PACIFIC SALMON COMMISSION
JOINT CHINOOK TECHNICAL COMMITTEE REPORT

2020 PSC Chinook Model Calibration

TCCHINOOK (2021)-04

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List of Acronyms and Abbreviations

AABM	Aggregate Abundance Based Management
ACL	Annual Catch Limit
ADF&G	Alaska Department of Fish & Game
AEQ	Adult Equivalent
AI	Abundance Index
AIC	Akaike Information Criterion
ARIMA	Auto Regressive Integrated Moving Average
AWG	Analytical Working Group of the CTC
BC	British Columbia
BSE	Base Calibration File
BY	Brood Year
CAN	Canada
CBC	Central British Columbia
CLB	Calibration
CNR	Chinook Nonretention
CRITFC	Columbia River Inter-Tribal Fish Commission
CTC	Chinook Technical Committee
CWT	Coded-Wire Tag
CY	Calendar Year
CYER	Calendar Year Exploitation Rate
DFO	Department of Fisheries and Oceans Canada
DGM	Data Generated Module
DIT	Double Index Tag
ERA	Exploitation Rate Analysis
ESA	Endangered Species Act
EV	Environmental Variable scalar
FCS	Forecast File
FI	Fishery Index
FNC	First Nations Caucus
FP	Fishery Policy
HRI	Harvest Rate Index
IDL	Interdam Loss File
IM	Incidental Mortality
ISBM	Individual Stock-Based Management
MAE	Mean Absolute Error
MAPE	Mean Absolute Percent Error
MASE	Mean Absolute Scaled Error
MAT	Maturity Factor
MRE	Mean Relative Error
NA	Not Available
NBC	Northern BC Dixon Entrance to Kitimat including Haida Gwaii
NOAA	National Oceanic and Atmospheric Administration
NWIFC	Northwest Indian Fisheries Commission
ODFW	Oregon Department of Fish & Wildlife
PCOH	Partial Cohort
PNV	Proportion Non-Vulnerable
PSC	Pacific Salmon Commission
PST	Pacific Salmon Treaty
QIN	Quinault Indian Nation
RMSE	Root Mean Squared Error
ROM	Ratio of Means
SACE	Stock Aggregate Cohort Evaluation
SEAK	Southeast Alaska Cape Suckling to Dixon Entrance
SPFI	Stratified Proportional Fishery Index
TAC	Technical Advisory Committee
TBD	To Be Determined
TBR	Transboundary Rivers
UAF	University of Alaska Fairbanks
U.S.	United States
USFWS	US Fish & Wildlife Service
WA/OR	Ocean areas off Washington and Oregon North of Cape Falcon
WCVI	West Coast Vancouver Island excluding Area 20
WDFW	Washington Department of Fish and Wildlife

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Note: Product names used in this publication are included for completeness, but do not constitute product endorsement.

EXECUTIVE SUMMARY

The 2019 Pacific Salmon Treaty (PST) Agreement requires the Chinook Technical Committee (CTC) to annually report a suite of catch and escapement data and modeling results used to manage Chinook salmon fisheries and stocks harvested within the Treaty area. To fulfill this obligation, the CTC provides a series of annual reports to the Pacific Salmon Commission (PSC). This report provides an overview of the annual PSC Chinook Model calibration process and results, including post-season abundance indices (AIs) through 2019 and pre-season AIs through 2020 used for the management of aggregate abundance-based management (AABM) fisheries. Also included is an initial evaluation of AABM fishery performance as it relates to the terms of the 2019 PST Agreement, in addition to evaluations of model performance such as model error, stock composition of AIs, fishery indices, and stock forecasts used as inputs to the PSC Chinook Model.

In October 2019, the PSC adopted the new "Phase II" configuration of the PSC Chinook Model for use beginning with the 2020 annual model calibration. The Phase II configuration of the PSC Chinook Model is based on an updated base period calibration (BPC) that includes finer scale stock and fishery stratifications. The CTC is in the process of documenting these improvements through a series of reports. The first report contrasts base period exploitation rate and observed catches over time between the previous BPC (9806) and the Phase II BPC fisheries (CTC 2021a). The second report contrasts base period coded-wire tag (CWT) recoveries, base period cohort sizes, maturation rates, and adult equivalents, and base period exploitation rates between the previous BPC (9806) and the Phase II BPC model stocks (CTC *In prep. a*). The third report contrasts other model parameters and programs from the previous BPC (9806) and the Phase II BPC (CTC *In prep. b*).

Unlike other annual calibration reports that present results from a single model calibration, this report contains results from three different 2020 model calibrations due to the need to: (1) produce 2020 pre-season AIs using the Phase II model configuration (CLB 2002), (2) produce 2019 post-season AIs with the previous 9806 model configuration (CLB 2000–9806), and (3) revise CLB 2002, as errors in maturation rate inputs were identified at a later date (CLB 2003). Model calibrations are named using the last two digits of the year (20) followed by the iteration number of the calibration (02). The 2019 PST Agreement applies to all analyses and model calibration results for 2019 through 2028.

AABM Abundance Indices and Associated Catches

Paragraph 6(a) and (b) of the 2019 PST Agreement defines abundance-based annual catch limits (ACLs) for the 3 AABM fisheries—Southeast Alaska (SEAK), Northern British Columbia (NBC), and West Coast Vancouver Island (WCVI). Each year, the annual model calibration provides the post-season AIs for the previous year and the pre-season AIs for the current year. Pre-season AIs are used to determine the ACLs in the upcoming fishing season for the NBC and WCVI AABM fisheries corresponding to Table 1 of Chapter 3. Beginning in 2019, the pre-season ACL for the SEAK AABM fishery is determined by the SEAK early winter District 113 Troll fishery catch per unit effort (CPUE) metric. Per paragraph 6(a), *"annual catch limits are specified in Table 1 (catch limits specified at levels of the Chinook abundance index)"* based on annual calibrations of the

PSC Chinook Model and "*Table 2 (catch limits for the SEAK AABM fishery and the catch per unit effort (CPUE)-based tiers), unless otherwise specified by the Commission.*"

Catch overages and underages in AABM fisheries are tracked relative to pre-season AIs (or CPUE metrics) and post-season AIs and their associated ACLs. Any overages relative to the pre-season ACLs must be paid back in the subsequent fishing year, per 2019 PST Agreement subparagraph 6(h)(i). If overages are observed in two successive years relative to post-season ACLs, then the PSC will request that the management entity responsible for the affected AABM fishery take steps to reduce the variance between the pre-season and post-season ACLs per subparagraph 7(b)(i) and the CTC must recommend a plan to the PSC to "*improve the performance of pre-season, in-season, and other management tools so that the deviations between the catches and post-season fishery limits to AABM fisheries are narrowed to a maximum level of 10%*" per subparagraph 7(b)(ii).

Abundance Indices for 2019–2020 for the Southeast Alaska (SEAK), Northern British Columbia (NBC), and West Coast Vancouver Island (WCVI) aggregate abundance-based management (AABM) fisheries. Post-season Indices for each year are from the first post-season calibration following the fishing year. Per paragraph 6(b) of the 2019 PST Agreement, SEAK annual catch limits are set based on a catch per unit effort (CPUE) statistic, which is provided in parentheses following the abundance index (AI).

	SEAK		NBC		WCVI	
Year	Pre-season	Post-season	Pre-season	Post-season	Pre-season	Post-season
2019[1]	1.07 (3.38)	1.04	0.96	0.94	0.61	0.58
2020[2]	1.13 (4.83)		1.08		0.75	

[1] Post-season AIs are from CLB 2000–9806 (old model configuration).
[2] Pre-season AIs are from CLB 2002 (Phase II model configuration).

The pre-season and post-season Treaty catch limits by fishery for each year and actual Treaty catches (total catch minus any hatchery add-on and exclusion catch) are shown for AABM fisheries for 2019–2020 in the table below.

Pre-season annual catch limits (ACLs) (2019–2020), and post-season ACLs and actual catches (2019) for aggregate abundance-based management (AABM) fisheries. Post-season values for each year are based on abundance indices (AIs) from the first post-season calibration following the fishing year.

Year	SEAK (Troll, Net, Sport)			NBC (Troll, Sport)			WCVI (Troll, Sport)		
	Pre-season ACL	Post-season ACL	Actual Catch	Pre-season ACL	Post-season ACL	Actual Catch	Pre-season ACL	Post-season ACL	Actual Catch
2019[2]	140,323[1]	140,323	140,307	124,800	122,200	88,026	79,900	76,000	73,482
2020[3]	205,165[1]			133,000			87,000		

[1] Per paragraph 6(b) of the 2019 PST Agreement, this number represents the ACL based on a CPUE statistic.
[2] Post-season ACLs are based on AIs from CLB 2000–9806 (old model configuration).
[3] Pre-season ACLs are based on AIs from CLB 2002 (Phase II model configuration).

Overages and underages in AABM catches, relative to pre-season and post-season ACLs for a fishing year can arise due to the operation of the inseason management system referred to herein as *management error*, errors in the pre-season calibration process (e.g., forecast error) or CPUE statistic referred to as *model error*, or a combination of the two referred to as *composite error*. The relative influence of each was evaluated by inspecting differences in actual landed catch and both pre-season ACLs, as shown in the table below. In 2019, actual landed catch was less than the pre-season ACL by 16 fish (0%) in SEAK, 36,774 (29%) in NBC, and 6,418 (8%) in WCVI due to inseason management; thus, no payback was necessary for the 2020 fishing season per the terms of subparagraph 6(h)(i) of the 2019 PST Agreement. In terms of the post-season ACLs for evaluation of the provisions of paragraph 7(b) of the 2019 PST Agreement, 2019 actual catches were less than the post-season ACLs by 16 fish in SEAK (0%), 34,174 (28%) in NBC and 2,518 (3%) in WCVI; thus, no additional actions are warranted.

Summary of aggregate abundance-based management (AABM) fishery performance and deviations between pre- and post-season annual catch limits (ACLs) and actual catches for Southeast Alaska (SEAK), Northern British Columbia (NBC), and West Coast Vancouver Island (WCVI), 2019.

Positive values indicate an overage and negative values indicate an underage. Colored cells indicate AABM fishery performance relative to Treaty obligations; cells shaded green indicate where a fishery met Treaty obligations and red cells indicate where a fishery exceeded Treaty obligations.

	Management Error Actual – Pre ACL		Model Error Pre ACL – Post ACL		Composite Error Actual – Post ACL	
Year	#	%	#	%	#	%
SEAK (Troll, Net, Sport)						
2019	-16	0%	0	0%	-16	0%
NBC (Troll, Sport)						
2019	-36,774	-29%	2,600	2%	-34,174	-28%
WCVI (Troll, Sport)						
2019	-6,418	-8%	3,900	5%	-2,518	-3%

1. INTRODUCTION

Chapter 3 of the 2019 Pacific Salmon Treaty (PST) Agreement requires the Chinook Technical Committee (CTC) to annually report a suite of catch and escapement data and modeling results used to manage Chinook salmon fisheries and stocks harvested within the Treaty area. To fulfill this obligation, the CTC provides a series of annual reports to the Pacific Salmon Commission (PSC). This report provides an overview of the annual PSC Chinook Model calibration process and results, including post-season abundance indices (AIs) through 2019 and pre-season AIs through 2020 used for the management of aggregate abundance-based management (AABM) fisheries. Also included is an evaluation of AABM fishery performance as it relates to the terms of the Treaty, in addition to evaluations of model error, stock composition of AIs, fishery indices, and stock forecasts used as inputs to the PSC Chinook Model. The CTC uses the PSC Chinook Model to generate key outputs of relevance to the PSC's annual fishery management cycle. The model is calibrated each year, incorporating pre-season stock-specific abundance forecasts with the latest information on catches, exploitation rates generated through cohort analysis, terminal runs, and escapements. The Parties rely upon the model to generate annual estimates of abundance for AABM fisheries (Figure 1.1).

Abundance index prediction is a primary goal of the pre-season PST Chinook salmon management process, as pre-season AIs determine the annual catch limits (ACLs) for 2 of the 3 AABM fisheries: Northern British Columbia (NBC) and West Coast Vancouver Island (WCVI). Beginning in 2019, the pre-season ACL for the Southeast Alaska (SEAK) AABM fishery is determined by the SEAK early winter District 113 Troll fishery catch per unit effort (CPUE) metric. These pre-season ACLs drive the in-season management of AABM fisheries and are used to evaluate fishery performance and management error. In addition to generating pre-season AIs, the model provides other information of immediate relevance to PSC management, most notably post-season AIs. The first post-season AI estimates are used to determine the post-season fishery limits from which model error can be evaluated.

This report describes the PSC Chinook Model calibration (CLB) process and results for 2019 (Section 2). The results of the pre-season model calibration for 2020 are based on the CTC's annual exploitation rate analysis (ERA) using CWT data through catch year 2019 (2018 for southern U.S. stocks); coastwide data on catch, spawning escapements, and age structure through 2019; and forecasts of Chinook salmon returns expected in 2020. This report includes: (1) estimated post-season AIs for 1979 through 2019 and the pre-season AIs for 2020 for the AABM fisheries; (2) estimated stock composition for 1979–2019 and a projection for 2020 for the AABM and other fisheries; and (3) estimated fishery indices (harvest rates) for the AABM fisheries. An evaluation of AABM fishery performance relative to the 2019 PST Agreement is provided in Section 3 of this report. Section 4 contains a validation of the PSC Chinook Model and summary of model improvement activities.

Appendix A shows the relationship between the exploitation rate indicator stocks, escapement indicator stocks, model stocks, and PST Attachment I stocks. Appendix B through Appendix G present additional output from the model calibration beyond the summaries presented in the main body of the report. Appendix B and Appendix C show the model estimates of stock composition in AABM and other sport and troll fisheries. Appendix D lists the incidental mortality (IM) rates used in the PSC Chinook Model. Appendix E gives the time series of total AIs for the AABM fisheries, and Appendix F provides the AIs for each Model stock within each AABM fishery. Appendix G provides a tabular summary of forecast error for PSC Chinook Model stocks. Calibration methodology is detailed in Appendix H. Issues with and changes to Model calibration, as well as their resolution, are detailed in Appendix I.

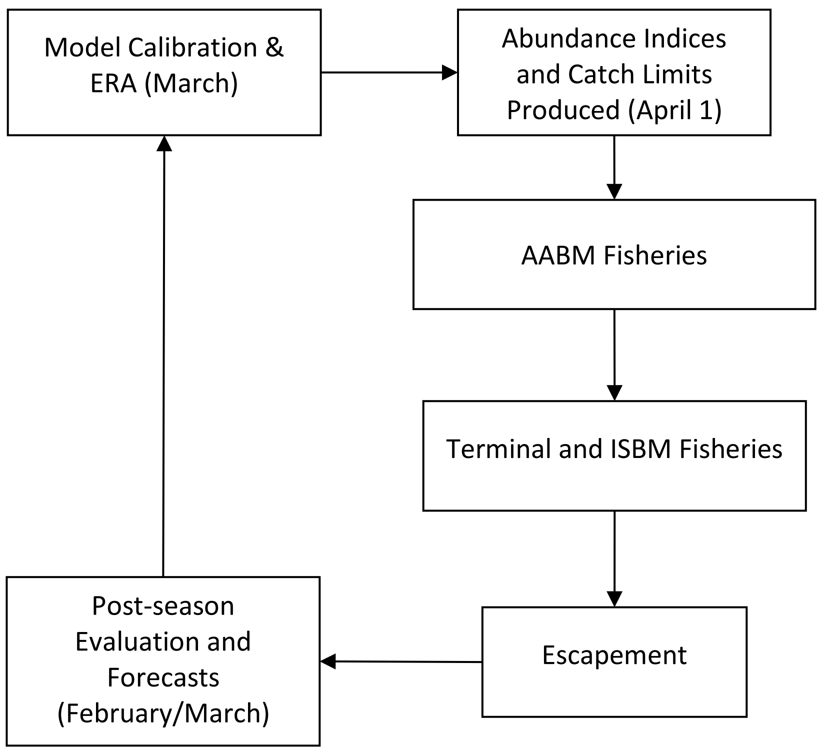

Figure 1.1.—Pacific Salmon Treaty (PST) Chinook management and fisheries process.

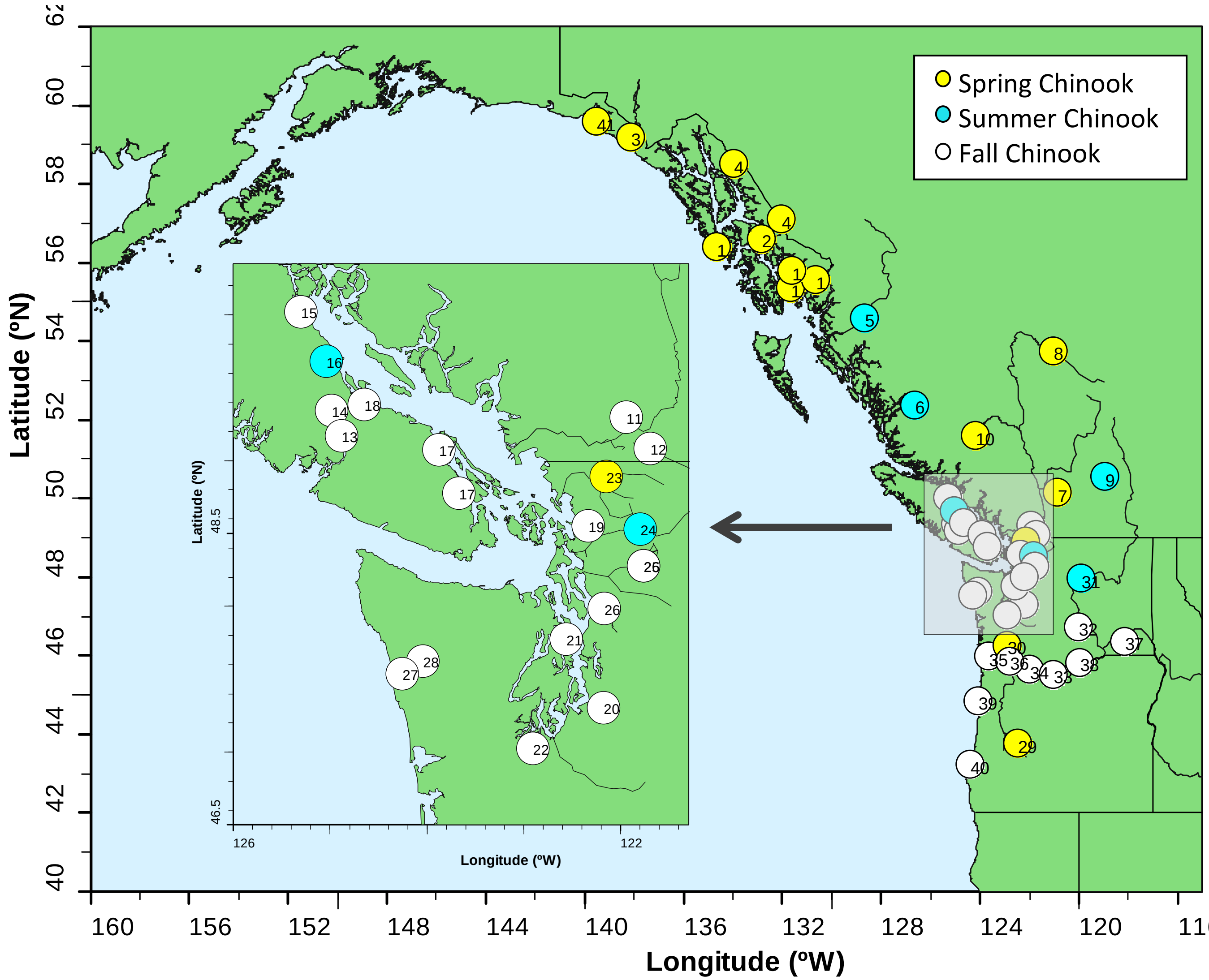

Figure 1.2.—Geographical locations of Phase II PSC Chinook Model stock groups.

Note: See Table 1.1 for the full stock names associated with each abbreviation and map indicator.

Table 1.1.—Stock groups used in the Phase II PSC Chinook Model, associated CWT indicator(s), location, run type, smolt age, and map indicator.

Area	Model Stock	CWT Indicator	Run Type	Smolt Age	Map ID
Southeast Alaska	Southern Southeast Alaska (SSA)	Whitman Lake (AHC), Little Port Walter (ALP), Deer Mountain (ADM), Neets Bay (ANB)	Spring	Age 1	1
	Northern Southeast Alaska (NSA)	Crystal Lake (ACI)	Spring	Age 1	2
Transboundary	Alsek (ALS)	Wild – No indicator	Spring	Age 1	3
	Taku and Stikine (TST)	Wild Taku and Stikine Rivers	Spring	Age 1	4
	Yakutat Forelands (YAK)	Wild – No indicator	Spring	Age 1	41
North/Central British Columbia	Northern B.C. (NBC)	Kitsumkalum (KLM)	Summer	Age 0	5
	Central B.C. (CBC)	Atnarko (ATN)	Summer	Age 1	6
West Coast Vancouver Island	WCVI Hatchery (WVH)	Robertson Creek (RBT)	Fall	Age 0	13
	WCVI Natural (WVN)	Robertson Creek (RBT)	Fall	Age 0	14
Strait of Georgia	Upper Strait of Georgia (UGS)	Quinsam (QUI)	Fall	Age 0	15
	Middle Strait of Georgia (MGS)	Big Qualicum (BQR)	Fall	Age 0	18
	Puntledge Summers (PPS)	Puntledge (PPS)	Summer	Age 0	16
	Lower Strait of Georgia (LGS)	Cowichan (COW); Nanaimo (NAN)[1]	Fall	Age 0	17
Fraser River	Fraser Spring 1.2 (FS2)	Nicola (NIC)	Spring	Age 1	7
	Fraser Spring 1.3 (FS3)	Dome (DOM)[2]	Spring	Age 1	8
	Fraser Ocean-type 0.3 (FSO)	Lower Shuswap (SHU)	Summer	Age 0	9
	Fraser Summer Stream-type 1.3 (FSS)	Chilko (CKO)	Summer	Age 1	10
	Fraser Harrison Fall (FHF)	Harrison (HAR)	Fall	Age 0	11
	Fraser Chilliwack Fall Hatchery (FCF)	Chilliwack (CHI)	Fall	Age 0	12
North Puget Sound	Nooksack Spring (NKS)	Nooksack Spring Fingerling (NSF)	Spring	Age 0	23
	Nooksack Fall (NKF)	Samish Fall Fingerling[3] (SAM)	Summer/Fall	Age 0	19
	Skagit Wild (SKG)	Skagit Summer Fingerling (SSF)	Summer	Age 0	24
	Stillaguamish Wild (STL)	Stillaguamish Fall Fingerling (STL)	Summer/Fall	Age 0	25
	Snohomish Wild (SNO)	Snohomish Wild (SNO)	Summer/Fall	Age 0	26
South Puget Sound	Puget Sound Fingerling (PSF)	S. Puget Sound Fall Fingerling[3] (SPS)	Summer/Fall	Age 0	20
	Puget Sound Natural Fall (PSN)	S. Puget Sound Fall Fingerling[3] (SPS)	Summer/Fall	Age 0	21
	Puget Sound Yearling (PSY)	South Puget Sound Fall Yearling (SPY); University of Washington Accelerated (UWA)[4]	Summer/Fall	Age 1	22
Washington Coast	Washington Coast Natural (WCN)	Hoko Fall Fingerling (HOK)	Fall	Age 0	28
	Washington Coast Hatchery (WCH)	Queets Fall Fingerling (QUE); Tsoo-Yess Fall Fingerling (SOO)	Fall	Age 0	27
Columbia River	Lower Bonneville Hatchery (BON)	Columbia Lower River Hatchery[3] (LRH)	Fall Tule	Age 0	34
	Fall Cowlitz Hatchery (CWF)	Cowlitz Tule (CWF)	Fall Tule	Age 0	35
	Cowlitz Spring Hatchery (CWS)	Cowlitz Spring Hatchery (CWS)	Spring	Age 1	30
	Lewis River Wild (LRW)	Lewis River Wild (LRW)	Fall Bright	Age 0	36
	Spring Creek Hatchery (SPR)	Spring Creek Tule[3] (SPR)	Fall Tule	Age 0	33
	Willamette River Spring (WSH)	Willamette Spring[3] (WSH)	Spring	Age 1	29
	Mid-Columbia River Brights	Mid-Columbia River Brights (MCB)	Fall	Age 0	38
	Columbia River Summer (SUM)	Columbia Summers[5] (WA) (SUM)	Summer	Age 0/1	31
	Upriver Brights (URB)	Columbia Upriver Bright (URB)[1]	Fall Bright	Age 0	32
Snake River	Lyons Ferry (LYF)	Lyons Ferry[3,5] (LYF)	Fall Bright	Age 0	37
North Oregon Coast	North Oregon Coast (NOC)	Salmon (SRH)	Fall	Age 0	39
Mid Oregon Coast	Mid-Oregon Coast (MOC)	Elk River (ELK)	Fall	Age 0	40

[1] Tagged releases for the Nanaimo Fall stock were discontinued after the 2004 brood.
[2] Hatchery production of the Dome Creek stock was discontinued after the 2002 brood.
[3] Double index tags (DIT) associated with this stock.
[4] The last year included in the exploitation rate analysis for University of Washington Accelerated was 1984.
[5] Subyearlings have been CWT-tagged since brood year (BY) 1986, except for BYs 1993–1997.

2. PSC Chinook Model Calibration and Output

The annual calibration of the PSC Chinook Model provides pre-season AIs for the three AABM fisheries and post-season AIs for the previous year. The AI is the ratio between the expected catch in the year of interest under base period exploitation patterns unless adjusted by fishery policy (FP) scalars and the estimated average catch during the 1979–1982 base period. The 2020 pre-season AIs are used to determine the ACLs of Treaty Chinook salmon in the NBC and WCVI AABM fisheries for 2020. Post-season AIs are used to determine the previous (2019) season's post-season ACLs for all three AABM fisheries and to evaluate model error. For additional calibration details, including key input data, procedures, and output data, see Appendix H.

2.1 Overview of 2020 Calibration Process

In October 2019 the PSC adopted the new "Phase II" configuration of the PSC Chinook Model for use beginning with the 2020 annual model calibration. The Phase II configuration of the PSC Chinook Model is based on an updated base period calibration (BPC) that includes improved finer scale stock and fishery stratifications. The CTC is currently in the process of documenting these improvements through a series of three reports. The first contrasts base period exploitation rate and actual catches over time between the previous BPC (9806) and the Phase II BPC fisheries (CTC 2021a). The second contrasts base period CWT recoveries, base period cohort sizes, maturation rates and adult equivalents, and base period exploitation rates between the 9806 BPC and the Phase II BPC model stocks (CTC *In prep.* a). The third contrasts other model parameters and programs from the 9806 BPC and the Phase II BPC (CTC *In prep.* b).

The CTC Analytical Work Group (AWG) met remotely in March 2020 to perform the PSC Chinook Model calibration for use in the upcoming fishing year. Necessitated by the COVID-19 pandemic, this marked the first remote meeting for the CTC AWG. This was also the first time the new Phase II PSC Chinook Model was used to set ACLs. Conducting the calibration remotely was challenging and a calibration was not produced during the initial meeting week. Compiling maturity rates for the PSC Chinook Model was the primary impediment to conducting a calibration. Several preliminary calibrations were produced after the initial meeting week and the AWG agreed to endorse calibration CLB 2002. In late March, the CTC produced its annual memo to the PSC detailing the 2020 pre-season AIs and ACLs for the AABM fisheries based on CLB 2002 and the SEAK early-winter troll fishery CPUE index (per the 2019 PST Agreement).

In April 2020, the CTC AWG produced an additional calibration (CLB 2000–9806) that used the 9806 model configuration in order to provide 2019 post-season AIs that were comparable to the 2019 pre-season AIs from CLB 1905. The 9806 model configuration was also used to produce CLB 1905. Following this, the CTC produced a memo to the PSC detailing the 2019 post-season AIs and related ACLs in addition to the 2019 pre-season AIs (for NBC & WCVI), CPUE (for SEAK), ACLs, and actual catches for each of the three AABM fisheries.

In March 2021, during the 2021 annual model calibration process, an error was identified in a program used to generate maturation rates used as inputs to the Model. This error affected the maturation rate inputs used in CLB 2002, resulting in incorrect estimates of cohort sizes and abundance indices. To address this, the CTC AWG re-ran CLB 2002 with corrected maturation rate inputs to produce CLB 2003.

While this report would typically present results from a single model calibration that provides both pre-season AIs for the current year and post-season AIs for the previous year, this report of the 2020 model calibration process includes results from three different model calibrations:

- *CLB 2002* – this is the annual calibration completed in March 2020 using the Phase II model configuration from which the pre-season AIs for 2020 were used to set pre-season ACLs for the NBC and WCVI AABM fisheries. Pre-season AIs and resulting ACLs for 2020 from this calibration are presented in section 3.2, and in related tables in the Executive Summary.
- *CLB 2000–9806* – this is the annual calibration completed in April 2020 using the 9806 model configuration from which the post-season AIs for 2019 were used to determine post-season ACLs for all three AABM fisheries in 2019. Post-season AIs and resulting ACLs for 2019 from this calibration are presented in section 3.2, and in related tables in the Executive Summary.
- *CLB 2003* – this is an updated version of CLB 2002, re-run with corrected maturation rates. With the exception of the specific sections noted above, all other calibration results included in this report are from CLB 2003 and represent the best and most accurate information available.

2.2 AABM Abundance Indices

The AABM fishery management regime relies on relationships that are based on data for catches and IM, fishing effort, fishery impacts (CWT indices), and the AIs generated by the PSC Chinook Model. The PSC Chinook Model uses catch data (i.e., encountered fish that are either kept or released), escapement data, CWT recovery data, and abundance forecasts to predict the AI for the upcoming year and to estimate the time series of AIs since 1979 (including the post-season AIs).

The PST specifies that AABM fisheries are to be managed through the use of pre-season AIs, where a fishery given AI corresponds to a specific ACL for each AABM fishery. The revised 2019 PST Agreement continues the use of pre-season AIs for NBC and WCVI AABM fisheries and establishes a CPUE metric to set ACLs for the SEAK AABM fishery. Pre-season AIs that were used to establish ACLs are listed in Table 2.1 along with the CPUE metric used to set the pre-season SEAK ACLs, beginning in 2019. The 2020 pre-season AI was 1.08 for the NBC AABM fishery and 0.75 for the WCVI AABM fishery; the 2020 CPUE metric was 4.83 for the SEAK AABM fishery.

In response to coastwide conservation concerns, the 2009 PST Agreement called for reduced catches and associated harvest rates in the SEAK and WCVI AABM fisheries. AABM catches prescribed for 2009–2018 included negotiated reductions of 15% in SEAK and 30% in WCVI, but the NBC AABM fishery retained the same ACLs and harvest rates specified in the 1999 PST Agreement. Similarly, in response to coastwide concerns over Chinook productivity and an emerging concern over the viability of the Southern Resident Killer Whale population which have a diet reliant on Chinook salmon, the 2019 PST Agreement called for additional reductions in catches and associated harvest rates in the SEAK and WCVI AABM fisheries. AABM catches prescribed for 2019–2028 include negotiated reductions of up to 7.5% in SEAK (based on CPUE tiers) and 12.5% in WCVI, but the NBC AABM fishery retained the same ACLs and harvest rates specified in the 1999 PST Agreement.

Post-season AIs are more accurate estimates of the AIs for the AABM fisheries than are the pre-season AIs because they contain empirical data rather than forecasts. Thus, the Treaty establishes post-season fishery limits based on the first post-season AI. Post-season AIs for 1999–2019 are listed Table 2.1.

Table 2.1.—Abundance Indices for 1999–2020 for the Southeast Alaska (SEAK), Northern British Columbia (NBC), and West Coast Vancouver Island (WCVI) aggregate abundance-based management (AABM) fisheries. Post-season values for each year are from the first post-season calibration following the fishing year.

	SEAK		NBC		WCVI	
Year	**Pre-season**	**Post-season**	**Pre-season**	**Post-season**	**Pre-season**	**Post-season**
1999	1.15	1.12	1.12	0.97	0.60	0.50
2000	1.14	1.10	1.00	0.95	0.54	0.47
2001	1.14	1.29	1.02	1.22	0.66	0.68
2002	1.74	1.82	1.45	1.63	0.95	0.92
2003	1.79	2.17	1.48	1.90	0.85	1.10
2004	1.88	2.06	1.67	1.83	0.90	0.98
2005	2.05	1.90	1.69	1.65	0.88	0.84
2006	1.69	1.73	1.53	1.50	0.75	0.68
2007	1.60	1.34	1.35	1.10	0.67	0.57
2008	1.07	1.01	0.96	0.93	0.76	0.64
2009	1.33	1.20	1.10	1.07	0.72	0.61
2010	1.35	1.31	1.17	1.23	0.96	0.95
2011	1.69	1.62	1.38	1.41	1.15	0.90
2012	1.52	1.24[1]	1.32	1.15[1]	0.89	0.76[1]
2013	1.20[1]	1.63	1.10[1]	1.51	0.77[1]	1.04
2014[2]	2.57	2.20	1.99	1.80	1.20	1.12
2015[2]	1.45	1.95	1.23	1.69	0.85	1.05
2016	2.06	1.65	1.70	1.39	0.89	0.70
2017	1.27	1.31	1.15	1.14	0.77	0.64
2018	1.07	0.92	1.01	0.89	0.59	0.59
2019[3]	1.07 (3.38)[5]	1.04	0.96	0.94	0.61	0.58
2020[4]	1.13 (4.83)[5]		1.08		0.75	

[1] Due to changes in calibration procedures (reviewed in section Appendix H), 2012 post-season (CLB 1309) and 2013 pre-season (CLB 1308) AIs are based on different calibrations; the procedures and assumptions CLB 1309 mirror those used during the 2012 pre-season calibration.
[2] Due to a disagreement over Model calibration 1503, the Commission agreed to use CLB 1602 to estimate the 2014 and 2015 post-season AIs and 2016 pre-season AI.
[3] Post-season AIs are from CLB 2000–9806 (old model configuration).
[4] Pre-season AIs are from CLB 2002 (Phase II model configuration).
[5] Per paragraph 6(b) of the 2019 PST Agreement, the number in parentheses represents a CPUE statistic used to determine the ACL.

