%	0%
1980	28%	9%	0%	0%	0%	0%	0%	0%	0%
1981	36%	15%	1%	0%	0%	0%	0%	0%	0%
1982	42%	19%	0%	0%	0%	0%	0%	0%	0%
1983	55%	17%	1%	0%	0%	0%	0%	0%	0%
1984	41%	39%	1%	0%	0%	0%	0%	0%	0%
1985	3%	37%	0%	0%	0%	0%	0%	0%	0%
1986	1%	54%	0%	0%	0%	0%	0%	0%	0%
1987	0%	29%	0%	0%	0%	0%	0%	0%	0%
1988	11%	21%	1%	0%	0%	0%	0%	0%	0%
1989	26%	26%	1%	0%	0%	0%	0%	0%	0%
1990	14%	14%	0%	0%	0%	0%	0%	0%	0%
1991	25%	24%	0%	0%	0%	0%	0%	0%	0%
1992	1%	13%	0%	0%	0%	0%	0%	0%	0%
1993	14%	24%	1%	0%	0%	0%	0%	0%	0%
1994	22%	31%	1%	0%	0%	0%	0%	0%	0%
1995	9%	12%	0%	0%	0%	0%	0%	0%	0%
1996	0%	3%	0%	0%	0%	0%	0%	0%	0%
1997	9%	27%	0%	0%	0%	0%	0%	0%	0%
1998	7%	27%	0%	0%	0%	0%	0%	0%	0%
1999	10%	29%	0%	0%	0%	0%	0%	0%	0%
2000	0%	0%	0%	0%	0%	0%	0%	0%	0%
2001	0%	1%	0%	0%	0%	0%	0%	0%	0%
2002	10%	20%	0%	0%	0%	0%	0%	0%	0%
2003	11%	21%	0%	0%	0%	0%	0%	0%	0%
2004	18%	20%	0%	0%	0%	0%	0%	0%	0%
2005	51%	9%	1%	0%	0%	0%	0%	0%	0%
2006	36%	15%	0%	0%	0%	0%	0%	0%	0%
2007	45%	21%	0%	0%	0%	0%	0%	0%	0%
2008	27%	17%	0%	0%	0%	0%	0%	0%	0%
2009	12%	21%	2%	0%	0%	0%	0%	0%	0%
2010	6%	3%	1%	0%	0%	0%	0%	0%	0%
2011	27%	26%	0%	0%	0%	0%	0%	0%	0%
2012	22%	24%	0%	0%	0%	0%	0%	0%	0%
2013	0%	4%	0%	0%	0%	0%	0%	0%	0%
2014	0%	7%	0%	0%	0%	0%	0%	0%	0%
2015	15%	13%	0%	0%	0%	0%	0%	0%	0%
2016	10%	10%	0%	0%	0%	0%	0%	0%	0%
2017	25%	16%	0%	0%	0%	0%	0%	0%	0%
2018	44%	14%	0%	0%	0%	0%	0%	0%	0%
2019	52%	12%	0%	0%	0%	0%	0%	0%	0%
2020	53%	10%	0%	0%	0%	0%	0%	0%	0%
2021	46%	9%	0%	0%	0%	0%	0%	0%	0%
2022	38%	10%	0%	0%	0%	0%	0%	0%	0%
2023	24%	12%	0%	0%	0%	0%	0%	0%	0%

Appendix F2— Quinsam Hatchery (QUI) harvest rate and terminally adjusted harvest rates for the East Vancouver Island North (EVIN) escapement indicator stock, 1979–2023.

Year	Quinsam Hatchery		East Vancovuer Island	
	TJNST TERM S	TGS FS	TJNST TERM S	TGS FS
1979	1%	0%	0%	0%
1980	8%	0%	0%	0%
1981	0%	0%	0%	0%
1982	2%	0%	0%	0%
1983	4%	0%	0%	0%
1984	7%	0%	0%	0%
1985	1%	1%	0%	0%
1986	4%	0%	0%	0%
1987	9%	0%	0%	0%
1988	3%	0%	0%	0%
1989	1%	0%	0%	0%
1990	13%	0%	0%	0%
1991	8%	0%	0%	0%
1992	1%	0%	0%	0%
1993	6%	0%	0%	0%
1994	2%	0%	0%	0%
1995	5%	0%	0%	0%
1996	4%	0%	0%	0%
1997	6%	0%	0%	0%
1998	5%	0%	0%	0%
1999	16%	0%	0%	0%
2000	2%	0%	0%	0%
2001	0%	0%	0%	0%
2002	6%	0%	0%	0%
2003	7%	0%	0%	0%
2004	5%	0%	0%	0%
2005	13%	0%	0%	0%
2006	2%	0%	0%	0%
2007	5%	0%	0%	0%
2008	1%	0%	0%	0%
2009	3%	0%	0%	0%
2010	12%	0%	0%	0%
2011	5%	0%	0%	0%
2012	8%	0%	0%	0%
2013	2%	0%	0%	0%
2014	2%	0%	0%	0%
2015	2%	0%	0%	0%
2016	8%	0%	0%	0%
2017	5%	0%	0%	0%
2018	5%	0%	0%	0%
2019	1%	0%	0%	0%
2020	7%	0%	0%	0%
2021	3%	0%	0%	0%
2022	9%	0%	0%	0%
2023	0%	0%	0%	0%

Appendix F3— Queets River Fall (QUE) harvest rate and terminally adjusted harvest rates for the Grays Harbor, Hoh River, and Quillayute River escapement indicator stocks, 1979–2022.

Year	Queets River Fall			Grays Harbor			Hoh			Quillayute		
	WA CST N	TWAC FN	TNF TERM S	WA CST N	TWAC FN	TNF TERM S	WA CST N hoh	TWAC FN hoh	TNF TERM S hoh	WA CST N	TWAC FN	TNF TERM S
1979	NA	NA	NA	0%	19%	0%	0%	21%	1%	0%	38%	3%
1980	NaN	NaN	NaN	0%	48%	0%	0%	21%	1%	0%	10%	2%
1981	0%	57%	0%	0%	42%	1%	0%	22%	0%	0%	15%	1%
1982	0%	53%	0%	0%	58%	1%	0%	22%	0%	0%	26%	1%
1983	0%	48%	0%	0%	39%	1%	0%	19%	5%	0%	42%	2%
1984	0%	60%	0%	0%	7%	2%	0%	24%	3%	0%	12%	1%
1985	0%	32%	0%	0%	35%	3%	0%	36%	1%	0%	24%	2%
1986	0%	13%	0%	0%	34%	2%	0%	14%	3%	0%	21%	4%
1987	0%	38%	0%	0%	38%	1%	0%	30%	5%	0%	38%	2%
1988	0%	24%	0%	0%	24%	5%	0%	37%	3%	0%	27%	4%
1989	0%	42%	0%	0%	50%	4%	0%	38%	3%	0%	40%	2%
1990	0%	19%	0%	0%	52%	5%	0%	31%	3%	0%	17%	2%
1991	0%	26%	0%	0%	44%	11%	0%	41%	5%	0%	13%	5%
1992	0%	33%	0%	0%	40%	8%	0%	19%	4%	0%	16%	2%
1993	0%	31%	0%	0%	46%	11%	0%	17%	6%	0%	8%	0%
1994	0%	41%	0%	0%	40%	12%	0%	6%	2%	0%	9%	5%
1995	0%	41%	1%	0%	41%	17%	0%	18%	6%	0%	9%	9%
1996	0%	22%	0%	0%	17%	22%	0%	21%	5%	0%	16%	5%
1997	0%	36%	0%	0%	31%	9%	0%	36%	5%	0%	6%	5%
1998	0%	18%	7%	0%	21%	14%	0%	16%	5%	0%	11%	4%
1999	0%	10%	0%	0%	16%	1%	0%	21%	14%	0%	26%	4%
2000	0%	4%	0%	0%	29%	11%	0%	16%	18%	0%	15%	8%
2001	0%	18%	0%	0%	33%	17%	0%	23%	14%	0%	23%	9%
2002	0%	30%	0%	0%	6%	18%	0%	20%	2%	0%	33%	3%
2003	0%	17%	0%	0%	5%	4%	0%	21%	8%	0%	15%	7%
2004	0%	14%	0%	0%	9%	14%	0%	18%	8%	0%	18%	20%
2005	0%	22%	0%	0%	11%	1%	0%	17%	4%	0%	17%	6%
2006	0%	22%	0%	0%	16%	6%	0%	26%	8%	0%	26%	0%
2007	1%	35%	0%	0%	16%	9%	0%	28%	8%	0%	22%	4%
2008	0%	29%	0%	0%	14%	2%	0%	16%	7%	0%	27%	4%
2009	0%	33%	0%	0%	24%	7%	0%	20%	5%	0%	41%	6%
2010	0%	22%	0%	0%	19%	9%	0%	10%	9%	0%	26%	8%
2011	0%	33%	0%	0%	24%	10%	0%	23%	17%	0%	29%	13%
2012	0%	51%	0%	0%	23%	16%	0%	28%	7%	0%	42%	5%
2013	0%	42%	0%	0%	16%	17%	0%	48%	14%	0%	29%	15%
2014	0%	25%	0%	0%	26%	4%	0%	23%	5%	0%	56%	6%
2015	0%	12%	0%	0%	31%	10%	0%	19%	7%	0%	36%	13%
2016	0%	21%	0%	0%	12%	14%	0%	4%	2%	0%	26%	1%
2017	0%	35%	0%	0%	14%	10%	0%	20%	8%	0%	50%	5%
2018	0%	29%	0%	0%	10%	11%	0%	5%	3%	0%	30%	11%
2019	0%	40%	0%	0%	12%	6%	0%	29%	11%	0%	15%	8%
2020	0%	48%	0%	0%	12%	4%	0%	30%	9%	0%	15%	7%
2021	0%	38%	0%	0%	13%	5%	0%	28%	5%	0%	10%	9%
2022	0%	70%	0%	0%	8%	6%	0%	18%	6%	0%	16%	2%

Appendix F4— Salmon River Hatchery (SRH) harvest rate and terminally adjusted harvest rates for Nehalem, Siletz, and Siuslaw escapement indicator stocks, 1979–2022.

Year	Salmon River Hatchery	Nehalem	Siletz	Siuslaw
	TSF.TERM.FS	TSF TERM FS	TSF TERM FS	TSF TERM FS
1979	28%	5%	9%	18%
1980	32%	11%	10%	10%
1981	36%	4%	15%	14%
1982	36%	10%	10%	15%
1983	0%	9%	14%	35%
1984	10%	6%	10%	25%
1985	11%	4%	6%	13%
1986	68%	10%	7%	15%
1987	38%	12%	14%	22%
1988	19%	12%	8%	14%
1989	35%	10%	13%	18%
1990	39%	16%	8%	14%
1991	43%	20%	9%	17%
1992	22%	18%	9%	12%
1993	45%	32%	22%	52%
1994	27%	22%	6%	16%
1995	37%	28%	16%	24%
1996	62%	20%	11%	22%
1997	30%	15%	19%	32%
1998	33%	15%	9%	35%
1999	44%	12%	15%	16%
2000	25%	14%	15%	40%
2001	33%	19%	11%	29%
2002	48%	12%	10%	19%
2003	45%	11%	13%	17%
2004	37%	22%	45%	18%
2005	50%	15%	22%	23%
2006	58%	16%	17%	20%
2007	31%	13%	27%	44%
2008	20%	13%	25%	20%
2009	41%	1%	17%	20%
2010	55%	9%	7%	22%
2011	39%	16%	36%	33%
2012	38%	14%	18%	20%
2013	29%	19%	20%	36%
2014	27%	24%	20%	27%
2015	28%	28%	41%	36%
2016	18%	17%	21%	39%
2017	18%	19%	30%	36%
2018	29%	22%	29%	45%
2019	26%	15%	39%	50%
2020	18%	14%	15%	22%
2021	28%	21%	31%	34%
2022	24%	35%	20%	0%

Appendix F5— Elk River Hatchery (ELK) harvest rate and terminally adjusted harvest rates for South Umpqua and Coquille escapement indicator stocks, 1979–2022.

Year	Elk River		South Umpqua		Coquille	
	TOR TERM T	TSF TERM FS	TOR TERM T	TSF TERM FS	TOR TERM T	TSF TERM FS
1979	NA	NA	0%	20%	0%	16%
1980	NA	NA	0%	22%	0%	12%
1981	NA	NA	0%	19%	0%	13%
1982	7%	76%	0%	21%	0%	8%
1983	8%	39%	0%	9%	0%	36%
1984	7%	24%	0%	9%	0%	11%
1985	4%	35%	0%	7%	0%	14%
1986	15%	25%	0%	15%	0%	11%
1987	8%	35%	0%	11%	0%	16%
1988	0%	47%	0%	10%	0%	13%
1989	15%	41%	0%	6%	0%	15%
1990	6%	45%	0%	10%	0%	13%
1991	0%	32%	0%	13%	0%	20%
1992	5%	45%	0%	10%	0%	12%
1993	15%	27%	0%	28%	0%	27%
1994	12%	41%	0%	11%	0%	24%
1995	9%	37%	0%	11%	0%	13%
1996	19%	14%	0%	13%	0%	18%
1997	16%	25%	0%	6%	0%	14%
1998	9%	12%	0%	43%	0%	19%
1999	19%	23%	0%	28%	0%	14%
2000	25%	23%	0%	26%	0%	20%
2001	11%	18%	0%	23%	0%	18%
2002	15%	15%	0%	14%	0%	17%
2003	23%	25%	0%	19%	0%	17%
2004	24%	9%	0%	20%	0%	19%
2005	25%	17%	0%	55%	0%	26%
2006	26%	16%	0%	37%	0%	23%
2007	23%	23%	0%	22%	0%	29%
2008	2%	24%	0%	20%	0%	15%
2009	2%	21%	0%	24%	0%	7%
2010	7%	14%	0%	31%	0%	10%
2011	21%	23%	0%	37%	0%	24%
2012	16%	21%	0%	35%	0%	28%
2013	23%	19%	0%	33%	0%	39%
2014	16%	18%	0%	30%	0%	25%
2015	22%	18%	0%	20%	0%	31%
2016	6%	19%	0%	36%	0%	19%
2017	11%	19%	0%	25%	0%	22%
2018	20%	18%	0%	24%	0%	64%
2019	13%	2%	0%	36%	0%	57%
2020	14%	8%	0%	27%	0%	5%
2021	8%	4%	0%	21%	0%	1%
2022	14%	4%	0%	31%	0%	0%

Appendix F6— Nooksack Spring Fingerling (NSF) harvest rate and terminally adjusted harvest rates for Nooksack Spring escapement indicator stock, 2009–2015 and 2018–2022.

Year	Nooksack Spring		Nooksack Spring adj.	
	TPS.FN.NSF	TPS.FS.NSF	TPS FN.nooksack-v7.1	TPS FS.nooksack-v7.1
2009	2%	0%	4%	0%
2010	1%	0%	7%	0%
2011	4%	0%	2%	0%
2012	9%	0%	5%	0%
2013	10%	0%	12%	0%
2014	11%	0%	7%	0%
2015	2%	0%	2%	0%
2016	NA	NA	NA	NA
2017	NA	NA	NA	NA
2018	14%	0%	0%	0%
2019	16%	0%	5%	0%
2020	18%	2%	6%	0%
2021	12%	2%	11%	1%
2022	13%	3%	6%	0%

APPENDIX G: FISHERY EXPLOITATION RATE INDICES BY STOCK, AGE AND FISHERY, BASED ON CODED-WIRE TAG DATA

Fishery Indices

When the PST was originally signed in 1985, catch ceilings and increases in stock abundance were expected to reduce harvest rates in fisheries. Fishery indices (FI) provide a means to assess performance against this expectation. The two fishery indices used by the CTC are the ratio of means and stratified proportional fishery index. Relative to the 1979–1982 base period, an index less than 1.0 represents a decrease from base period harvest rates, whereas an index greater than 1.0 represents an increase. Fishery indices are used to measure relative changes in fishery harvest rates because it is not possible to directly estimate the fishery harvest rates, and may reduce or eliminate the effect of data biases that are consistent from year to year.