2.3 Stock Composition of Abundances Available in AABM Fisheries, 1979–2019

The majority of catches in each AABM fishery are often composed of only a small subset of geographically similar stocks listed in Appendix A. Figure 2.1–Figure 2.3 show the post-season AIs (resulting from CLB 2003) decomposed into geographic stock groups using a combination of

CWT and genetic data. In general, post-season AIs had peaks during the late 1980s (1987–1989), in 2003 and 2004, and in 2014 and 2015.

The major stock groups contributing to the SEAK AIs are Columbia River Brights, WCVI, Oregon Coast, Fraser Early, SEAK/TBR and Washington Coast (Figure 2.1). Since 1999, the average contribution to the SEAK AIs for these stock groups has been 49%, 25%, 16%, 12%, 12% and 11% respectively.

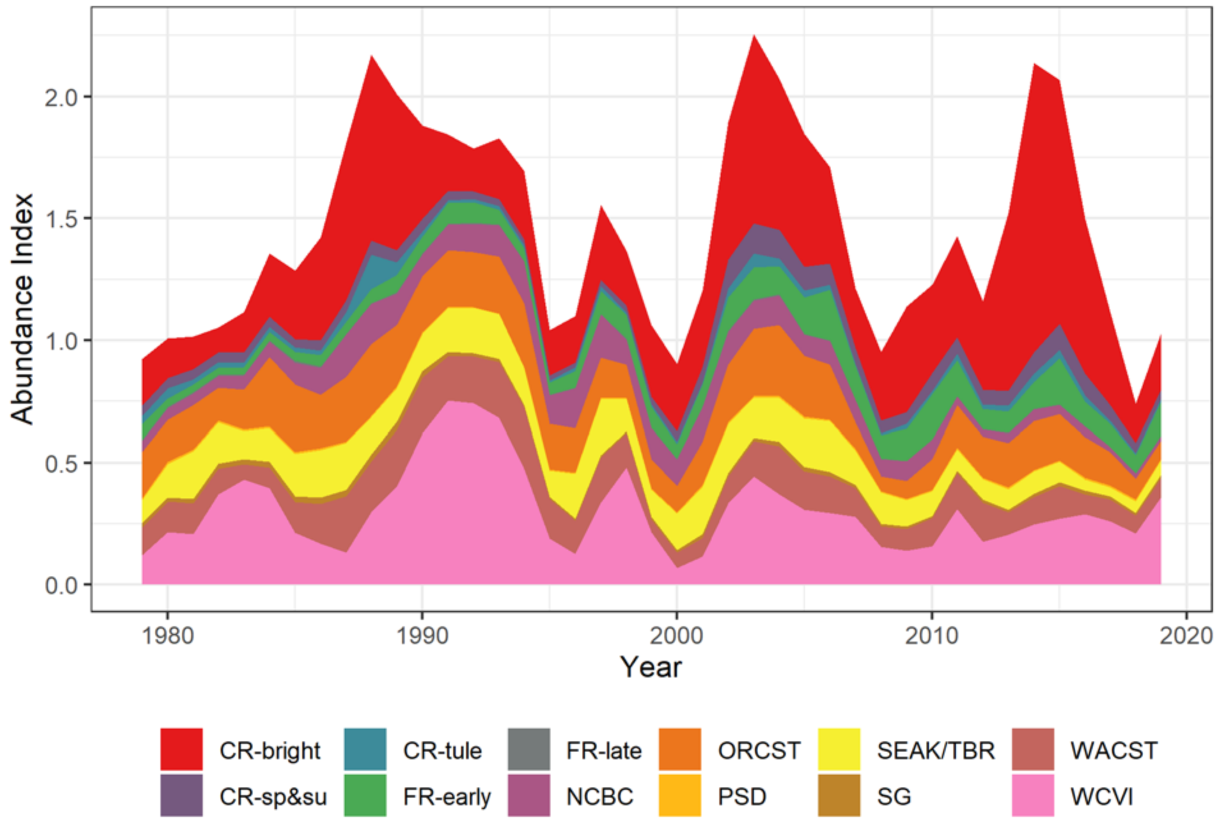

Figure 2.1.—Stock composition of the annual abundance indices for the SEAK troll fishery from CLB 2003.

The major stock groups contributing to the NBC AIs are Columbia River Brights, Oregon Coast, Fraser Early, Washington Coast, Columbia Spring/Summer and WCVI (Figure 2.2). Since 1999, the average contribution to the NBC AIs for these stock groups has been 32%, 32%, 18%, 16%, 15% and 15% respectively.

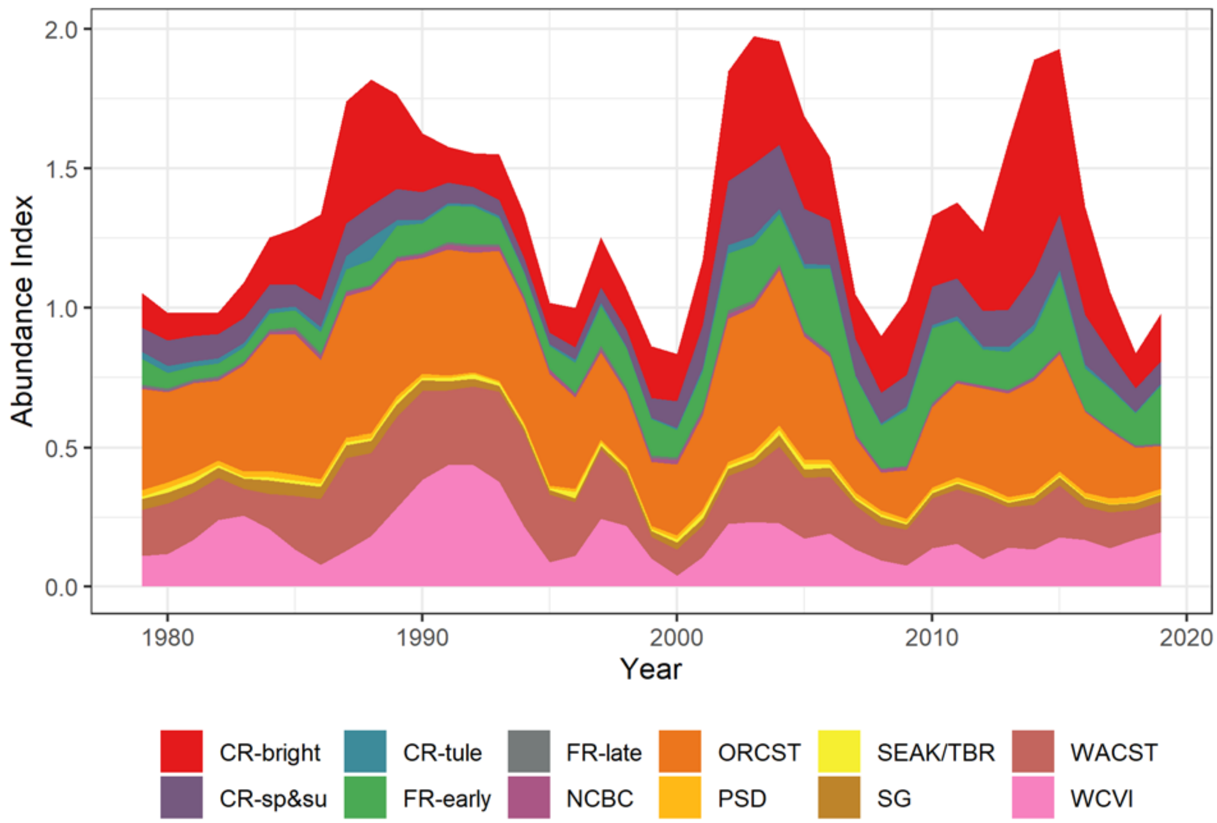

Figure 2.2.—Stock composition of the abundance indices for the Northern B.C. troll fishery from CLB 2003.

The major stock groups contributing to the WCVI AIs are Columbia River Tules, Columbia River Brights, Puget Sound, Fraser Late and Columbia Spring/Summer (Figure 2.3). Since 1999, the average contribution to the WCVI AIs for these stock groups has been 21%, 20%, 17%, 8% and 7% respectively.

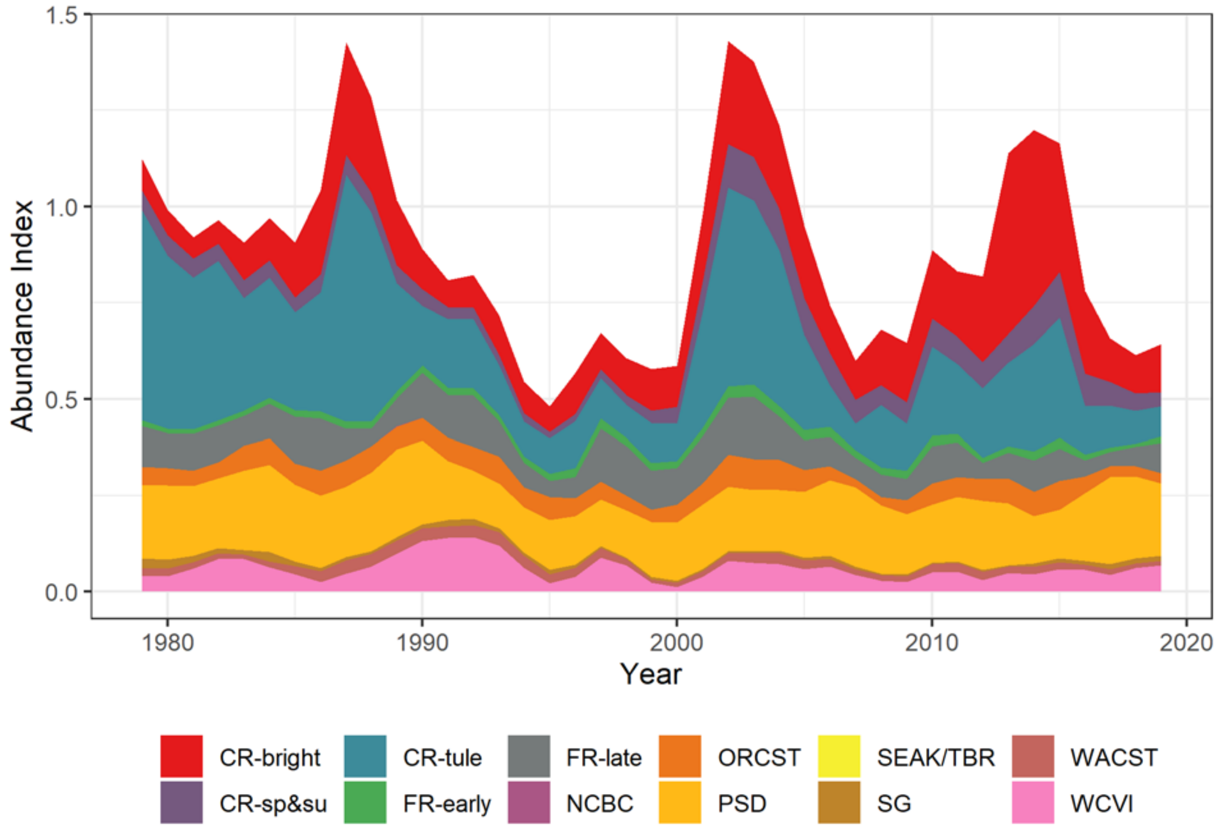

Figure 2.3.—Stock composition of the abundance indices for the WCVI troll fishery from CLB 2003.

For additional stock composition information, see Appendix B and Appendix F which decomposes catches and post-season AIs by the 41 PSC Chinook Model stock stratification. For additional fishery information, see Appendix C for Model-generated stock composition estimates for all fisheries (AABM and ISBM).

3. AABM Fishery Performance

The 2019 PST Agreement defines an AABM fishery as "*an abundance-based regime that constrains catch or total mortality to a numerical limit computed from either a pre-season forecast or an in-season estimate of abundance, from which a harvest rate index can be calculated, expressed as a proportion of the 1979 to 1982 base period*" per paragraph 5(a). The 2019 PST Agreement identified three such fisheries to be managed under an AABM regime: (1) SEAK troll, net, and sport, (2) NBC troll and Haida Gwaii sport, and (3) WCVI troll and outside sport. The CTC is tasked with evaluating AABM fishery performance relative to the obligations set forth in paragraphs 6 and 7 annually.

3.1 AABM Management Framework

Paragraph 6(a) of the 2019 PST Agreement specifies that "*the SEAK, NBC, and WCVI AABM fisheries shall be abundance based with the annual catch limits specified in Table 1 (catch limits specified for AABM fisheries at levels of the Chinook abundance index)*" and "*Table 2 (catch limits for the SEAK AABM fishery and the catch per unit effort (CPUE)-based tiers)*". Under previous PST Agreements since 1999, ACLs were determined from Table 1 in Chapter 3 of the 1999 and 2009 PST Agreements. In the 2009 and 2019 PST Agreements, the relationships between the AIs and the ACLs changed for SEAK and WCVI from the 1999 PST Agreement; thus, Table 1 has been revised for each successive PST Agreement. The 2019 PST Agreement also contains a new Table 2 which identifies seven catch tiers for the SEAK AABM fishery. The early winter CPUE from the SEAK troll fishery in District 113 during statistical weeks 41–48 (October–November) determines the pre-season SEAK tier level and the associated ACLs using Table 2. The post-season tier level for SEAK is also determined using Table 2 and the SEAK AI from the post-season calibration of the PSC Chinook Model.

The CTC is tasked with reporting AABM fishery performance for each fishing year relative to pre-season and post-season ACLs. The differences between actual catches and ACLs are the result of two processes: 1) *management error*, defined here as the difference between the actual catch and the pre-season ACL; and 2) *model error* which is the difference between the pre-season ACL and the post-season ACL. We use the term *management error* but recognize that it may be a misnomer in many situations as the deviations of actual catch from the pre-season ACLs may have been the result of deliberate actions. The combination of management error and model error is referred to as *composite error*. Poor performance is generally greatest when management error and model error are in the same direction. Improved performances can also be the result of management errors in the opposite direction of model errors, thereby cancelling out portions of these different deviations. The relative influence of each type of error is evaluated by inspecting differences in actual landed catch and ACLs from both the pre-season calibration or CPUE statistic and the post-season calibration.

The 2019 PST Agreement AABM management framework is diagrammed in Figure 3.1.

SEAK AABM fishery limits are determined using a CPUE-based approach pre-season and an AI-based approach post-season. Paragraph 7(d) requires the CTC to conduct "*up to two reviews of the CPUE-based approach*" with the *"first review occurring as soon as practical after the 2022 post-season AI is calculated and the second review as soon as practical after the 2025 post-season AI is calculated."*

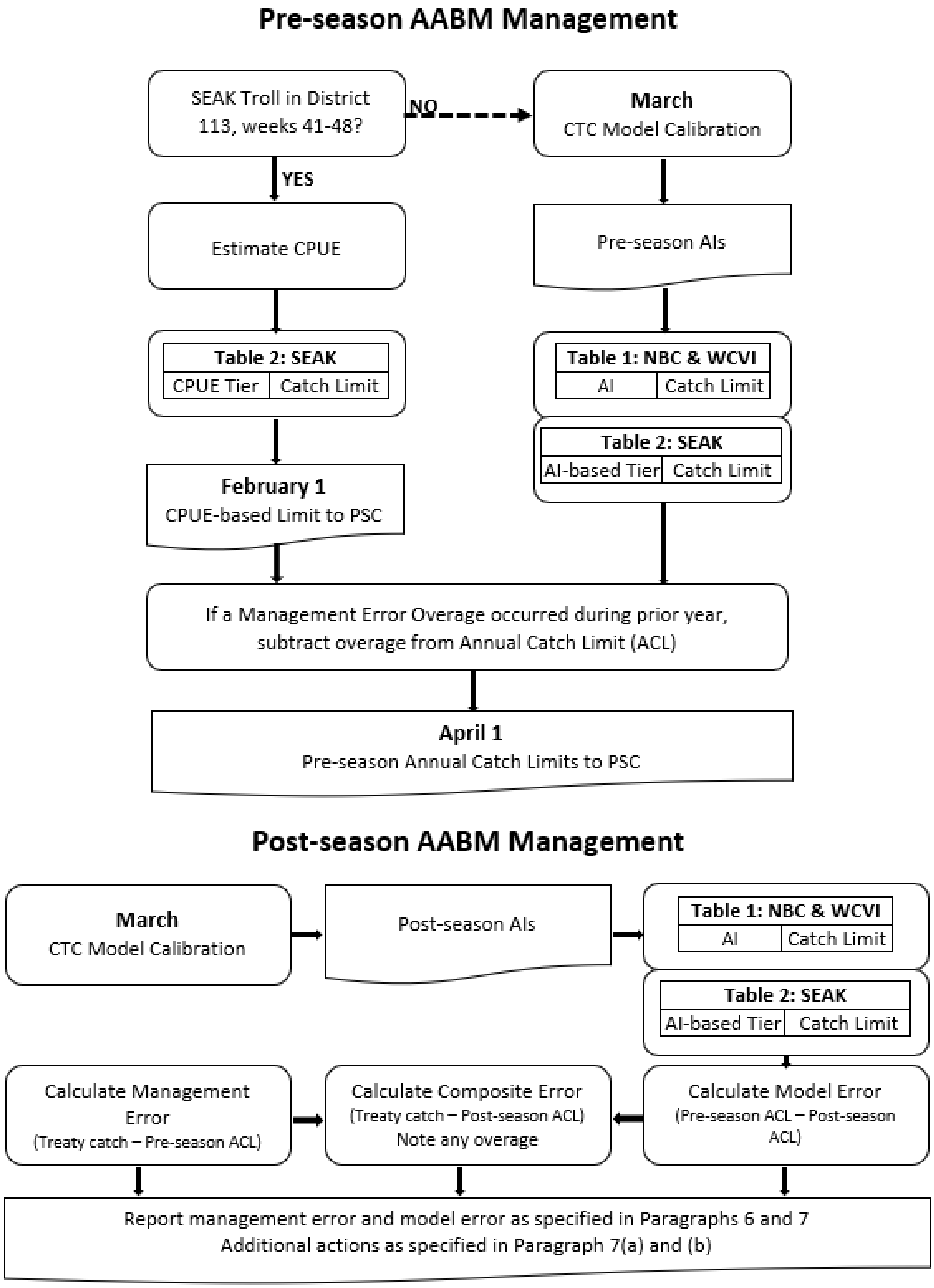

Figure 3.1.—Flow diagrams depicting the sequence of steps for pre-season (top) and post-season (bottom) aggregate abundance-based management (AABM) fisheries management framework under the 2019 PST Agreement.

3.2 ACTUAL CATCHES VS PRE-SEASON AND POST-SEASON ANNUAL CATCH LIMITS

In 2019, the actual catches in SEAK, NBC, and WCVI AABM fisheries were all below pre-season and post-season ACLs. Actual landed catch was less than the pre-season ACLs by 16 in SEAK, 36,774 in NBC, and 6,418 in WCVI. In terms of the post-season ACLs for evaluation of the provisions of the PST (paragraph 6(g)), 2019 actual catches were less than the post-season ACL by 16 fish in SEAK, 34,174 fish in NBC, and 2,518 fish in WCVI. Pre-season ACLs, post-season ACLs, and actual catches are provided in Table 3.1.

Management errors and model errors are linked but the relationships have not been constant so their respective contributions to the final assessments have been considered independently (Table 3.2). Overall, the performance of AABM fisheries in 2019, as measured by the deviation of actual catches from pre-season ACLs, was good with catches in all three fisheries below the ACL. Deviations were 0% in SEAK, -29% in NBC, and -8% in WCVI. The management error in NBC was the result of deliberate management actions by Fisheries and Oceans Canada to conserve Chinook salmon.

Model error was relatively minor in 2019 and ranged from 0% SEAK to 5% for WCVI. Composite error, the difference in actual catches and the post-season ACLs, had deviations of 0% in SEAK, -28% in NBC, and -3% in WCVI.

Composite error was 0% in SEAK, -28% in NBC, and -3% in WCVI for 2019. Per paragraph 7(b), relative to post-season ACLs "*overages are of particular concern*"*;* in 2019, there were no overages for any of the AABM fisheries.

Table 3.1.—Pre-season annual catch limits (ACLs) for 1999–2020, and post-season ACLs and actual catches for 1999–2019, for aggregate abundance-based management (AABM) fisheries. Post-season values for each year are from the first post-season calibration following the fishing year.

	SEAK (Troll, Net, Sport)			NBC (Troll, Sport)			WCVI (Troll, Sport)		
Year	Pre-season ACL	Post-season ACL	Actual Catch	Pre-season ACL	Post-season ACL	Actual Catch	Pre-season ACL	Post-season ACL	Actual Catch
1999	192,800	184,200	198,842	145,600	126,100	84,324	128,300	107,000	38,540
2000	189,900	178,500	186,493	130,000	123,500	32,048	115,500	86,200	88,617
2001	189,900	250,300	186,919	132,600	158,900	43,334	141,200	145,500	120,304
2002	356,500	371,900	357,133	192,700	237,800	149,831	203,200	196,800	157,920
2003	366,100	439,600	380,152	197,100	277,200	194,797	181,800	268,900	173,561
2004	383,500	418,300	417,019	243,600	267,000	241,508	192,500	209,600	215,252
2005	416,400	387,400	388,640	246,600	240,700	243,606	188,200	179,700	199,479
2006	346,800	354,500	360,094	223,200	200,000	215,985	160,400	145,500	145,511
2007	329,400	259,200	328,268	178,000	143,000	144,235	143,300	121,900	140,614
2008	170,000	152,900	172,905	124,800	120,900	95,647	162,600	136,900	145,726
2009	218,800	176,000	227,954	143,000	139,100	109,470	107,800	91,300	124,617
2010	221,800	215,800	230,611	152,100	160,400	136,613	143,700	142,300	139,047

Year	SEAK (Troll, Net, Sport) Pre-season ACL	SEAK Post-season ACL	SEAK Actual Catch	NBC (Troll, Sport) Pre-season ACL	NBC Post-season ACL	NBC Actual Catch	WCVI (Troll, Sport) Pre-season ACL	WCVI Post-season ACL	WCVI Actual Catch
2011	294,800	283,300	291,161	182,400	186,800	122,660	196,800	134,800	204,232
2012	266,800	205,100	242,821	173,600	149,500	120,307	133,300	113,800	135,210
2013	176,000	284,900	191,388	143,000	220,300	115,914	115,300	178,000	116,871
2014[1]	439,400	378,600	435,195	290,300	262,600	216,901	205,400	191,700	192,705
2015[1]	237,000	337,500	335,026	160,400	246,600	158,903	127,300	179,700	118,974
2016	355,600	288,200	350,704	248,000	183,900	190,181	133,300	104,800	103,093
2017	209,700	215,800	175,414	149,500	148,200	143,330	115,300	95,800	117,416
2018	144,500	118,700	127,776	131,300	115,700	108,976	88,300	88,300	85,330
2019[3]	140,323[2]	140,323	140,307	124,800	122,200	88,026	79,900	76,000	73,482
2020[4]	205,165[2]			133,000			87,000		

[1] Due to a disagreement over Model calibration 1503, the Commission agreed to use output from CLB 1602 to estimate the catches associated with the 2014 and 2015 post-season AIs and 2016 pre-season AIs.
[2] Per paragraph 6(b) of the 2019 PST Agreement, this number represents an ACL based on a CPUE statistic.
[3] Post-season ACLs are based on AIs from CLB 2000–9806 (old model configuration).
[4] Pre-season ACLs are based on AIs from CLB 2002 (Phase II model configuration).

Table 3.2.—Summary of aggregate abundance-based management (AABM) fishery performance and deviations between pre- and post-season annual catch limits (ACLs) and actual catches for Southeast Alaska (SEAK), Northern British Columbia (NBC), and West Coast Vancouver Island (WCVI), 2019.

Positive values indicate an overage and negative values indicate an underage. Colored cells indicate AABM fishery performance relative to Treaty obligations; cells shaded green indicate where a fishery met Treaty obligations and red cells indicate where a fishery exceeded Treaty obligations.

	Management Error Actual Catch – Pre ACL		Model Error Pre ACL – Post ACL		Composite Error Actual Catch – Post ACL	
Year	#	%	#	%	#	%
SEAK (Troll, Net, Sport)						
2019	-16	0%	0	0%	-16	0%
NBC (Troll, Sport)						
2019	-36,774	-29%	2,600	2%	-34,174	-28%
WCVI (Troll, Sport)						
2019	-6,418	-8%	3,900	5%	-2,518	-3%

3.2.1 SEAK AABM Fishery

Average management error was 1% for SEAK across the 1999–2018 time series and ranged between -16% and 41%[1]. Average management error was 2% across the 2009–2018 time period and 1% in the 1999–2008 time period (Figure 3.2). The difference in the average management error in the 2009 PST Agreement period was driven by the large deviation in 2015 (41%). Model error ranged from -38% to 30% but averaged 3% to 5% for the time periods examined. Deviation of actual catch in SEAK from post-season ACLs was largely driven by model error. SEAK management error was relatively small in all years other than 2015 and was in the opposite direction of the model error in 7 of the 10 years 2009–2018 (Figure 3.2). In 2019, management error and model error were both 0% (Table 3.2).

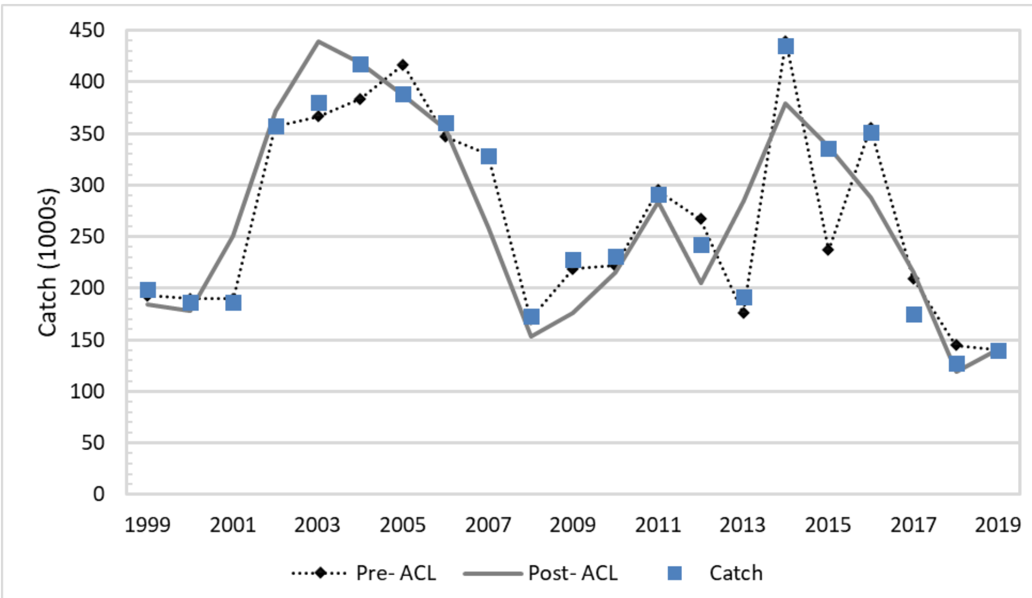

Figure 3.2.—Performance of Southeast Alaska aggregate abundance-based management (AABM) fishery annual catch limits (ACLs) and model metrics, 1999–2019.

3.2.2 NBC AABM Fishery

NBC actual catch was consistently below the pre-season ACL with an average of -22% from 1999–2018 (range -1% to -75%; Figure 3.3)[1]. The average NBC catch was -26% below the pre-season ACLs from 1999–2008 and -19% from 2009–2018. Management errors in NBC were the result of Canada's domestic efforts to reduce impacts on WCVI-origin Chinook. Management error in the NBC fishery was near zero from 2003 to 2006 and in 2015 and 2017, but catches were significantly below the ACL in all other years except 2016 (Figure 3.3). Management actions in NBC outweigh model errors in most years with a -23% average error between the

[1] Historical error data are provided in CTC (2021b).

observed catch and the post-season ACL. In 2019, model error was 2% and conservative management actions resulted in an actual catch 29% below the ACLs (Table 3.2).

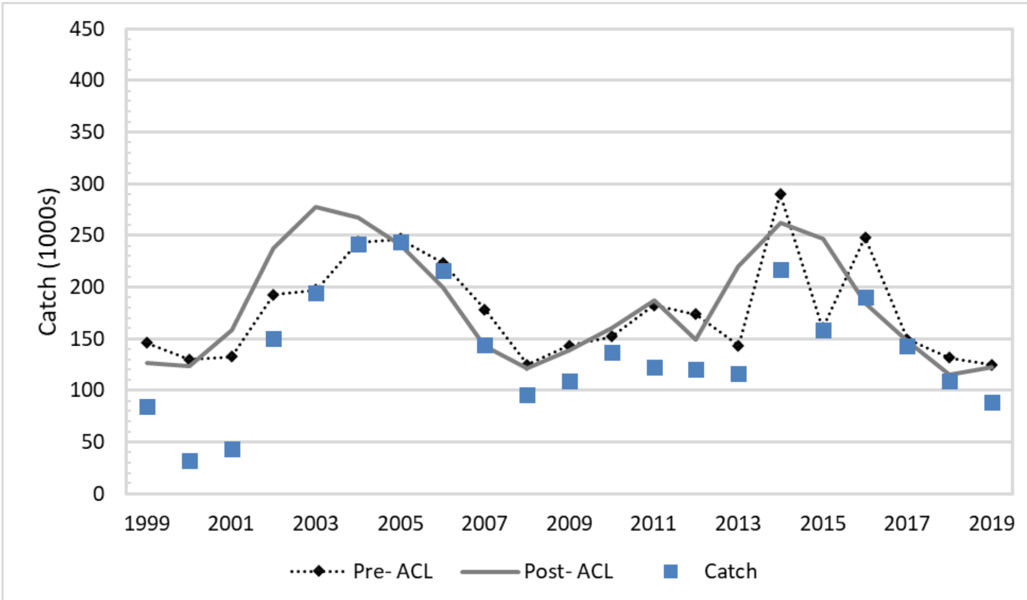

Figure 3.3.—Performance of Northern British Columbia aggregate abundance-based management (AABM) fishery annual catch limits (ACLs) and model metrics, 1999–2019.

3.2.3 WCVI AABM Fishery

Average management error in WCVI was -8% from 1999 to 2018 with more negative values in the beginning of the time series resulting in averages of -14% from 1999–2008 and -2% from 2009–2018 (Figure 3.4)[2]. The deviations of actual catch from the post-season ACL in WCVI ranged from -64% to 52%. Although management error in WCVI played a larger role in the deviation from the post-season ACL, model errors made up the largest component of the deviations. In 5 of 10 years during the 2009–2018 time series, the WCVI management and model errors occurred in a common direction. In 2010, 2014, 2018, and 2019 both model and management errors were small (Figure 3.4; Table 3.2).

[2] Historical error data are provided in CTC (2021b).

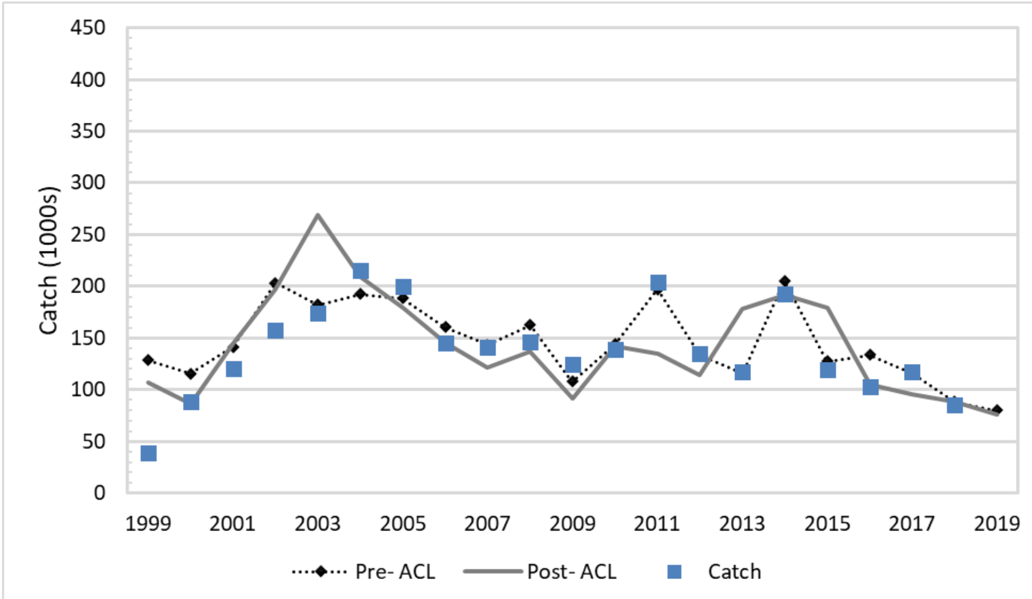

Figure 3.4.—Performance of West Coast Vancouver Island aggregate abundance-based management (AABM) fishery annual catch limits (ACLs) and model metrics, 1999–2019.

3.3 Performance Evaluation

Paragraph 7 of the 2019 PST Agreement defines the accountability provisions for AABM and ISBM fisheries. It describes a set of rules for evaluating fishery performance, stock status, models, management tools, and the effectiveness of the harvest reduction measures taken under the 2019 PST Agreement (Figure 3.1). It also contains conditional tasks in the event of overages. For AABM fisheries, paragraph 7 requires the CTC to conduct specific evaluations of pre-season and post-season deviations, make recommendations for reducing overages meeting specific criteria, and conduct up to two reviews of the CPUE approach to setting pre-season ACLs for the SEAK fishery.

Subparagraph 7(a)(i) requires the CTC to provide the Commission with "*the AABM fisheries pre-season limits, observed catches, and identify the extent of any exceedance (overage) of those limits for the prior fishing season (management error)*." In 2019, none of the three AABM fisheries exceeded pre-season ACLs. Management error data are provided in section 3.2 of this report.

Subparagraph 7(a)(ii) requires the CTC to provide the Commission with "*the AABM fisheries post-season limits for fisheries that occurred two years prior and any exceedance (overage) between the annual pre- and post-season limits from two years prior (model error)*." For 2018 and 2019, the pre-season limit exceeded the post-season limit in four out of six cases, with 2018 having the largest of the exceedances for SEAK and NBC (Table 3.3). Model error is described in detail in section 4.3 of this report.

Table 3.3.—Model Error (calculated as (pre-season ACL – post-season ACL) / post-season ACL) for the past two years for aggregate abundance-based management (AABM) fisheries.

Fishery	2018[1]	2019
SEAK	22%	0%
NBC	13%	2%
WCVI	0%	5%

[1] 2018 is subject to the 2009 PST Agreement. Subparagraph 7(a)(ii) evaluation begins with 2019.

Paragraph 7(b) defines "*AABM post-season fishery limits by using the first post-season Commission Chinook model estimate*" and, when compared with actual catches, expresses that overages are of concern. It directs the CTC to provide an analysis of deviations from post-season limits. "*If, in two consecutive years, the NBC or WCVI AABM fishery catches exceed post-season limits by more than 10%, or the SEAK AABM fishery the pre-season tier and catches exceed the post-season tier*," then management agency action is requested by the Commission and the CTC is required to recommend a plan to the Commission to "*improve the performance of pre-season, in-season, and other management tools so that the deviations between catches and post-season fishery limits to AABM fisheries are narrowed to a maximum level of 10%*." For the past two consecutive years (2018 and 2019) no AABM fishery catches exceeded post-season limits by more than 10 % (Table 3.4).

Table 3.4.—Composite error (calculated as (actual catch – post-season ACL) / post-season ACL) for the past two years for aggregate abundance-based management (AABM) fisheries.

Fishery	2018	2019
SEAK	8%	0%
NBC	-6%	-28%
WCVI	-3%	-3%

[1] 2018 is subject to the 2009 PST Agreement. Paragraph 7(b) evaluation begins with 2019.

4. PSC Chinook Model Validation and Improvement

The changes in AIs between pre- and post-season calibrations from 2012 to 2016 that are noted in section 4.3 were among the largest observed, and resulted in large discrepancies (greater than 20% difference) between pre-season and post-season ACLs across the three AABM fisheries (Table 3.1; Figure 4.9). Model errors of this magnitude underscore the importance of routine model validation, as well as occasional targeted investigations and ongoing longer-term efforts to improve the PSC Chinook Model. The reliability of model outputs, including AI predictions, is dependent on a number of factors including model parameters (e.g., base period exploitation rates); model structure (e.g., spatio-temporal fishery strata); and/or the annual CWT, catch, and run-size inputs (forecast or post-season estimates) used for calibration. In the following section, we report on annual comparisons of fishery indices based on model-generated data and CWT estimates and pre-season (forecast) versus post-season run sizes. Lastly, we briefly review ongoing, related model improvement activities.

4.1 Evaluation of Fishery Indices

Fishery mortality indices (FI) calculated from model-generated data for all model stocks can be compared to values generated from the estimates of catches or total mortality of CWT exploitation rate indicator stocks. Model and CWT-based FIs use the same equation, however CWT empirical estimates are considered more accurate. Fishery indices can be constructed as a ratio of means (ROM) or as a stratified proportional fishery index (SPFI; CTC 2009). Results from the Harvest Rate Index Analysis in 2009 (CTC 2009) indicated that the SPFI was unbiased and the most accurate estimator for most fishery, time, and area combinations. Therefore, a recommendation was made to use the SPFI estimator as the FI, not only for the SEAK troll fishery but also for the other two AABM troll fisheries. Consequently, a SPFI was developed for the WCVI and NBC troll fisheries. However, the CTC recently determined that the single time strata of data available for the NBC troll SPFI and a number of missing year-area data values for the WCVI troll SPFI make implementation of these FIs in the Model problematic. Therefore, in 2019, the CTC decided that ROMs were more appropriate FIs for the WCVI and NBC troll fisheries. Comparisons among the SPFI, the currently implemented CWT-based ROM FI, and the model data-based FI are provided in this section.

4.1.1 Southeast Alaska Troll Fishery Indices

The SEAK troll FI based on model data closely follows the trend of the CWT-derived estimate from 1979 through 1989 for both landed catch and total mortality (Figure 4.1 and Figure 4.2). Between 1990 and 2000, the model estimates of both the landed catch and total FIs were less than the CWT-derived estimate for most years. However, since 2001, the model estimates have typically been higher. Since 1990, the model estimates also show less year-to-year variability than the CWT-derived indices.

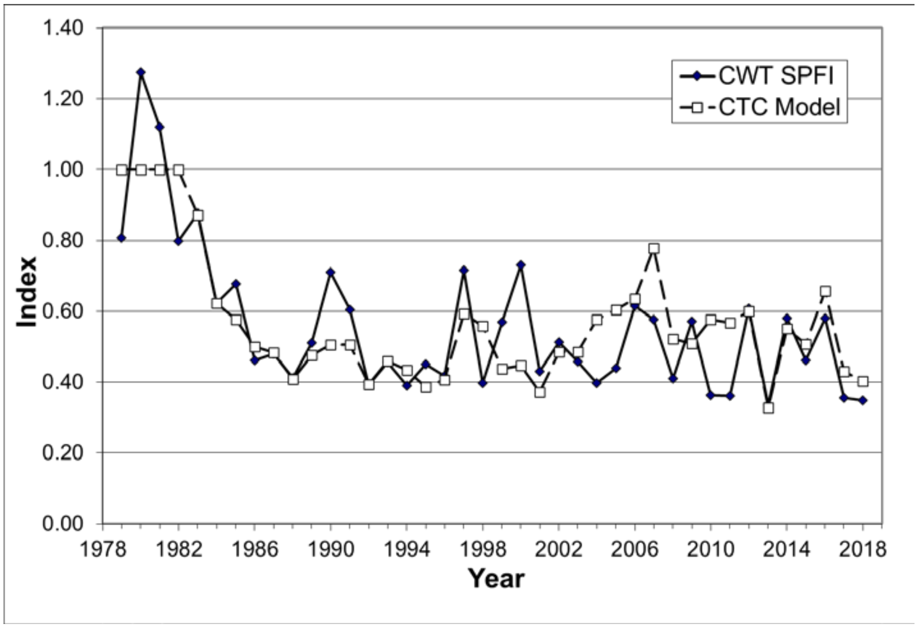

Figure 4.1.—Estimated coded-wire tag (CWT)-based stratified proportional fishery index (SPFI) and model landed catch fishery indices for the Southeast Alaska (SEAK) troll fishery through 2018.

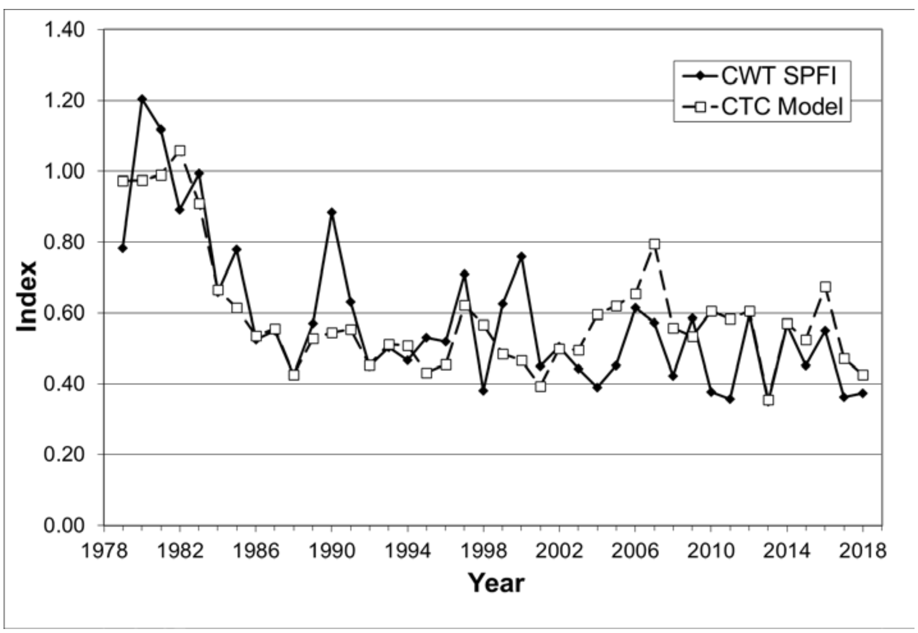

Figure 4.2.—Estimated coded-wire tag (CWT)-based stratified proportional fishery index (SPFI) and model total mortality fishery indices for the Southeast Alaska (SEAK) troll fishery through 2018.

4.1.2 Northern British Columbia Troll Fishery Indices

The model-derived fishery mortality indices for NBC troll generally follow the same trend as the CWT-derived ROM FIs (Figure 4.3 and Figure 4.4). Since 1991, however, the model-based FIs exceeded the CWT-derived estimates in all but four years for both landed catch and total mortality indices. Differences between the two indices (CWT and model-based FIs) have been consistently greater since 2003 compared to preceding years. The SPFI has followed the same general pattern displayed by the other two FIs (ROM and model-based) but has been lower in magnitude and the year-to-year fluctuations have been smaller in most years throughout the time series. In 2018, the CWT index was much higher than the model-based FI for both landed catch and total mortality.

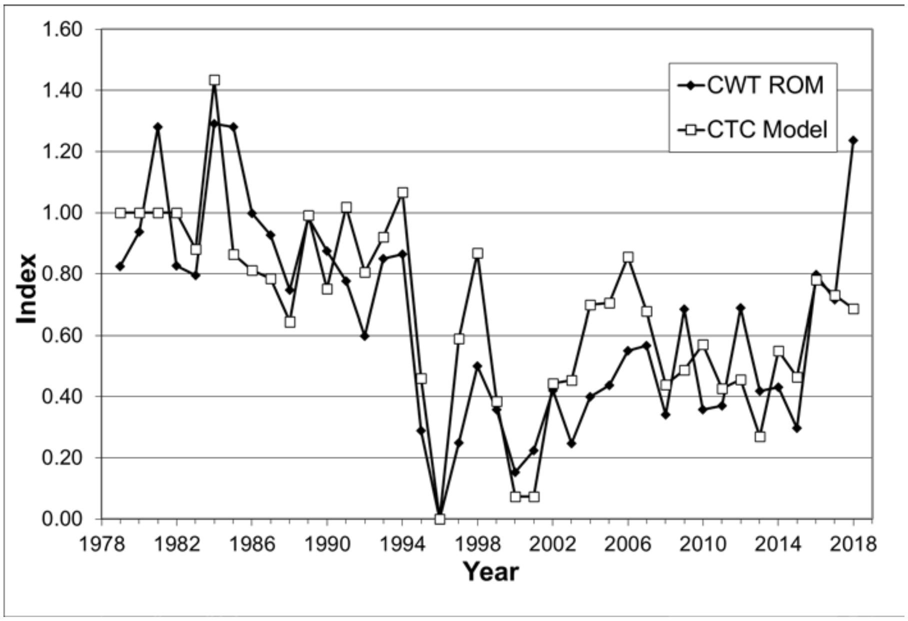

Figure 4.3.—Estimated coded-wire tag (CWT) ratio of means (ROM) and model landed catch fishery indices for the Northern B.C. (NBC) troll fishery through 2018.

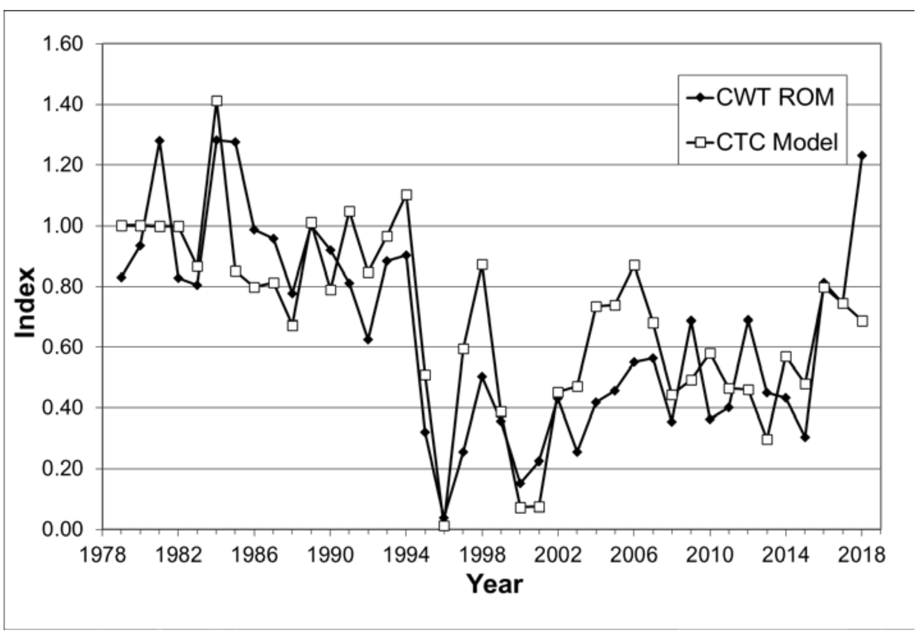

Figure 4.4.—Estimated coded-wire tag (CWT) ratio of means (ROM) and model total mortality fishery indices for the Northern B.C. (NBC) troll fishery through 2018.

4.1.3 West Coast Vancouver Island Troll Fishery Indices

For the WCVI troll fishery, correspondence between the model-derived FI and the CWT-based ROM FI was reasonably close from the start of the time series (1979) to the mid-1990s for both landed catch (Figure 4.5) and mortality (Figure 4.6). Starting around 2000, model data-based and CWT-based ROM FIs diverged noticeably, with the CWT FIs consistently exceeding the model-based FIs. This divergence is attributed to changes in the spatial and temporal conduct of the fishery (e.g., cessation of fishing in the summer period) to reduce impacts on B.C. stocks of conservation concern (e.g., Fraser River early return-timing stocks). Although the SPFI is considered to be a better approach for incorporating temporal and spatial changes in fishery catch patterns, between-year fluctuations have been much greater at times with the SPFI calculated for the WCVI troll fishery. Since about 2000, after the fishery management changes took place, the SPFI has tended to correspond more closely with the model data-based FI compared to the CWT-based FI (Figure 4.5 and Figure 4.6).

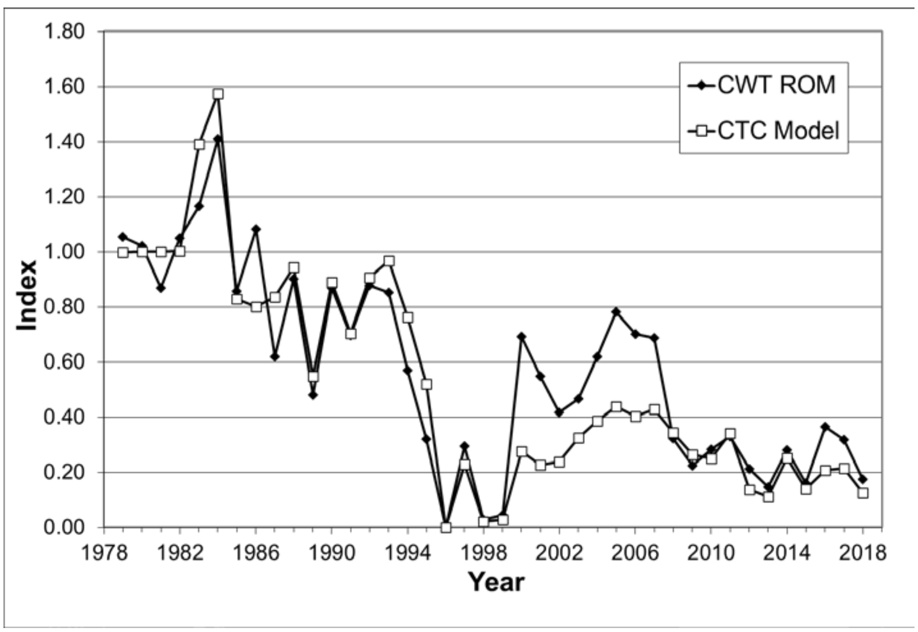

Figure 4.5.—Estimated coded-wire tag (CWT) ratio of means (ROM) and model landed catch fishery indices for the West Coast Vancouver Island (WCVI) troll fishery through 2018.

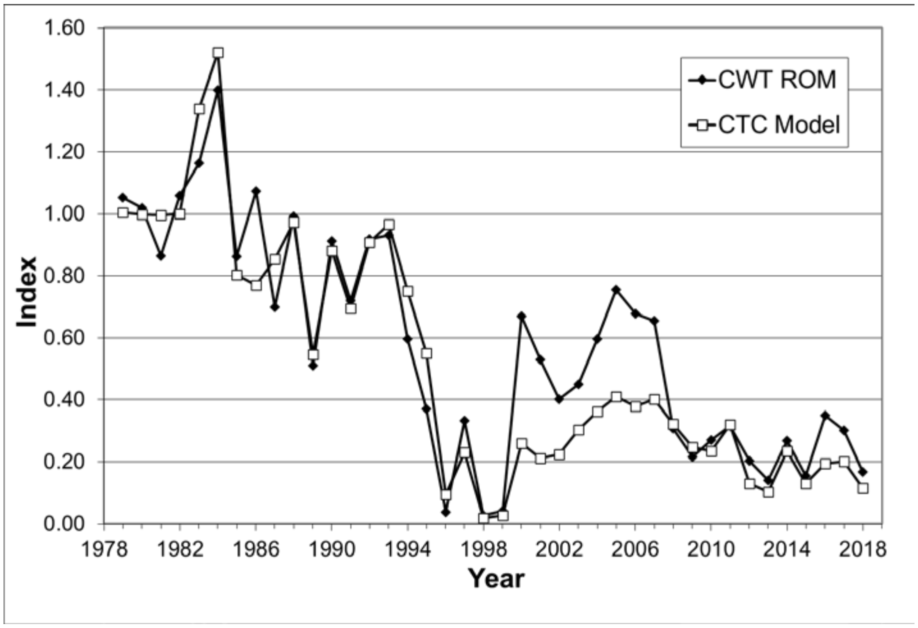

Figure 4.6.—Estimated coded-wire tag (CWT) ratio of means (ROM) and model total mortality fishery indices for the West Coast Vancouver Island (WCVI) troll fishery through 2018.

4.1.4 Comparison of Fishery Indices

The AABM troll fishery indices derived from CWT recoveries should in most instances provide a more accurate estimate of the pattern of exploitation rates compared to fishery indices derived from PSC Chinook Model output. This is due to the fact that CWT-based indices use empirical information from the fisheries each year whereas Model-based indices assume that the yearly pattern of exploitation in a fishery remains static compared to the base period (1979–1982) both temporally and spatially (with the exception of any yearly modifications achieved through stock and age specific exploitation rate scalers) and that most of the change in exploitation can be attributed to stock abundances and the magnitude of the catch. In Figure 4.1 and Figure 4.2 the Model-based fishery indices generally track the CWT-based SPFI indices. Although, there is a period of years from 2004 to 2011 where the Model-based indices are mostly higher than the SPFIs. In Figure 4.3 and Figure 4.4 it can be seen that the Model-based fishery indices generally track the CWT-based ROM indices. Although, there is a period of years from 2003 to 2008 where the Model-based indices are mostly higher than the ROMs. In Figure 4.5 and Figure 4.6 the Model-based fishery indices generally track the CWT-based ROM indices with the exception of the years that roughly corresponds to the 1999 PST Agreement. During these years the WCVI CWT ROM indices are consistently higher that the Model indices. This would seem to indicate that the temporal and/or spatial pattern of exploitation in the WCVI troll fishery had changed compared to the base period which resulted in the discrepancies between the CWT ROM indices and the Model-based indices. This is corroborated by an examination of the temporal distribution of catch in WCVI troll which shows that the majority of the catch in years prior to 1998 occurred during the July to September time frame, however during 1998 and the years of the 1999 PST Agreement the catch shifted to other months of the year.

4.2 Evaluation of Stock Forecasts Used in the PSC Chinook Model

A major factor influencing the ability of the PSC Chinook Model to predict Chinook salmon abundance in AABM fisheries is the ability of the model to predict the returns of Chinook salmon (in terms of ocean escapement or spawning escapement) in the forecast year. During model calibration, all available agency forecasts for model stocks are input to the model. Thus, for model stocks with external forecasts, the variation between model forecasts and actual returns can be broken into two parts: the ability of the model to match the agency forecasts used as inputs, and the ability of the agency forecasts to accurately predict the actual return of Chinook salmon in the upcoming year.

A summary of model-produced and agency-produced forecasts for 1999–2020, with actual returns through 2019, is shown in Appendix G. For information regarding the relationship between the model indicator stocks, exploitation rate indicator stocks, and PST Attachment I stocks, see Appendix A. Note that with the transition to the Phase II PSC Chinook Model base period, the stock structure and number of stocks represented in the model have changed. Accordingly, Appendix G now includes two tables: Appendix G1 contains forecast and return data for old model stocks from 1999 to present, and Appendix G2 contains 2020 forecasts for new model stocks, which were used in the 2020 calibration. No data prior to 2020 are reported for the new model, as 2020 was the first year in which it was implemented. As a result of this, since there are currently no years with overlap of new model stock forecasts and actual returns, the evaluations of forecast performance that follow in this section are for model stocks found in the old model.

Overall, the model forecasts are similar to the agency forecasts. This result is strongly influenced by the incorporation of the agency forecasts into the model calibration procedure. The average percent error by which model forecasts differ from agency forecasts is -2.5%, meaning that, on average, the agency forecasts were close to but slightly lower than the model forecasts. Relative to actual returns, both the agency and model forecasts were, on average, greater, with mean percent error of -4.9% and -4.8%, respectively. The performance of forecasts used in model calibrations (agency when available, model otherwise) is depicted by stock for each year since 1999 in Figure 4.7.

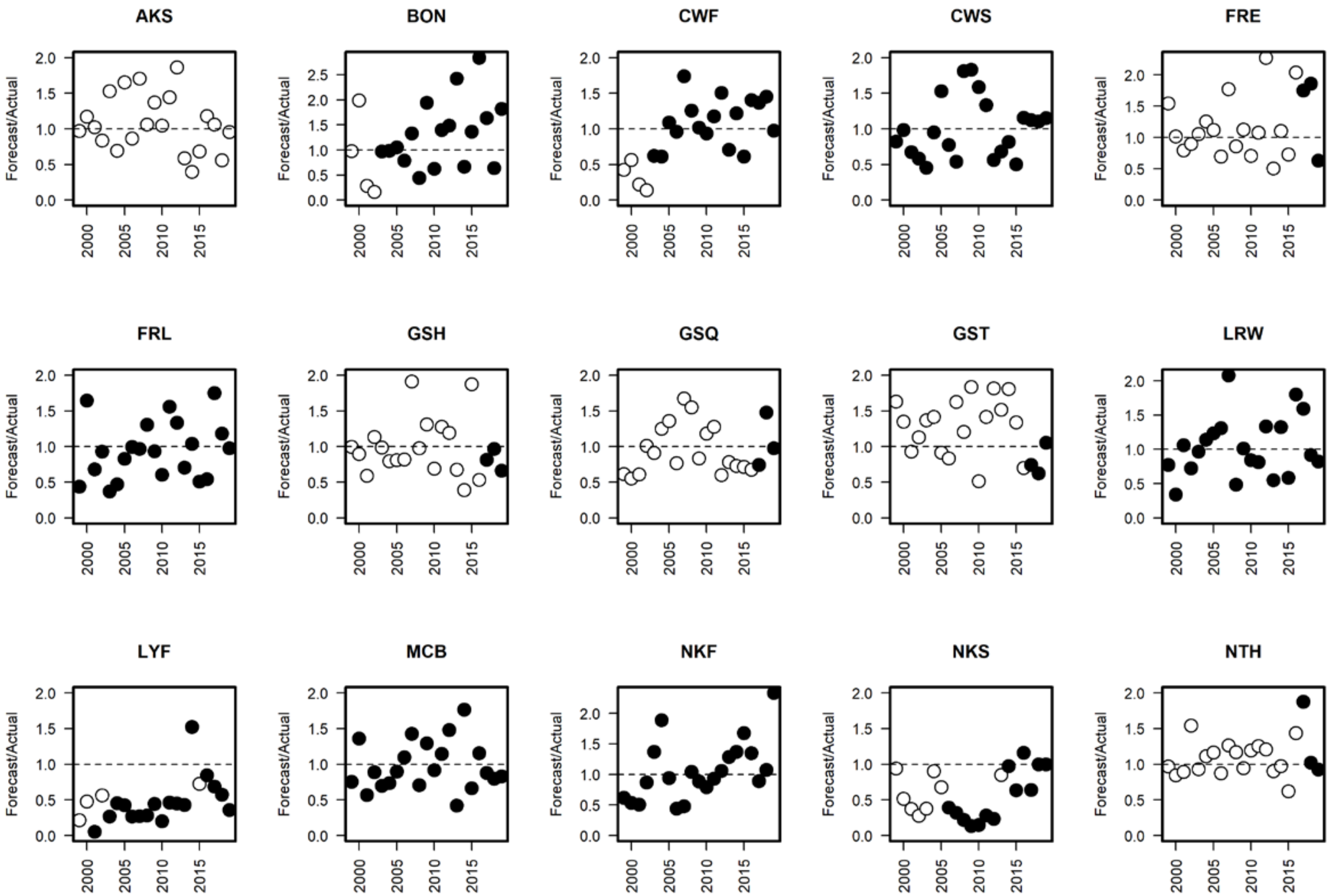

Figure 4.7.—Forecast performance (Forecast/Actual) plots for PSC Chinook Model stocks.

Note: Solid black circles correspond to years when calibrations were based on agency forecasts and unfilled (white) circles correspond to years when model-generated forecasts were used. Stock abbreviations follow those defined in Appendix G.

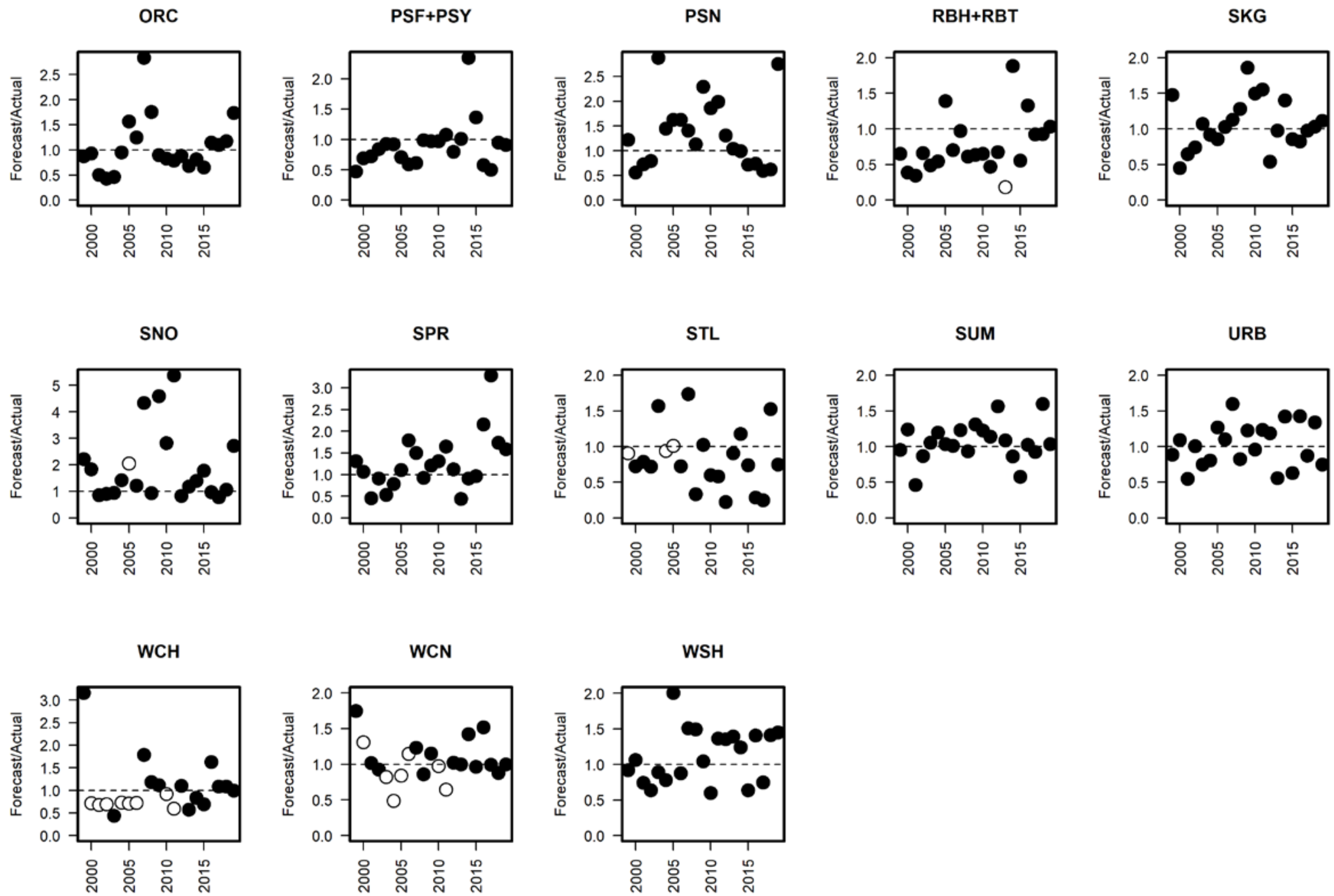

Figure 4.7.—Page 2 of 2.

In the 2020 calibration of the PSC Chinook Model (using the old base period CLB 2000–9806) the post-season aggregate abundance for 2019 was similar to the forecast in all three AABM fisheries. In all three fisheries the 2019 post-season AI values decreased slightly relative to the pre-season forecasted AIs (Table 2.1). This result can be largely attributed to the fact that the majority of agency-provided forecasts used as inputs to the calibration procedure were close to the actual return and there was no consistent bias across stocks towards either over- or under-forecasting (Figure 4.8, Appendix G). Only one stock (Alaska Springs [AKS]) lacked an agency forecast and used the forecast generated by the PSC Chinook Model, which was very similar to the actual return (Figure 4.8).

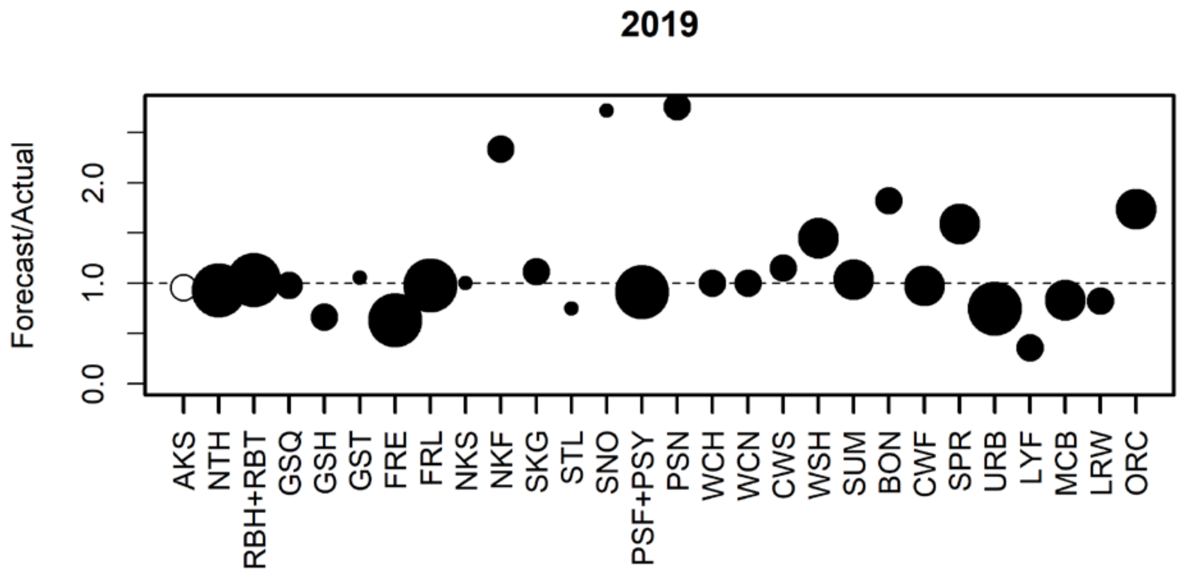

Figure 4.8.—Ratio of the 2019 forecast to the actual return for stocks represented in the PSC Chinook Model.