Indices are presented for the AABM troll fisheries only, although allowable catch limits (ACLs) also apply to sport and net fisheries in SEAK, and sport fisheries in NBC and WCVI. CWT recoveries from the troll fisheries are used because they represent the majority of the catch and have the most reliable CWT sampling. In addition, there are data limitations in the base period for the sport fisheries (e.g., few observed recoveries in NBC due to small fishery size). Because the allocation of the catch among gear types has changed in some fisheries (e.g., the proportion of the catch harvested by the sport fishery has increased in all AABM fisheries), the indices may not represent the harvest impact of all gear types.

Ratio of Means

Fishery indices are computed in AEQs for both reported catch and total mortality (reported catch plus IM). The total mortality AEQ exploitation rate is estimated as (see Appendix B2 for a description of notation):

$$ER_{s,a,f,CY} = \frac{TotMorts_{s,a,f,CY} * AEQ_{s,a,f,BY=CY-a}}{Cohort_{s,a,BY=CY-a} * (1-NM_a)}$$

Equation G.1

whereas the reported catch AEQ exploitation rate is estimated as

$$ER_{s,a,f,CY} = \frac{RepMorts_{s,a,f,CY} * AEQ_{s,a,f,BY=CY-a}}{Cohort_{s,a,BY=CY-a} * (1-NM_a)}$$

Equation G.2

and a ratio of means (ROM) estimator is used to calculate the FI:

$$FI_{f,CY} = \frac{\sum_{s\epsilon\{S\}} \sum_{a\epsilon\{A\}} ER_{s,a,f,CY}}{\left(\frac{\sum_{CY=1979}^{1982} \sum_{s\epsilon\{S\}} \sum_{a\epsilon\{A\}} ER_{s,a,f,CY}}{4}\right)}$$

Equation G.3

The ROM estimator of the fishery index constrains inclusion of stocks to those with adequate tagging during the 1979–1982 base period. However, fishing patterns for some fisheries have changed substantially since the base period and some stocks included in the index are no longer tagged (e.g., University of Washington Accelerated).

Stratified Proportional Fishery Index

To account for changes in stock composition and to include stocks without base period data, the CTC created alternative fishery indices (CTC 1996). The CTC determined that a useful FI should have the following characteristics:

1. The index should measure changes in fishery harvest rates if the distribution of stocks is assumed to be unchanged from the base period.
2. The index should have an expected value of 1.0 for random variation around the base period fishery harvest rate, cohort size, and stock distributions.
3. The index should weight changes in stock distribution by abundance.

After exploring several possibilities, the CTC concluded that the most appropriate index consisted of the product of a fishery harvest rate index and an index of stock abundance weighted by average distribution (i.e., the proportion of a cohort vulnerable to the fishery). To that effect, a report by the CTC (2009) proposed this stratified proportional fishery index was the most accurate and precise index for estimating the harvest rate occurring in AABM fisheries. However, the SPFI was never fully implemented for the NBC and WCVI Troll fisheries for reasons described in CTC 2021a, which instead still rely on exploitation rate indices (Appendix G4–Appendix G8).

For computation of the SPFI, the CWT harvest rate ($h_{t,CY}$) must initially be set to an arbitrary value between 0 and 1. Then, the distribution parameter ($d_{t,s,a}$) is calculated (Equation G.4), and the result is substituted into Equation G.5 to recursively recalculate $h_{t,CY}$ and subsequently $d_{t,s,a}$. The largest stock-age distribution parameter in a stratum is then set to 1 to create a unique solution (see Appendix B for a description of notation):

$$d_{t,s,a} = \sum_{CY} r_{t,CY,s,a} / \sum_{CY} \left(h_{t,CY} * n_{CY,s,a} \right)$$

Equation G.4

$$h_{t,CY} = \sum_{s} \sum_{a} r_{t,CY,s,a} / \sum_{s} \sum_{a} \left(d_{t,s,a} * n_{CY,s,a} \right)$$

Equation G.5

The resulting unique solution is inserted into the following equations to compute the yearly harvest rates for each stratum (Equation G.8) and the overall fishery harvest rate (Equation G.9).

$$H_{t,CY} = \left[\left(\frac{\sum_{s} \sum_{a} c_{t,CY,s,a}}{\sum_{s} \sum_{a} r_{t,CY,s,a}} \right) * \left(C_{t,CY} - A_{t,CY} \right) \right] / \left[\left(C_{t,CY} - A_{t,CY} \right) / h_{t,CY} \right]$$

Equation G.6

$$H_{CY} = \sum_{t} \left[\left(\frac{\sum_{s} \sum_{a} c_{t,CY,s,a}}{\sum_{s} \sum_{a} r_{t,CY,s,a}} \right) * \left(C_{t,CY} - A_{t,CY} \right) \right] \Big/ \sum_{t} \left[\left(C_{t,CY} - A_{t,CY} \right) / h_{t,CY} \right]$$

Equation G.7

$$S_{t,CY} = H_{t,CY} / \left[\sum_{CY=1979}^{1982} H_{t,CY} / 4 \right]$$

Equation G.8

$$S_{CY} = H_{CY} / \left[\sum_{CY=1979}^{1982} H_{CY} / 4 \right]$$

Equation G.9

LIST OF APPENDIX G TABLES

Appendix G1– Exploitation rate stocks and age classes that contribute to the Alaska troll Stratified Proportion Fishery Index (SPFI).

Exploitation Rate Stock Identifiers	Age Classes		
Atnarko	Age 4	Age 5	
Elk	Age 4	Age 5	
Kitsumkalum	Age 5		
Northern Southeast Alaska	Age 5	Age 6	
Queets	Age 4	Age 5	
Quinsam	Age 4	Age 5	
Robertson Creek	Age 3	Age 4	Age 5
Shuswap	Age 3	Age 4	
Salmon River Hatchery	Age 3	Age 4	Age 5
Southern Southeast Alaska	Age 4	Age 5	Age 6
Skagit Summer Fingerling	Age 4		
Columbia River Summers	Age 4	Age 5	
Columbia Upriver Brights	Age 4	Age 5	
Willamette Spring Hatchery	Age 4	Age 5	

Appendix G2– Alaska troll Stratified Proportion Fishery Index (SPFI) values as landed catch, based on CWT data. OUT = outside waters, IN = inside waters.

		FISHERY STRATA					
YEAR	**SPFI**	**WIN/SPR**	**JUNE OUT**	**JUNE IN**	**JULY OUT**	**JULY IN**	**FALL**
1979	0.80	1.23	1.08	0.63	0.72	0.35	0.72
1980	1.27	0.63	0.94	1.43	1.57	1.81	1.57
1981	1.13	1.18	1.12	0.94	1.06	0.90	1.06
1982	0.80	0.96	0.86	1.00	0.66	0.93	0.66
1983	1.00	1.07	0.61	0.71	1.27	1.07	1.27
1984	0.63	0.41	0.96	0.99	0.51	0.26	0.51
1985	0.68	0.46	0.58	0.80	0.79	0.73	0.79
1986	0.43	0.45	0.16	0.39	1.27	0.60	1.27
1987	0.42	0.62	0.18	0.50	0.56	1.21	0.56
1988	0.35	1.29	0.00	0.13	0.63	1.22	0.63
1989	0.48	0.84	0.18	0.41	0.49	0.50	0.49
1990	0.67	0.62	0.11	0.83	1.14	1.12	1.14
1991	0.61	1.35	0.21	0.89	0.82	0.57	0.82
1992	0.40	1.11	0.06	0.47	0.40	0.22	0.40
1993	0.46	0.79	0.02	0.26	0.86	0.27	0.86
1994	0.40	0.72	0.03	0.11	0.63	0.16	0.63
1995	0.41	0.45	0.04	0.30	0.74	0.89	0.74
1996	0.36	0.53	0.08	0.53	0.53	0.45	0.53
1997	0.65	0.63	0.13	0.53	1.36	0.09	1.36
1998	0.44	0.80	0.05	0.18	0.94	0.45	0.94
1999	0.56	0.87	0.10	0.25	0.90	0.10	0.90
2000	0.51	1.07	0.09	0.12	1.37	0.06	1.37
2001	0.38	0.60	0.06	0.14	0.73	0.11	0.73
2002	0.52	0.80	0.06	0.13	1.33	0.18	1.33
2003	0.49	1.27	0.07	0.14	0.89	0.32	0.89
2004	0.37	0.83	0.06	0.16	0.87	0.33	0.87
2005	0.47	0.78	0.10	0.21	1.09	0.48	1.09
2006	0.61	1.34	0.11	0.62	1.19	0.13	1.19
2007	0.66	1.12	0.13	0.80	1.20	0.24	1.20
2008	0.38	0.79	0.07	0.68	0.71	0.09	0.71
2009	0.51	0.78	0.13	0.29	0.94	0.15	0.94
2010	0.36	1.10	0.05	0.25	0.74	0.07	0.74
2011	0.35	1.01	0.04	0.26	0.83	0.20	0.83
2012	0.66	1.43	0.09	0.20	1.27	0.10	1.27
2013	0.36	0.71	0.10	0.53	0.52	0.12	0.52
2014	0.51	1.23	0.08	0.46	0.91	0.12	0.91
2015	0.46	1.19	0.09	1.18	0.65	0.45	0.65
2016	0.58	1.95	0.10	0.57	1.06	0.14	1.06
2017	0.36	1.24	0.10	0.32	0.45	0.34	0.45
2018	0.25	0.46	0.04	0.01	0.76	0.33	0.76
2019	0.16	0.44	0.04	0.01	0.50	0.18	0.50
2020	0.50	0.69	0.09	0.01	1.00	0.20	1.00
2021	0.44	0.69	0.08	0.03	0.90	0.40	0.90
2022	0.64	1.04	0.09	0.03	1.31	0.44	1.31

Appendix G3– Alaska troll Stratified Proportion Fishery Index (SPFI) values as total mortality, based on CWT data. OUT = outside waters, IN = inside waters.

		FISHERY STRATA					
YEAR	SPFI	WIN/SPR	JUNE OUT	JUNE IN	JULY OUT	JULY IN	FALL
1979	0.80	1.23	1.08	0.63	0.72	0.35	0.72
1980	1.27	0.63	0.94	1.43	1.57	1.81	1.57
1981	1.13	1.18	1.12	0.94	1.06	0.90	1.06
1982	0.80	0.96	0.86	1.00	0.66	0.93	0.66
1983	1.00	1.07	0.61	0.71	1.27	1.07	1.27
1984	0.63	0.41	0.96	0.99	0.51	0.26	0.51
1985	0.68	0.46	0.58	0.80	0.79	0.73	0.79
1986	0.43	0.45	0.16	0.39	1.27	0.60	1.27
1987	0.42	0.62	0.18	0.50	0.56	1.21	0.56
1988	0.35	1.29	0.00	0.13	0.63	1.22	0.63
1989	0.48	0.84	0.18	0.41	0.49	0.50	0.49
1990	0.67	0.62	0.11	0.83	1.14	1.12	1.14
1991	0.61	1.35	0.21	0.89	0.82	0.57	0.82
1992	0.40	1.11	0.06	0.47	0.40	0.22	0.40
1993	0.46	0.79	0.02	0.26	0.86	0.27	0.86
1994	0.40	0.72	0.03	0.11	0.63	0.16	0.63
1995	0.41	0.45	0.04	0.30	0.74	0.89	0.74
1996	0.36	0.53	0.08	0.53	0.53	0.45	0.53
1997	0.65	0.63	0.13	0.53	1.36	0.09	1.36
1998	0.44	0.80	0.05	0.18	0.94	0.45	0.94
1999	0.56	0.87	0.10	0.25	0.90	0.10	0.90
2000	0.51	1.07	0.09	0.12	1.37	0.06	1.37
2001	0.38	0.60	0.06	0.14	0.73	0.11	0.73
2002	0.52	0.80	0.06	0.13	1.33	0.18	1.33
2003	0.49	1.27	0.07	0.14	0.89	0.32	0.89
2004	0.37	0.83	0.06	0.16	0.87	0.33	0.87
2005	0.47	0.78	0.10	0.21	1.09	0.48	1.09
2006	0.61	1.34	0.11	0.62	1.19	0.13	1.19
2007	0.66	1.12	0.13	0.80	1.20	0.24	1.20
2008	0.38	0.79	0.07	0.68	0.71	0.09	0.71
2009	0.51	0.78	0.13	0.29	0.94	0.15	0.94
2010	0.36	1.10	0.05	0.25	0.74	0.07	0.74
2011	0.35	1.01	0.04	0.26	0.83	0.20	0.83
2012	0.66	1.43	0.09	0.20	1.27	0.10	1.27
2013	0.36	0.71	0.10	0.53	0.52	0.12	0.52
2014	0.51	1.23	0.08	0.46	0.91	0.12	0.91
2015	0.46	1.19	0.09	1.18	0.65	0.45	0.65
2016	0.58	1.95	0.10	0.57	1.06	0.14	1.06
2017	0.36	1.24	0.10	0.32	0.45	0.34	0.45
2018	0.25	0.46	0.04	0.01	0.76	0.33	0.76
2019	0.16	0.44	0.04	0.01	0.50	0.18	0.50
2020	0.50	0.69	0.09	0.01	1.00	0.20	1.00
2021	0.44	0.69	0.08	0.03	0.90	0.40	0.90
2022	0.64	1.04	0.09	0.03	1.31	0.44	1.31

Appendix G4– List of stock acronyms used in landed catch and total mortality exploitation rate tables below (Appendices G5–G7).

Acronym	Stock Name
CWF	Cowlitz Fall Tule
GAD	George Adams Fall Fingerling
LRH	Lower River Hatchery
LRW	Lewis River Wild
QUE	Queets Fall Fingerling
QUI	Quinsam Fall
RBT	Robertson Creek Hatchery
SAM	Samish Fall Fingerling
SHU	Lower Shuswap
SPR	Spring Creek National Fish Hatchery
SPS	South Puget Sound Fall Fingerling
SRH	Salmon River Hatchery
SSA	Southern Southeast Alaska
SUM	Columbia River Summers
URB	Columbia Upriver Brights
WSH	Willamette Spring

Appendix G5– Landed catch exploitation rate indices by stock and age in the Northern British Columbia troll fishery, based on coded-wire tag (CWT) data. Values shaded in gray are averages across years.