Note: Points lying above the dashed horizontal line returned lower than forecast; points lying below the dashed horizontal line returned greater than forecast. Filled (black) circles correspond to stocks with agency-supplied forecasts; unfilled (white) circles correspond to stocks with forecasts generated by the PSC Chinook Model. The four symbol sizes correspond to categories of increasing relative stock size (based on average terminal run size: <10,000, 10,000–50,000, 50,000–100,000, and >100,000). Stocks are arranged along the x-axis from north to south and are defined according to the codes in Appendix G.

4.3 Model Error

For the purposes of this section of the report, model error will refer to differences between model-generated pre-season AIs for the AABM fisheries and the first post-season estimate of AIs for the AABM fisheries as generated by the annual calibration in the following year. The yearly percent deviations between pre-season and post-season AIs for the three AABM fisheries are illustrated in Figure 4.9. For each AABM fishery, the deviations between the pre-season and post-season AIs have varied considerably since 1999. Large deviations can compromise the utility of pre-season AIs for setting objectives for each of the fisheries, which provisions in the 2009 PST Agreement were intended to address.

AIs are generated without any measures of their uncertainty and although corrective techniques have been explored, none have been applied. The regimes for the three AABM fisheries relate fishery-specific catch and fishery indices to AIs using a proportionality constant that varies annually but is currently based on the 1979–1997 average. Uncertainty in the proportionality constant is not explicitly considered within the current AABM fishery regime; it is assumed to be stable in the long term. As part of its model improvement initiative, the CTC is developing a model evaluation tool that will facilitate the ability to compare different types of abundance estimation models (e.g., statistical catch-at-age model) using a common data set of simulated abundance values.

In 2019, model error was low for all three AABM fisheries (Figure 4.9).

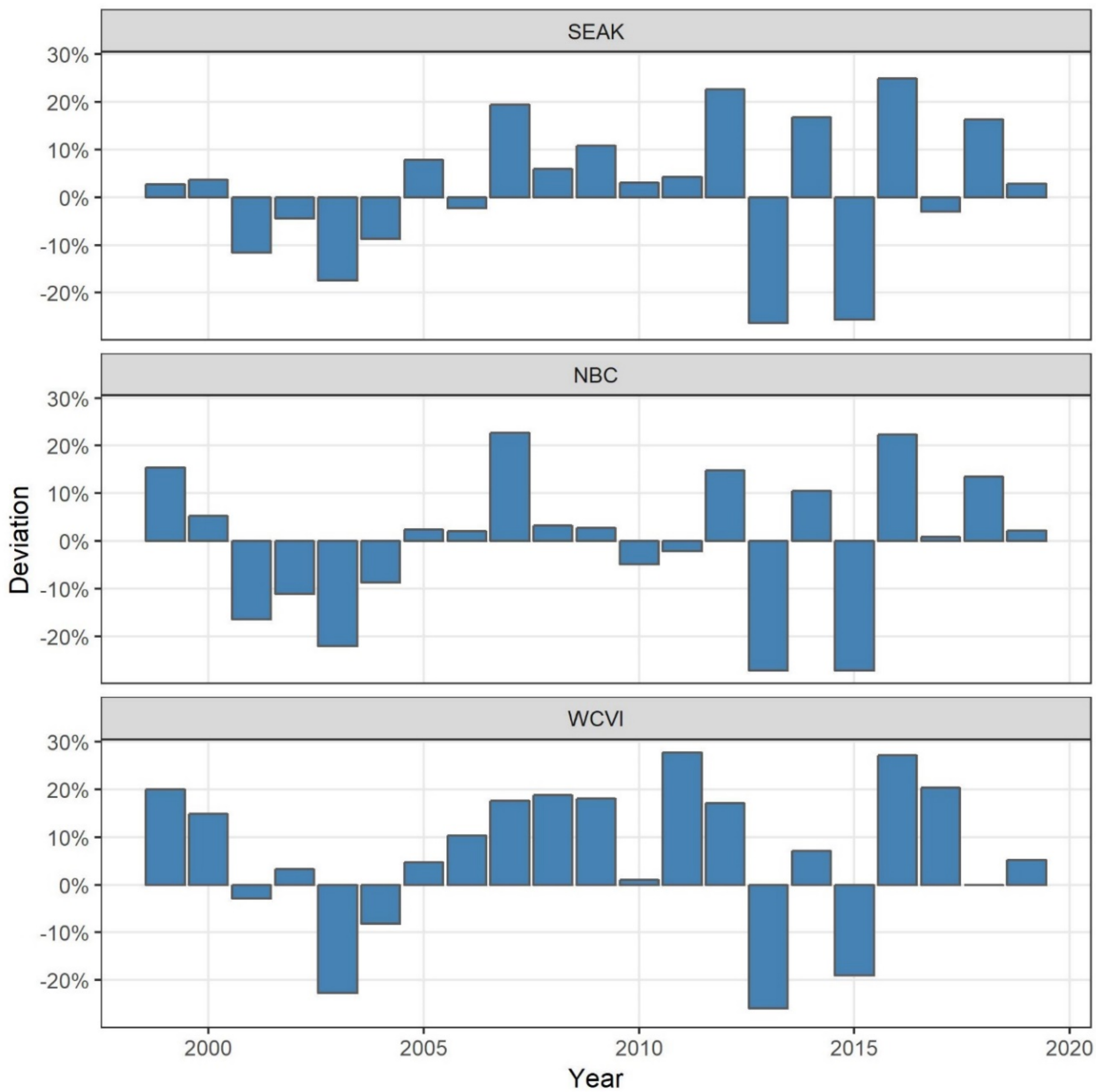

Figure 4.9.—Deviation between pre- and post-season abundance indices (AIs) for the three aggregate abundance-based management (AABM) fisheries, 1999–2019.

Errors are calculated as: (pre-season AI - post-season AI) / post-season AI

Note: there was no CTC consensus on the 2015 and 2016 model calibrations (CLB 1503 and 1601). Outputs from CLB 1503 was used by the Commission to configure AABM fisheries in 2015. Abundances indices for AABM fisheries generated from CLB 1601 were accepted by the Commission. Values for the 2014 and 2015 post-season AIs are from CLB 1601 and values for the 2015 pre-season AI is from CLB 1503.
Note: Beginning in 2019, the SEAK AABM fishery transitioned to a CPUE index for management in place of the AI.

4.4 Model Improvement Activities

Information and data generated by the PSC Chinook Model are used for several purposes, including management of AABM and ISBM fisheries and estimating fishery impacts on model stocks. In the paragraphs below, model improvement activities occurring and completed in 2019 and 2020 are described. Model calibration methods can be found in Appendix H. Activities from 2019 are described in the 2019 Calibration and ERA report (CTC 2019).

4.4.1 Base Period Calibration

The completion of the base period calibration culminated in 2019. The BPC results formed the underpinnings for the PSC Chinook Model (Phase II), which also underwent significant revisions during this process. The PSC Chinook Model (Phase II) was formally adopted by the PSC for use in October 2019. Considerable effort has been expended on trying to complete a new base period calibration in previous years. The new calibration incorporates substantial changes, including additional and improved base period data, improved stock representation, and increased fishery stratification. Documentation of new stock and fishery representation can be found in the three volumes of the Base Period Calibration reports (CTC 2021a; CTC *In prep. a*; CTC *In prep. b*).

4.4.2 Maturation Rate and Environmental Variable Investigation

The CTC-AWG reevaluated a suite of assumptions concerning which averages to use for maturation rates and environmental variable (EV) scalars when modeling incomplete broods or making projections (CTC 2016). The CTC had previously recommended to use a 9-year average for maturation rates used as inputs to the PSC Chinook Model and the most recent EV, but these recommendations had never been tested on the Phase II PSC Chinook Model. A thorough investigation was conducted in May 2019 (CTC *In prep. b*). The first stage of this investigation indicated that the basic time series exponential smoothing method outperformed all other maturation rate forecasting methods and subsequent analyses focused on combinations of exponential smoothing with EV averaging assumptions. The second stage of this investigation systematically increased the number of recent years (3 to 15) to average EVs. Minimization of AI and partial cohort (PCOH) mean raw errors was achieved with a recent 12-year EV average.

4.4.3 Data Generation Module (DGM)

The CTC's stock and fishery assessments often rely on fishery data that have an unknown amount of uncertainty, making it difficult to assess the performance of model estimates and management frameworks. The DGM was developed so the performance of the CTC's methods and assessments can be evaluated using data of known properties. The DGM was completed in January of 2019. Currently, the DGM is being used by the Calendar Year Exploitation Rate

Workgroup to test the performance of different cohort analysis methods that incorporate impacts for mark-selective fisheries (MSFs).

4.4.4 Salmon Forecasting Tool: ForecastR

This program relies on the open-source statistical software R to generate age-specific (or total abundance) forecasts of salmon escapement or terminal run using a variety of generic models and enabling users to perform interactive tasks with the help of a Shiny app. These tasks include: (a) the selection of forecasting approaches from a wide set of statistical and/or mechanistic models for forecasting terminal run and escapement; (b) the selection of several measures of retrospective forecast performance (e.g., mean raw error [MRE], mean absolute percentage error [MAPE], root mean square error [RMSE]); and (c) the comparison of forecasting models and model selection and ranking. After five developmental phases, the latest release has successfully implemented many of the originally envisioned capabilities for this tool. Model improvement funds and PSC Endowment Funds were used for the first four developmental phases. Phase-5 developments were funded by Fisheries and Oceans Canada, allowing the incorporation of additional forecasting modules and Shiny app features. Counting with an html-based Shiny application allows online forecasting exercises without users having ForecastR installed in their computers. The App can be accessed through two different servers: the SOLV server and the PSC server. ForecastR is considered a 'working project' in which additional forecasting modules and program capabilities to assist the PSC technical committees and its participating agencies can be incorporated in the future as needed. Following completion of select functionalities (e.g., the incorporation of covariate analysis in sibling regression forecasts), the CTC would like to obtain funding to facilitate workshops in which agency staff can be introduced to the ForecastR tool.

5. References Cited

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LIST OF APPENDICES

Note: Product names used in this publication are included for completeness but do not constitute product endorsement.

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	TAK	Taku and Stikine	TST
		Yes	Stikine (14,000–28,000)	Stikine	STI		
		Yes	Alsek (3,500–5,300)			Alsek	ALS
Southeast Alaska (SEAK)		Yes	Situk (500–1,000)			Yakutat Forelands	YAK
		Yes	Chilkat (1,750–3,500)	Chilkat Northern Southeast Alaska	CHK, NSA[1]	Northern Southeast Alaska	NSA
		Yes	Unuk (1,800–3,800)	Unuk Chickamin Southern Southeast Alaska	UNU, CHM, SSA[2]	Southern Southeast Alaska	SSA

[1]NSA is an aggregate of Crystal Lake (ACI) and Douglas Island Pink and Chum (DIPAC)/Macaulay (AMC) hatcheries.
[2]SSA is an aggregate of Little Port Walter (ALP), Neets Bay (ANB), Whitman Lake (AHC), and Deer Mountain (ADM) hatcheries.

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
		Yes	Skeena (TBD)				
Central BC (CBC)	Fall	No	Wannock	Atnarko (Snootli Hatchery)	ATN	Central BC	CBC
	Summer		Chuckwalla and Killbella				
		Yes	Atnarko				
West Coast Vancouver Island (WCVI)	Fall	Yes	North West Vancouver Island Aggregate (Colonial-Cayeagle, Tashish, Artlish, Kaouk)	Robertson Creek Hatchery	RBT (adj)[1]	West Coast Vancouver Island Natural	WVN
		Yes	South West Vancouver Island Aggregate (Bedwell/Ursus, Megin, Moyeha)				
		No	West Coast Vancouver Island Aggregate (14 Streams)	Robertson Creek Hatchery	RBT	West Coast Vancouver Island Hatchery	WVH

[1]CWT indicator stocks and fishery adjustments described in CTC (2016), CTC (2019; ISBM Subgroup Technical Note) and CTC (*In prep. c*).

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	Fraser Spring 1.2	Nicola (Spius Creek Hatchery)	NIC	Fraser Spring 1.2	FS2
		No	Fraser Spring 1.3	Dome (Penny Creek Hatchery)	DOM	Fraser Spring 1.3	FS3
		Yes		Lower Chilcotin *(in development)*	LCT		
	Summer	Yes	Fraser Summer 0.3	Lower Shuswap (Shuswap Falls Hatchery)	SHU	Fraser Ocean 0.3	FSO
		No		Middle Shuswap (Shuswap Falls Hatchery)	MSH		
		Yes	Fraser Summer 1.3	Chilko (Multiple Hatcheries)	CKO	Fraser Summer 1.3	FSS
	Fall	No	Harrison River	Chilliwack Hatchery	CHI	Fraser Chilliwack Fall Hatchery	FCF
		Yes		Harrison (Chehalis Hatchery)	HAR	Fraser Harrison Fall	FHF
North Strait of Georgia	Fall	No	TBD	Quinsam Hatchery	QUI	Upper Strait of Georgia	UGS
		Yes	East Vancouver Island North (TBD)		QUI (adj)[1]		
		Yes	Phillips	Phillips (Gillard Pass Hatchery)	PHI		
South Strait of Georgia	Fall	No	Lower Strait of Georgia	Big Qualicum Hatchery	BQR	Middle Strait of Georgia	MGS
		Yes		Cowichan Hatchery	COW	Lower Strait of Georgia	LGS
		No		Nanaimo Hatchery	NAN		
	Summer	No		Puntledge Hatchery	PPS	Puntledge Hatchery	PPS

[1]CWT indicator stocks and fishery adjustments described in CTC (2016), CTC (2019; ISBM Subgroup Technical Note) and CTC (*In prep. c*).

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	Nooksack Spring Fingerling (Kendall Creek Hatchery)	NSF	Nooksack Spring	NKS
		No		Nooksack Spring Yearling (Kendall Creek Hatchery)	NKS		
		Yes	Skagit Spring (690)	Skagit Spring Fingerling (Marblemount Hatchery)	SKF		
		No		Skagit Spring Yearling (Marblemount Hatchery)	SKS		
	Fall			Samish Fall Fingerling (Samish Hatchery)	SAM	Nooksack Fall	NKF
	Summer/Fall	Yes	Skagit Summer/Fall (9,202)	Skagit Summer Fingerling (Marblemount Hatchery)	SSF	Skagit Summer/Fall	SKG
	Fall	Yes	Stillaguamish	Stillaguamish Fall Fingerling (Whitehorse Hatchery)	STL	Stillaguamish	STL
	Summer	Yes	Snohomish	Skykomish Fingerling (Wallace Hatchery)	SKY	Snohomish	SNO
Central Puget Sound	Fall	No	Lake Washington			Puget Sound Natural Fingerling	PSN
		No	Green	Green River Fingerling[1] (Soos Creek Hatchery)	GRN[1]		
Hood Canal				George Adams Hatchery Fall Fingerling	GAD	Puget Sound Hatchery Fingerling	PSF
Southern Puget Sound (SPS)				SPS Fall Fingerling[1]	SPS[1]		
				Nisqually Fall Fingerling (Clear Creek Hatchery)	NIS		
				SPS Fall Yearling (Tumwater Hatchery)	SPY	Puget Sound Hatchery Yearling	PSY
				Squaxin Pens Fall Yearling	SQP		
				University of Washington Accelerated[2]	UWA		
	Spring			White River Hatchery Spring Yearling	WRY		

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

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			Elwha Fall Fingerling (Lower Elwha Hatchery)	ELW		
Washington Coast (WAC)		Yes	Hoko	Hoko Fall Fingerling (Hoko Falls Hatchery)	HOK		
		Yes (adj)	Grays Harbor Fall (13,326)	Queets Fall Fingerling (Salmon River brood stock)	QUE	WA Coastal Wild	WCN
		Yes	Queets Fall (2,500)				
		Yes (adj)	Quillayute Fall (3,000)				
		Yes (adj)	Hoh Fall (1,200)				
						WA Coastal Hatchery	WCH
				Tsoo-Yess Fall Fingerling (Makah National Fish Hatchery)	SOO		
	Spring	No	Grays Harbor Spring[1]				
	Spring/Summer	No	Queets Spring/Summer (700)[1]				
	Summer	No	Quillayute Summer[1]				
	Spring/Summer	No	Hoh Spring/Summer (900)[1]				

[1] Escapement indicator stock is not included in the Washington Coastal model stocks.

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					Cowlitz Spring Hatchery	CWS
				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
	Fall			Columbia Upriver Brights (Priest Rapids Hatchery)	URB	Mid-Columbia Brights	MCB
		Yes	Upriver Brights (40,000)			Columbia Upriver Brights	URB
				Hanford Wild	HAN		
				Lyons Ferry Fingerling	LYF	Lyons Ferry Hatchery	LYF
				Lyons Ferry Year	LYY		
		Yes	Lewis (5,700)	Lewis River Wild	LRW	Lewis River	LRW
		Yes	Coweeman	Cowlitz Hatchery Fall Tule	CWF	Cowlitz Hatchery	CWF
				Spring Creek National Fish Hatchery	SPR	Spring Creek	SPR
				Lower River Hatchery (Big Creek Hatchery)	LRH	Bonneville Hatchery	BON
North Oregon Coast (NOC)	Fall	Yes	Nehalem (6,989)	Salmon River Hatchery (adj)	SRH (adj)	North Oregon Coast	NOC
		Yes	Siletz (2,944)				
		Yes	Siuslaw (12,925)				
Mid-Oregon Coast (MOC)		Yes	Coquille	Elk River Hatchery (adj)	ELK (adj)	Mid-Oregon Coast	MOC
		Yes	South Umpqua				

APPENDIX B: MODEL STOCK COMPOSITION ESTIMATES FOR THE AABM AND ISBM FISHERIES IN 2019 AND THE 1985–2018 AVERAGE

This appendix shows the Model stock composition estimates of catch for the three AABM fisheries (Appendix B1, Appendix B2, and Appendix B3) and all ISBM fisheries by country (Appendix B4, Appendix B5). These estimates are based on summing the 41 model stock contributions for each model fishery aggregate, expressed as a percentage of the total catch.

The estimated stock composition may not reflect the true stock composition for several reasons:

1. The yearly catch estimates by stock are influenced by the base period stock composition in a fishery which may not reflect the current stock composition in the fishery, amongst the 41 model stocks.
2. The distribution of certain stocks may have changed over time.
3. The 41 model stocks do not represent all production available to a fishery.

For example, in the SEAK fishery a substantial component (over 20%) of the catch is comprised of Alaska hatchery fish, most of which do not count as Treaty catch and are not included in Appendix B1. Also, in the sport fishery portion of the present NBC AABM fishery, the base period data used is from fisheries which were located near shore and do not represent the current stock composition of the sport fishery which is located offshore.

Hence, these tables do not necessarily portray the true stock composition of the total catch of the fisheries in Appendices C1 to C5. Genetic stock composition estimates are available for most of these fisheries in select years, which provide more accurate accounting of contributions by stocks or stock groups.

LIST OF APPENDIX B TABLES

Appendix B1— Southeast Alaska aggregate-abundance based management (AABM) troll, net, sport.

Model Stock	2019	Average (1985–2018)			Associated Escapement Indicator Stocks[1]
	% of Fishery Catch	% of Fishery Catch	% of Stock Catch	% of Stock Total Return	
Upriver Brights	13.82%	19.22%	21.85%	12.08%	Upriver Brights
WCVI Hatchery	28.06%	15.68%	28.85%	13.56%	NA
North Oregon Coast	5.34%	9.80%	21.73%	12.00%	Nehalem Siletz Siuslaw
Northern BC	2.73%	7.99%	66.74%	13.52%	Skeena
Fraser Summer Ocean-type 0.3	13.93%	6.93%	30.68%	12.09%	Lower Shuswap
WA Coastal Wild	3.64%	6.13%	33.56%	16.15%	Grays Harbor Fall Queets Fall Quillayute Fall Hoh Fall
Mid-Columbia River Brights	5.76%	5.39%	19.32%	11.18%	Not Represented
Taku and Stikine	1.90%	4.89%	47.00%	10.13%	Taku Stikine
Southern SE AK	3.28%	4.05%	96.60%	32.45%	Unuk
WA Coastal Hatchery	3.76%	3.84%	31.82%	14.18%	NA
Columbia River Summer	3.60%	3.17%	17.86%	9.82%	Mid-Columbia Summers
Northern SE AK	3.20%	2.80%	99.63%	46.71%	Chilkat
WCVI Natural	3.88%	2.19%	30.86%	16.48%	NWVI Natural Aggregate SWVI Natural Aggregate
Mid-Oregon Coast	1.14%	2.13%	10.62%	5.60%	South Umpqua Coquille
Upper Strait of Georgia	1.38%	1.14%	40.27%	13.62%	East Vancouver Island North Phillips
Willamette River Spring	0.67%	0.98%	6.26%	2.70%	NA
Fall Cowlitz Hatchery	0.68%	0.86%	3.05%	1.62%	NA
Central BC	0.39%	0.65%	29.47%	7.10%	Atnarko

Model Stock	2019	Average (1985–2018)			Associated Escapement Indicator Stocks[1]
	% of Fishery Catch	% of Fishery Catch	% of Stock Catch	% of Stock Total Return	
Lewis River Wild	0.64%	0.59%	16.30%	5.76%	Lewis
Middle Strait of Georgia	0.68%	0.39%	9.67%	3.06%	NA
Harrison Fall	0.34%	0.33%	1.81%	0.53%	Harrison
Puget Sound Fingerling	0.38%	0.19%	0.37%	0.21%	NA
Fraser Summer Stream-type 1.3	0.08%	0.16%	2.25%	0.94%	Chilko
Skagit Wild	0.18%	0.11%	3.72%	1.28%	Skagit Summer/Fall
Spring Cowlitz Hatchery	0.03%	0.09%	1.49%	0.81%	NA
Lower Strait of Georgia	0.23%	0.09%	2.76%	1.10%	Cowichan
Lyons Ferry	0.14%	0.07%	1.84%	1.17%	Not Represented
Nooksack Fall	0.03%	0.06%	0.30%	0.20%	Not Represented
Puget Sound Natural Fall	0.02%	0.02%	0.33%	0.18%	NA
Chilliwack Fall Hatchery	0.03%	0.02%	0.20%	0.07%	NA
Nooksack Spring	0.03%	0.02%	4.83%	1.65%	Nooksack Spring
Puget Sound Yearlings	0.01%	0.01%	0.25%	0.15%	NA
Fraser Spring 1.2	0.01%	0.01%	0.40%	0.14%	Nicola
Puntledge Summers	0.01%	0.01%	5.83%	1.72%	NA
Snohomish Wild	0.01%	0.01%	1.01%	0.23%	Snohomish
Stillaguamish Wild	0.00%	0.00%	1.01%	0.39%	Stillaguamish
Alsek	0.00%	0.00%	0.00%	0.00%	Alsek
Fraser Spring 1.3	0.00%	0.00%	0.00%	0.00%	Chilcotin
Lower Bonneville Hatchery	0.00%	0.00%	0.00%	0.00%	NA
Spring Creek Hatchery	0.00%	0.00%	0.00%	0.00%	NA
Yakutat Forelands	0.00%	0.00%	0.00%	0.00%	Situk

[1] NA = a hatchery stock; Not represented = a wild stock without an escapement indicator.

Appendix B2— Northern British Columbia aggregate-abundance based management (AABM) troll and sport.

Model Stock	2019	Average (1985–2018)			Associated Escapement Indicator Stocks[1]
	% of Fishery Catch	% of Fishery Catch	% of Stock Catch	% of Stock Total Return	
North Oregon Coast	15.19%	21.10%	31.78%	18.05%	Nehalem
					Siletz
					Siuslaw
Upriver Brights	13.47%	16.35%	12.60%	7.15%	Upriver Brights
Fraser Summer Ocean-type 0.3	22.49%	12.21%	34.92%	14.61%	Lower Shuswap
WCVI Hatchery	12.29%	10.10%	11.05%	5.56%	NA
WA Coastal Wild	4.79%	8.01%	28.93%	14.60%	Grays Harbor Fall
					Queets Fall
					Quillayute Fall
					Hoh Fall
Mid-Oregon Coast	5.00%	6.79%	22.27%	11.90%	South Umpqua
					Coquille
Columbia River Summer	7.07%	6.06%	22.95%	13.05%	Mid-Columbia Summers
WA Coastal Hatchery	4.91%	5.11%	28.50%	13.29%	NA
Mid-Columbia River Brights	4.20%	3.55%	9.12%	5.50%	Not Represented
Willamette River Spring	1.67%	2.16%	9.27%	4.14%	NA
WCVI Natural	1.82%	1.32%	11.21%	6.42%	NWVI Natural Aggregate
					SWVI Natural Aggregate
Upper Strait of Georgia	0.74%	0.93%	20.78%	7.55%	East Vancouver Island North
					Phillips
Fall Cowlitz Hatchery	0.62%	0.88%	2.11%	1.15%	NA
Middle Strait of Georgia	0.84%	0.62%	9.98%	3.31%	NA
Taku and Stikine	0.26%	0.49%	3.31%	0.66%	Taku
					Stikine
Fraser Summer Stream-type 1.3	0.20%	0.49%	4.50%	1.91%	Chilko
Northern BC	0.15%	0.48%	2.95%	0.62%	Skeena

Model Stock	2019	Average (1985–2018)			Associated Escapement Indicator Stocks[1]
	% of Fishery Catch	% of Fishery Catch	% of Stock Catch	% of Stock Total Return	
Puget Sound Fingerling	0.95%	0.46%	0.64%	0.37%	NA
Lewis River Wild	0.53%	0.36%	6.03%	2.32%	Lewis
Central BC	0.23%	0.32%	9.81%	2.44%	Atnarko
Lyons Ferry	0.63%	0.31%	6.26%	4.04%	Not Represented
Spring Cowlitz Hatchery	0.08%	0.30%	3.62%	2.02%	NA
Skagit Wild	0.41%	0.28%	6.21%	2.19%	Skagit Summer/Fall
Harrison Fall	0.18%	0.26%	0.83%	0.26%	Harrison
Chilliwack Fall Hatchery	0.38%	0.22%	1.13%	0.45%	NA
Lower Strait of Georgia	0.58%	0.20%	2.54%	1.20%	Cowichan
Southern SE AK	0.12%	0.19%	3.08%	1.03%	Unuk
Nooksack Fall	0.04%	0.09%	0.27%	0.18%	Not Represented
Puget Sound Natural Fall	0.03%	0.06%	0.42%	0.24%	NA
Lower Bonneville Hatchery	0.01%	0.05%	0.21%	0.11%	NA
Puntledge Summers	0.03%	0.05%	11.08%	3.52%	NA
Nooksack Spring	0.05%	0.04%	6.95%	2.54%	Nooksack Spring
Spring Creek Hatchery	0.02%	0.04%	0.07%	0.06%	NA
Fraser Spring 1.2	0.01%	0.03%	0.48%	0.18%	Nicola
Snohomish Wild	0.01%	0.03%	2.00%	0.48%	Snohomish
Stillaguamish Wild	0.01%	0.02%	2.16%	0.89%	Stillaguamish
Northern SE AK	0.01%	0.02%	0.17%	0.08%	Chilkat
Puget Sound Yearlings	0.00%	0.01%	0.04%	0.03%	NA
Yakutat Forelands	0.00%	0.00%	0.00%	0.00%	Situk
Fraser Spring 1.3	0.00%	0.00%	0.00%	0.00%	Chilcotin
Alsek	0.00%	0.00%	0.00%	0.00%	Alsek

[1] NA = a hatchery stock; Not represented = a wild stock without an escapement indicator.

Appendix B3— West Coast Vancouver Island aggregate-abundance based management (AABM) troll and sport.

Model Stock	2019	Average (1985–2018)			Associated Escapement Indicator Stocks[1]
	% of Fishery Catch	% of Fishery Catch	% of Stock Catch	% of Stock Total Return	
Puget Sound Fingerling	22.79%	13.11%	18.43%	11.11%	NA
Upriver Brights	13.40%	12.83%	10.18%	5.94%	Upriver Brights
Spring Creek Hatchery	6.91%	10.76%	20.84%	16.14%	NA
Fall Cowlitz Hatchery	5.65%	8.44%	22.08%	12.49%	NA
Lower Bonneville Hatchery	1.77%	6.57%	33.15%	18.70%	NA
Harrison Fall	3.98%	5.91%	19.20%	6.31%	Harrison
WCVI Hatchery	5.21%	5.29%	5.81%	3.11%	NA
Chilliwack Fall Hatchery	9.99%	5.20%	25.40%	10.94%	NA
Mid-Columbia River Brights	5.90%	4.26%	11.16%	6.99%	Not Represented
Columbia River Summer	3.33%	3.78%	17.14%	10.03%	Mid-Columbia Summers
North Oregon Coast	4.42%	3.77%	6.00%	3.45%	Nehalem
					Siletz
					Siuslaw
Nooksack Fall	1.06%	3.02%	10.76%	7.20%	Not Represented
Puget Sound Natural Fall	1.13%	2.47%	22.36%	13.24%	NA
Mid-Oregon Coast	1.46%	1.74%	6.49%	3.61%	South Umpqua
					Coquille
WA Coastal Wild	0.91%	1.59%	6.05%	3.07%	Grays Harbor Fall
					Queets Fall
					Quillayute Fall
					Hoh Fall
Puget Sound Yearlings	0.45%	1.42%	14.31%	9.48%	NA
Fraser Summer Stream-type 1.3	0.52%	1.38%	13.25%	5.73%	Chilko
Lyons Ferry	2.08%	1.08%	20.60%	13.97%	Not Represented
WA Coastal Hatchery	0.90%	1.05%	6.19%	2.92%	NA
Skagit Wild	1.16%	0.93%	21.86%	8.06%	Skagit Summer/Fall
Willamette River Spring	0.57%	0.83%	3.73%	1.70%	NA
Lewis River Wild	1.45%	0.80%	15.11%	6.00%	Lewis

<table>
<tr><th rowspan="2">Model Stock</th><th>2019</th><th colspan="3">Average (1985–2018)</th><th rowspan="2">Associated Escapement Indicator Stocks[1]</th></tr>
<tr><th>% of Fishery Catch</th><th>% of Fishery Catch</th><th>% of Stock Catch</th><th>% of Stock Total Return</th></tr>
<tr><td>Spring Cowlitz Hatchery</td><td>0.24%</td><td>0.79%</td><td>9.63%</td><td>5.73%</td><td>NA</td></tr>
<tr><td>Fraser Summer Ocean-type 0.3</td><td>1.18%</td><td>0.70%</td><td>2.30%</td><td>1.01%</td><td>Lower Shuswap</td></tr>
<tr><td>Lower Strait of Georgia</td><td>1.68%</td><td>0.67%</td><td>9.96%</td><td>4.61%</td><td>Cowichan</td></tr>
<tr><td rowspan="2">WCVI Natural</td><td rowspan="2">0.80%</td><td rowspan="2">0.53%</td><td rowspan="2">5.71%</td><td rowspan="2">3.42%</td><td>NWVI Natural Aggregate</td></tr>
<tr><td>SWVI Natural Aggregate</td></tr>
<tr><td>Middle Strait of Georgia</td><td>0.57%</td><td>0.37%</td><td>5.86%</td><td>2.04%</td><td>NA</td></tr>
<tr><td>Snohomish Wild</td><td>0.10%</td><td>0.19%</td><td>18.76%</td><td>4.72%</td><td>Snohomish</td></tr>
<tr><td>Fraser Spring 1.2</td><td>0.08%</td><td>0.19%</td><td>4.03%</td><td>1.47%</td><td>Nicola</td></tr>
<tr><td>Stillaguamish Wild</td><td>0.07%</td><td>0.13%</td><td>18.49%</td><td>7.94%</td><td>Stillaguamish</td></tr>
<tr><td>Nooksack Spring</td><td>0.11%</td><td>0.09%</td><td>16.47%</td><td>6.06%</td><td>Nooksack Spring</td></tr>
<tr><td>Fraser Spring 1.3</td><td>0.05%</td><td>0.06%</td><td>1.01%</td><td>0.27%</td><td>Chilcotin</td></tr>
<tr><td>Puntledge Summers</td><td>0.02%</td><td>0.03%</td><td>7.47%</td><td>2.34%</td><td>NA</td></tr>
<tr><td rowspan="2">Upper Strait of Georgia</td><td rowspan="2">0.01%</td><td rowspan="2">0.02%</td><td rowspan="2">0.57%</td><td rowspan="2">0.22%</td><td>East Vancouver Island North</td></tr>
<tr><td>Phillips</td></tr>
<tr><td>Central BC</td><td>0.01%</td><td>0.01%</td><td>0.38%</td><td>0.09%</td><td>Atnarko</td></tr>
<tr><td>Northern SE AK</td><td>0.00%</td><td>0.00%</td><td>0.05%</td><td>0.02%</td><td>Chilkat</td></tr>
<tr><td>Alsek</td><td>0.00%</td><td>0.00%</td><td>0.00%</td><td>0.00%</td><td>Alsek</td></tr>
<tr><td>Taku and Stikine</td><td rowspan="2">0.00%</td><td rowspan="2">0.00%</td><td rowspan="2">0.00%</td><td rowspan="2">0.00%</td><td>Taku</td></tr>
<tr><td></td><td>Stikine</td></tr>
<tr><td>Southern SE AK</td><td>0.00%</td><td>0.00%</td><td>0.00%</td><td>0.00%</td><td>Unuk</td></tr>
<tr><td>Yakutat Forelands</td><td>0.00%</td><td>0.00%</td><td>0.00%</td><td>0.00%</td><td>Situk</td></tr>
<tr><td>Northern BC</td><td>0.00%</td><td>0.00%</td><td>0.00%</td><td>0.00%</td><td>Skeena</td></tr>
</table>

[1] NA = a hatchery stock; Not represented = a wild stock without an escapement indicator.

Appendix B4— Canada individual stock-based management (ISBM) troll, net, and sport.

Model Stock	2019	Average (1985–2018)			Associated Escapement Indicator Stocks[1]
	% of Fishery Catch	% of Fishery Catch	% of Stock Catch	% of Stock Total Return	
WCVI Hatchery	42.48%	28.02%	53.88%	25.93%	NA
Harrison Fall	3.33%	7.77%	39.05%	13.76%	Harrison
Puget Sound Fingerling	9.27%	6.01%	13.18%	7.80%	NA
Fraser Summer Stream-type 1.3	2.62%	5.86%	75.75%	33.72%	Chilko
Fraser Summer Ocean-type 0.3	6.72%	5.73%	28.32%	11.49%	Lower Shuswap
Nooksack Fall	1.86%	5.36%	28.92%	19.39%	Not Represented
Lower Strait of Georgia	9.37%	4.60%	75.62%	41.85%	Cowichan
Chilliwack Fall Hatchery	4.52%	4.16%	35.89%	17.39%	NA
WCVI Natural	5.48%	3.85%	51.86%	28.55%	NWVI Natural Aggregate
					SWVI Natural Aggregate
Fraser Spring 1.3	0.62%	3.76%	84.15%	23.19%	Chilcotin
Northern BC	0.54%	3.71%	30.31%	6.21%	Skeena
Fraser Spring 1.2	0.22%	3.31%	87.76%	33.22%	Nicola
Middle Strait of Georgia	4.10%	3.20%	72.09%	30.11%	NA
Upriver Brights	1.06%	2.54%	3.62%	2.19%	Upriver Brights
Fall Cowlitz Hatchery	0.77%	1.58%	5.93%	3.30%	NA
Columbia River Summer	1.46%	1.51%	11.72%	6.58%	Mid-Columbia Summers
Central BC	1.01%	1.25%	60.25%	14.64%	Atnarko
Upper Strait of Georgia	0.61%	1.15%	38.38%	15.43%	East Vancouver Island North
					Phillips
Skagit Wild	1.24%	1.03%	37.26%	14.02%	Skagit Summer/Fall
Puget Sound Natural Fall	0.40%	0.99%	14.46%	8.29%	NA
Puget Sound Yearlings	0.26%	0.88%	14.34%	9.57%	NA
Spring Creek Hatchery	0.60%	0.81%	2.71%	2.07%	NA
Mid-Columbia River Brights	0.42%	0.68%	4.10%	2.81%	Not Represented
Lower Bonneville Hatchery	0.21%	0.49%	3.76%	2.00%	NA
North Oregon Coast	0.03%	0.34%	0.93%	0.53%	Nehalem

Model Stock	2019	Average (1985–2018)			Associated Escapement Indicator Stocks[1]
	% of Fishery Catch	% of Fishery Catch	% of Stock Catch	% of Stock Total Return	
					Siletz
					Siuslaw
Snohomish Wild	0.12%	0.23%	35.38%	8.78%	Snohomish
Nooksack Spring	0.22%	0.20%	57.26%	21.00%	Nooksack Spring
Puntledge Summers	0.13%	0.19%	75.62%	30.26%	NA
Lewis River Wild	0.11%	0.17%	4.36%	1.75%	Lewis
Stillaguamish Wild	0.08%	0.16%	35.51%	15.10%	Stillaguamish
WA Coastal Wild	0.03%	0.14%	0.86%	0.45%	Grays Harbor Fall
					Queets Fall
					Quillayute Fall
					Hoh Fall
Spring Cowlitz Hatchery	0.02%	0.11%	2.06%	1.16%	NA
WA Coastal Hatchery	0.03%	0.10%	0.89%	0.45%	NA
Lyons Ferry	0.06%	0.05%	2.75%	2.02%	Not Represented
Willamette River Spring	0.01%	0.03%	0.22%	0.12%	NA
Mid-Oregon Coast	0.01%	0.01%	0.06%	0.03%	South Umpqua
					Coquille
Southern SE AK	0.00%	0.01%	0.32%	0.10%	Unuk
Northern SE AK	0.00%	0.00%	0.05%	0.02%	Chilkat
Alsek	0.00%	0.00%	0.00%	0.00%	Alsek
Yakutat Forelands	0.00%	0.00%	0.00%	0.00%	Situk
Taku and Stikine	0.00%	0.00%	0.00%	0.00%	Taku
					Stikine

[1] NA = a hatchery stock; Not represented = a wild stock without an escapement indicator.

Appendix B5— U.S. individual stock-based management (ISBM) troll, net, and sport.

Model Stock	2019	Average (1985–2018)			Associated Escapement Indicator Stocks[1]
	% of Fishery Catch	% of Fishery Catch	% of Stock Catch	% of Stock Total Return	
Upriver Brights	20.50%	17.47%	51.76%	28.94%	Upriver Brights
Puget Sound Fingerling	30.25%	12.70%	67.38%	38.70%	NA
Spring Creek Hatchery	8.31%	10.68%	76.38%	58.67%	NA
Fall Cowlitz Hatchery	4.83%	7.07%	66.83%	37.26%	NA
North Oregon Coast	4.73%	6.88%	39.56%	21.60%	Nehalem
					Siletz
					Siuslaw
Mid-Columbia River Brights	5.55%	5.93%	56.29%	33.58%	Not Represented
Willamette River Spring	2.34%	5.36%	80.52%	37.37%	NA
Mid-Oregon Coast	2.49%	4.83%	60.56%	32.36%	South Umpqua
					Coquille
Nooksack Fall	2.13%	4.64%	59.75%	38.91%	Not Represented
Lower Bonneville Hatchery	1.14%	3.52%	62.89%	33.91%	NA
Harrison Fall	2.34%	3.32%	39.11%	13.01%	Harrison
Columbia River Summer	2.30%	2.37%	30.32%	17.08%	Mid-Columbia Summers
WA Coastal Wild	1.52%	2.26%	30.59%	14.66%	Grays Harbor Fall
					Queets Fall
					Quillayute Fall
					Hoh Fall
Puget Sound Yearlings	0.73%	2.07%	71.06%	45.64%	NA
Puget Sound Natural Fall	1.06%	1.96%	62.43%	35.11%	NA
Chilliwack Fall Hatchery	3.33%	1.89%	37.38%	15.88%	NA
Spring Cowlitz Hatchery	0.34%	1.88%	83.19%	47.74%	NA
WA Coastal Hatchery	1.94%	1.70%	32.59%	14.52%	NA
Lewis River Wild	0.49%	0.96%	58.20%	23.68%	Lewis
Lyons Ferry	1.55%	0.86%	68.55%	45.56%	Not Represented
Skagit Wild	0.48%	0.34%	30.94%	10.94%	Skagit Summer/Fall
Fraser Summer Ocean-type 0.3	0.64%	0.30%	3.79%	1.54%	Lower Shuswap

Model Stock	2019	Average (1985–2018)			Associated Escapement Indicator Stocks[1]
	% of Fishery Catch	% of Fishery Catch	% of Stock Catch	% of Stock Total Return	
Fraser Spring 1.3	0.15%	0.27%	14.85%	3.90%	Chilcotin
Lower Strait of Georgia	0.35%	0.18%	9.13%	4.19%	Cowichan
Snohomish Wild	0.08%	0.12%	42.85%	10.55%	Snohomish
Fraser Summer Stream-type 1.3	0.05%	0.11%	4.26%	1.79%	Chilko
WCVI Hatchery	0.14%	0.09%	0.40%	0.19%	NA
Stillaguamish Wild	0.06%	0.08%	42.83%	18.01%	Stillaguamish
Fraser Spring 1.2	0.04%	0.08%	7.33%	2.60%	Nicola
Middle Strait of Georgia	0.07%	0.04%	2.39%	0.82%	NA
Nooksack Spring	0.04%	0.02%	14.50%	5.22%	Nooksack Spring
WCVI Natural	0.02%	0.01%	0.35%	0.19%	NWVI Natural Aggregate
					SWVI Natural Aggregate
Northern SE AK	0.00%	0.00%	0.09%	0.04%	Chilkat
Central BC	0.00%	0.00%	0.09%	0.02%	Atnarko
Northern BC	0.00%	0.00%	0.00%	0.00%	Skeena
Yakutat Forelands	0.00%	0.00%	0.00%	0.00%	Situk
Puntledge Summers	0.00%	0.00%	0.00%	0.00%	NA
Taku and Stikine	0.00%	0.00%	0.00%	0.00%	Taku
					Stikine
Alsek	0.00%	0.00%	0.00%	0.00%	Alsek
Upper Strait of Georgia	0.00%	0.00%	0.00%	0.00%	East Vancouver Island North
					Phillips
Southern SE AK	0.00%	0.00%	0.00%	0.00%	Unuk

APPENDIX C: FIGURES OF PSC CHINOOK MODEL-GENERATED STOCK COMPOSITION OF ACTUAL LANDED CATCH FOR ALL (AABM AND ISBM) MODEL FISHERIES, 1979–2019

Stock composition in the AABM and ISBM fisheries are estimated using the PSC Chinook Model. Assumptions of the estimation procedure are described in Appendix B. The relative contribution of a model stock to a model fishery is computed as:

$$P_{F,S,Y} = \frac{Q_{F,S,Y}}{\sum_S Q_{F,S,Y}}$$

where $Q_{F,S,Y}$ is model landed catch by fishery F, stock S, and year Y. Landed catch stock composition is computed:

$$C_{F,S,Y} = C_{F,Y} * P_{F,S,Y}$$

where $C_{F,Y}$ is the landed catch by fishery F and year Y. Since the PSC Chinook Model does not include the Alaska Hatchery Addon, the landed catch stock composition is adjusted to include this harvest:

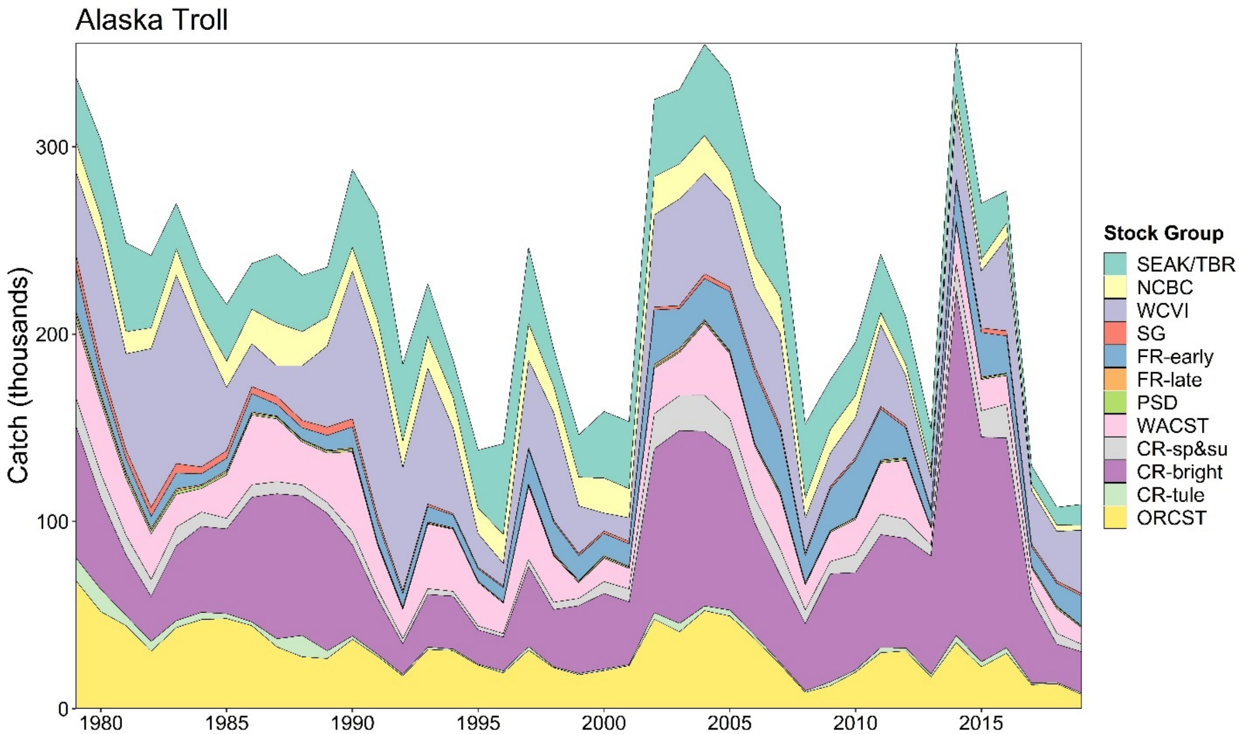
$$C_{F,S=AK,Y} = C_{F,S=AK,Y} + A_{F,S=AK,Y}$$

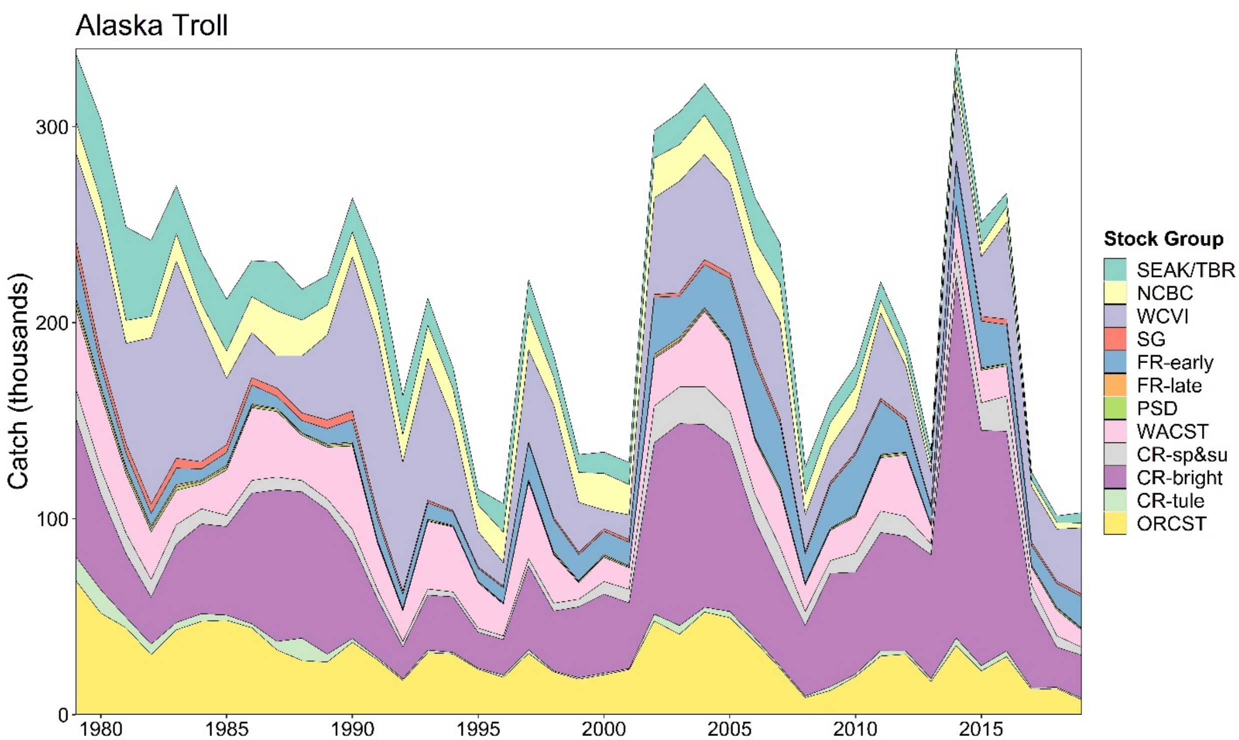
where $A_{F,S=AK,Y}$ is the Alaska Hatchery Addon by fishery F and year Y for the SEAK and TBR stock groups. Results with and without the Alaska Hatchery Addon are reported. Stock group definitions in each figure correspond to the following model stock aggregations:

SEAK/TBR	Southeast Alaska and Transboundary River stocks (Southern and Northern SE AK, Alsek, Taku and Stikine, and Yakutat Forelands)
NCBC	North and Central British Columbia stocks
WCVI	West Coast Vancouver Island stocks (hatchery and natural)
SG	Strait of Georgia stocks (Upper, Middle, Lower, and Puntledge Summers)
FR-early	Fraser River Early stocks (Fraser Spring 1.2 and 1.3, Fraser Summer Ocean-type 0.3 and Stream-type 1.3)
FR-late	Fraser River Late stocks (Harrison Fall, Chilliwack Fall Hatchery)
PSD	Puget Sound stocks (Nooksack Fall and Spring, Puget Sound Natural Fall, Puget Sound Fingerlings and Yearlings, Skagit Wild, Stillaguamish Wild, and Snohomish Wild)
WACST	Washington Coast stocks (hatchery and wild)
CR-sp&su	Columbia River Spring and Summer stocks (Willamette, Spring Cowlitz Hatchery, and Columbia Summers)
CR-bright	Columbia River Fall Bright stocks (Upriver, Mid-Columbia, Lewis River Wild, and Lyons Ferry)
CR-tule	Columbia River-Fall Tule stocks (Spring Creek, Lower Bonneville, and Fall Cowlitz Hatchery)
ORCST	North and Mid-Oregon Coast stocks

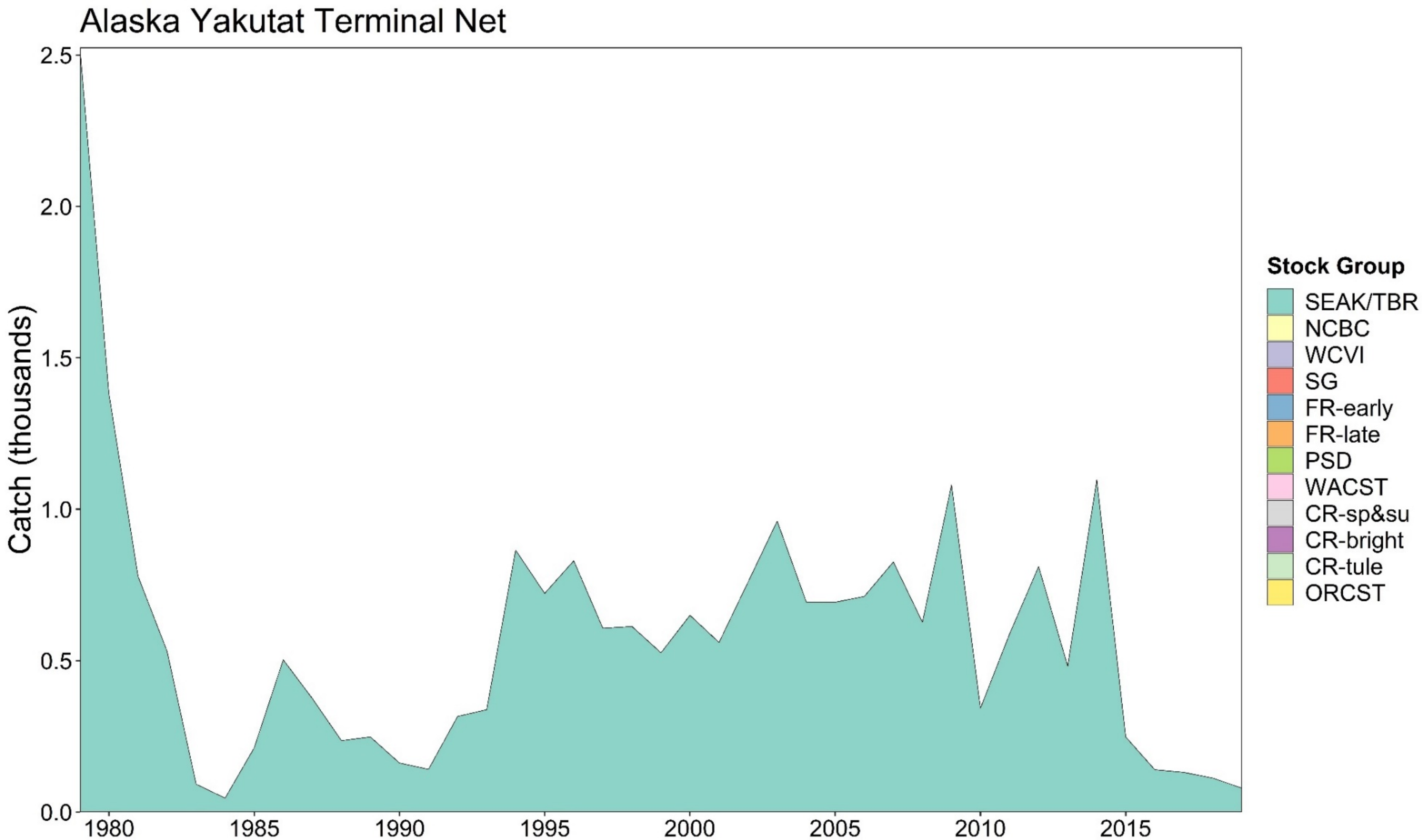
LIST OF APPENDIX C FIGURES

Appendix C1— PSC Chinook Model estimates of landed catch stock composition for Alaska troll with (upper) and without (lower) Alaska hatchery add-on and terminal exclusion, 1979–2019.

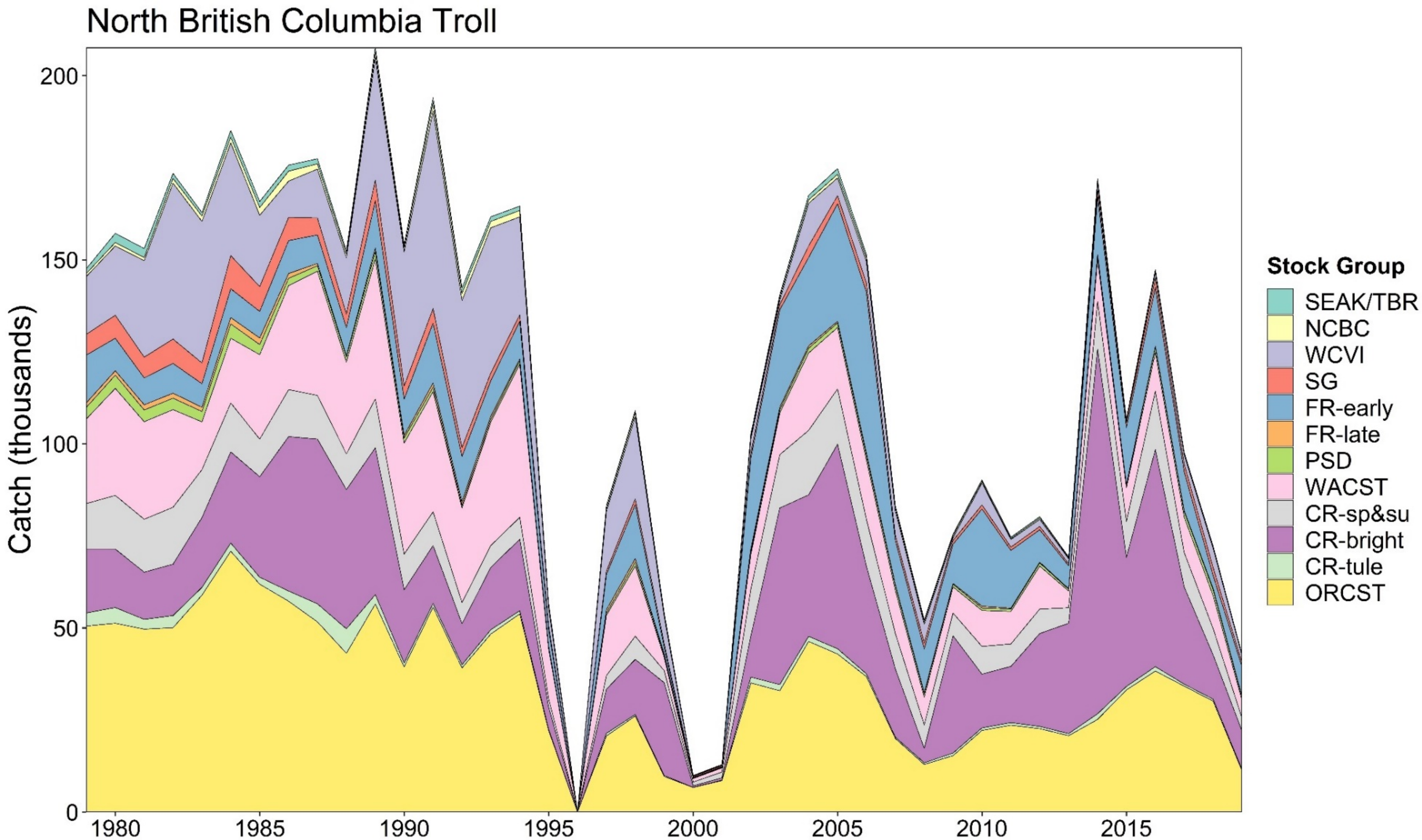




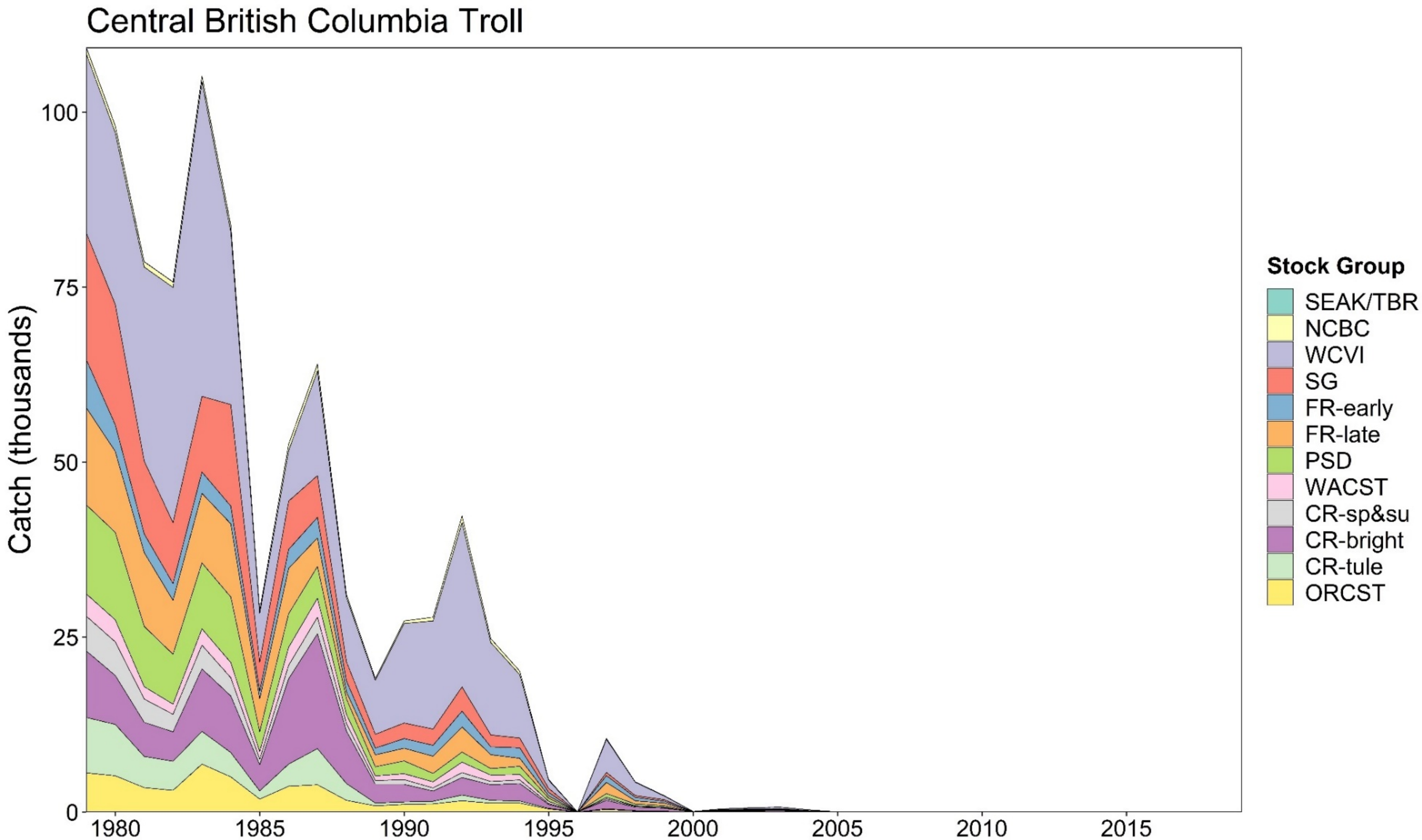
Appendix C2— PSC Chinook Model estimates of landed catch stock composition for Alaska Yakutat Terminal Net, 1979–2019.



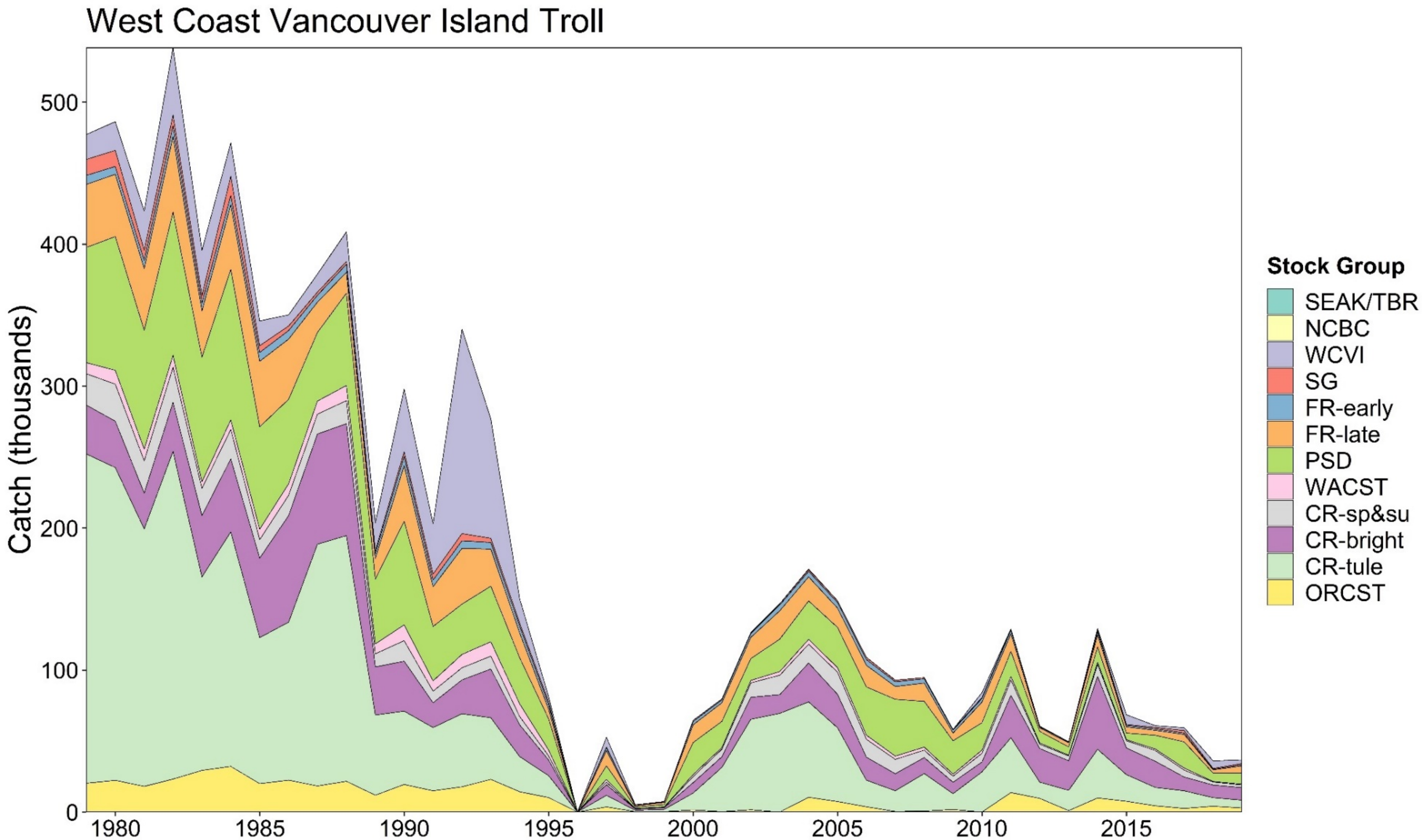
Appendix C3— PSC Chinook Model estimates of landed catch stock composition for North British Columbia Troll, 1979–2019.