Year	QUE Age 5	QUI Age 3	QUI Age 4	RBT Age 3	RBT Age 4	RBT Age 5	SHU Age 4	SRH Age 3	SRH Age 4	SRH Age 5	SSA Age 4	URB Age 4	URB Age 5	WSH Age 4	Fishery Index
1979		0.55	0.87	1.15	0.83	0.48		1.01				1.10		0.65	0.81
1980		0.79	0.98	1.05	0.85	0.77			0.77			1.02	1.14	1.18	0.91
1981		1.78	1.44	0.85	1.04	1.75		1.41		1.00		1.27	1.50	1.53	1.29
1982		0.88	0.71	0.95	1.28		1.00	0.58	1.23		1.00	0.61	0.36	0.64	0.88
2009			0.11	0.18	0.20		0.64	0.01	1.13	0.91	0.85	1.75		0.00	0.65
2010		0.00		0.13	0.08		0.80	0.18	0.90	0.42	0.20			0.14	0.42
2011		0.00	0.00	0.00	0.31		0.68	0.05	0.75	0.53	0.00	0.55		0.07	0.40
2012			0.09	0.07	0.20	0.36	0.93	0.03	1.15	0.69	0.25	1.44	2.41	0.10	0.69
2013			0.12	0.01	0.18	0.13	0.67	0.02	0.76	0.72	0.30	0.81		0.11	0.43
2014		0.00	0.00		0.24		0.61	0.07	0.59	0.28	0.42	0.93	1.47	0.17	0.44
2015		0.00	0.00	0.03	0.00	0.00	0.36	0.03	0.51	0.43	0.17	0.38	0.91	0.16	0.27
2016		0.00	0.04	0.09	0.16		0.98	0.05	1.71	0.91	0.56	1.55	1.89	0.34	0.79
2017		0.08	0.11	0.10	0.20	0.15	0.69	0.00	1.62	1.09		1.10	1.72	0.14	0.68
2018		0.11	0.32	0.23	0.49	0.35	0.40	0.05	2.65	1.56		1.55	2.04	0.25	0.96
2019		0.08	0.00	0.16	0.24		0.00	0.30	0.78	0.65		1.10		0.06	0.39
2020		0.07	0.22	0.20	0.17	0.32	0.00	0.10	0.66		0.14	0.68	0.26	0.07	0.25
2021		0.10	0.06	0.20	0.35	0.14	0.03	0.25	1.05	0.49	0.00	1.05	0.61	0.40	0.39
2022			0.12	0.07	0.17	0.39	0.00	0.29	1.39	0.98	0.00	0.99	1.67	0.05	0.60
83-95	NA	0.49	0.87	0.43	0.85	0.94	1.11	0.21	0.81	1.11	1.02	1.26	1.90	0.39	0.93
96-98	NA	0.20	0.13	0.11	0.41	NA	0.40	0.07	0.33	0.26	0.00	0.25	1.11	0.04	0.27
99-08	NA	0.04	0.11	0.05	0.34	0.28	0.62	0.07	0.58	0.47	0.23	0.71	0.88	0.08	0.40
09-18	NA	0.03	0.09	0.09	0.21	0.20	0.68	0.05	1.18	0.75	0.34	1.12	1.74	0.15	0.57
19-22	NA	0.09	0.10	0.16	0.23	0.28	0.01	0.24	0.97	0.71	0.05	0.95	0.85	0.14	0.41

Appendix G6– Total mortality exploitation rate indices by stock and age in the Northern British Columbia troll fishery, based on coded-wire tag (CWT) data. Values shaded in gray are averages across years.

Year	QUE Age 5	QUI Age 3	QUI Age 4	RBT Age 3	RBT Age 4	RBT Age 5	SHU Age 4	SRH Age 3	SRH Age 4	SRH Age 5	SSA Age 4	URB Age 4	URB Age 5	WSH Age 4	Fishery Index
1979		0.56	0.85	1.16	0.83	0.48		1.00				0.55	1.10		0.63
1980		0.79	0.98	1.02	0.85	0.77			0.78		0.45	1.14	1.03	1.14	1.14
1981		1.75	1.45	0.85	1.04	1.76		1.39		1.00			1.27	1.51	1.52
1982		0.89	0.72	0.96	1.28		1.00	0.61	1.22		1.55	1.31	0.60	0.35	0.70
2009			0.11	0.19	0.19		0.65	0.10	1.14	0.93	1.39		1.77		0.00
2010		0.00		0.16	0.08		0.82	0.22	0.91	0.42	0.35	0.19			0.14
2011		0.00	0.00	0.07	0.34		0.74	0.08	0.81	0.57	0.08		0.60		0.07
2012		0.00	0.09	0.13	0.20	0.37	0.93	0.07	1.16	0.70	0.51	0.15	1.41	2.41	0.10
2013		0.00	0.11	0.03	0.17	0.13	0.74	0.08	0.83	0.79	0.51	0.13	0.88		0.11
2014		0.00	0.00		0.24		0.62	0.11	0.60	0.28	0.70	0.33	0.95	1.47	0.17
2015		0.00	0.00	0.03	0.00	0.00	0.37	0.08	0.52	0.43	0.24	0.21	0.39	0.93	0.17
2016		0.00	0.04	0.11	0.17		0.99	0.26	1.74	0.92	0.88	0.78	1.59	1.90	0.32
2017		0.10	0.10	0.11	0.21	0.16	0.71	0.24	1.67	1.11	1.04	0.67	1.13	1.73	0.14
2018		0.15	0.33	0.26	0.49	0.35	0.41	0.19	2.65	1.57		0.47	1.55	2.06	0.27
2019		0.09	0.00	0.20	0.27		0.00	0.38	0.88	0.73		0.75	1.25		0.05
2020		0.08	0.22	0.22	0.17	0.34	0.00	0.15	0.68		0.20	0.42	0.70	0.25	0.07
2021		0.12	0.06	0.24	0.36	0.14	0.03	0.29	1.06	0.48	0.00	0.88	1.07	0.60	0.41
2022		0.37	0.12	0.08	0.17	0.40	0.00	0.37	1.41	0.99	0.00	0.64	1.01	1.68	0.04
83-95	NA	0.56	0.89	0.54	0.86	0.95	1.14	0.31	0.83	1.12	1.73	1.07	1.29	1.91	0.42
96-98	NA	0.16	0.13	0.15	0.42	NA	0.41	0.13	0.34	0.27	0.07	0.17	0.28	1.09	0.06
99-08	NA	0.03	0.11	0.08	0.35	0.29	0.63	0.12	0.59	0.48	0.44	0.22	0.72	0.90	0.09
09-18	NA	0.03	0.09	0.12	0.21	0.20	0.70	0.15	1.20	0.77	0.63	0.37	1.14	1.75	0.15
19-22	NA	0.16	0.10	0.19	0.24	0.29	0.01	0.30	1.01	0.73	0.07	0.67	1.01	0.84	0.14

Appendix G7– Landed catch exploitation rate indices by stock and age in the West Coast Vancouver Island (WCVI) troll fishery, based on coded-wire tag (CWT) data. Values shaded in gray are averages across years.

Year	CWF Age 4	GAD Age 3	GAD Age 4	LRH Age 3	LRH Age 4	LRW Age 4	RBT Age 3	RBT Age 4	RBT Age 5	SAM Age 3	SAM Age 4	SAM Age 5	SPR Age 3	SPR Age 4	SPS Age 3	SPS Age 4	SRH Age 3	SRH Age 4	SRH Age 5	SUM Age 4	URB Age 3	URB Age 4	WSH Age 4	Fishery Index
1979				1.16			1.17	1.26			1.00	1.00	0.97	0.84		1.15	1.45				1.12	1.63	1.03	1.06
1980				0.55	0.90		1.41	1.43					1.17	1.39				0.94		0.69	1.10	0.98	1.11	1.01
1981	0.79	0.73		1.14	0.79	0.85	0.67	0.58	1.00				0.94	0.63	0.76		0.55		1.00	1.31		0.99	0.63	0.87
1982	1.21	1.27	1.00	1.15	1.31	1.16	0.75	0.73		1.00			0.93	1.14	1.24	0.85		1.06			0.78	0.39	1.23	1.05
2009	0.00	0.64	0.52	0.20	0.22		0.00	0.00		0.67	0.16		0.16	0.06	0.62	0.25	0.04	0.03	0.10	0.40		0.11	0.15	0.23
2010	0.11	0.99	0.45	0.34			0.04	0.24		0.99	0.13		0.24	0.36	0.64	0.12	0.00	0.00	0.00	0.32	0.09		0.19	0.28
2011	0.07	0.43	0.22	0.41	0.75		0.00	0.00		0.00	0.42		0.25	0.59	0.14	0.27	0.11	0.48	0.42	0.21	0.00	0.33	0.41	0.34
2012	0.20	0.32	0.25	0.16	0.00		0.00	0.00	0.16	0.32	0.05		0.09	0.43	0.36	0.18	0.04	0.36	0.68	0.26	0.08	0.31	0.93	0.20
2013	0.06	0.20	0.24	0.18	0.14		0.00	0.00		0.14	0.09		0.15	0.14	0.09	0.20	0.04	0.06	0.00	0.16	0.03	0.25	0.23	0.14
2014	0.13	0.17	0.28	0.26		0.20		0.17		0.70	0.26		0.12	0.30	0.36	0.18	0.13	0.22	0.52	0.47	0.05	0.42	1.19	0.26
2015		0.08	0.09	0.22	0.33		0.01				0.15		0.09	0.22	0.25	0.16	0.08	0.12	0.36	0.07	0.03	0.09	0.13	0.16
2016	0.18	0.21	0.38	0.23	1.13		0.01	0.17			0.07		0.13	0.61	0.15	0.32	0.02	0.21	0.54	0.44	0.16	0.38	1.16	0.37
2017	0.33	0.46	0.18	0.52			0.11	0.13	0.14	0.81			0.32		0.58	0.28	0.00	0.16	0.28	0.40	0.25	0.21	1.14	0.33
2018	0.00	0.22	0.09	0.31			0.15	0.26		0.50	0.05		0.15		0.20	0.17		0.27	0.73	0.17	0.02	0.28	0.54	0.17
2019	0.08	0.11	0.04	0.07			0.13	0.13		0.19	0.06		0.10	0.00	0.39	0.05	0.11			0.00	0.06	0.23	0.00	0.07
2020	0.08	0.19	0.00	0.06	0.12	0.16	0.04	0.05	0.17	0.06	0.15		0.07		0.19	0.03	0.15	0.34		0.02	0.04	0.12	0.05	0.09
2021	0.13	0.24	0.00	0.14	0.13		0.16	0.13	0.00	0.25	0.04		0.09	0.00	0.26	0.11	0.73	0.70		0.04	0.19	0.31	0.13	0.12
2022	0.08	0.17	0.02	0.21	0.23		0.10	0.06	0.32	0.28	0.13		0.17	0.12	0.35	0.10	0.21	0.28		0.05	0.11	0.25	0.10	0.14
83-95	0.90	0.82	0.84	1.10	1.24	0.74	0.69	0.90	1.64	0.49	0.60	1.09	0.78	0.79	0.84	0.65	0.64	0.66	1.88	1.02	0.54	1.14	0.44	0.84
96-98	0.19	0.00	0.10	0.37	NA	NA	0.00	0.02	NA	0.01	0.11	NA	0.17	0.20	0.02	0.11	0.00	0.01	0.00	0.02	0.01	0.03	0.02	0.11
99-08	0.46	0.44	0.91	0.36	1.09	0.31	0.01	0.01	0.00	0.48	0.56	NA	0.34	0.87	0.53	0.60	0.06	0.08	0.29	0.41	0.11	0.29	0.84	0.53
09-18	0.12	0.37	0.27	0.28	0.43	0.20	0.04	0.11	0.15	0.52	0.15	NA	0.17	0.34	0.34	0.21	0.05	0.19	0.36	0.29	0.08	0.26	0.61	0.25
19-22	0.09	0.18	0.01	0.12	0.16	0.16	0.11	0.09	0.16	0.19	0.09	NA	0.11	0.04	0.30	0.07	0.30	0.44	NA	0.03	0.10	0.22	0.07	0.11

Appendix G8– Total mortality exploitation rate indices by stock and age in the West Coast Vancouver Island (WCVI) troll fishery, based on coded-wire tag (CWT) data. Values shaded in gray are averages across years.

Year	CWF Age 4	GAD Age 3	GAD Age 4	LRH Age 3	LRH Age 4	LRW Age 4	RBT Age 3	RBT Age 4	RBT Age 5	SAM Age 3	SAM Age 4	SAM Age 5	SPR Age 3	SPR Age 4	SPS Age 3	SPS Age 4	SRH Age 3	SRH Age 4	SRH Age 5	SUM Age 4	URB Age 3	URB Age 4	WSH Age 4	Fishery Index
1979				1.15			1.20	1.25			1.00	1.00	0.95	0.84		1.15	1.46				1.39	1.64	1.00	1.06
1980				0.56	0.88		1.38	1.42					1.16	1.39				0.95		0.69	1.37	1.00	1.09	1.02
1981	0.79	0.72		1.13	0.78	0.85	0.66	0.60	1.00				0.92	0.63	0.78		0.54		1.00	1.31	0.26	0.98	0.64	0.85
1982	1.21	1.28	1.00	1.17	1.34	1.15	0.75	0.72		1.00			0.97	1.14	1.22	0.85		1.05			0.98	0.38	1.27	1.06
2009	0.00	0.55	0.51	0.19	0.22		0.00	0.00		0.57	0.15		0.15	0.05	0.54	0.25	0.03	0.03	0.10	0.40		0.10	0.14	0.22
2010	0.11	0.83	0.44	0.31			0.03	0.23		0.86	0.13		0.22	0.34	0.56	0.12	0.00	0.00	0.00	0.32	0.11		0.17	0.27
2011	0.07	0.37	0.22	0.38	0.74	0.45	0.00	0.00		0.00	0.42		0.23	0.57	0.13	0.27	0.11	0.47	0.42	0.21	0.00	0.33	0.38	0.33
2012	0.20	0.27	0.25	0.14	0.00		0.00	0.00	0.16	0.28	0.05		0.08	0.42	0.31	0.18	0.04	0.36	0.68	0.25	0.09	0.30	0.84	0.20
2013	0.06	0.17	0.24	0.16	0.13		0.00	0.00		0.13	0.09		0.14	0.13	0.08	0.19	0.04	0.06	0.00	0.16	0.04	0.25	0.20	0.14
2014	0.13	0.14	0.28	0.24		0.20		0.17		0.61	0.25		0.11	0.29	0.32	0.18	0.12	0.21	0.53	0.47	0.06	0.41	1.08	0.25
2015		0.06	0.09	0.20	0.32		0.01			0.00	0.14		0.09	0.21	0.24	0.16	0.08	0.12	0.36	0.07	0.03	0.09	0.11	0.15
2016	0.18	0.17	0.37	0.20	1.11		0.01	0.17			0.07		0.12	0.59	0.12	0.31	0.02	0.21	0.54	0.44	0.19	0.38	1.06	0.35
2017	0.33	0.39	0.18	0.47			0.10	0.12	0.14	0.69			0.29		0.51	0.27	0.00	0.15	0.28	0.39	0.28	0.21	1.04	0.32
2018	0.00	0.19	0.09	0.30			0.14	0.25		0.43	0.05		0.14		0.17	0.17		0.28	0.73	0.16	0.02	0.27	0.49	0.17
2019	0.08	0.10	0.04	0.07			0.12	0.13		0.19	0.06		0.09	0.00	0.34	0.05	0.11			0.00	0.06	0.22	0.00	0.07
2020	0.08	0.16	0.00	0.06	0.12	0.15	0.03	0.05	0.17	0.05	0.14		0.06		0.17	0.03	0.15	0.34		0.02	0.05	0.11	0.04	0.08
2021	0.14	0.20	0.00	0.13	0.13		0.15	0.13	0.00	0.21	0.04		0.08	0.00	0.23	0.10	0.67	0.69		0.04	0.22	0.30	0.12	0.11
2022	0.08	0.15	0.02	0.19	0.23		0.10	0.05	0.32	0.24	0.12		0.16	0.12	0.32	0.10	0.20	0.28		0.04	0.12	0.24	0.09	0.14
83-95	0.93	0.86	0.86	1.18	1.30	0.77	0.79	0.93	1.70	0.61	0.61	1.09	0.81	0.80	0.92	0.66	0.78	0.63	1.93	1.04	0.72	1.18	0.47	0.88
96-98	0.21	0.07	0.12	0.47	NA	NA	0.01	0.02	NA	0.08	0.12	NA	0.22	0.22	0.08	0.12	0.03	0.02	0.00	0.03	0.05	0.06	0.02	0.13
99-08	0.46	0.34	0.91	0.34	1.09	0.30	0.01	0.01	0.00	0.42	0.55	NA	0.32	0.85	0.47	0.59	0.05	0.08	0.29	0.41	0.13	0.29	0.77	0.51
09-18	0.12	0.31	0.27	0.26	0.42	0.32	0.03	0.10	0.15	0.40	0.15	NA	0.16	0.33	0.30	0.21	0.05	0.19	0.36	0.29	0.09	0.26	0.55	0.24
19-22	0.09	0.15	0.01	0.11	0.16	0.15	0.10	0.09	0.16	0.17	0.09	NA	0.10	0.04	0.26	0.07	0.28	0.43	NA	0.03	0.11	0.22	0.06	0.10

APPENDIX H: CALENDAR YEAR EXPLOITATION RATE METRICS

Calendar year exploitation rates were introduced with paragraph 5(e) of the 2019 PST Agreement as a way to monitor the total mortality in ISBM fisheries. CYERs are calculated for each calendar year and CTC fishery as:

$$CYDIST_{CY,F} = \frac{\sum_{a=Minage}^{Maxage} \sum_{f \in \{F_{ISBM}\}} Morts_{CY,a,f} * AEQ_{BY=CY-a,a,f}}{\sum_{a=Minage}^{Maxage} \left(\sum_{f=1}^{Numfisheries} Morts_{CY,a,f} * AEQ_{BY=CY-a,a,f} + Esc_{CY,a} \right)}$$

The CYER values are updated each year with the most current ERA results, and beginning in 2024 are based on the unmarked fish ERA, which includes adjustments to account for MSFs. For each ERIS and EIS each year, sums of mortalities for all the fisheries/escapement are converted to percentages of total mortalities for each fishery/escapement. The CYER metric sums the percentage of mortalities in U.S. or Canadian ISBM fisheries. These values for recent years are compared to the average values that occurred across the 2009–2015 base period. This comparison serves as a gauge of whether ISBM management has reduced their impacts proportionally to other fisheries.