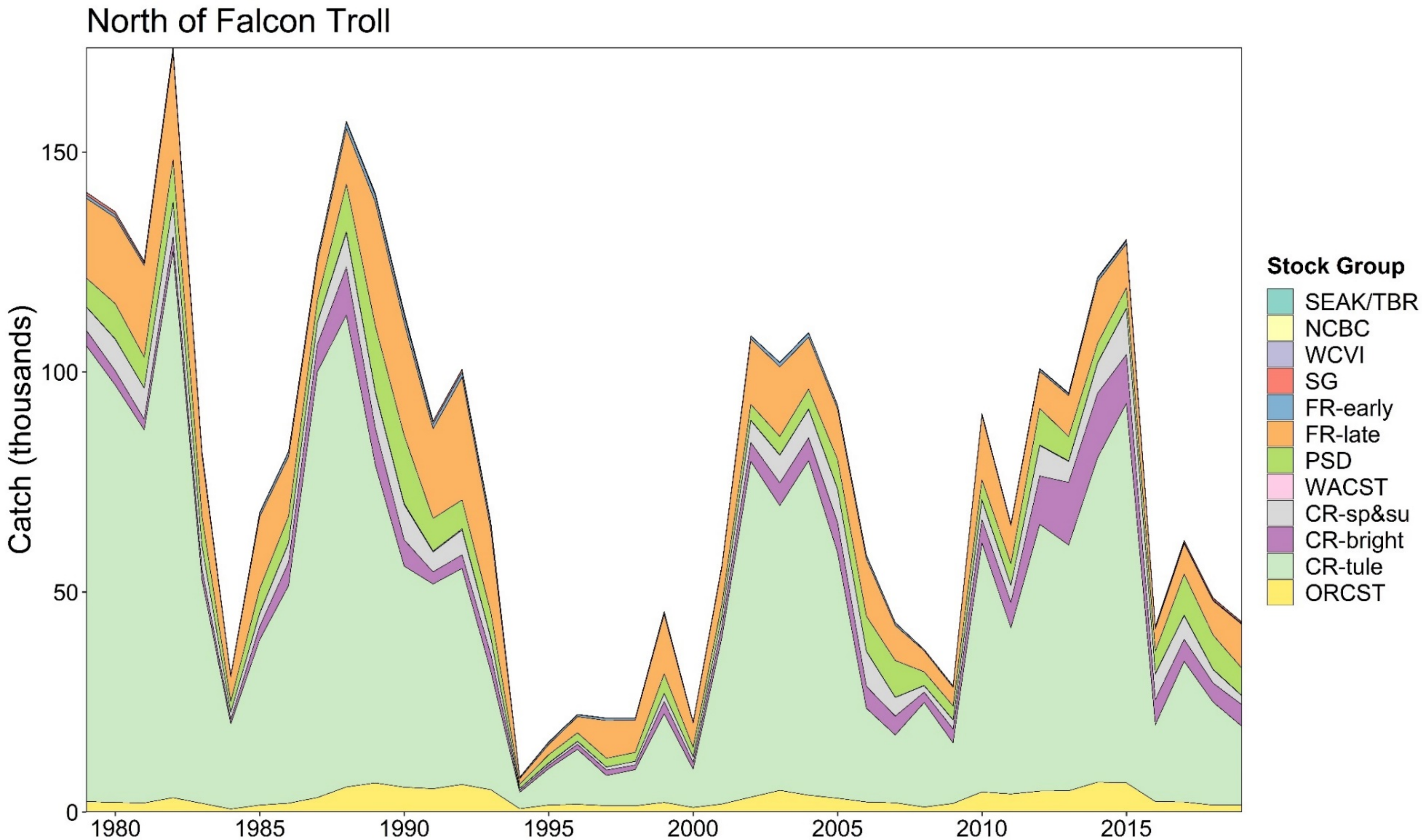
Appendix C4— PSC Chinook Model estimates of landed catch stock composition for Central British Columbia Troll, 1979–2019.



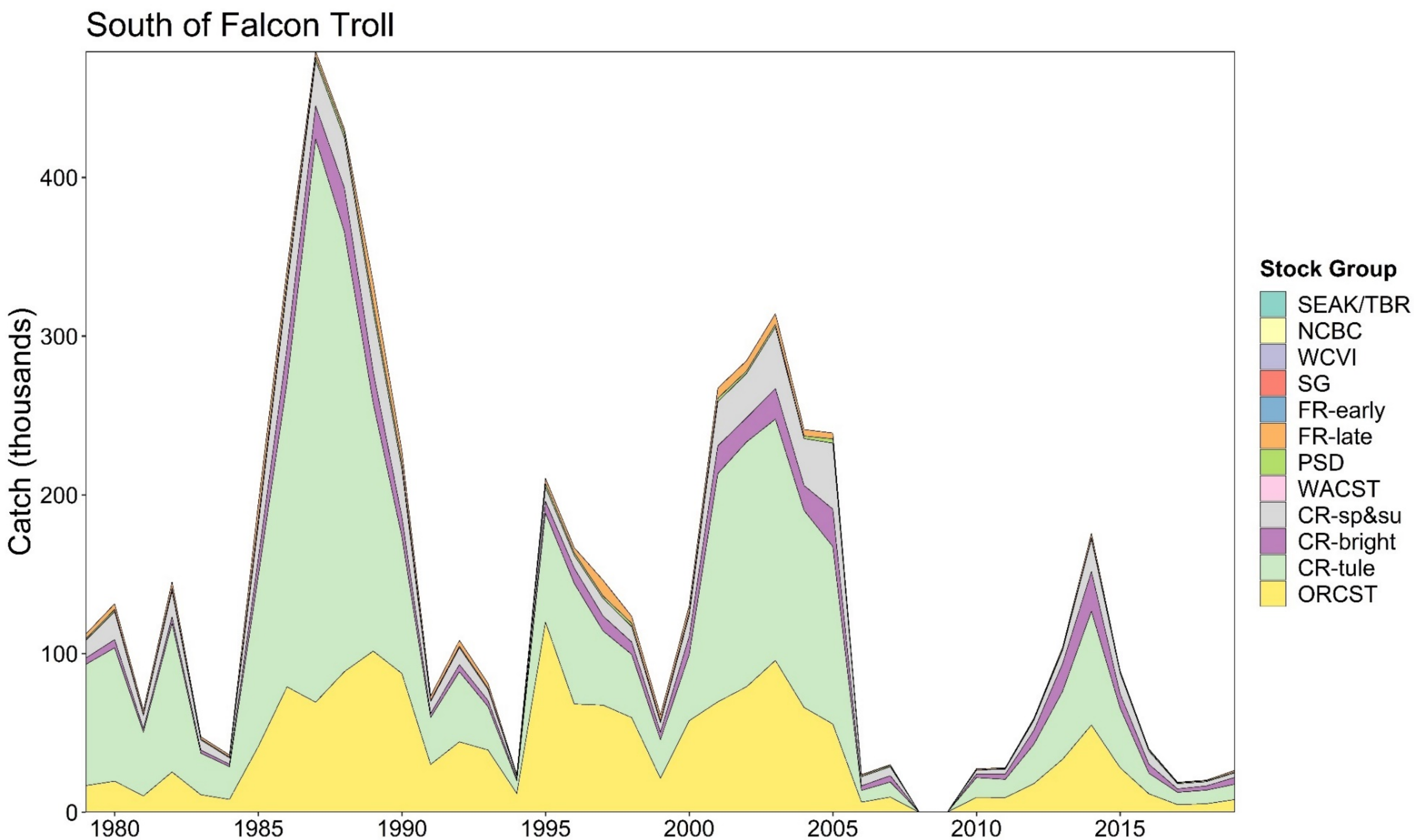
Appendix C5— PSC Chinook Model estimates of landed catch stock composition for West Coast Vancouver Island Troll, 1979–2019.



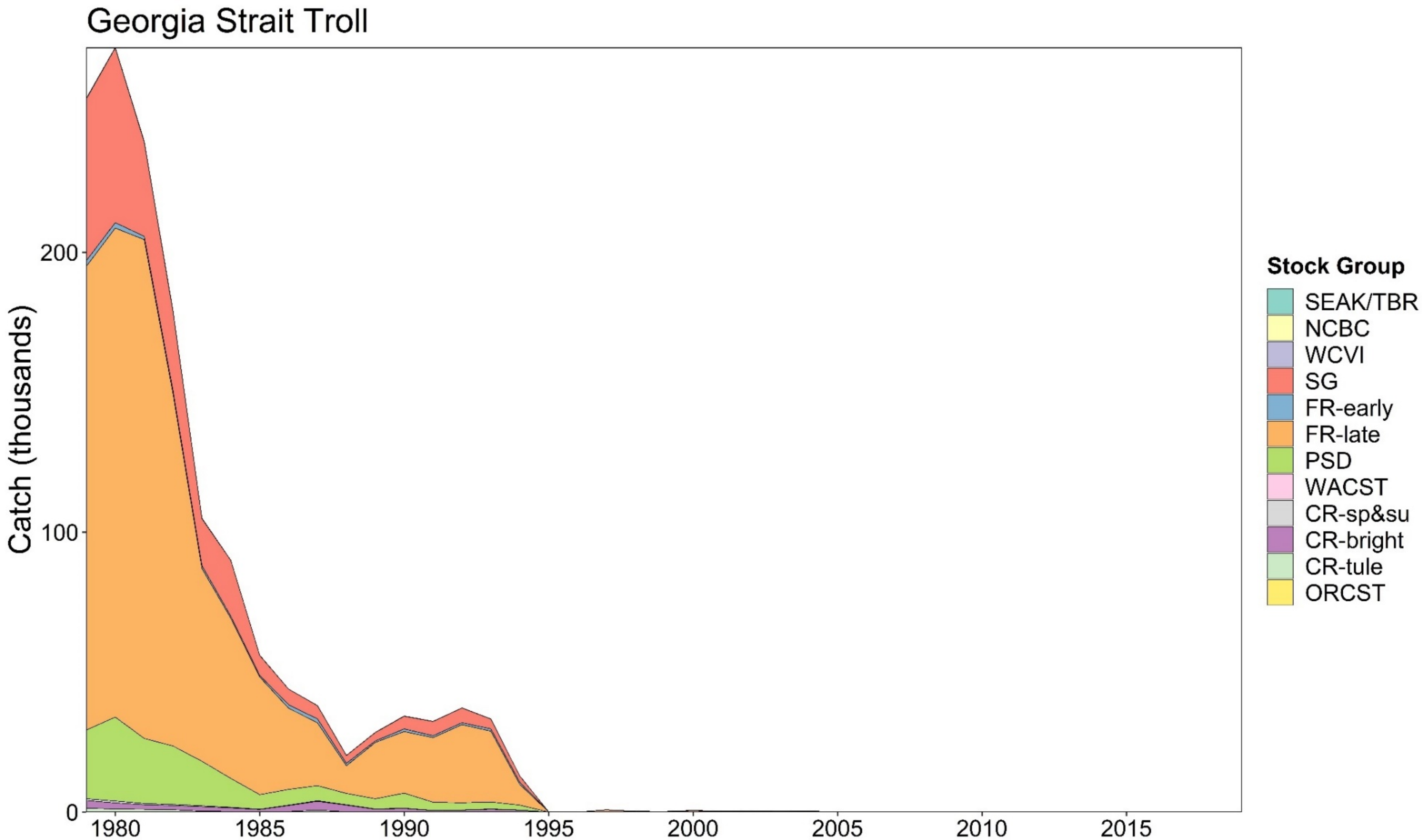
Appendix C6— PSC Chinook Model estimates of landed catch stock composition for North of Falcon Troll, 1979–2019.



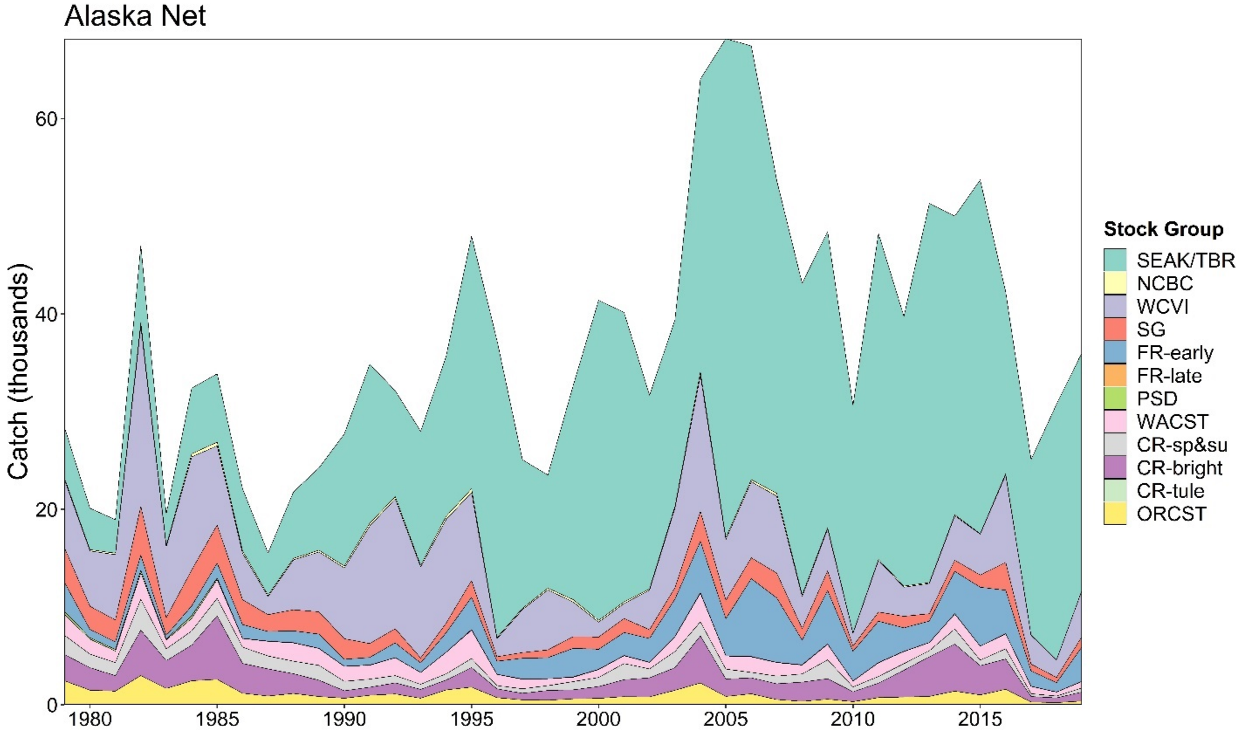
Appendix C7— PSC Chinook Model estimates of landed catch stock composition for South of Falcon Troll, 1979–2019.

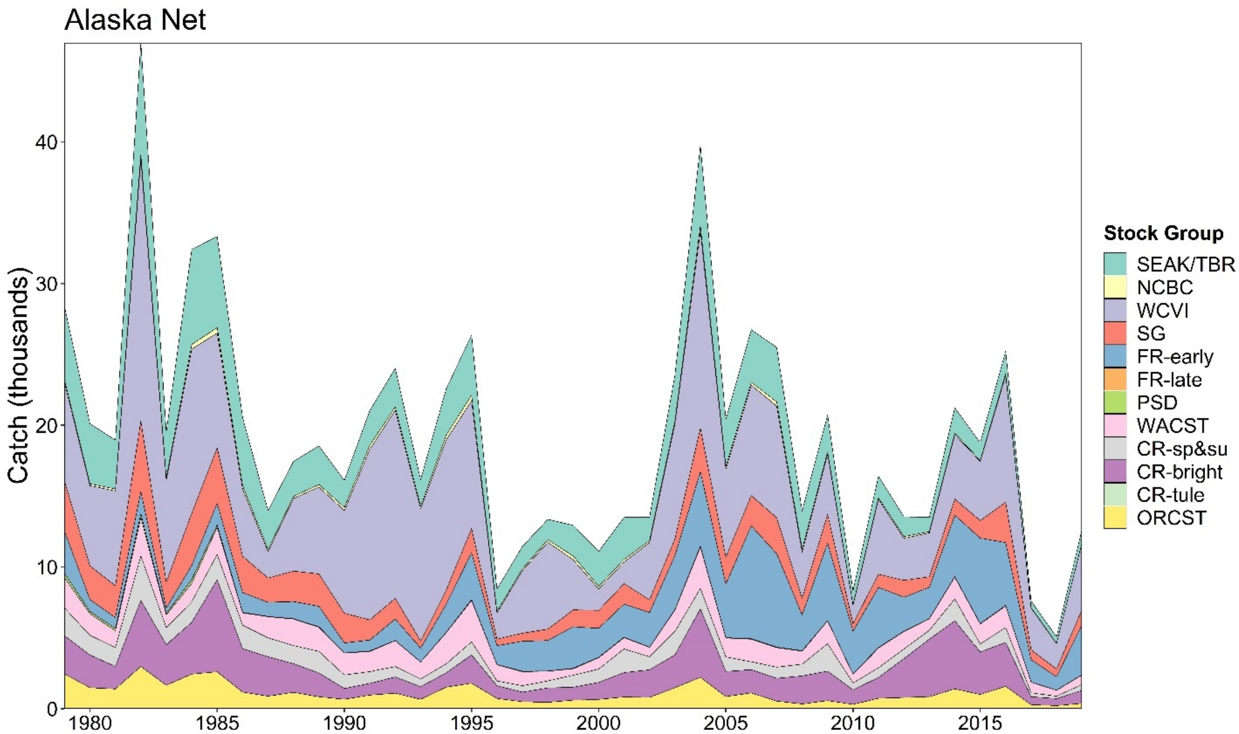


Appendix C8— PSC Chinook Model estimates of landed catch stock composition for Strait of Georgia Troll, 1979–2019.

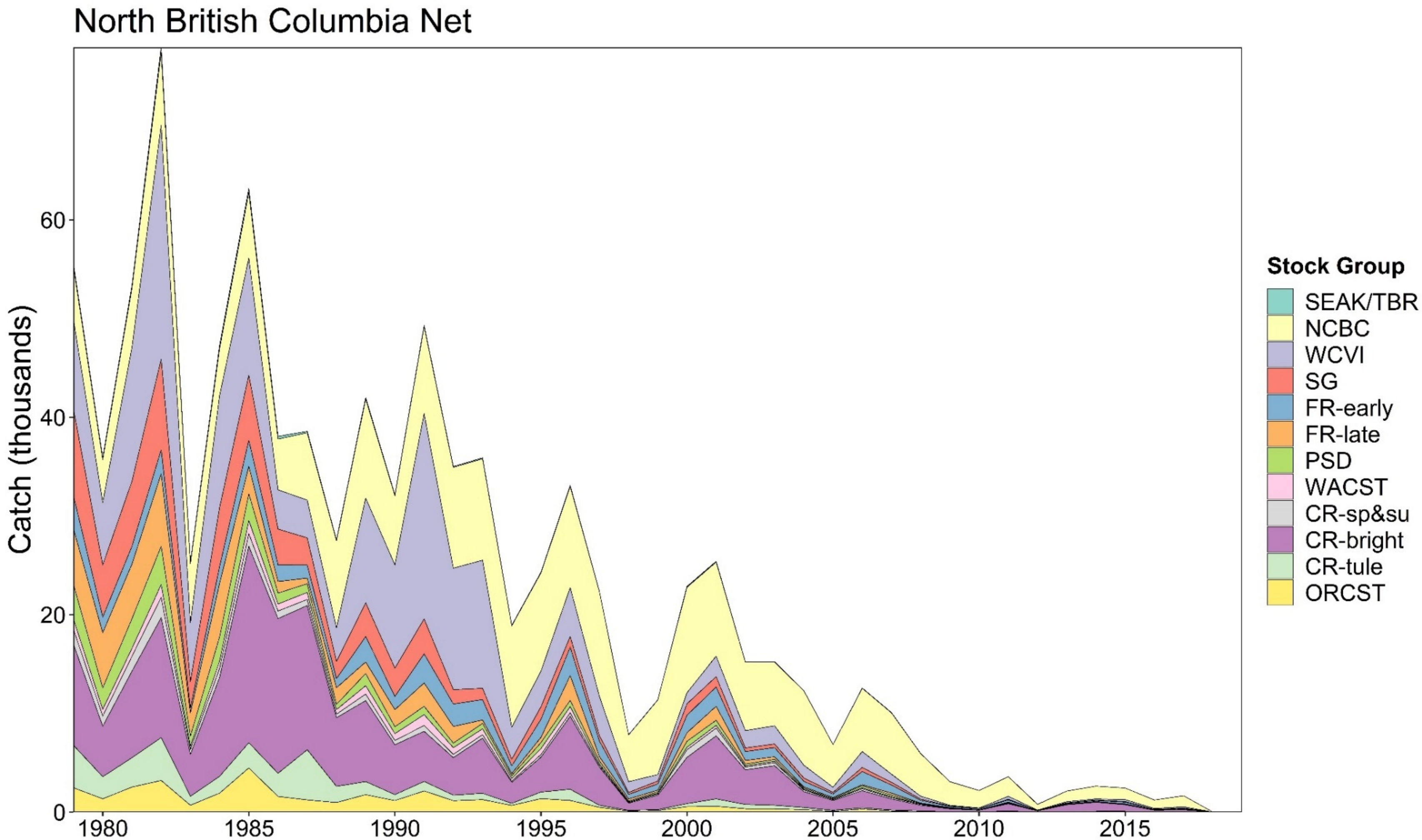


Appendix C9— PSC Chinook Model estimates of landed catch stock composition for Alaska net with (upper) and without (lower) hatchery add-on and terminal exclusion, 1979–2019.

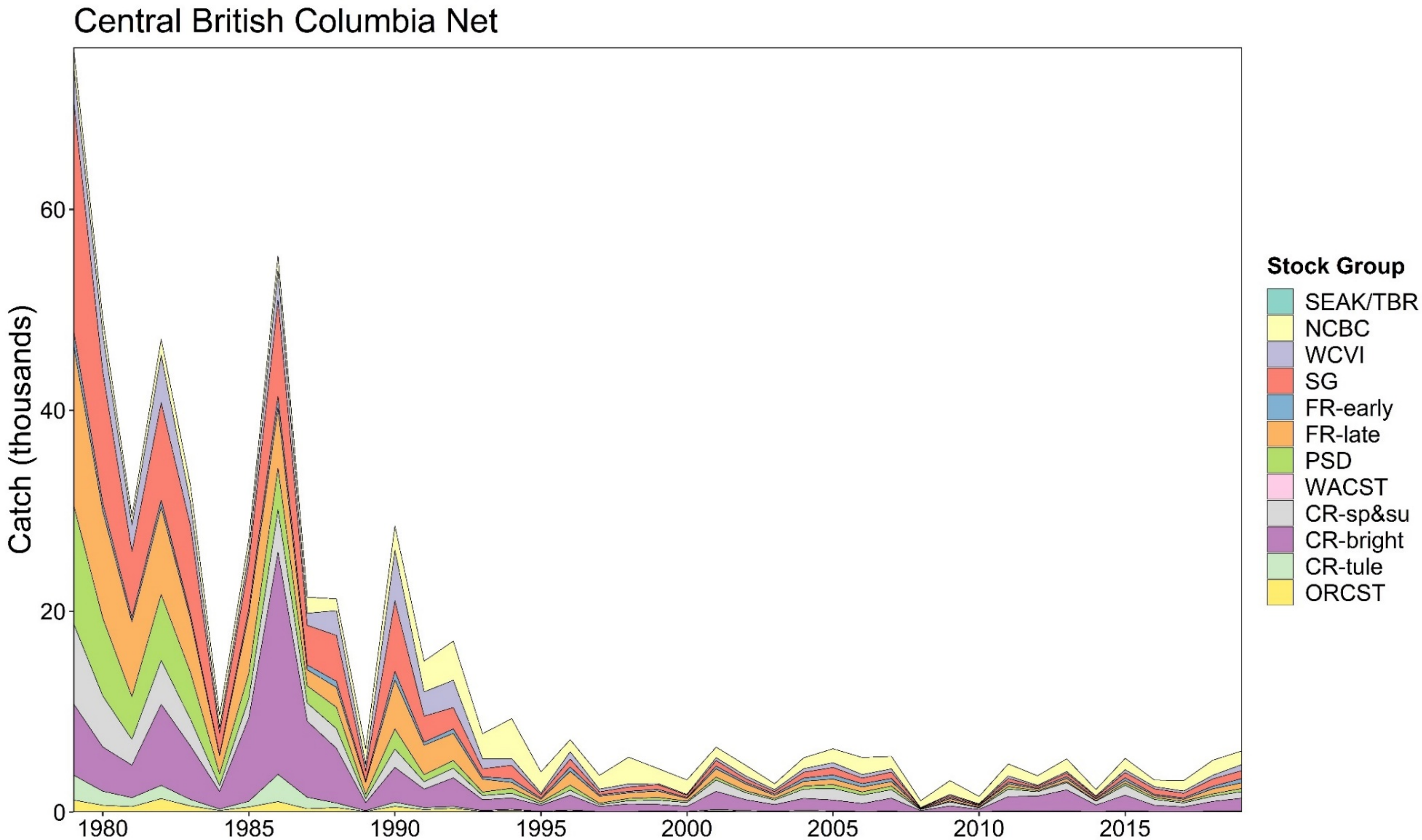




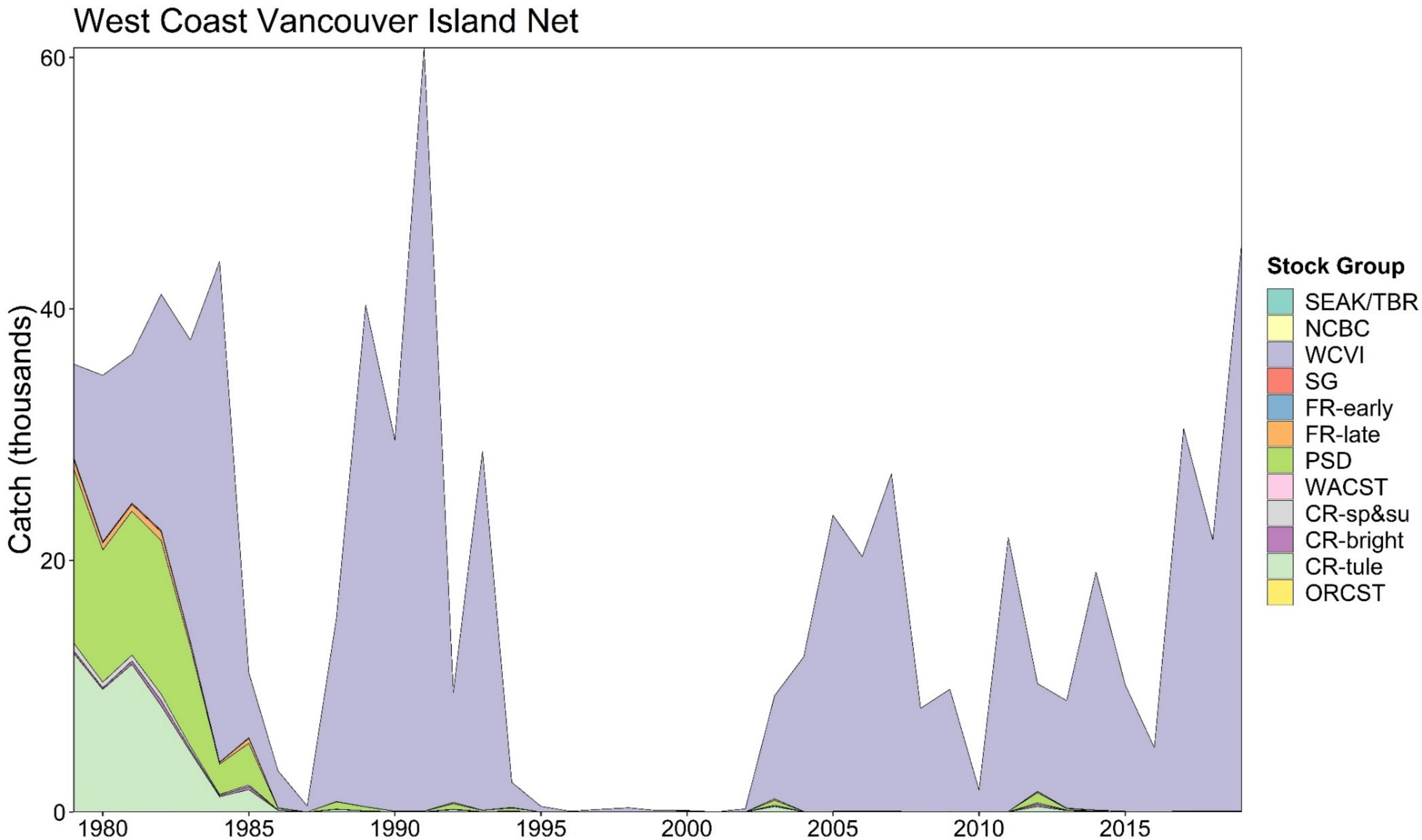
Appendix C10— PSC Chinook Model estimates of landed catch stock composition for North British Columbia Net, 1979–2019.



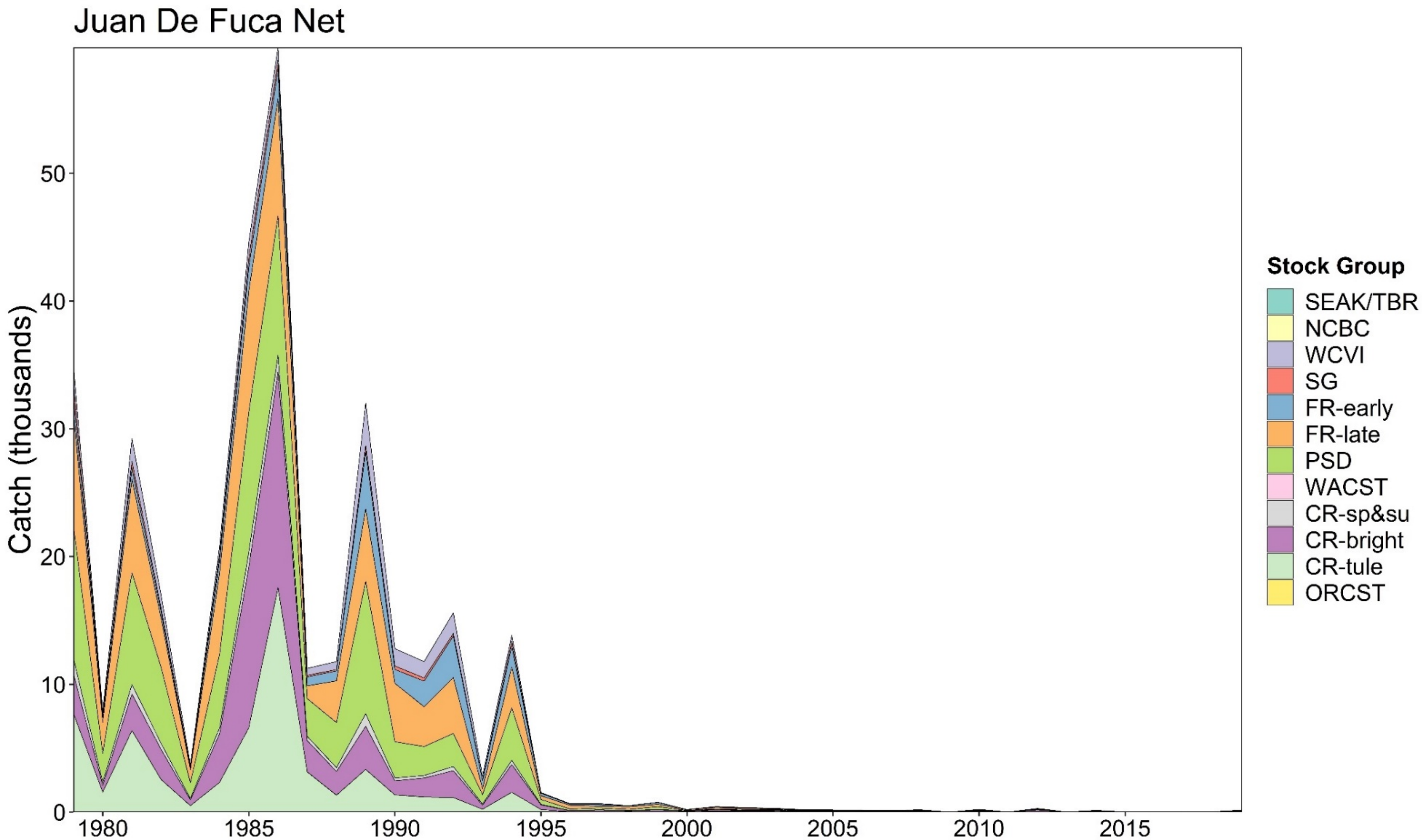
Appendix C11— PSC Chinook Model estimates of landed catch stock composition for Central British Columbia Net, 1979–2019.



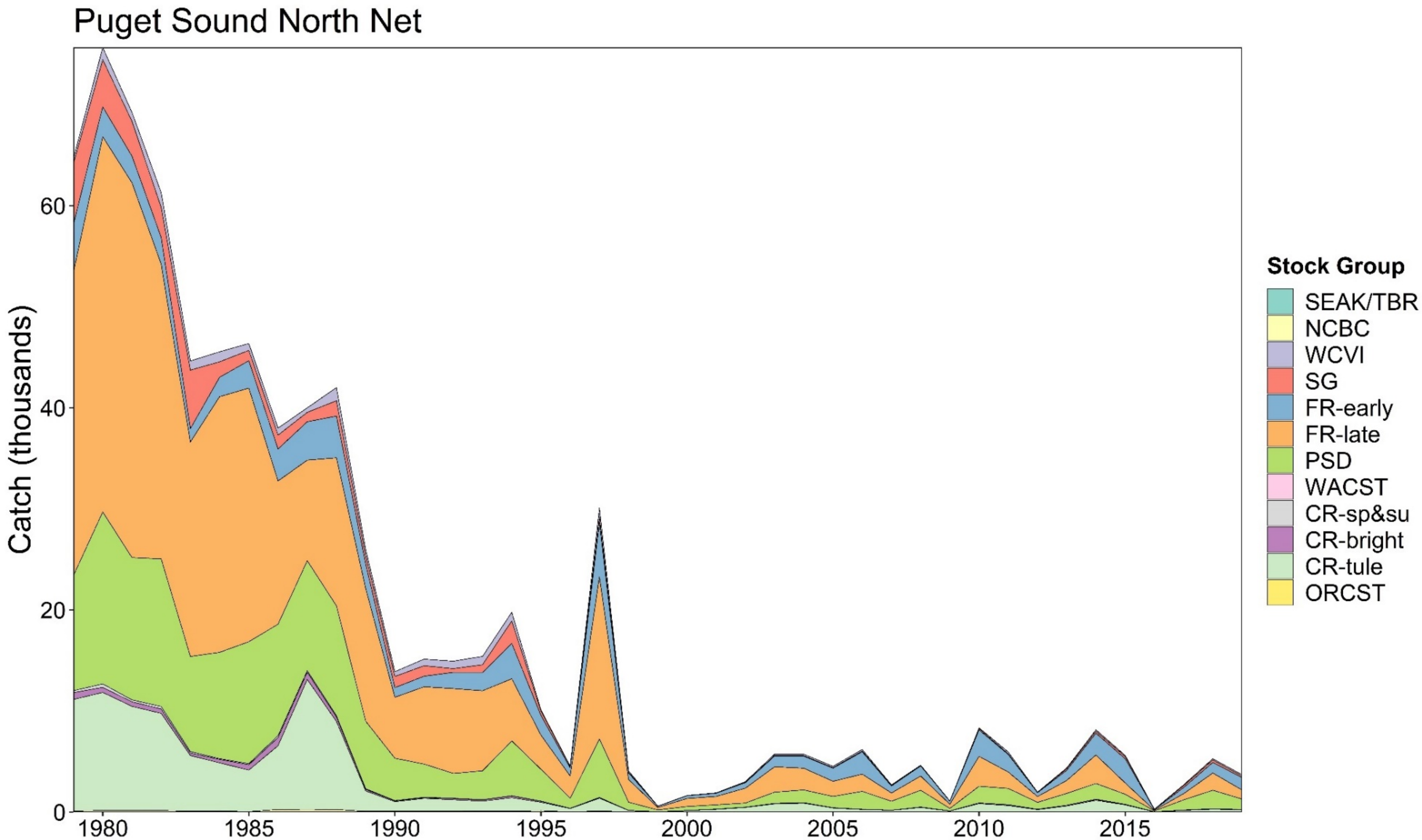
Appendix C12— PSC Chinook Model estimates of landed catch stock composition for West Coast Vancouver Island Net, 1979–2019.



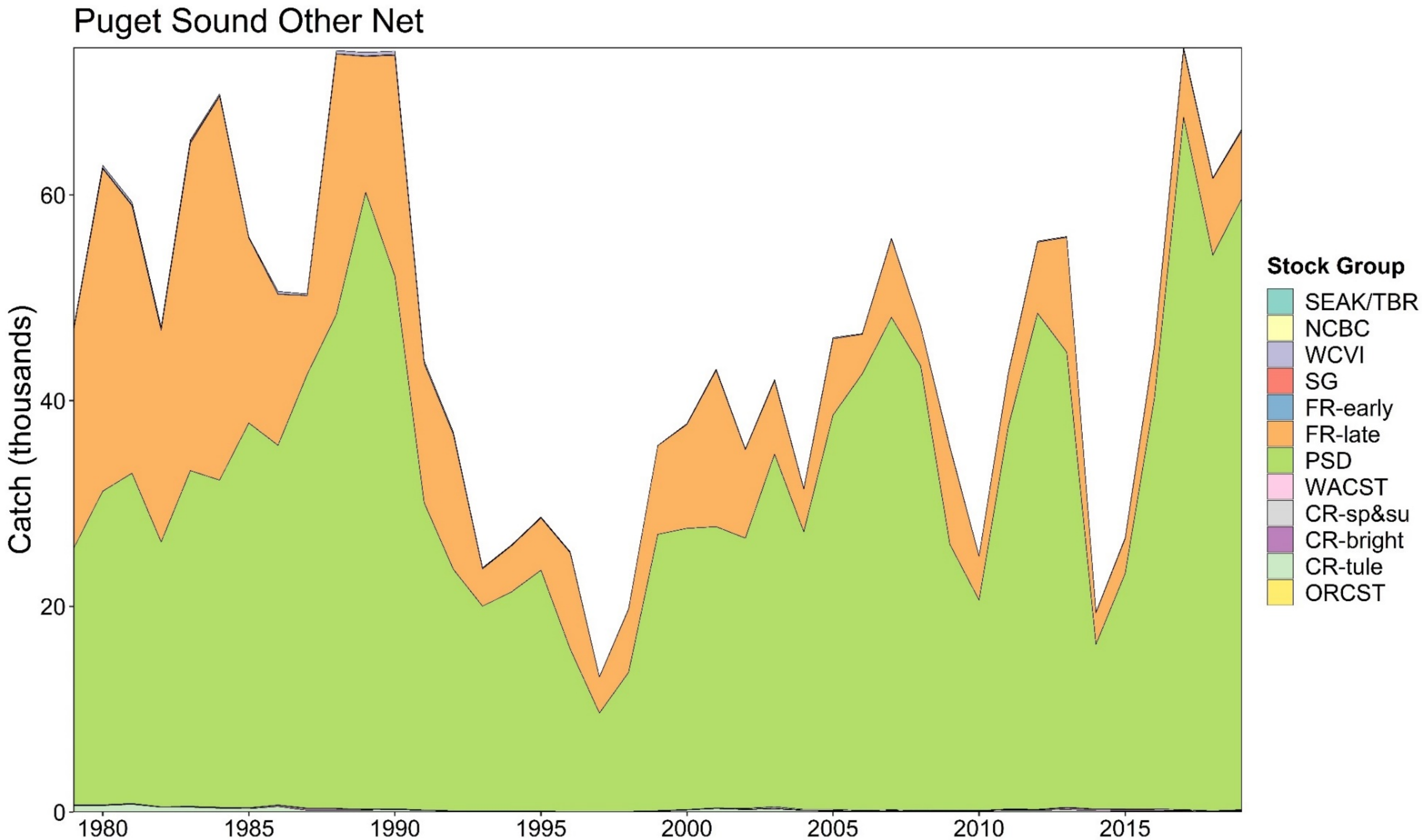
Appendix C13— PSC Chinook Model estimates of landed catch stock composition for Juan De Fuca Net, 1979–2019.



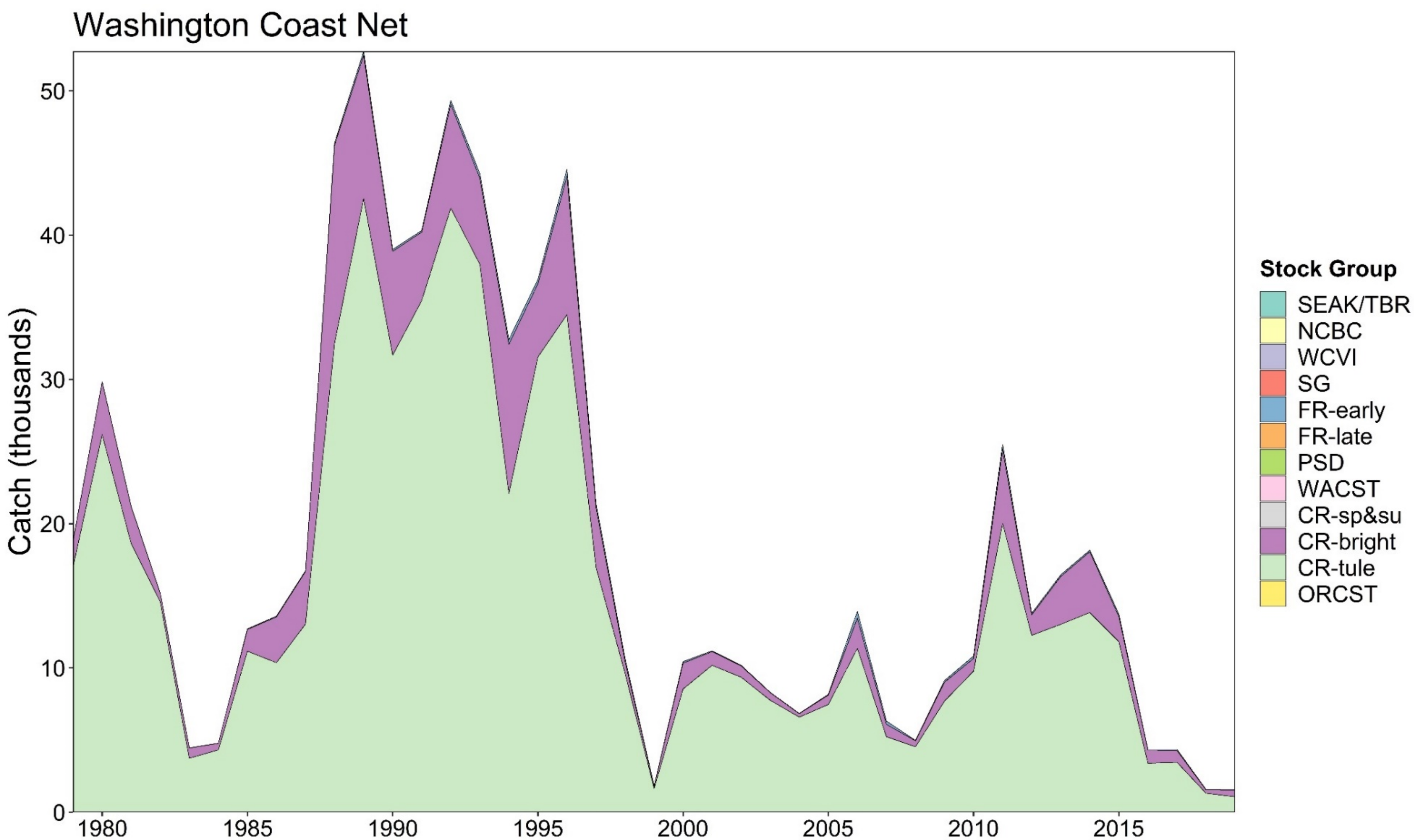
Appendix C14— PSC Chinook Model estimates of landed catch stock composition for Puget Sound North Net, 1979–2019.



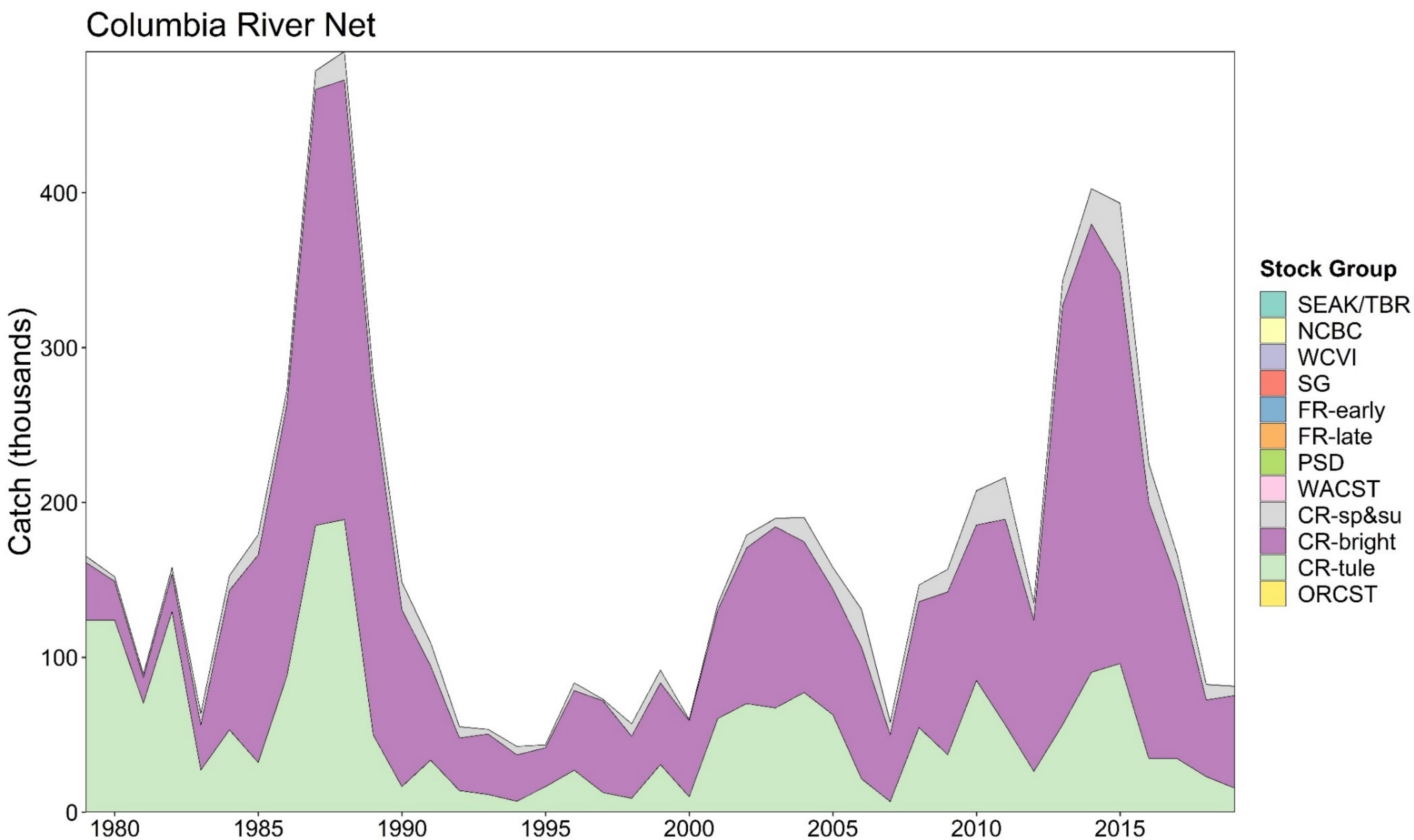
Appendix C15— PSC Chinook Model estimates of landed catch stock composition for Puget Sound Other Net, 1979–2019.



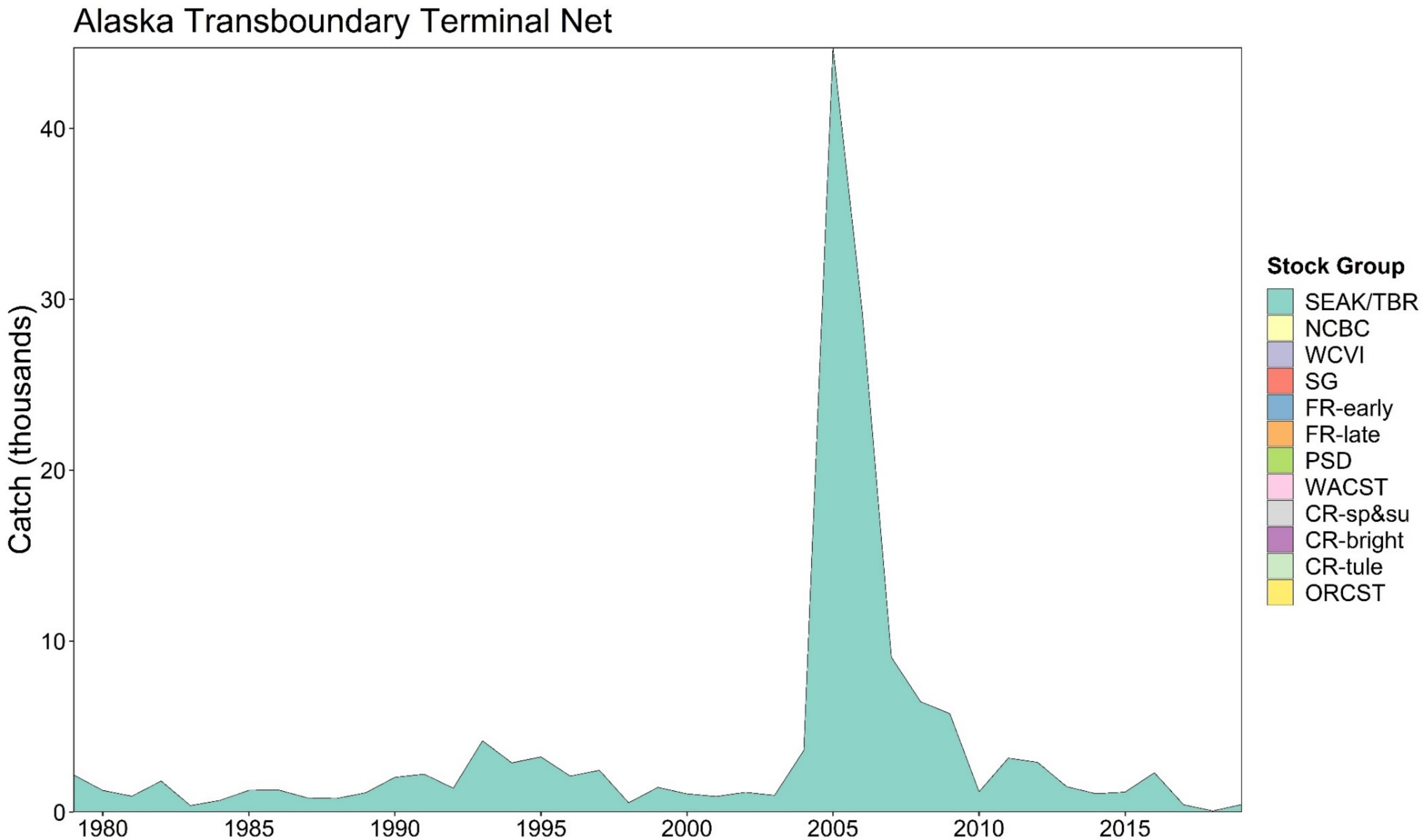
Appendix C16— PSC Chinook Model estimates of landed catch stock composition for Washington Coast Net, 1979–2019.



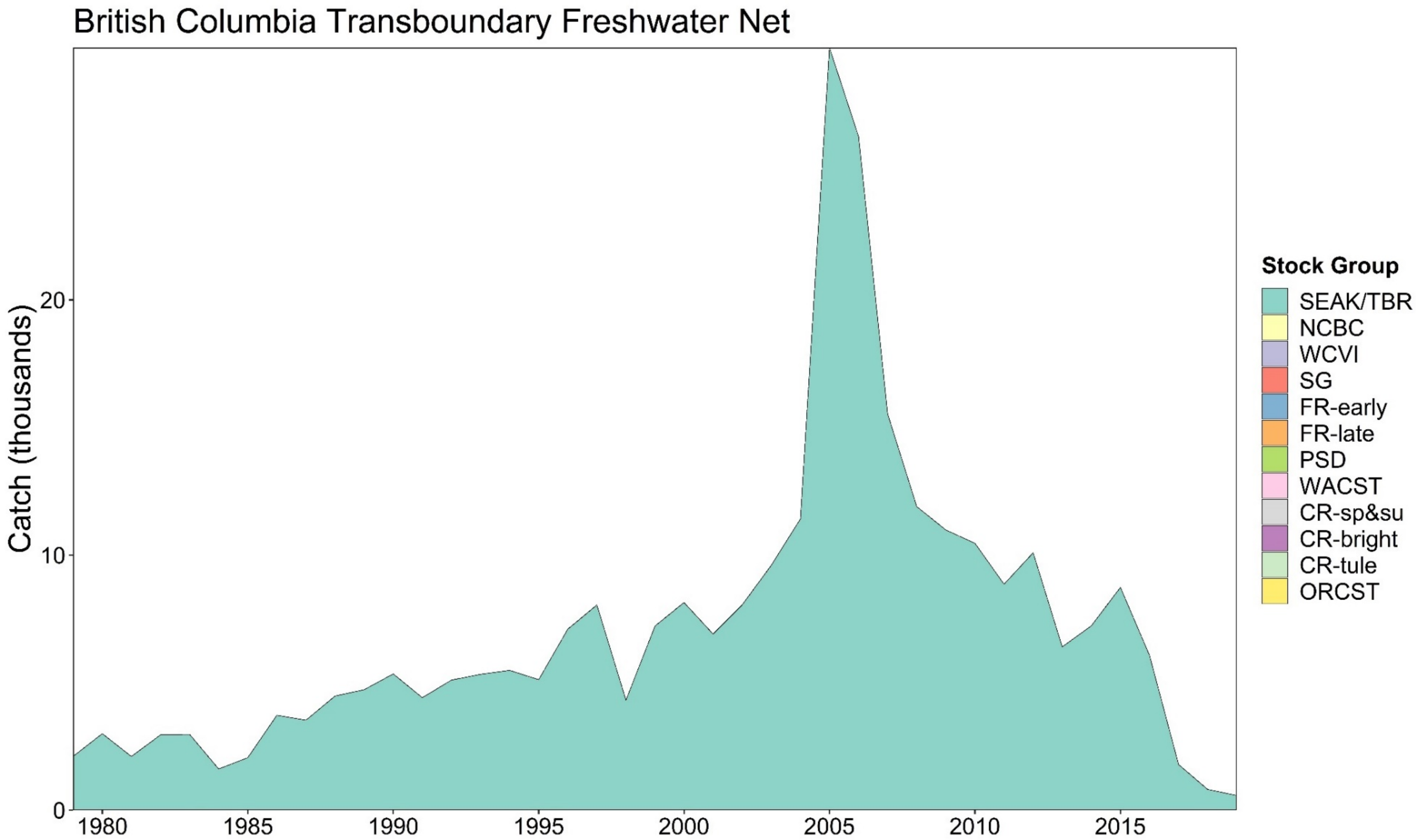
Appendix C17— PSC Chinook Model estimates of landed catch stock composition for Columbia River Net, 1979–2019.



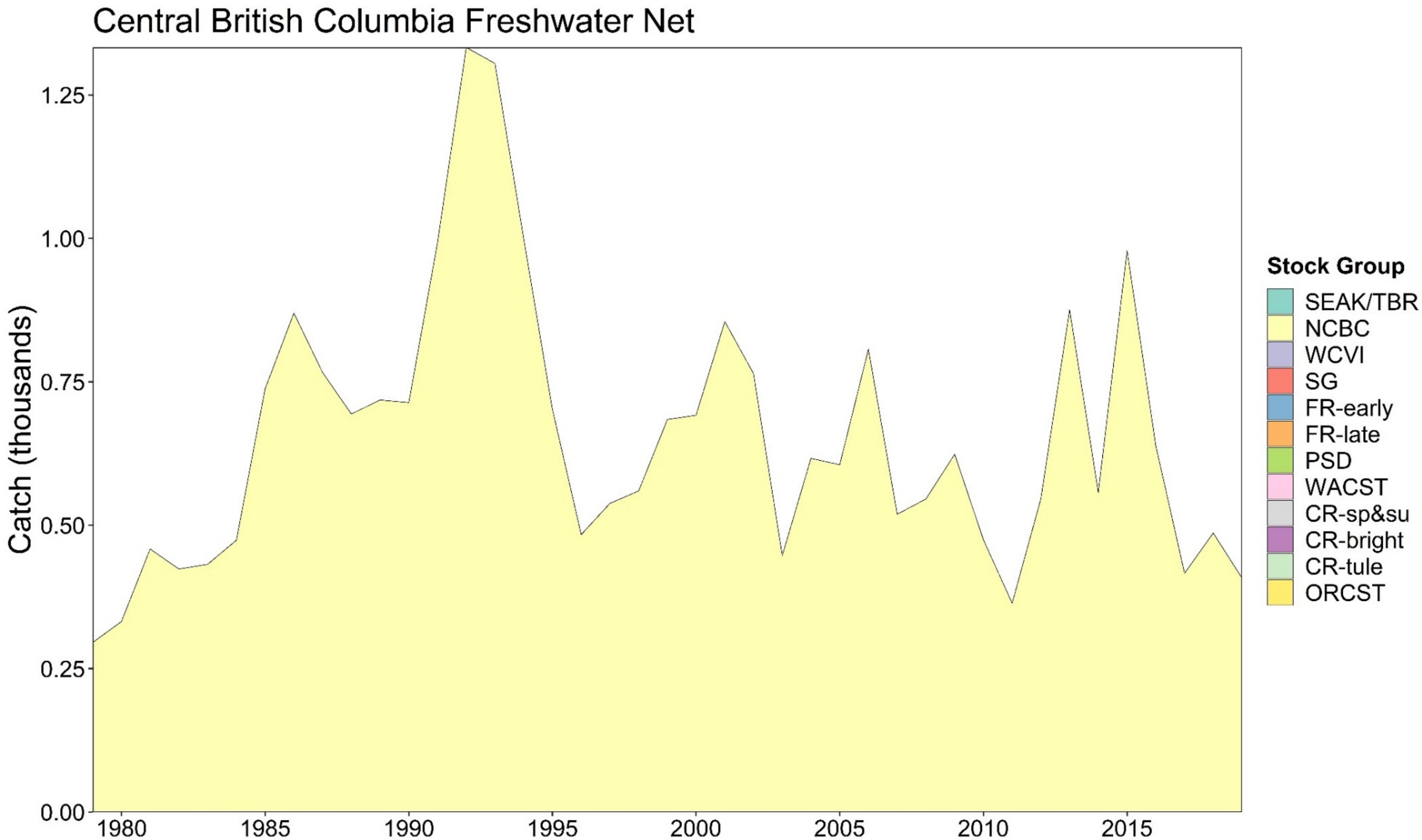
Appendix C18— PSC Chinook Model estimates of landed catch stock composition for Alaska Transboundary River Terminal Net, 1979–2019.



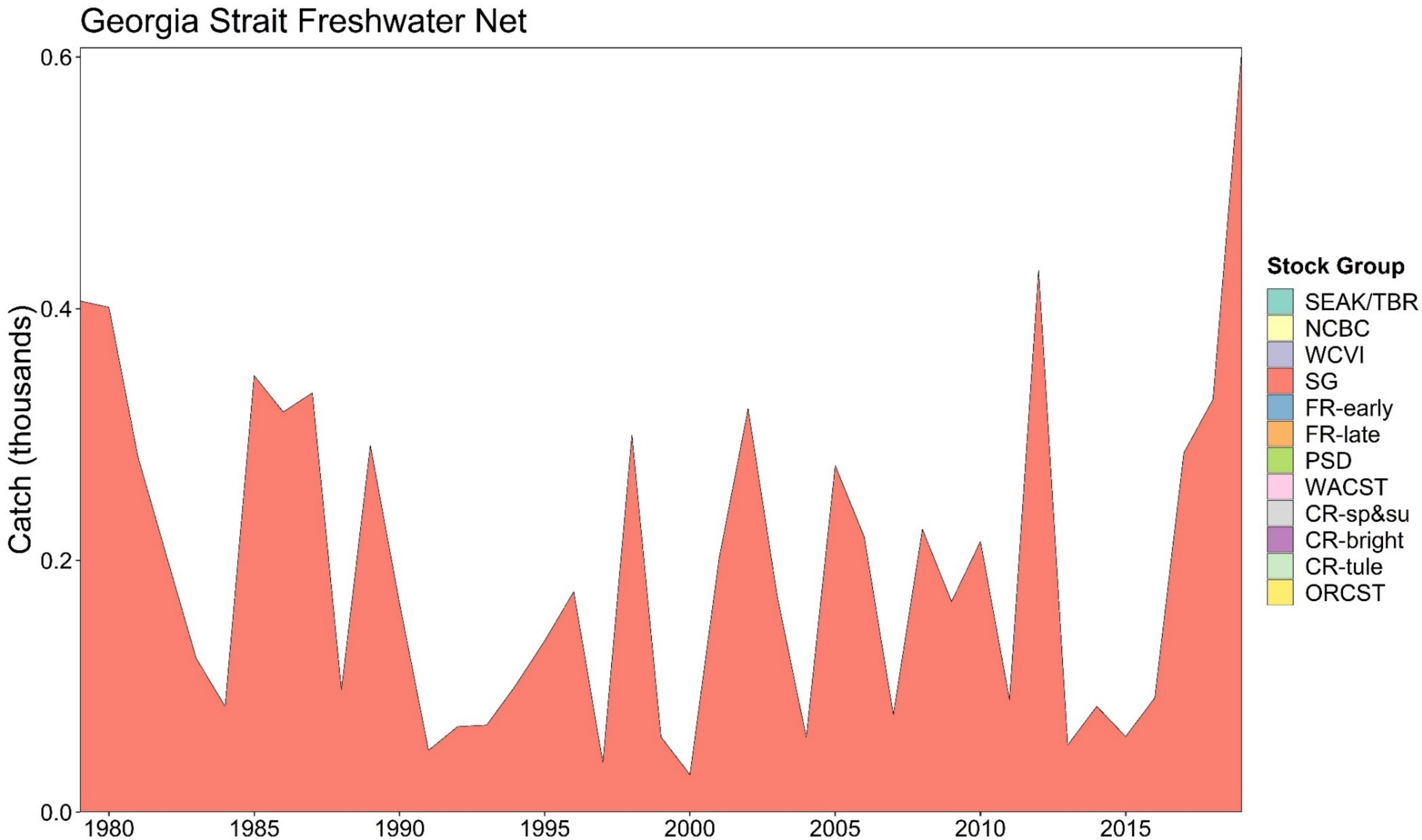
Appendix C19— PSC Chinook Model estimates of landed catch stock composition for Canada Transboundary River Freshwater Net, 1979–2019.



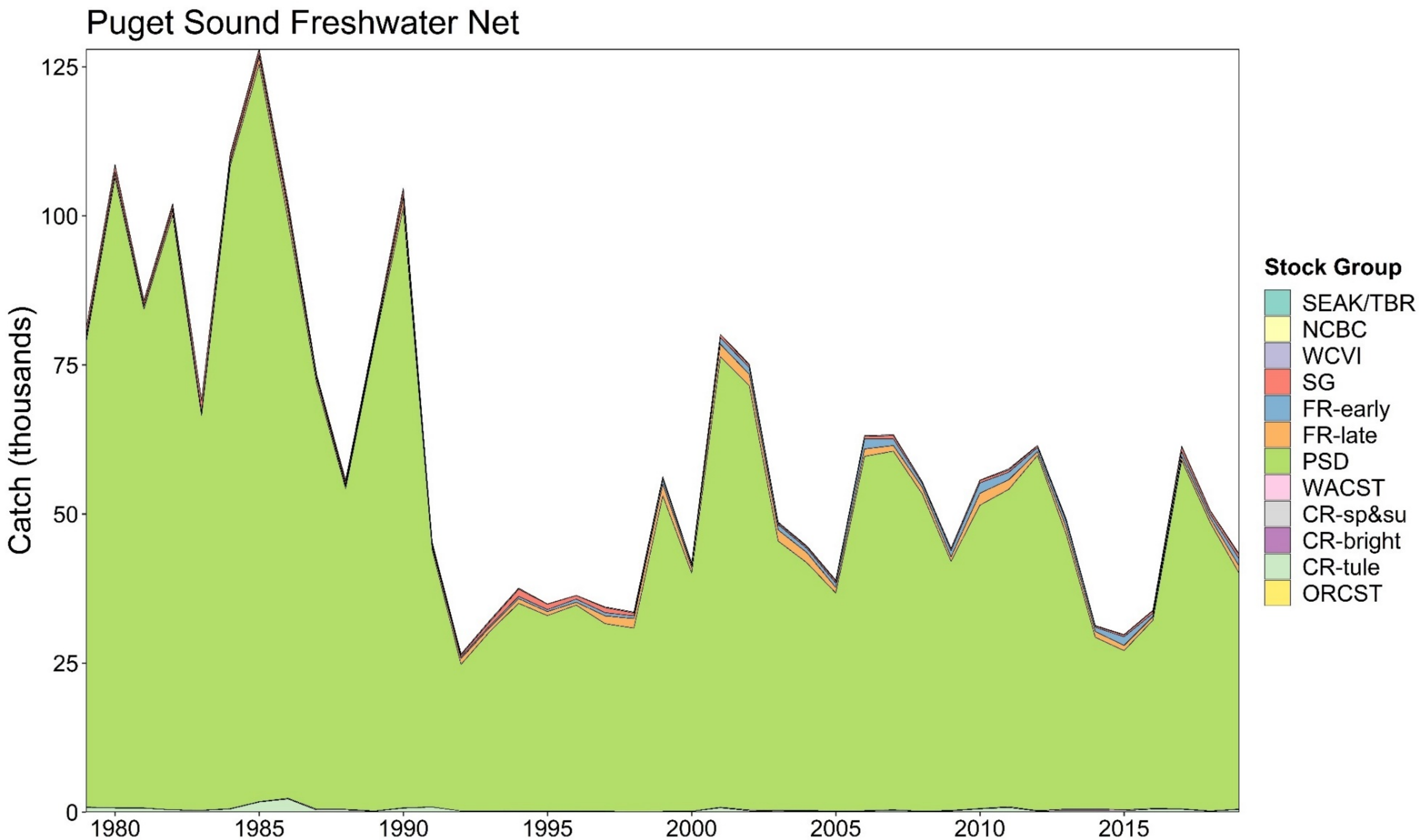
Appendix C20— PSC Chinook Model estimates of landed catch stock composition for Central British Columbia Freshwater Net, 1979–2019.