Equation notations can be found in Appendix B. The method for computing CYER limits for each stock and ISBM fishery is laid out in Attachment I of the 2019 PST Agreement and is based on a base period average from 2009–2015 as shown in Appendix H1 and Appendix H2 below. ISBM fisheries are listed in Table 4.2. ISBM performance and CYER limit evaluation can be found in section 4.1.

LIST OF APPENDIX H TABLES

Appendix H1— Calculation of individual stock-based management (ISBM) calendar year exploitation rate (CYER) limits for all Canadian ISBM fisheries based on coded wire tag (CWT)-based exploitation rate analysis.

Note: Escapement indicator stocks correspond to Annex IV, Chapter 3, Attachment I of the 2019 Pacific Salmon Treaty Agreement.

Escapement Indicator	CWT Indicator	CYER Obj.	Base Period CYER								CYER Limit
			2009	2010	2011	2012	2013	2014	2015	Avg.	
Skeena	KLM	100.0%	0.068	0.189	0.259	0.123	0.098	0.172	0.119	0.147	0.147
Atnarko	ATN	100.0%	0.374	0.295	0.373	0.286	0.224	0.211	0.169	0.276	0.276
NWVI Natural Aggregate	RBT adj	95.0%	0.123	0.078	0.084	0.103	0.100	0.065	0.117	0.096	0.091
SWVI Natural Aggregate	RBT adj	95.0%	0.123	0.078	0.084	0.103	0.100	0.065	0.117	0.096	0.091
East Coast Vancouver Island North	QUI adj	95.0%	0.160	0.254	0.159	0.157	0.078	0.093	0.260	0.166	0.158
Phillips	PHI	100.0%					0.052	0.112	0.127	0.097	0.097
Cowichan	COW	95.0%	0.549	0.497	0.292	0.426	0.388	0.512	0.423	0.441	0.419
Nicola	NIC	95.0%	0.477	0.066	0.117	0.229	0.070	0.128	0.147	0.176	0.167
Chilcotin											
Chilko											
Lower Shuswap	SHU	100.0%	0.255	0.216	0.219	0.209	0.166	0.182	0.156	0.200	0.200
Harrison	HAR	95.0%	0.079	0.080	0.071	0.132	0.102	0.195	0.143	0.115	0.109
Nooksack Spring adj	NSF adj	87.5%	0.228	0.059	0.170	0.181	0.177	0.258	0.117	0.170	0.149
Skagit Spring	SKF	87.5%	0.081	0.094	0.076	0.141	0.088	0.091	0.059	0.090	0.079
Skagit Summer/Fall	SSF	87.5%	0.086	0.090	0.080	0.031	0.084	0.190	0.140	0.100	0.088
Stillaguamish	STL	87.5%	0.083	0.073	0.142	0.102	0.148	0.300	0.173	0.146	0.128
Snohomish	SKY	87.5%	0.046	0.065	0.088	0.197	0.108	0.166	0.069	0.106	0.092

Appendix H2— Calculation of individual stock-based management (ISBM) calendar year exploitation rate (CYER) limits for all United States ISBM fisheries based on coded wire tag (CWT)-based exploitation rate analysis.

Note: Escapement indicator stocks correspond to Annex IV, Chapter 3, Attachment I of the 2019 Pacific Salmon Treaty Agreement.

Escapement Indicator	**CWT**	**CYER**	**Base Period CYER**								**CYER**
	Indicator	**Obj.**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**Avg.**	**Limit**
Cowichan	COW	95.0%	0.080	0.083	0.102	0.116	0.118	0.052	0.038	0.084	0.080
Nicola	NIC	95.0%	0.060	0.009	0.034	0.088	0.043	0.018	0.017	0.038	0.036
Harrison	HAR	95.0%	0.026	0.064	0.053	0.064	0.086	0.082	0.058	0.062	0.059
Nooksack Spring adj	NSF adj	100.0%	0.057	0.083	0.039	0.135	0.117	0.076	0.063	0.081	0.081
Skagit Spring	SKF	95.0%	0.346	0.226	0.233	0.248	0.296	0.324	0.187	0.266	0.252
Skagit Summer/Fall	SSF	95.0%	0.361	0.100	0.233	0.036	0.180	0.102	0.072	0.155	0.147
Stillaguamish	STL	100.0%	0.104	0.083	0.064	0.037	0.186	0.158	0.106	0.105	0.105
Snohomish	SKY	100.0%	0.110	0.075	0.152	0.088	0.072	0.081	0.176	0.108	0.108
Hoko	HOK	10.0%	0.010	0.007	0.006	0.020	0.048	0.034	0.055	0.026	0.100
Grays Harbor Fall	QUE adj	85.0%	0.158	0.183	0.204	0.161	0.150	0.167	0.242	0.181	0.154
Queets Fall	QUE	85.0%	0.167	0.145	0.202	0.207	0.191	0.140	0.076	0.161	0.137
Quillayute Fall	QUE adj	85.0%	0.236	0.219	0.252	0.194	0.195	0.328	0.280	0.243	0.207
Hoh Fall	QUE adj	85.0%	0.122	0.125	0.245	0.149	0.273	0.149	0.157	0.174	0.148
Upriver Brights	URB	85.0%	0.294	0.300	0.386	0.371	0.389	0.268	0.246	0.322	0.274
Hanford Wild Brights	HAN	85.0%	0.525	0.185	0.329	0.378	0.379	0.309	0.267	0.339	0.288
Lewis River Fall	LRW	85.0%	0.049	0.164	0.312	0.261	0.422	0.206	0.149	0.223	0.190
Coweeman	CWF	100.0%	0.198	0.247	0.053	0.181	0.118	0.253	0.316	0.195	0.195
Mid-Columbia Summers	SUM	85.0%	0.268	0.360	0.377	0.289	0.324	0.452	0.437	0.358	0.304
Nehalem	SRH adj	85.0%	0.022	0.081	0.149	0.154	0.184	0.210	0.268	0.152	0.130
Siletz	SRH adj	85.0%	0.114	0.067	0.299	0.180	0.190	0.180	0.377	0.201	0.171
Siuslaw	SRH adj	85.0%	0.133	0.181	0.271	0.190	0.311	0.233	0.332	0.236	0.201
South Umpqua	Elk adj	85.0%	0.214	0.309	0.360	0.382	0.400	0.308	0.221	0.313	0.266
Coquille	Elk adj	85.0%	0.067	0.138	0.255	0.332	0.447	0.275	0.322	0.262	0.223

Appendix H3— Individual stock-based management (ISBM) calendar year exploitation rates (CYERs) for all Canadian fisheries based on coded wire tag (CWT)-based exploitation rate analysis under the 2019 Pacific Salmon Treaty (PST) Agreement. Values shaded in green indicate that the annual ISBM obligation was met for that stock in that year while values shaded in red indicate that the annual ISBM obligation was not met for that stock in that year.

Note: Escapement indicator stocks correspond to Annex IV, Chapter 3, Attachment I of the 2019 PST Agreement.

Escapement Indicator	**CYER**									
	2019	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**
Skeena	0.127	0.121	0.037	0.028						
Atnarko	0.332	0.248	0.186	0.116						
NWVI Natural Aggregate	0.109	0.052	0.063	0.150						
SWVI Natural Aggregate	0.109	0.052	0.063	0.150						
East Coast Vancouver Island North	0.301	0.106	0.213	0.203						
Phillips	0.093	0.050	0.152	0.104						
Cowichan	0.600	0.205	0.312	0.393						
Nicola	0.024	0.280	0.053	0.024						
Chilcotin										
Chilko										
Lower Shuswap	0.131	0.189	0.143	0.191						
Harrison	0.259	0.205	0.204	0.062						
Nooksack Spring adj	0.123	0.187	0.044	0.078						
Skagit Spring	0.059	0.190	0.150	0.121						
Skagit Summer/Fall	0.057	0.104	0.050	0.041						
Stillaguamish	0.167	0.076	0.091	0.088						
Snohomish	0.113	0.095	0.155	0.120						

Appendix H4— Individual stock-based management (ISBM) calendar year exploitation rates (CYERs) for all United States fisheries based on coded wire tag (CWT)-based exploitation rate analysis under the 2019 Pacific Salmon Treaty (PST) Agreement. Values shaded in green indicate that the annual ISBM obligation was met for that stock in that year while values shaded in red indicate that the annual ISBM obligation was not met for that stock in that year.

Note: Escapement indicator stocks correspond to Annex IV, Chapter 3, Attachment I of the 2019 PST Agreement.

Escapement Indicator	**CYER**									
	2019	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**
Cowichan	0.042	0.017	0.023	0.017						
Nicola	0.014	0.009	0.005	0.004						
Harrison	0.047	0.024	0.059	0.022						
Nooksack Spring adj	0.059	0.062	0.104	0.077						
Skagit Spring	0.418	0.205	0.239	0.333						
Skagit Summer/Fall	0.089	0.058	0.065	0.168						
Stillaguamish	0.122	0.093	0.118	0.042						
Snohomish	0.035	0.057	0.154	0.090						
Hoko	0.043	0.005	0.009	0.056						
Grays Harbor Fall	0.104	0.086	0.074	0.066						
Queets Fall	0.202	0.239	0.154	0.319						
Quillayute Fall	0.126	0.108	0.078	0.082						
Hoh Fall	0.201	0.193	0.135	0.109						
Upriver Brights	0.209	0.241	0.204	0.201						
Hanford Wild Brights	0.163	0.205	0.206	0.249						
Lewis River Fall	0.030	0.085	0.074	0.193						
Coweeman	0.115	0.073	0.138	0.161						
Mid-Columbia Summers	0.255	0.141	0.245	0.292						
Nehalem	0.137	0.131	0.161	0.239						
Siletz	0.333	0.136	0.226	0.146						
Siuslaw	0.419	0.186	0.244	0.027						
South Umpqua	0.358	0.266	0.219	0.268						
Coquille	0.517	0.092	0.073	0.057						

APPENDIX I: ISSUES WITH AND CHANGES TO THE EXPLOITATION RATE ANALYSIS

PROGRAM/METHODOLOGICAL CHANGES

CETL

To support the ERA analysis, the CETL package was modified to handle coded-wire-tag recoveries with estimates greater than 50. In the past, these recoveries had their estimate adjusted to a maximum value of 50. However, these higher values might be representative of their sampling regime and thus should only be modified by the reporting agency if they are incorrect. So, starting with catch year 2008, CWT estimates are allowed to be higher than 50 and are identified in the quality control report produced by the qcamp R package. This will allow the appropriate agency to review the values and correct the estimates, if needed.

In addition, CETL now implements the expansion factors previously done in the original CAS program. These expansion factors account for Alaskan catch that may not have had CWT sampling.

R Exploitation Rate Analysis Module (REAM)

Weighted Mark Release Rate

When estimating fishery-related mortality within a fishery comprising a mix of mark-selective and non-selective regulations, an aggregate mark-release rate ($\mathrm{MRR};\ \omega$) is needed for estimating incidental CWT mortalities. Within the ERA, fishery mark-release rates are provided by regional fishery organisations as inputs into the model at a "fine scale fishery" level, where fisheries are temporally or spatially defined to capture a stratum with similar stock composition and propensity for fishers to release marked fish. These rates are defined by fine scale fishery (*f*) and year based on total legal kept catch (C_f) and releases (R_f), but are not stock-specific:

$$\omega_f = \frac{R_f}{R_f + C_f}$$

In the REAM algorithms, fishery information is aggregated at the level of Exploitation Rate (ERA) fisheries for the purpose of the cohort analysis. ERA fisheries comprise one or more fine scale fisheries with different marked release rates (MRR) and stock compositions. For a given ERA fishery (*F*) and stock (*s*), the ERA fishery mark release rate (ω_F) is defined as the average ω_f weighted by the stock-specific legal size? encounters ($E_{s,f}$) associated with each fine scale fishery,

$$\omega_{s,F} = \sum_f \left(\frac{E_{s,f}}{\sum_f E_{s,f}} \cdot \omega_{s,f} \right), f \epsilon\ F$$

where legal size encounters of a particular stock (*s*) within a fine scale fishery is defined below based on stock-specific estimates of legal-sized kept and released Chinook. For the purposes of weighted MRR, drop-off mortality is ignored:

$$E_{s,f} = C_{s,f} + R_{s,f}$$

As $R_{s,f}$ is not directly observed, the above equations are re-arranged to solve for $R_{s,f}$ as a function of ω_f and $C_{s,f}$, using:

$$R_{s,f} = C_{s,f} \cdot \frac{\omega_f}{1-\omega_f}$$

In addition, stock-specific data is not typically available for estimates of legal size, kept fish. Instead, the ERA model uses stock-specific CWT estimates of marked, legal kept mortalities ($m_{s,f,g=1,r=3,l=1}$) as a proxy for $C_{s,f}$. Stock-specific legal encounter rates are then re-written as:

$$E_{s,f} = m_{s,f,g=1,r=3,l=1} \cdot \left(1 + \frac{\omega_f}{1-\omega_f}\right)$$

Inserting this into the equation for ERA fishery mark release rate produces the formula used for calculating stock-specific weighted average MRRs ($\omega_{s,F}$) for each ERA fishery (F) within the model:

$$\omega_{s,F} = \sum_f \left(\frac{m_{s,f,g=1,r=3,l=1} \cdot \left(1 + \frac{\omega_f}{1-\omega_f}\right)}{\sum_f m_{s,f,g=1,r=3,l=1} \cdot \left(1 + \frac{\omega_f}{1-\omega_f}\right)} \cdot \omega_{s,f} \right), f \epsilon F$$

Calculating Incidental Mortalities Using MRR

In 2024, a new approach was introduced into the ERA model to estimate incidental mortalities of marked fish that may occur during fisheries with a mixture of regulations (e.g. mixed bag, MSF, retention and non-retention etc.). This approach replaced previous CNR methods for many fisheries going back to 2005. Instead of rescaling mortalities occurring during legal retention periods using ratios of fishing effort, the weighted MRRs described above were used to identify the relative amount of fishing attributable to periods associated with legal releases. Two separate formulations were created, depending on if sublegal release data was also explicitly available for a fishery.

Step 1: Convert the weighted MRR (ω) from a rate into a ratio (ρ):

$$\rho_{y,s,f} = \frac{\omega_{y,s,f}}{1-\omega_{y,s,f}}$$

Step 2: Calculate the number of legal-size Chinook encountered ($e_{b,s,f,g=2,l=1,a}$) during "release" periods as a function of legal, kept mortalities:

$$e_{b,s,f,g=3,l=1,a} = m_{b,s,f,g=1,r=3,l=1,a} \cdot \rho_{y,s,f}$$

Step 3a: Multiply encounters by drop-off ($\varphi_{r=2}$) or release ($\varphi_{r=1,l=1}$) mortality rates to calculate the number of incidental mortalities for legal fish:

$$m_{b,s,f,g=3,r=1,l=1,a} = e_{b,s,f,g=3,l=1,a} \cdot \varphi_{r=1,l=1}$$

$$m_{b,s,f,g=3,r=2,l=1,a} = e_{b,s,f,g=3,l=1,a} \cdot \varphi_{r=2}$$

If no sublegal release data exists, then go to Step 3b, else go to Step 3c.

Step 3b: Sublegal mortalities are calculated by simply rescaling the mortalities calculated during retention periods by the marked release ratio:

$$m_{b,s,f,g=3,r=1,l=2,a} = m_{b,s,f,g=1,r=1,l=2,a} \cdot \rho_{y,s,f}$$
$$m_{b,s,f,g=3,r=2,l=2,a} = m_{b,s,f,g=1,r=2,l=2,a} \cdot \rho_{y,s,f}$$

Step 3ci: If information on sublegal releases is provided, create a ratio ($\partial_{y,s,f}$) for rescaling between total mortalities and stock-specific CWT mortalities using legal kept catch ($C_{y,f,l=1}$):

$$\partial_{y,s,f} = \frac{\sum_a m_{y,s,f,g=1,r=3,l=1,a}}{C_{y,f,l=1}}$$

Step 3cii: Calculate the total number of sublegal CWT encounters ($\varepsilon_{y,s,f,l=2}$) by converting annual sublegal releases ($R_{y,f,l=2}$) recorded for a fishery into CWT "units" (stock-specific but not age-specific):

$$\varepsilon_{y,s,f,l=2} = \partial_{y,s,f} \cdot R_{y,f,l=2}$$

Step 3ciii: Calculate *age-specific* numbers of sublegal CWT encounters using the ratio of the relative proportion of stock- and age-specific sublegal mortalities in retention fisheries divided by the *total* number of sublegal mortalities in retention fisheries:

$$\varepsilon_{b,s,f,l=2,a} = \varepsilon_{y,s,f,l=2} \cdot \frac{m_{b,s,f,g=1,r=1,l=2,a} + m_{b,s,f,g=1,r=2,l=2,a}}{\sum_a \left(m_{y,s,f,g=1,r=1,l=2,a} + m_{y,s,f,g=1,r=2,l=2,a} \right)}$$

Step 3civ: Multiply the number of stock- and age-specific legal encounters by release and drop-off mortality rates. Mortality rates are still required in this formulation since the equations are a function of expected sublegal encounter rate, not sublegal mortality rate (as in Eqns. 8c and 8d).

$$m_{b,s,f,g=3,r=1,l=2,a} = \varepsilon_{b,s,f,l=1,a} \cdot \varphi_{r=1,l=2}$$

$$m_{b,s,f,g=3,r=2,l=2,a} = \varepsilon_{b,s,f,l=1,a} \cdot \varphi_{r=2}$$

Corrections to Model Errors in Incidental Mortality Equations

In addition to the introduction of new incidental mortality calculations using weighted MRR, several other minor changes were made to REAM catch non-retention (CNR) algorithms to correct small errors identified in the code prior to the 2024 ERA.

Corrections to CNR equations included:

a) change to cohort size estimation for ages with escapement data within an incomplete brood year
b) removal of legal drop-off mortality from sublegal incidental mortality calculations in CNR fisheries
c) change to algorithms for calculating incidental mortality using external estimates of legal kept and released catch

Cohort size estimation during incomplete brood years

In previous ERA models, the mature (i.e., terminal) cohort size (i.e., fish exposed to terminal fisheries and/or fish ≥ 4-years old exposed to ocean net fisheries) for all ages comprising an incomplete brood year (i.e., a brood for which all ages have not yet passed through the fisheries and escaped) was calculated as a function of average ocean harvest rates ($\bar{h}_a$) and maturity rates ($\overline{\alpha}_a$):

$$N_{b,a,v=3} = N_{b,a,v=2} \cdot \left(1 - \bar{h}_a\right) \cdot \overline{\alpha}_a$$

where $N_{b,a,v=2}$ is the pre-fishery ocean cohort size after natural survival (v=2).

In 2024, this equation was corrected so that mature cohort size for ages within an incomplete brood which have already passed through the fishery could be calculated using the same equation as applied to ages in complete brood years, which is simply a summation of catch in terminal fisheries plus escapement:

$$N_{b,a,v=3} = \sum_{f} m_{b,s,f,g,r,l,a} + E_{b,a} \;\in \{f = terminal\}$$

As cohort size is used in the ERA to calculate incidental mortalities for sublegal fish during retention periods, this update impacted mortality estimation during incomplete brood years.

Correction to sublegal incidental mortality algorithms

Re-evaluation of the ERA code identified potential overestimation of sublegal release mortalities during non-retention periods. This error occurred because the model stored sublegal release and drop-off mortalities, as well as legal drop-off mortalities, occurring during retention fisheries within a single object. The summation of all retention fishery release mortalities (both legal and sublegal) was then incorrectly passed into calculations of the encounter rate of sublegal fish during non-retention periods, resulting in double-counting of legal dropoff mortalities?. The REAM code was refactored in 2024 to separate calculations of legal versus sublegal drop-off and release mortalities. As a result, the 2024 ERA was able to correctly calculate the sublegal mortalities in non-retention fisheries purely as a function of sublegal encounters:

$$m_{b,s,f,g=2,r=1,l=2,a} = m_{b,s,f,g=1,r=1,l=2,a} \cdot r_{y,f} \cdot \sigma_{f,l=2}$$

$$m_{b,s,f,g=2,r=2,l=2,a} = m_{b,s,f,g=1,r=2,l=2,a} \cdot r_{y,f} \cdot \sigma_{f,l=2}$$

where $r_{y,f}$ is a ratio of relative season lengths and $\sigma_{f,l=2}$ is the selectivity factor for sublegal fish in non-retention fisheries.

Incidental Mortalities Calculated from Estimates of Legal-size Release and Kept Fish

The ERA model previously used a single set of algorithms to calculate incidental mortalities during non-retention periods when external data was provided as either relative season lengths (or boat days), or as total estimates of legal kept and released fish. For the 2024 ERA, modelers recognized that separate algorithms should be applied when using size-specific data in comparison to indices of fishing effort.

When effort-based indices are applied, which are not size-specific, algorithms need to account for potential differences in vulnerability or selectivity of fish during non-retention and retention periods. The selectivity scalar accounts for potential changes in encounter rate as a function of changes in fisheries management (e.g., spatial or temporal window closures and/or gear restrictions) or fish behaviour (e.g., assumption that the modelled stock has migrated out of the fishing area by the time non-retention Chinook fisheries are opened) during non-retention openings. In such scenarios, non-retention mortalities are calculated as a function of mortalities during retention periods multiplied by ratios of either fishing effort or selectivity. For example, legal release mortalities are calculated as:

$$m_{b,s,f,g=2,r=2,l=1,a} = m_{b,s,f,g=1,r=2,l=1,a} \cdot r_{y,f} \cdot \sigma_{f,l=1}$$

where $r_{y,f}$ is a ratio of retention to non-retention effort, and $\sigma_{f,l=1}$ is legal-size selectivity in non-retention periods relative to that during Chinook retention fisheries.

Upon review, members of the AWG noted a legal selectivity scalar should not be applied when the external data consisted of kept and released legal sized fish, as the kept:released ratio would already account for changes in legal encounter rates during non-retention periods. Applying the selectivity scalar would therefore result in a potential underestimation of legal-size mortalities. In the 2024 ERA, the legal-release mortality equations in non-retention fisheries were re-written as:

$$m_{b,s,f,g=2,r=1,l=1,a} = m_{b,s,f,g=1,r=1,l=1,a} \cdot \partial_{y,f}$$

$$m_{b,s,f,g=2,r=2,l=1,a} = m_{b,s,f,g=1,r=2,l=1,a} \cdot \partial_{y,f}$$

where $\partial_{y,f}$ represents the ratio of legal kept to legal released fish.

However, in this scenario the external data still does not account for potential selectivity differences between legal and sublegal fish. Therefore, an alternative relative selectivity approach was applied based on the ratio of relative sublegal to legal selectivity:

$$\beta_f = \frac{\sigma_{f,l=2}}{\sigma_{f,l=1}}$$

The selectivity ratio was then multiplied by the legal kept-to-release ratio and the release and drop-off mortalities of sub-legal fish during retention periods:

$$m_{b,s,f,g=2,r=1,l=2,a} = m_{b,s,f,g=1,r=1,l=2,a} \cdot \partial_{y,f} \cdot \beta_f$$

$$m_{b,s,f,g=2,r=2,l=2,a} = m_{b,s,f,g=1,r=2,l=2,a} \cdot \partial_{y,f} \cdot \beta_f$$

Appendix I1— Subscripts used in incidental mortality equations

Notation	Range	Description
f	1-F	ERA fisheries (currently 1-79)
b	1-B	Brood years (variable by stock)
y	1-Y	Calendar years (variable by stock)
s	1-45	ERA stocks (currently 45)
a	2-5 or 3-6	Ages
g	1-3	Fishery regulation (1=retention; 2=non-retention; 3=non-retention Method 5 (MRR))
r	1-3	Mortality type (1=release, 2=drop-off, 3=kept)
l	1-2	Fish size categories (1=legal, 2=sublegal)
v	1-3	Vulnerable cohort size (1 = initial, 2 = exposed to ocean fisheries, 3 = exposed to terminal fisheries)

Appendix I2— Parameter and variable names used in incidental mortality equations

Notation	Dimensions	Description
m	by mortality type, fishery regulation, fish size, fishery, brood year, and age	Mortality estimate using expanded CWT recoveries
C	by fishery and calendar year	Total kept catch
d	by fishery and calendar year	Season length or boat days
r	by fishery and calendar year	Ratio of retention to non-retention fishing periods
e	by age	Ratio of sublegal to legal cohort size
E	by brood year and age	Escapement
∂	by fishery and calendar year	Ratio between annual legal CWT mortalities and legal kept catch
ε	by fishery regulation, fish size, brood year, and age	Encounters of CWT recoveries in a fishery
$\bar{\alpha}$	by age	Average maturity rate
φ	by mortality type; by size if for release mortality	Incidental mortality rate (release or drop-off)
σ	by fishery, calendar year, and fish size	Relative vulnerability of fish in non-retention periods (i.e. selectivity factor)
N	by brood year, age, vulnerability	Cohort size
R	by fishery by calendar year	Total releases
$\bar{h}$	by year, by age	Average ocean harvest rate
β	by fishery, by calendar year	Ratio of relative sublegal to legal selectivity
ω	by fishery by calendar year	Weighted marked release rate (MRR)
ρ	by fishery by calendar year	Weighted marked release ratio

Inter-dam loss (IDL)

Many fishery lookups in CAMP were modified to revise the way IDLs were being applied to Hanford Reach (HAN), Upriver Brights (URB), Similkameen (SMK) and Upper Columbia Summers (SUM). In 2020, it was decided to move fishery recoveries that occur upstream of where the IDL is calculated to escapement. This was done so that these fishery recoveries, which occurred in close proximity to escapement locations, would also get expanded for IDL. This should result in more accurate estimates of terminal run and ocean cohort sizes, as the terminal run size would be underestimated if fishery recoveries that occurred after IDL were not expanded.

The decision to move fishery recoveries to escapement in 2020 was viewed as a temporary measure. This approach was not ideal because, while it resulted in more accurate terminal run and ocean cohort size estimates, it also resulted in underestimates of terminal harvest rates.

REAM was anticipated to be finished in 2021, allowing proper accounting for this in REAM. Unfortunately, REAM was not finished until February 2024.

An attempt was made to properly account for IDL dynamics in REAM this year by applying IDL expansion to fishery recoveries upstream of IDL without moving these recoveries to escapement, but that had the unintended consequences of expanding the fishery recoveries and resulting in an overestimate of terminal total mortality. It became apparent that without significant changes to REAM, there was no ideal way to handle IDL application to fishery recoveries.

It was decided to temporarily revert back to the way IDLs were being applied prior to 2020. Thus, in the current analysis, only escapement recoveries are expanded for IDL. This results in underestimates of terminal run size and ocean cohort sizes but less biased terminal harvest rates. Ongoing work in REAM is occurring to better account for IDL and will be incorporated into the 2025 ERA.

For the Lyons Ferry stocks (LYF and LYY), there were also some data updates and corrected calculations. First, newly updated data for 2002-2023 Tucannon escapement estimates were incorporated. Second, fish trapped for broodstock at LGR had been counted as removals between LMN and LGR, but since the trap is above the counting window at LGR, those fish should not have been counted as removals there. This has been corrected and revised brood stock numbers incorporated. All broodstock is currently collected at the LGR trap and some are released, although there also used to be volunteer broodstock at LYF. The current calculation is based on LYF volunteer removals between LMN and LGR minus any of those fish subsequently released. Finally, the Ice Harbor (IH) to Lower Monumental dam IDL rate was changed from the Snake R single pool rate squared (which was copied from the Technical Advisory Committee spreadsheets and would be appropriate for two pools) to just the Snake R single pool rate, since there is only one pool between IH and LMN.

Stock Changes

PSS

Before the transition to REAM, there were two groups of tag codes referred to as SPS (South Puget Sound): a superstock that uses production from four different stocks (GRN, GRO, ISS, and SPS) and the stock within that superstock that contains Puget Sound tag codes released south of GRN, GRO, and ISS. The smaller SPS stock is now named PSS (Puget Sound, South) to avoid confusion.

Similkameen (SMK)

Several additions to the fishery lookup table in CAMP were added so that SMK recoveries in the Columbia River Buoy 10 fishery are treated as terminal. This is consistent with all other Columbia River indicator stocks. Indicator stocks originating outside of the Columbia River that are caught in the Buoy 10 fishery are treated as pre-terminal. These additions should have been made when the SMK indicator stock was created in 2019. It wasn’t until this year that it became apparent that additional fishery lookups were needed.

FISHERY CHANGES

Proportion Non Vulnerable (PNV) Assumptions

Current and historical size limits in North and South Falcon troll and sport fisheries were reviewed. As a result of this review, it was determined that the PNV values previously used were inappropriate given the fishery size limits in some years. A spreadsheet (“pvcalcs4.xlsx”), which has been used historically by the CTC in the ERA and the Chinook Model to determine PNVs based on specific size limits, was referenced to calculate more appropriate PNV values. The following changes were made:

North of Falcon Troll

	Old PNVs				Revised PNVs			
	Age 2	Age 3	Age 4	Age 5	Age 2	Age 3	Age 4	Age 5
1997-1998	0.3193	0.0824	0.0149	0.0049	0.5864	0.5010	0.1444	0.0633
2021-2022	0.5864	0.501	0.1444	0.0633	0.5732	0.4151	0.0915	0.0438

South of Falcon Troll

	Old PNVs				Revised PNVs			
	Age 2	Age 3	Age 4	Age 5	Age 2	Age 3	Age 4	Age 5
2003-2004	0.5924	0.5813	0.217	0.090	0.5732	0.4151	0.0915	0.0438

North of Falcon Sport

	Old PNVs				Revised PNVs			
	Age 2	Age 3	Age 4	Age 5	Age 2	Age 3	Age 4	Age 5
2003-2004	0.5322	0.0824	0.0149	0.0049	0.9165	0.3399	0.0635	0.0316
2020-2022	0.5322	0.0824	0.0149	0.0049	0.3263	0.0149	0.0035	0.0024

South of Falcon Sport

	Old PNVs				Revised PNVs			
	Age 2	Age 3	Age 4	Age 5	Age 2	Age 3	Age 4	Age 5
1992-2006	0.1656	0.0023	0.0004	0.000	0.1139	0.0012	0.000	0.000

CNR

Canadian CNR

Significant Chinook non-retention measures were implemented in most South Coast Areas to address conservation concerns for wild Southern BC, including Fraser River, Chinook Salmon starting in 2019. At the PSC Post Season Meeting in January, 2024 in Seattle, the CIG recommended that the CTC ensure that non-retention impacts are being appropriately incorporated into the ERA for Canadian fisheries where non-retention has been used as a tool to reduce ISBM fishery impacts. After review, there were two changes made to methods used for Canadian fisheries in the 2024 ERA. First, the NBC AABM sport fishery was updated from Method 3 to Method 1 in 1996 as non-retention/non-possession of Chinook was implemented in the Area 1, 2W sport fishery after June 1 to October 31, indicating that this year includes data from both CR and CNR fisheries (TCCHINOOK 99-02). The second change occurred for GEO ST Sport, JNST Sport, and JDF Sport, which were updated from Method 0 to Method 1 in the 2024 ERA from years 2019 to current, which is a reflection of the Chinook non-retention measures that were implemented in these South Coast Areas.

CNR for Puget Sound Sport Fisheries

A concern was identified by WDFW staff in early Spring 2023 with how Chinook non-retention estimates were being generated for marine sport fisheries in the Puget Sound North (PGSDN) and Puget Sound Other (PGSDO) ERA fishery stratifications. Chinook non-retention estimates for the ERA were previously produced using CNR Method 1, which uses season length and the number of angler trips as inputs. CNR Method 1 assumes constant angler effort over time, which is probably not representative of true angler behavior. For example, it is impossible to know which species were targeted during a given angler trip recorded in the Catch Record Card (CRC) database. Anglers fishing during a CNR period may be targeting a different species, using different gear, or changing behavior in other ways to minimize catch of the non-retention species. Shifts in angler behavior during non-retention periods can introduce bias into CNR estimates if not properly accounted for in the estimation method. Old CNR estimates produced using Method 1 did not account for this potential bias, likely leading to overestimates of CNR in Puget Sound marine sport fisheries. Therefore, WDFW staff resolved to provide external estimates (i.e., CNR Method 2) of legal- and sublegal-marked releases in Puget Sound marine sport fisheries using creel data.

External estimates of legal- and sublegal-marked releases were obtained by aligning regulations data with CRC trip data to estimate the number of non-retention trips ($Trips_{NR}$) within a given

CRC catch period and multiplying by the rate of marked releases (MR) (legal or sublegal) per angler.

Equation 1.

$$CNR = Trips_{NR} * MR/Angler$$

The number of non-retention trips was calculated by simply multiplying the total number of angler trips in a CRC catch period by the proportion of days that were non-retention (Equation 2).

Equation 3.

$$Trips_{NR} = Trips_{Total} * \frac{Days_{NR}}{Days_{Total}}$$

Next, the number of legal releases (LR), regardless of mark status, was estimated by assuming an inverse relationship between the total number of releases (R) estimated from creel sampling and the sublegal to legal ratios (SLR) used in FRAM (Equation 4). Similarly, the number of sublegal releases can be solved for by substituting SLR with $\frac{1}{SLR}$ in Equation 5.

Equation 6.

$$LR = \frac{1}{1 + SLR} * R$$

In creel data there is usually some component of the releases with unknown mark status (m) *which must be apportioned correctly into their respective categories to properly estimate the number of marked and unmarked releases (Equation 7).*

Equation 8.

$$Legal\ Marked\ Releases = LR_{m=marked} + \frac{LR_{m=marked}}{LR_{m=unmarked}} * LR_{m=unknown}$$

Finally, the number of legal (or sublegal) marked releases per angler $MR/Angler$ can be calculated by dividing the total number of legal (or sublegal) releases by the total number of anglers in each stratum estimated from CRC data.

Nooksack Springs Terminal Area Adjustment

The Nooksack Spring Fingerlings (NSF) stock exceeded ISBM CYER limits in the 2023 ERA, prompting a management response under subparagraph 7(c) of the PST. As part of the management response, Washington co-managers developed a terminal area adjustment method to account for both a) mark-selective fishing in the terminal areas, b) changes in the distribution of fisheries and fishery regulations over time, and c) shifts in the geographic distribution of marked fish returning to the basin (i.e., the growing contribution of marked releases from the Skookum Creek Hatchery on the South Fork compared to the marked CWT indicator group released at Kendall Creek Hatchery on the North Fork). The terminal area adjustment uses empirical estimates of harvest rates on the wild cohort from fishery monitoring data in the terminal areas and applies fishery-specific release mortality rates in terminal mark-selective fisheries (Freshwater Sport: 12.3%; Tanglenet C&S: 36.3%; Gillnet: 90%)

to adjust the CYERs produced by the ERA such that they more accurately represent exploitation in the wild population. The new terminal area adjustment on NSF accounts for changes in both fishery and hatchery practices that have occurred since the 2009–2015 CYER baseline and produces more accurate CYERs for measuring fishery management objectives.

Alaska Department of Fish and Game Sport Fishery CWT Recovery Data Update

Coded wire tag (CWT) data collected by ADF&G are stored and reported differently throughout the State of Alaska; however, the ADF&G Mark, Tag, and Age Lab (MTAL) provides a unified means of accessing and reporting data from all CWT-related projects statewide. In Southeast Alaska, CWT data collected from sport fisheries are gathered by the Marine Harvest Studies (MHS) program, which until 2016 collected data on “mark sense” forms and stored it in Microsoft Excel spreadsheets and Statistical Analysis Software (SAS) datasets. Electronic data collection began in 2016, coinciding with the creation of an MHS database. These changes made it possible to connect and share information with other ADF&G databases, and a modernization effort connecting the MHS and MTAL databases was initiated in 2019. The goals of the modernization project were two-fold: 1) update the process of transmitting sport data to MTAL and subsequently the Regional Mark Information System (RMIS), and 2) update the methodology used to estimate CWT expansions.

Results from this project were rolled out in the summer of 2023, beginning in May and continuing through August. Numerous changes were made, including:

- A full link between the MHS and MTAL databases (domestic ADF&G) was established, allowing the MHS program to make changes dynamically with immediate downstream effects.
- Automation procedures such as Quality Assurance/Quality Control (QA/QC) routines and daily synching of data were implemented, reducing staff time needed and the number of errors.
- Updates to data collected from 1996–2022, with the greatest impact to data from 2009–present, resulting from methodological changes and an extensive QA/QC effort.
- A new RMIS location code format was adopted for the sport fishery, resulting in a more standardized format used by commercial and sport fisheries, impacting all records from 1977–present.

The changes to the individual CWT estimates and use of a new location code format will be of primary interest to the CTC. The degree to which estimates changed on RMIS can be separated into three time periods: 1977–1995, 1996–2008, and 2009–2022. Outside of the change to the sport location code, no changes were made to the 1977–1995 data. For the 1996–2008 period, the primary change was to strata definitions (i.e., year-time-area-harvest code-species), resulting in mostly minor changes. By far the largest changes were made to data collected between 2009–2022, where the originally reported harvests were based solely on creel (unexpanded to full Southeast Alaska harvest level), resulting in the corresponding CWT estimates being biased low (i.e., sampling rate was over estimated). Proper expansions and resulting *adjusted* CWT estimates were available upon request through the MHS program but were not available or updated on the MTAL, or subsequently further downstream in RMIS.

These differences impact individual CWT indicator stocks differently, with the greatest changes occurring within the 2009–2022 data, but also with minor changes to data from 1996–2008. There remains an outstanding issue related to the harvest of jacks, meaning that another change, albeit small relative to the aforementioned, is expected in the future.

Changes to the RMIS location code format are shown in Appendix I3—I5. The original sport fishery code format (*Appendix I3*) first reported where a fish was surveyed and then where it was harvested, whereas the commercial fishery format only reported where a fish was harvested (*Appendix I4*). To standardize these two definitions, the sport location code format was updated to mimic the commercial fishery format and now reports where a fish was harvested first, followed by where it was surveyed (*Appendix I5*).

The results from this modernization project provided updated CWT estimates on the MTAL and RMIS databases with the best available data and is a marked improvement over older methodologies. The automation, QA/QC, and database management protocols now in place provides the best available sport data of Alaska's recoveries for end users of RMIS.

Appendix I3— Original ADF&G Sport Fishery RMIS Location Code format

	Agency 1 = Alaska	Water - M/F	Region	Survey Site	Sport Harvest Code	Fishing Site Code	? Not used ?	Quadrant	District	Subdistrict	Location Code
# of characters	1	1	1	2	2	1	1	2	3	2	19 max
EXAMPLES	1	M	1	04	TF	B		NE	111	50	1M104TFB NE11150
	1	M	1	04	MB			NW	181	60	1M104MB NW11160
	1	M	1	04				NW	181	60	1M104 NW18160

Appendix I4— ADF&G Commercial Fishery RMIS Location Code format (unchanged)

	Agency 1 = Alaska	Water - M/F	Region	Quadrant	District	? Not Used ?	Subdistrict	not used			Location Code
# of characters	1	1	1	2	3	1	2	8			19 max
EXAMPLES	1	M	1	NE	111		11				1M1NE111 11
	1	M	1	NE	111		12				1M1NE111 12
	1	M	1	NE	111		13				1M1NE111 13

Appendix I5— Updated ADF&G Sport Fishery RMIS Location Code format

	Agency 1 = Alaska	Water - M/F	Region	Quadrant	District	? Not used ?	Subdistrict	Survey Site or Rollup Area Code	Sport Harvest Code	Fishing Site Code	Location Code
# of characters	1	1	1	2	3	1	2	4	2	1	19 max
EXAMPLES	1	M	1	NE	111		50	04	TF	B	1M1NE111 5004 TFB
	1	M	1	NW	181		60	NO1	MB		1M1NE111 60N01 MB
	1	M	1	NW	181		60	NONI			1M1NW181 60NONI

Exclusion of Canadian Pseudo-Recovery Estimates in Washington Fisheries from the 2023 ERA analysis

Due to the two-year lag of CWT estimates for southern U.S. fisheries, Canada has previously produced interim estimates (described as pseudo-recoveries) of Canadian stocks in U.S. Juan de Fuca and Puget Sound fisheries since the 2016 analysis year. These values are used in the ERA (uploaded via auxiliary files) and replaced the following year, once the U.S. estimates became available.

Starting in 2023, these pseudo-recoveries will be excluded due to the tendency to overestimate recoveries. Therefore, the last year of data for affected stocks (CHI, COW, HAR, NIC, MSH and SHU) will not include impacts from southern U.S. fisheries in Appendix C Mortality Distribution Tables. However, Canada will continue to utilize an in-filling technique for their domestic processes and planning purposes.

Overview / Explanation of Chinook Extract, Transform, and Load (CETL) and new loading process

Traditionally, CWT recovery and release data was manually downloaded from RMIS and processed using CAS.exe (a VB.NET application). This application was migrated to an R package called CETL (Chinook Extract, Transform, and Load)[6]. CETL directly downloads, processes, and loads data from RMIS into the CAMP database. CETL replicates all of the logic that existed in CAS, including importing RMIS recovery and release data. Also, CETL adds additional functionality by supporting a test mode and produces comparison/quality assurance reports to allow CTC members to see the impact of data changes before implementation. For the 2023

[6] https://gitlab.com/chinook-technical-committee/programs/r-packages/cetl

ERA, CETL version 1.5.4 was used to load CWT release and recovery data. A full set of changes made to the package is provided in the NEWS page of the code.

In addition to the CETL R Package, a new R Package called qccamp[7] was created to provide numerous data quality checks. The results of the data quality checks are reviewed by CTC members and addressed as needed before the final stock ERA analysis. Functionality and data quality checks incorporated into this package include:

- Comparison of summary data between two successive versions of CAMP databases
- CWT recoveries that do not align with defined fisheries
- CWT recoveries with inconsistent ages
- Tag codes and fisheries with negative total CWT estimates

Auxiliary Files

Instead of the accustomed production of post-hoc expansions for WSH terminal releases, which has been typically accomplished with an update query applied to the CAMP database, auxiliary files were produced to reflect those needed expansion values for this year's ERA. The interaction between data loading from CETL and the need to ensure data integrity in CAMP precluded the utilization of the standardized query structure used for this task in the past. The expansion process (for those terminal WSH recoveries) was accomplished within the structure of CETL, which produced requisite auxiliary files during this year's ERA.

SRH auxiliary records for 1983-1985 were removed: their origin/development is not documented, and such undocumented auxiliary records for SRH had been removed in previous ERAs. In any case, these are not base period years, and their removal has no effect on estimates for recent and upcoming years in the ERA and the CTC Chinook Model Calibration.

[7] https://gitlab.com/chinook-technical-committee/programs/r-packages/qccamp

Appendix J: Pseudo recovery inclusion assessment

LIST OF APPENDIX J FIGURES/TABLES

Introduction

As a result of COVID-19 impacts to hatchery operations in 2020, the 2019 brood year of several Canadian Chinook indicator stocks were released without CWTs or adipose-fin-clip marks, or with insufficient numbers of tags and/or marks. In order to address this information gap, pseudo-recoveries (e.g., CWT recoveries that would have occurred had the 2019 broods been released with sufficient tags and/or marks) were estimated based on historical data. The CTC was interested in what impacts these pseudo-recoveries might have on ERA output; therefore, this Appendix was developed to compare the calendar-year statistics with and without pseudo-recoveries and assess their contribution to the analysis.

Pseudo-recoveries have been estimated for different age classes of fish across multiple years starting with age-2 fish in 2021, and currently up to age-4 fish are included in 2023 for the affected Canadian stocks: Atnarko River (ATN), Big Qualicum (BQR), Chilliwack (CHI), Harrison (HAR), Kitsumkalum River Summer (KLM), Kitsumkalum Yearling (KLY), Middle Shuswap (MSH), Puntledge (PPS), and Robertson Creek (RBT). Previously, Lower Shuswap (SHU) was also included but as of 2023 it was determined that SHU had a sufficient amount of CWT recoveries, and actual CWT recovery data was used for the 2024 ER. The process of estimating pseudo-recoveries was described in a memo provided to the Chinook Interface Group (CIG) by the CTC on February 25, 2022 (CTC 2022c) to which a technical report describing and evaluating the methods used to estimate age-specific pseudo-recoveries was attached. That memo and technical report were included as supplementary materials to the 2022 ERA Report (CTC 2023c), which also includes comparisons of calendar-year statistics with and without pseudo-recoveries. Each ERA Report published since then also includes previous years' comparisons within Appendix J, which is updated annually for every ERA that includes these pseudo-recoveries. This appendix presents comparisons of 2023 calendar-year statistics derived from the 2024 ERA run with and without age-4 pseudo-recoveries. These comparisons were undertaken as a proxy for a sensitivity analysis in order to understand how estimates of ER might vary based on the inclusion of projections of these tag recoveries in both catch and escapement.

Methods

Methods used to estimate stock-specific escapement mortality, landed catch, and total fishery mortalities (landed catch plus incidental mortalities) attributed to component fisheries of ERA indicator stocks are described in Section 2 of this report.

The 2024 ERA was run for each of the nine Canadian ERA indicator stocks missing CWT recoveries from the 2019 brood year due to COVID-19: ATN, BQR, CHI, HAR, KLM, KLY, MSH, PPS, and RBT, both with and without inclusion of age-4 pseudo-recoveries. Age-2 and age-3 pseudo-recoveries from the 2021 and 2022 calendar years, respectively, were included in each ERA run. For this ERA, SHU pseudo-recoveries for all ages were removed from the analysis and, instead, analyses were based on recovery data from the limited tag releases. The results from the ERA runs were then collated across all age classes to calculate stock- and calendar-year-specific total estimated CWT recoveries (escapement, stray, and total fishery mortalities combined), numeric and proportional escapement mortality, and total fisheries mortality. Total fisheries mortality was expressed as Canadian and U.S. calendar year mortalities (CYMs) and CYERs. Calendar year 2023 estimates of these metrics derived from ERA runs with and without age-4 pseudo-recoveries were then compared. Throughout, estimates (*Est*) of CYMs and CYERs derived with pseudo-recoveries are denoted "*PseudoRec*" and those derived without pseudo-recoveries are denoted "*None*". Differences were calculated by subtracting ERA estimates derived without age-4 pseudo-recoveries (Est_{None}) from those derived with them ($Est_{pseudo-rec}$):

$$Diff = Est_{pseudo-rec} - Est_{none}$$

Therefore, positive proportional differences correspond to higher estimates when pseudo-recoveries were included in the ERA ($Est_{PseudoRec} > Est_{None}$), and negative proportional differences correspond to lower estimates when pseudo-recoveries were included in the ERA ($Est_{PseudoRec} < Est_{None}$). Summary figures and associated tables of these results are presented herein. This appendix focuses on estimated total combined mortality, escapement mortality, and total mortality from associated Canadian and U.S. ISBM and AABM fisheries (e.g., data from which CYM and CYER estimates are derived).

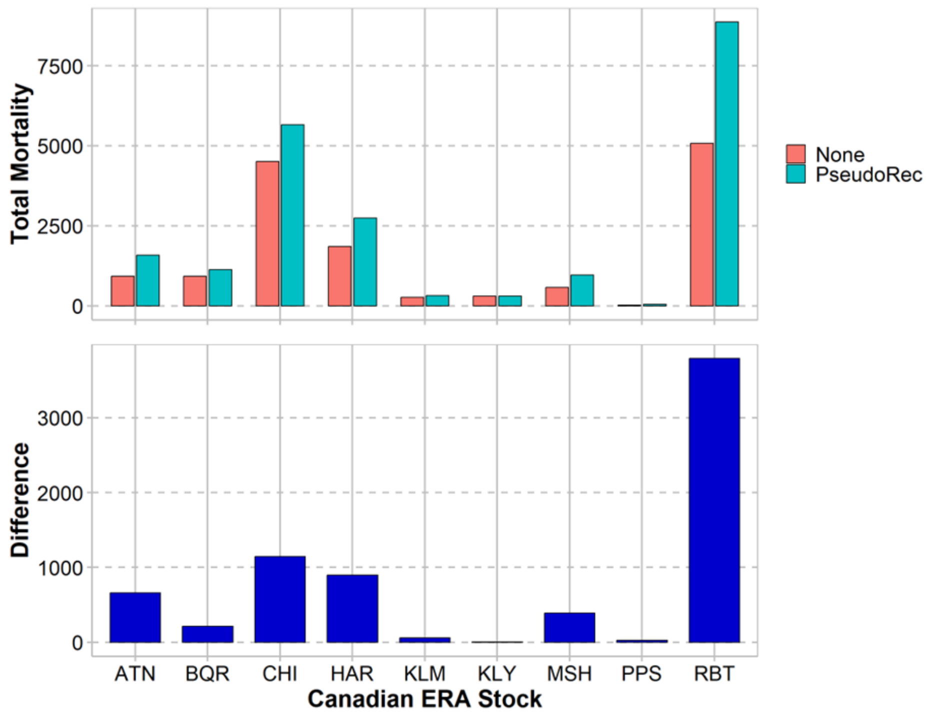
Results

The effects of including age-4 pseudo-recoveries on estimated CWT recoveries across all fisheries (Appendix J1; Appendix J3) and escapement mortalities (Appendix J2; Appendix J3 for the nine Canadian ERA stocks in the 2024 ERA were greater than those for age-2 pseudo-recoveries in 2021 (CTC 2023d). Inclusion of age-4 pseudo-recoveries added between 5 (KLY) and 3,790 (RBT) total mortalities to individual stocks, or between a 3.6% and 33.8% increase in the number of total mortalities, corresponding to a 0 (KLY) to 1,581 (RBT) increase in total escapement mortality. However, the relative differences in escapement mortality between estimates with and without pseudo-recoveries (hereafter referred to as proportional escapement mortality), were minor, ranging from -30.8% to 16% (mean = -6.1%).

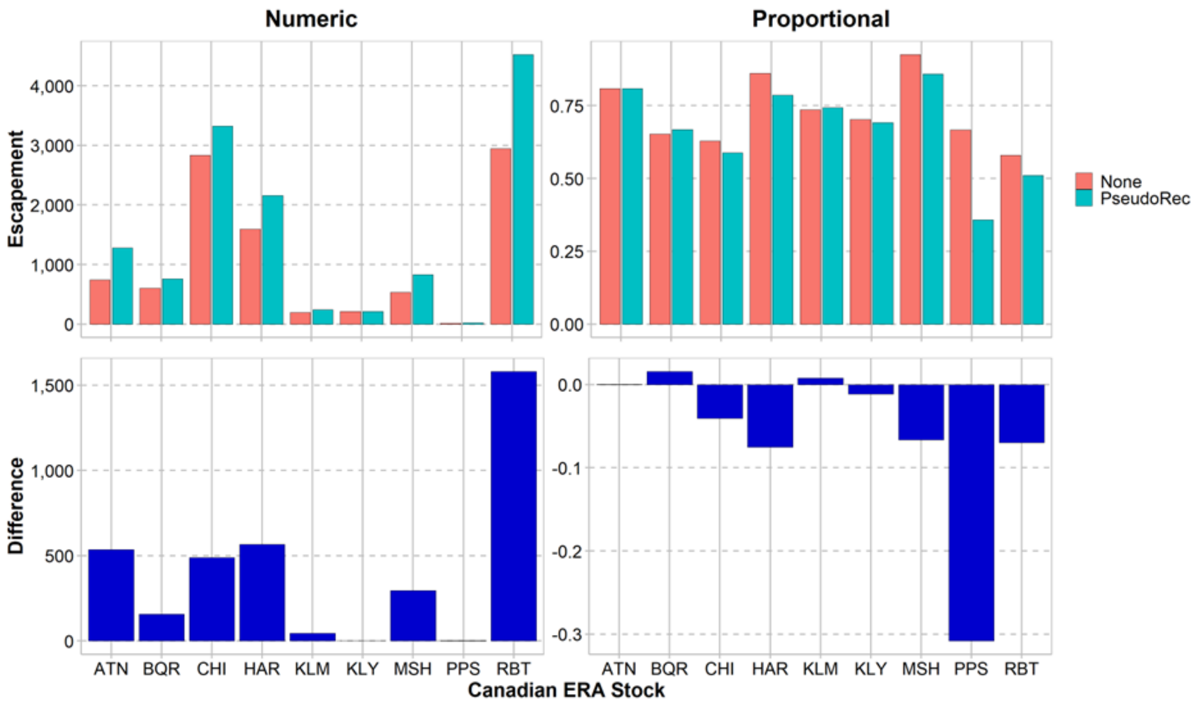
Overall differences in fishery mortalities (i.e., CYM) followed the same trend as total mortalities. Stock-specific total CYMs increased by between five and 2,209 fish for combined Canadian and U.S. ISBM and AABM fisheries with the inclusion of age-4 pseudo recoveries, corresponding to a -1.6% to 30.8% (mean = 6.2 %) change in CYERs (Appendix J4 and Appendix J9).

Differences in Canadian and U.S. ISBM CYMs with and without age-4 pseudo-recoveries were largest for RBT (Canada) and CHI (Canada and U.S.), followed by HAR (U.S.) and ATN (Canada) (Appendix J5; Appendix J9). Canadian ISBM CYER estimates were higher with inclusion of age-4 pseudo-recoveries in all but one case (BQR), with differences ranging from -2.2% to 30.8% (mean 5.9%; Appendix J6; Appendix J9). Among the four Canadian stocks from which fish were caught in U.S. ISBM fisheries, CYER estimates were marginally higher with inclusion of pseudo-recoveries for two stocks (CHI and HAR), with all differences being less than 1%. Most ISBM fishery CYERs were below annual limits and 10% buffers for ERA stocks stipulated in

Attachment I of the PST regardless of whether age-4 pseudo-recoveries were included. However, Canadian estimates for RBT and HAR exceeded these limits, both with and without the inclusion of pseudo-recoveries (Appendix J6). Differences in Canadian AABM CYMs with and without age-4 pseudo-recoveries, relative to those observed for ISBM fisheries, were typically larger for Canadian fisheries and smaller for U.S. fisheries, and greatest for RBT, MSH, and CHI in Canadian fisheries and RBT in U.S. fisheries (Appendix J7 and Appendix J8). However, despite the variable differences in CYM estimates, differences in AABM CYERs were still relatively small, ranging from -3.4% to 3.7%.



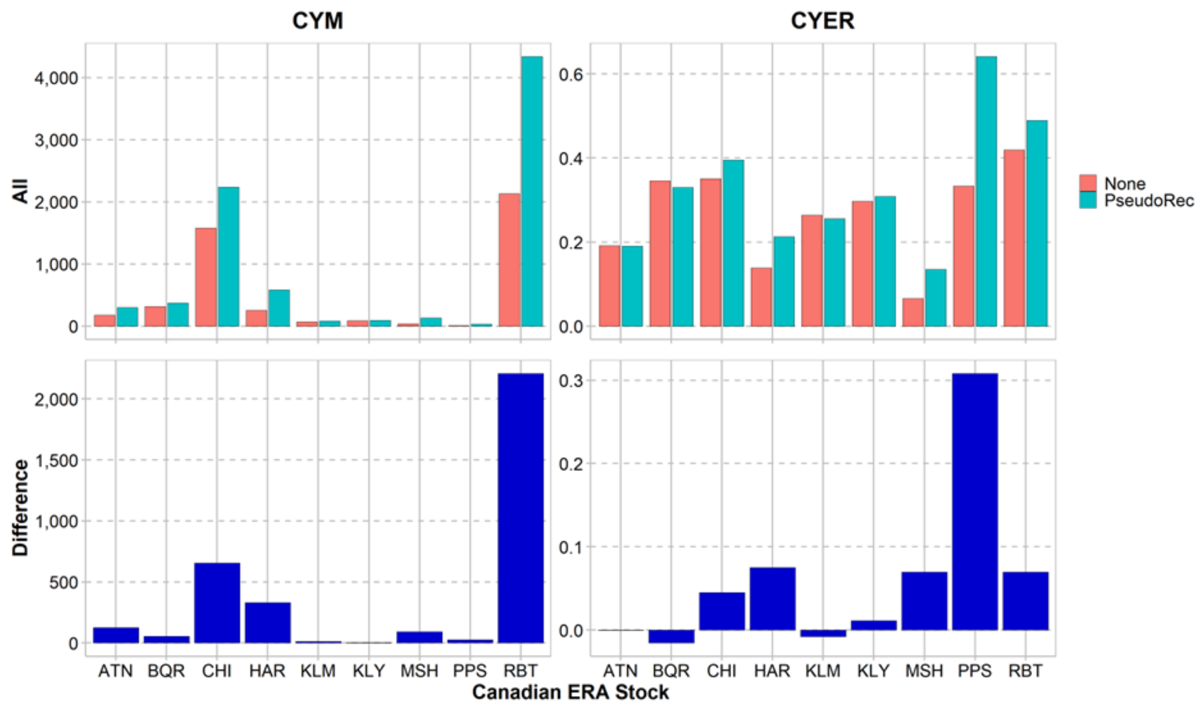
Appendix J1— Comparison of 2023 calendar-year stock-specific estimated coded wire tag recoveries derived with and without age-3 pseudo-recoveries across all fisheries and escapement for 9 Canadian exploitation rate analysis stocks (top) and differences between estimates (bottom).



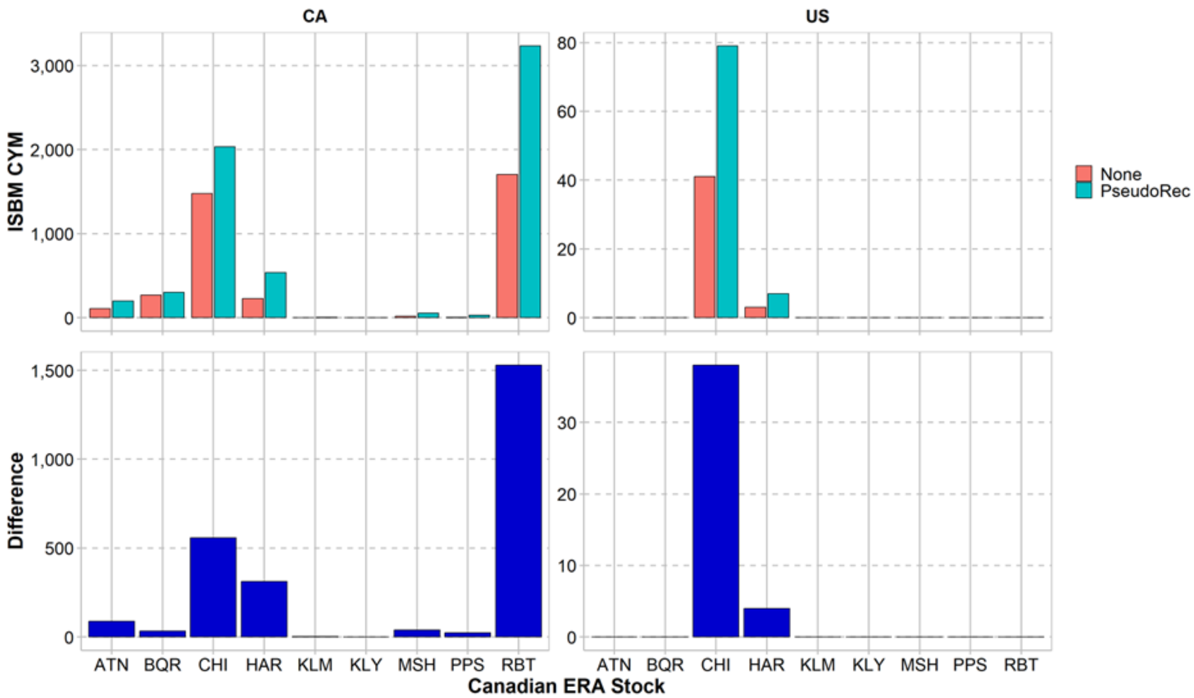
Appendix J2— 2023 calendar-year stock-specific numeric and proportional escapement mortality estimates derived with and without age-4 pseudo-recoveries for 9 Canadian exploitation rate analysis stocks (top) and differences between numeric and proportional estimates (bottom).

Appendix J3— Summary of exploitation rate analysis 2023 calendar-year stock-specific estimated coded wire tag recoveries (mortalities) derived with and without age-4 pseudo-recoveries across all fisheries and escapement mortalities for 9 Canadian stocks.

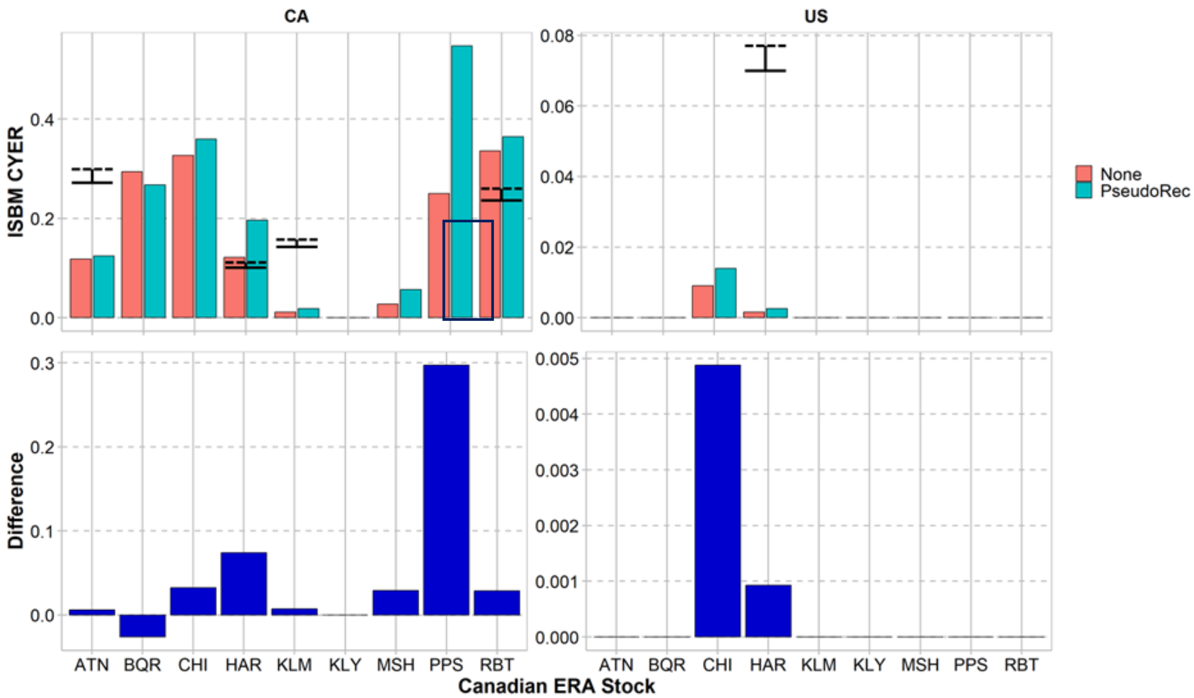
Estimated CWT Recoveries	Metric	Method	Mean	SD	Min	Max
All Fisheries	Numeric	None	1,605.9	1,888.5	24.0	5,075.0
		PseudoRec	2,404.7	2,979.9	53.0	8,865.0
		Difference	798.8	1,192.5	5.0	3,790.0
Escapement	Numeric	None	1,076.2	1,125.9	16.0	2,945.0
		PseudoRec	1,484.7	1,557.8	19.0	4,526.0
		Difference	408.4	495.1	0.0	1,581.0
	Proportional	None	0.729	0.115	0.580	0.926
		PseudoRec	0.669	0.160	0.358	0.859
		Difference	-0.061	0.099	-0.308	0.016



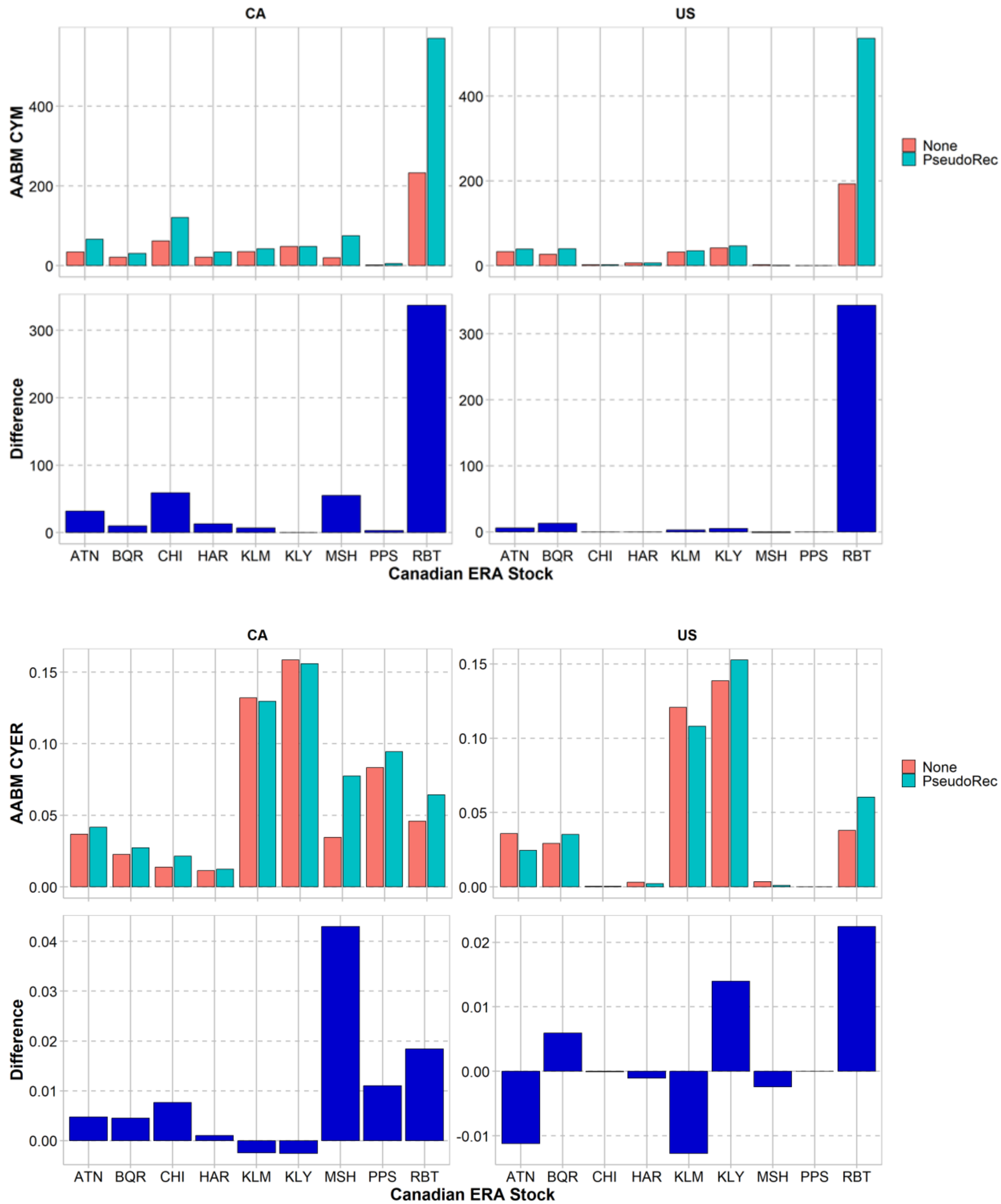
Appendix J4— Stock-specific total 2023 calendar year mortalities (CYM) and exploitation rates (CYER) derived with and without age-4 pseudo-recoveries for 9 Canadian exploitation rate analysis stocks (top) and differences between them (bottom) for abundance-based management regime (AABM) fisheries and individual stock-based management regime (ISBM) fisheries combined.



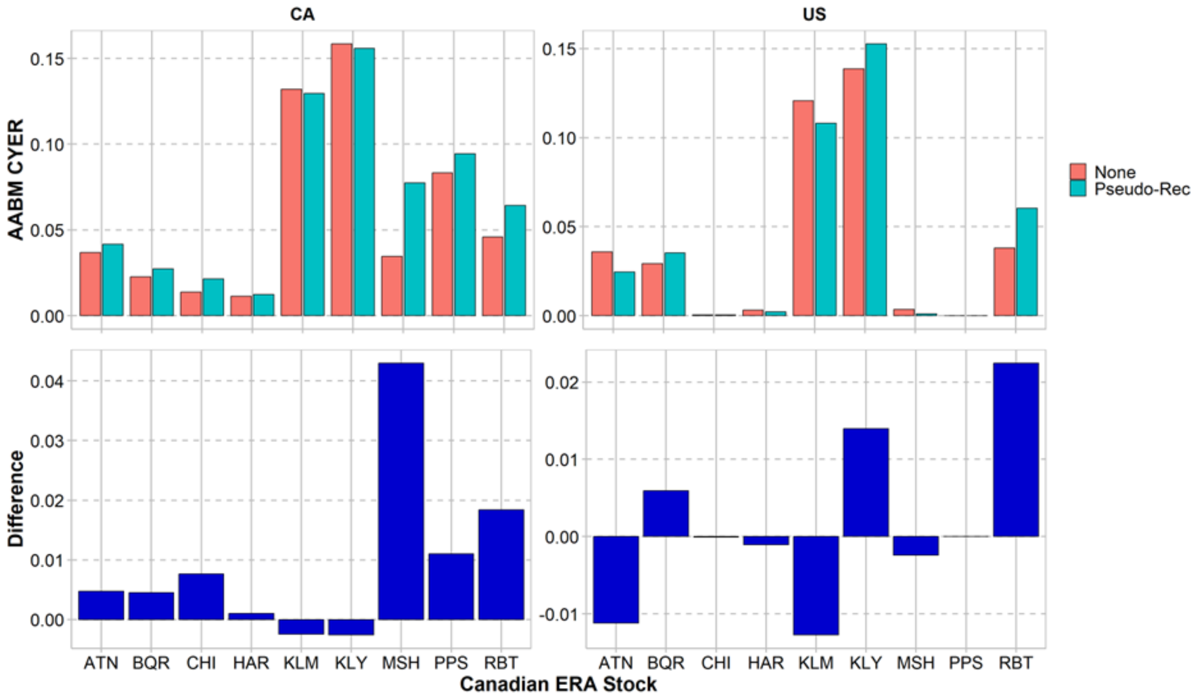
Appendix J5— Comparison of (top), and differences between (bottom) stock- and country-specific individual stock-based management regime (ISBM) total 2023 calendar year mortalities (CYM) derived with and without age-4 pseudo-recoveries for 9 exploitation rate analysis stocks.



Appendix J6— Comparison of (top), and differences between (bottom) stock- and country-specific individual stock-based management (ISBM) regime total 2023 calendar year exploitation rates (CYER) derived with and without age-4 pseudo-recoveries for 9 exploitation rate analysis stocks. Annual CYER limits for specific stocks from Attachment I of Chapter 3 of the Pacific Salmon Treaty are depicted by horizontal black lines (solid) with 10% upper buffers (dashed).



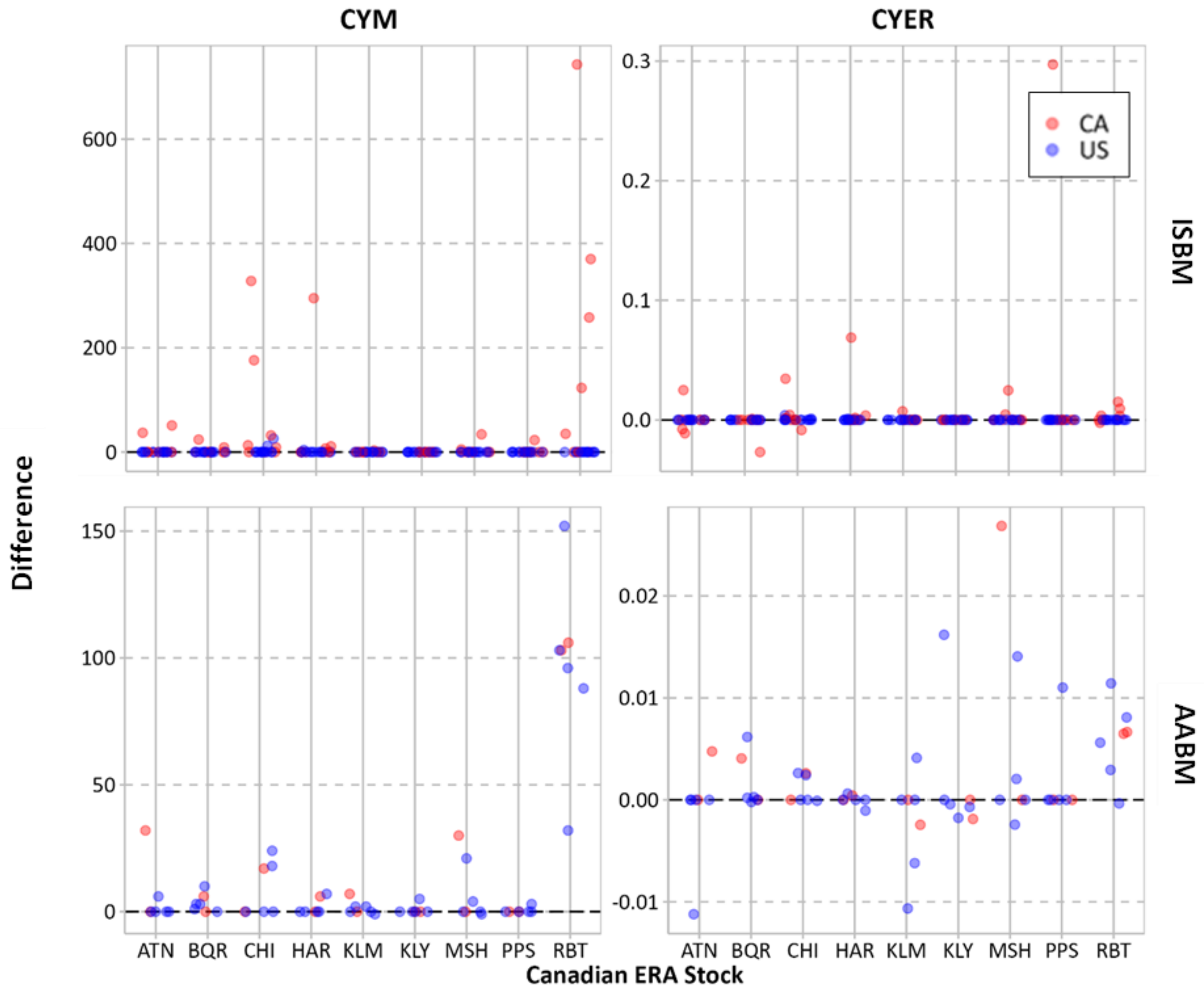
Appendix J7— Comparison of (top), and differences between (bottom) stock- and country-specific abundance-based management regime (AABM) total 2023 calendar year mortalities (CYM) derived with and without age-3 pseudo-recoveries for 9 exploitation rate analysis stocks.



Appendix J8— Comparison of (top), and differences between (bottom) stock- and country-specific abundance-based management regime (AABM) total 2023 calendar year exploitation rates (CYER) derived with and without age-4 pseudo-recoveries for 9 exploitation rate analysis stocks.

Appendix J9— Summary of ERA stock-specific estimates of total 2023 calendar year mortalities (CYM) and exploitation rates (CYER) across all associated individual stock-based management regime (ISBM) and aggregate abundance-based management regime (AABM) fisheries combined and all Canadian and U.S fisheries separately.

Fisheries Group	Metric	Method	Mean	SD	Min	Max
All Fisheries	CYM	None	518.7	776.9	8.0	2,130.0
		PseudoRec	909.0	1,457.7	34.0	4,339.0
		Difference	390.3	713.7	5.0	2,209.0
	CYER	None	0.267	0.114	0.066	0.420
		PseudoRec	0.329	0.160	0.135	0.642
		Difference	0.0617	0.099	-0.016	0.308
ISBM	CYM	None	428.3	679.3	0.0	1,704.0
		PseudoRec	720.3	1,155.4	0.0	3,233.0
		Difference	292.0	504.6	0.0	1,529.0
	CYER	None	0.166	0.140	0.000	0.336
		PseudoRec	0.217	0.187	0.000	0.547
		Difference	0.051	0.097	-0.026	0.297
AABM	CYM	None	90.3	128.8	2.0	426.0
		PseudoRec	188.7	345.8	5.0	1,106.0
		Difference	98.3	219.1	3.0	680.0
	CYER	None	0.101	0.103	0.014	0.297
		PseudoRec	0.112	0.099	0.015	0.308
		Difference	0.0111	0.019	-0.015	0.041
Canada	CYM	None	476.3	728.6	8.0	1,937.0
		PseudoRec	821.0	1,302.5	34.0	3,803.0
		Difference	344.7	604.7	0.0	1,866.0
	CYER	None	0.225	0.117	0.062	0.382
		PseudoRec	0.284	0.171	0.134	0.642
		Difference	0.059	0.099	-0.022	0.308
US	CYM	None	42.3	58.8	0.0	193.0
		PseudoRec	88.0	169.9	0.0	536.0
		Difference	45.7	112.1	-1.0	343.0
	CYER	None	0.042	0.052	0.000	0.139
		PseudoRec	0.045	0.053	0.000	0.153
		Difference	0.002	0.011	-0.013	0.022



Appendix J8— Canadian and U.S. individual stock-based management regime (ISBM; top) and aggregate abundance-based management regime (AABM; bottom) Fishery-specific differences in total 2023 calendar year mortalities (CYM; left) and exploitation rates (CYER; right) derived with and without age-4 pseudo-recoveries for 9 ERA stocks.