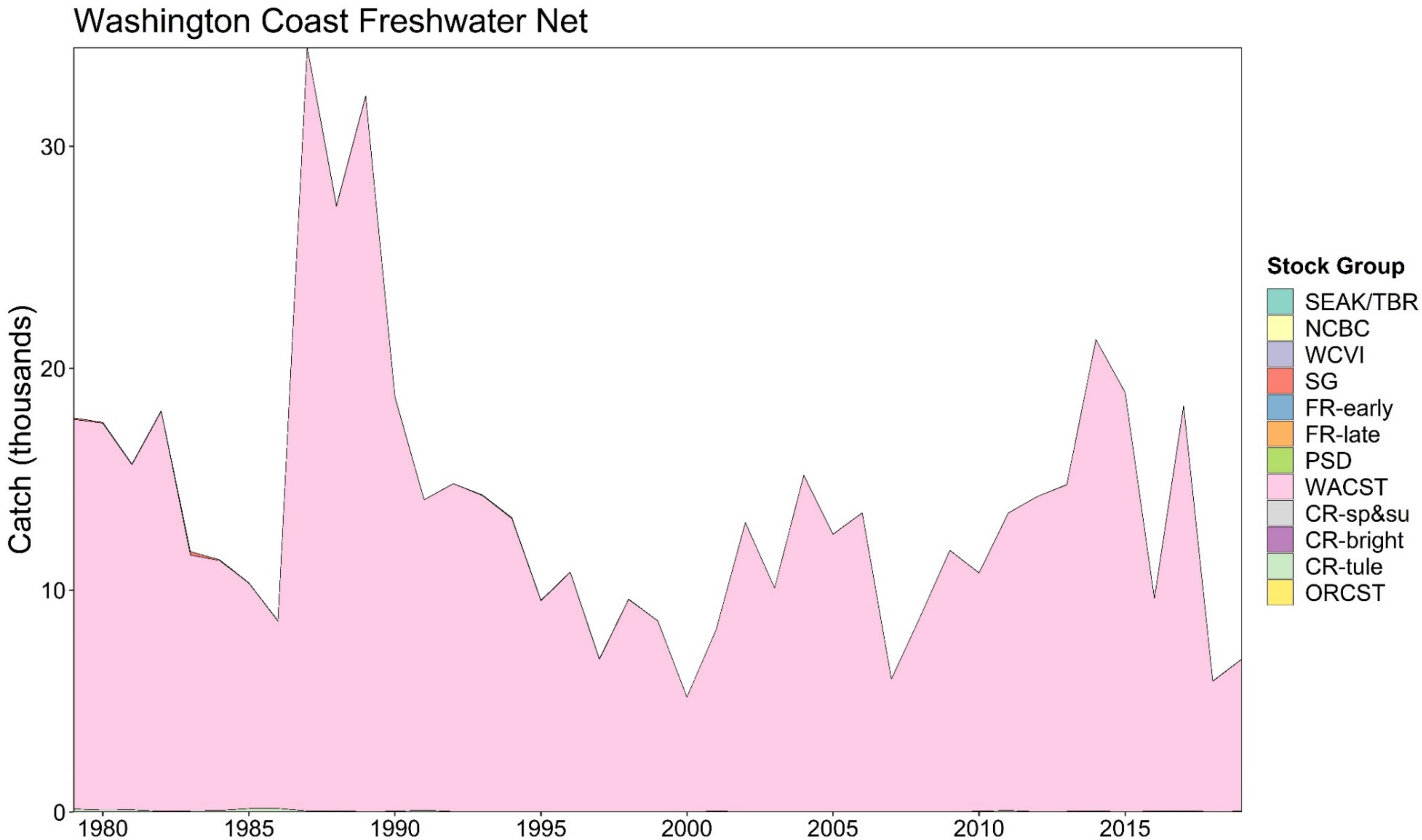
Appendix C21— PSC Chinook Model estimates of landed catch stock composition for Strait of Georgia Freshwater Net, 1979–2019.



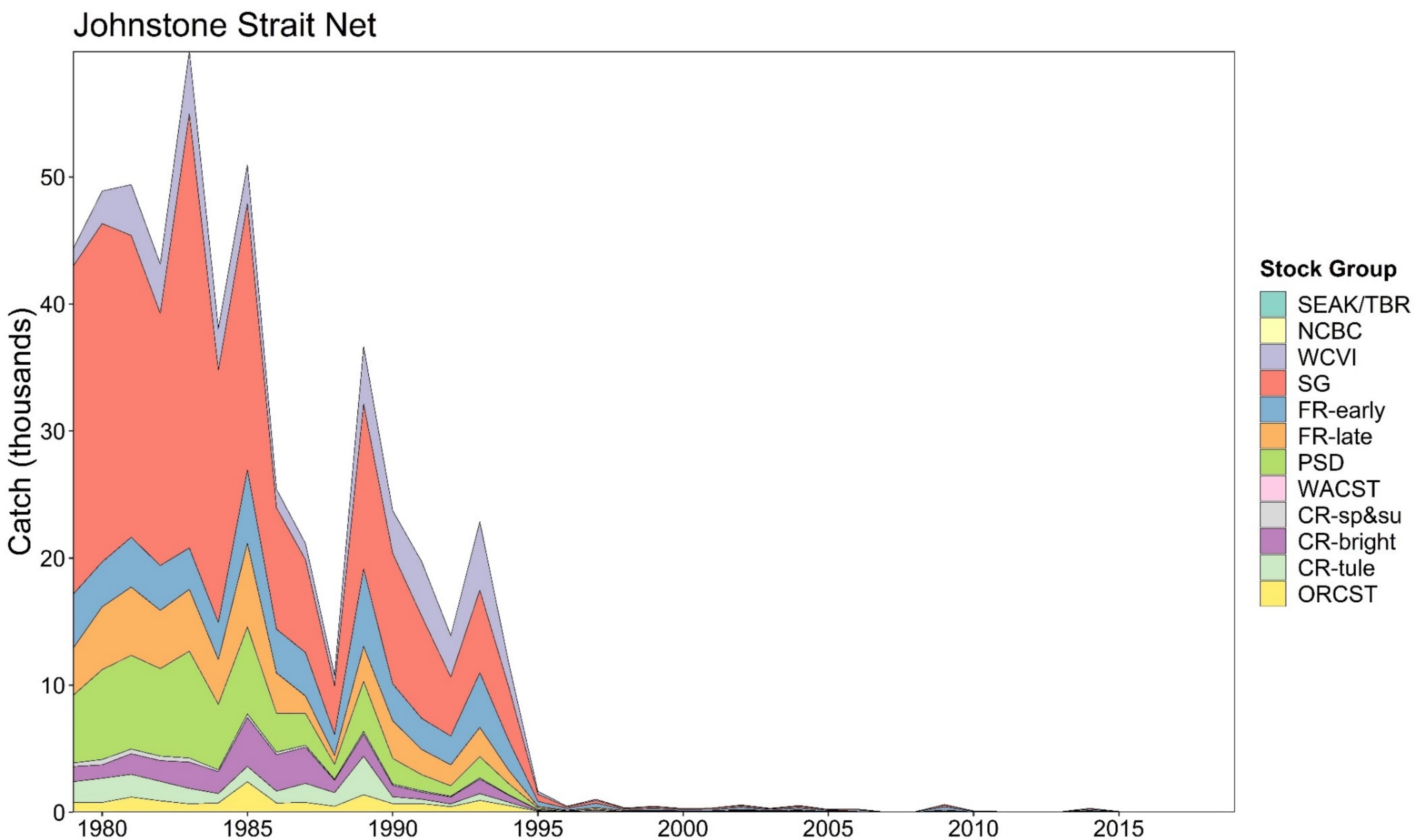
Appendix C22— PSC Chinook Model estimates of landed catch stock composition for Puget Sound Freshwater Net, 1979–2019.



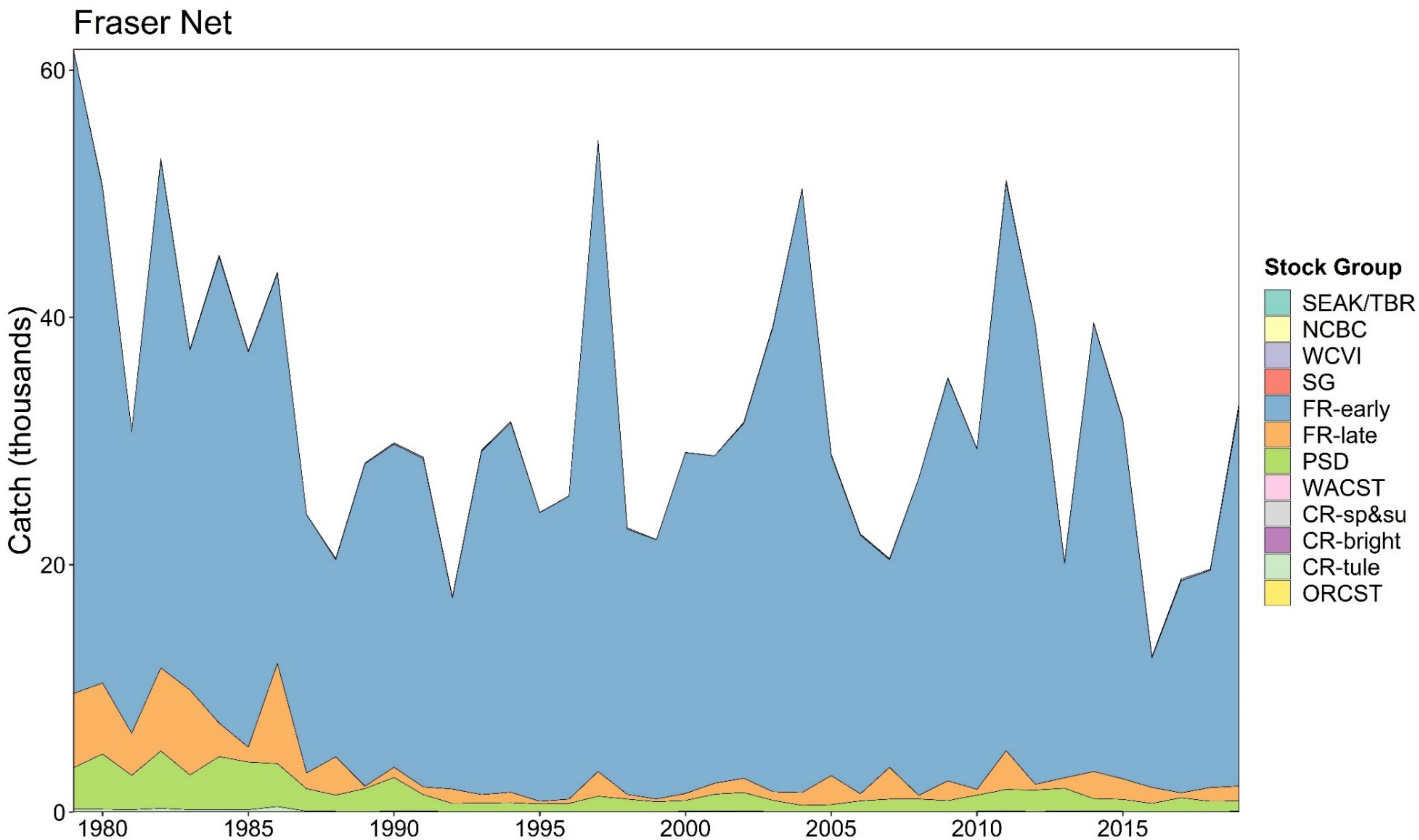
Appendix C23— PSC Chinook Model estimates of landed catch stock composition for Washington Coast Freshwater Net, 1979–2019.



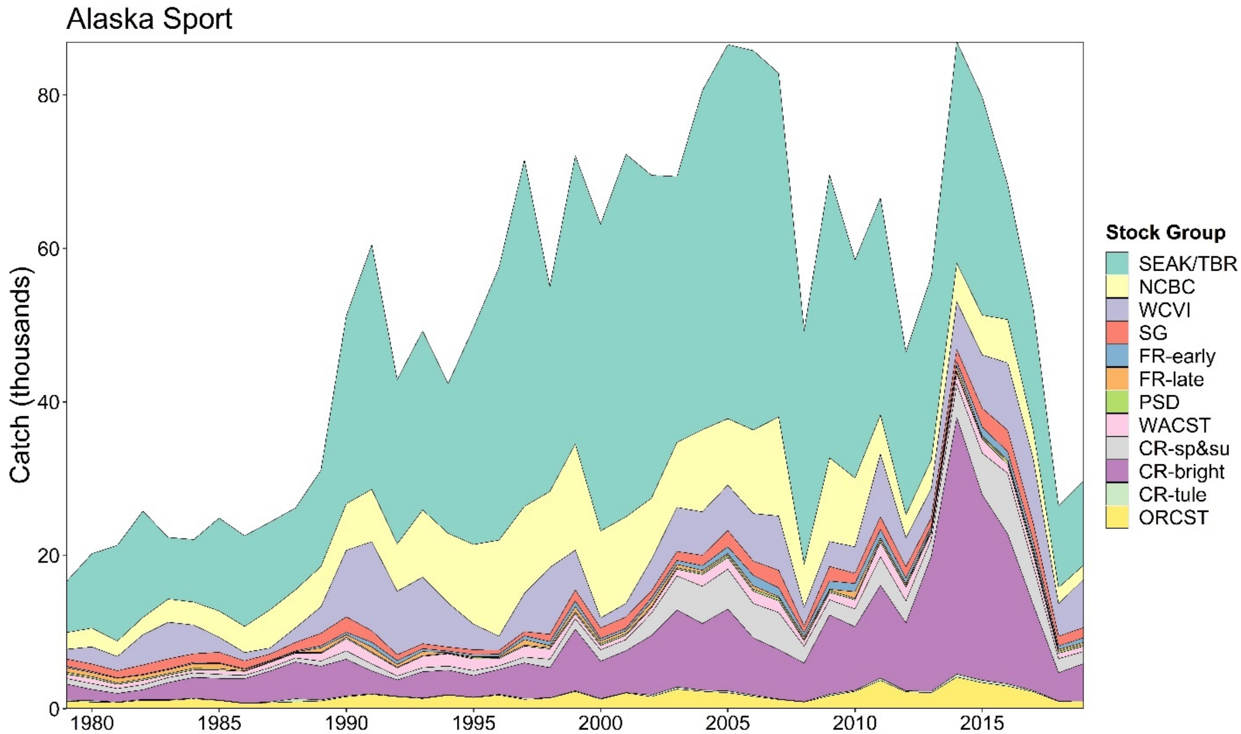
Appendix C24— PSC Chinook Model estimates of landed catch stock composition for Johnstone Strait Net, 1979–2019.

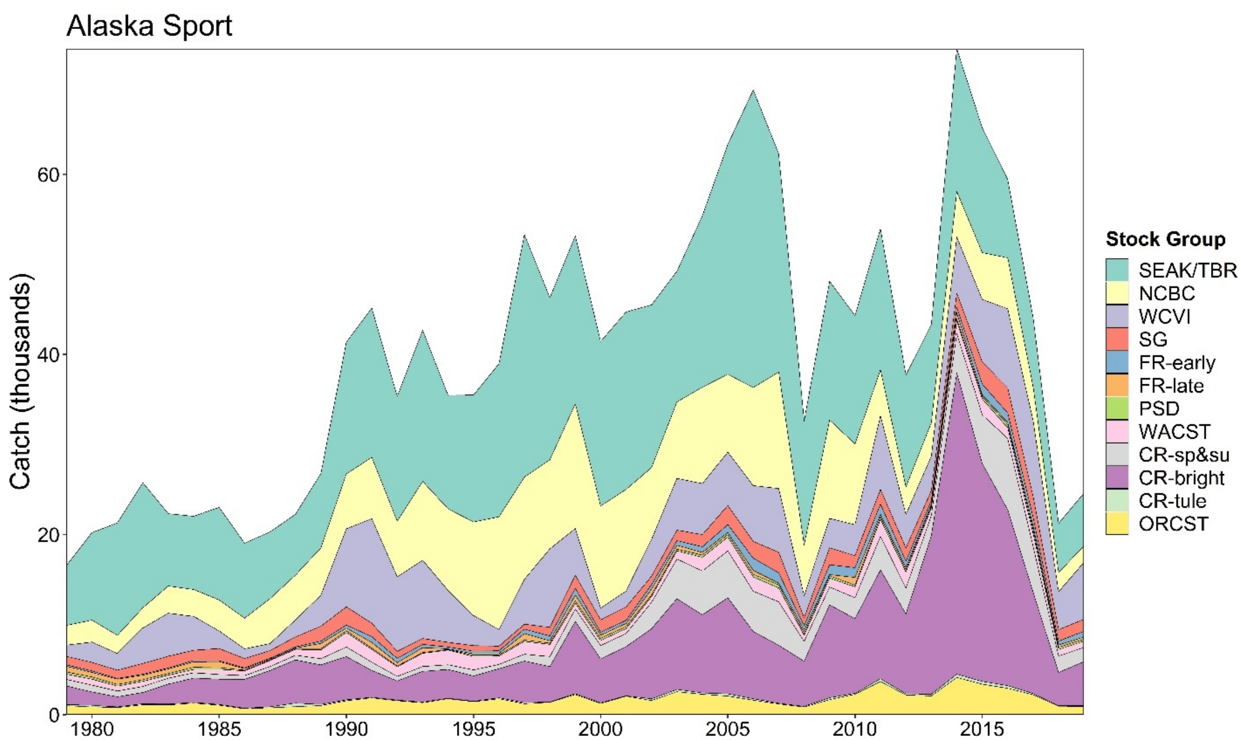


Appendix C25— PSC Chinook Model estimates of landed catch stock composition for Fraser Net, 1979–2019.

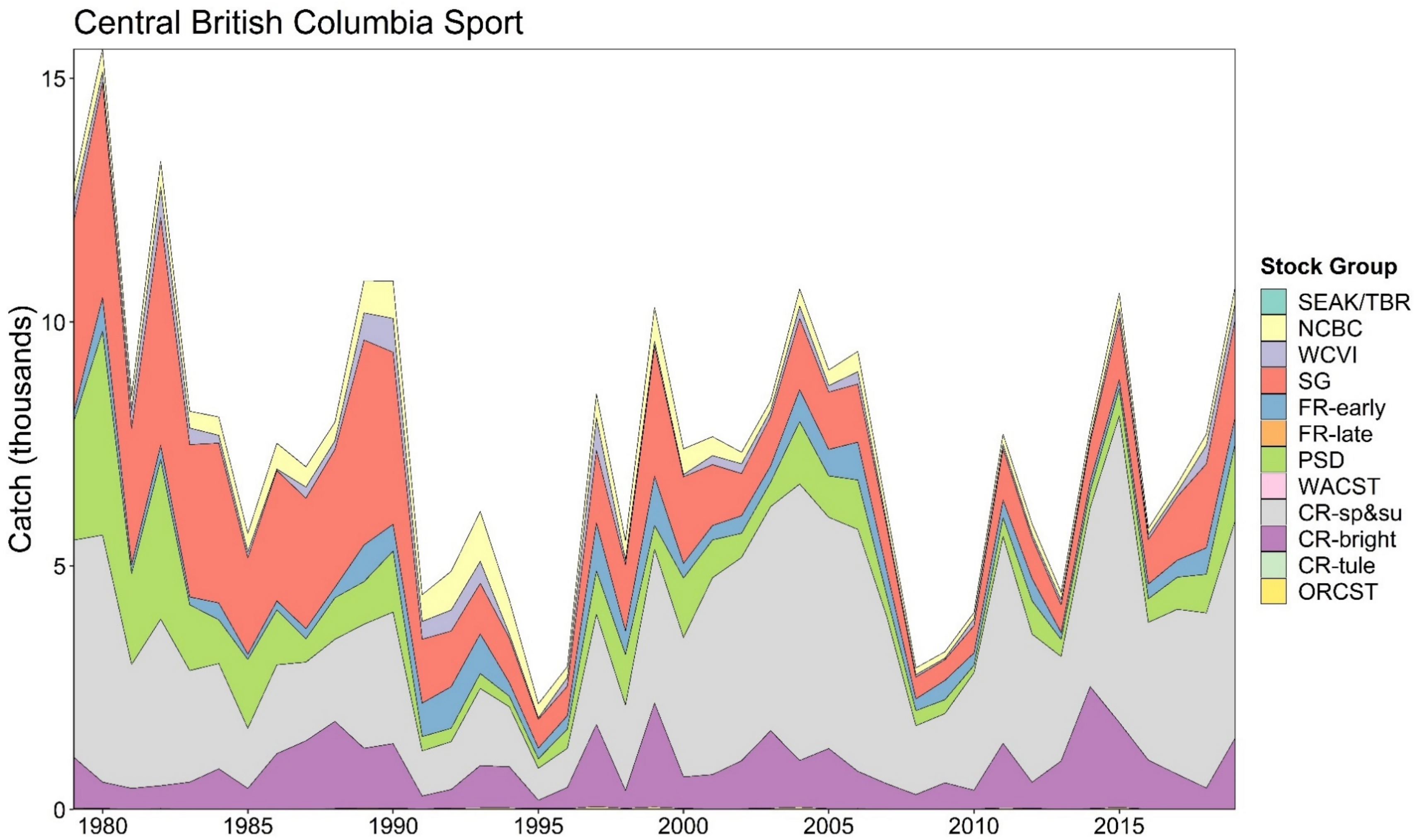


Appendix C26— PSC Chinook Model estimates of landed catch stock composition for Alaska sport with (upper) and without (lower) Alaska hatchery add-on and terminal exclusion, 1979–2019.

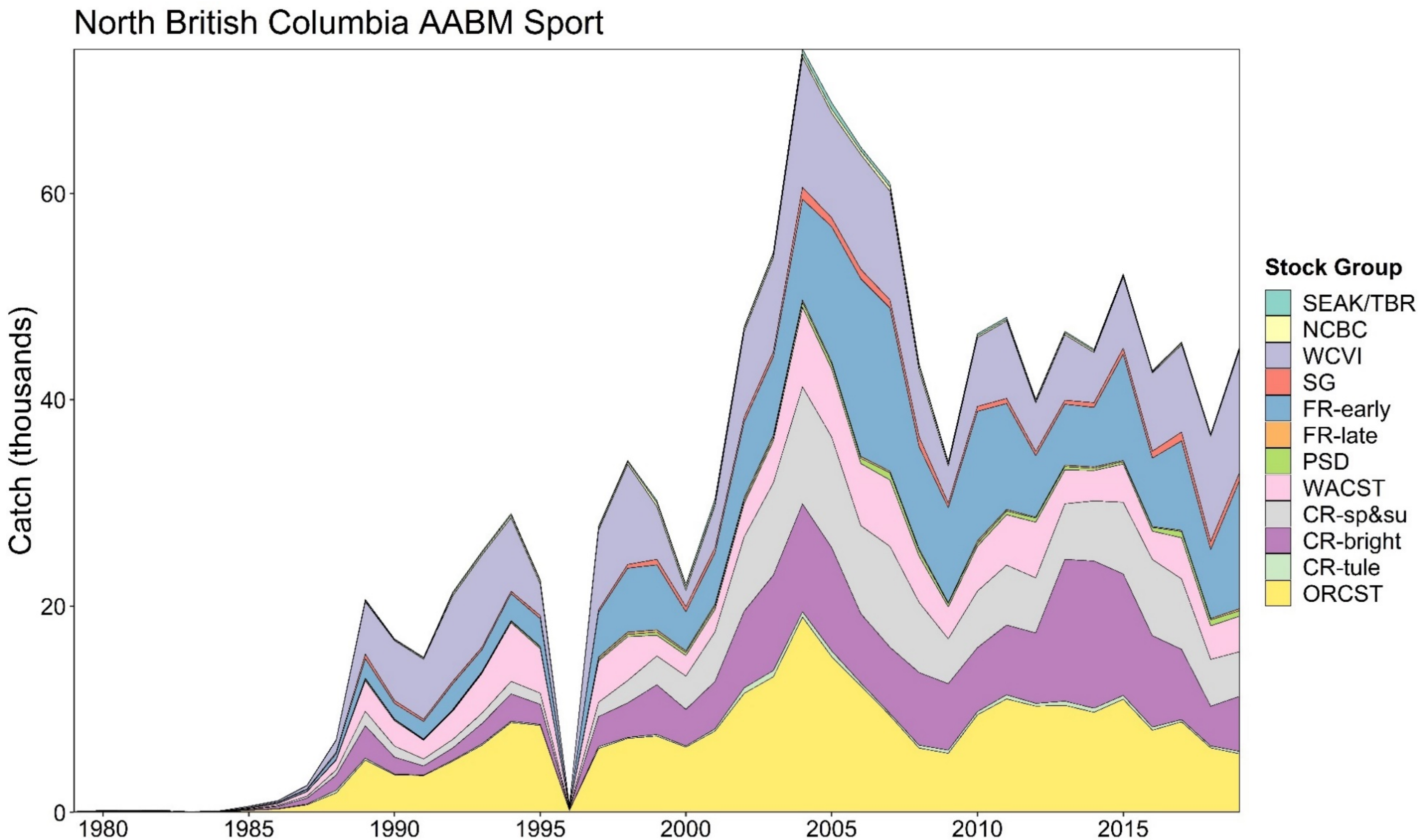




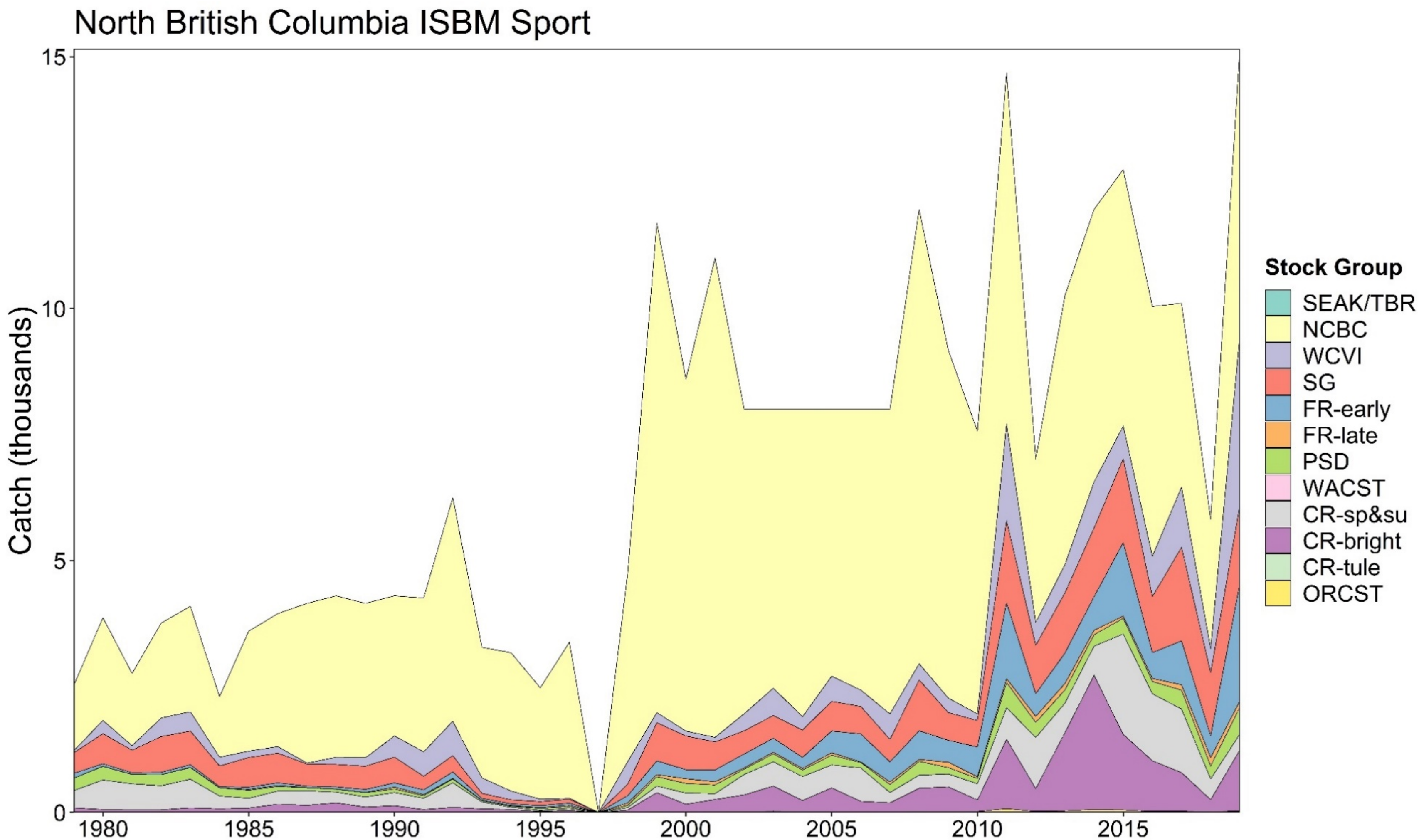
Appendix C27— PSC Chinook Model estimates of landed catch stock composition for Central British Columbia Sport 1979–2019.



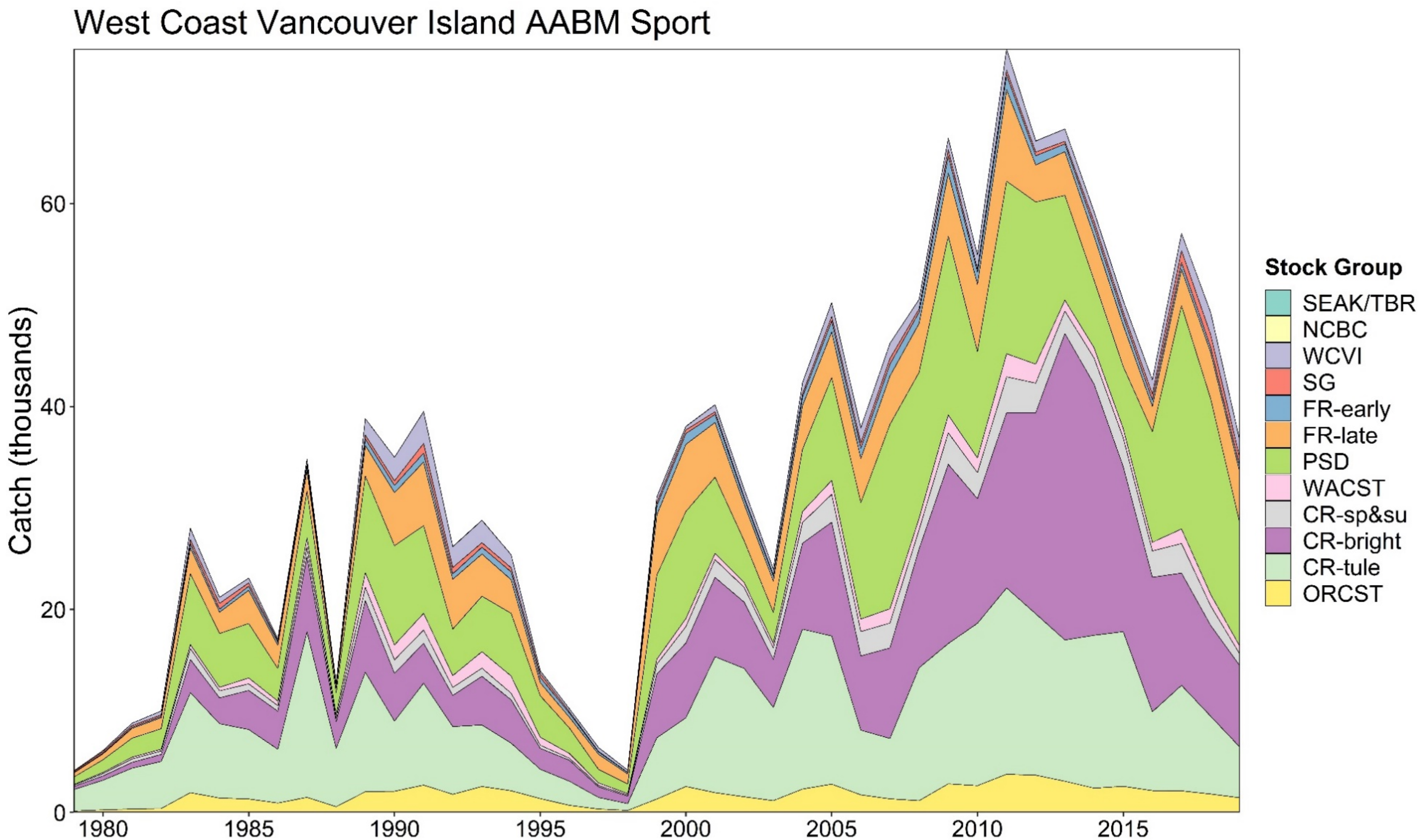
Appendix C28— PSC Chinook Model estimates of landed catch stock composition for North British Columbia AABM Sport, 1979–2019.



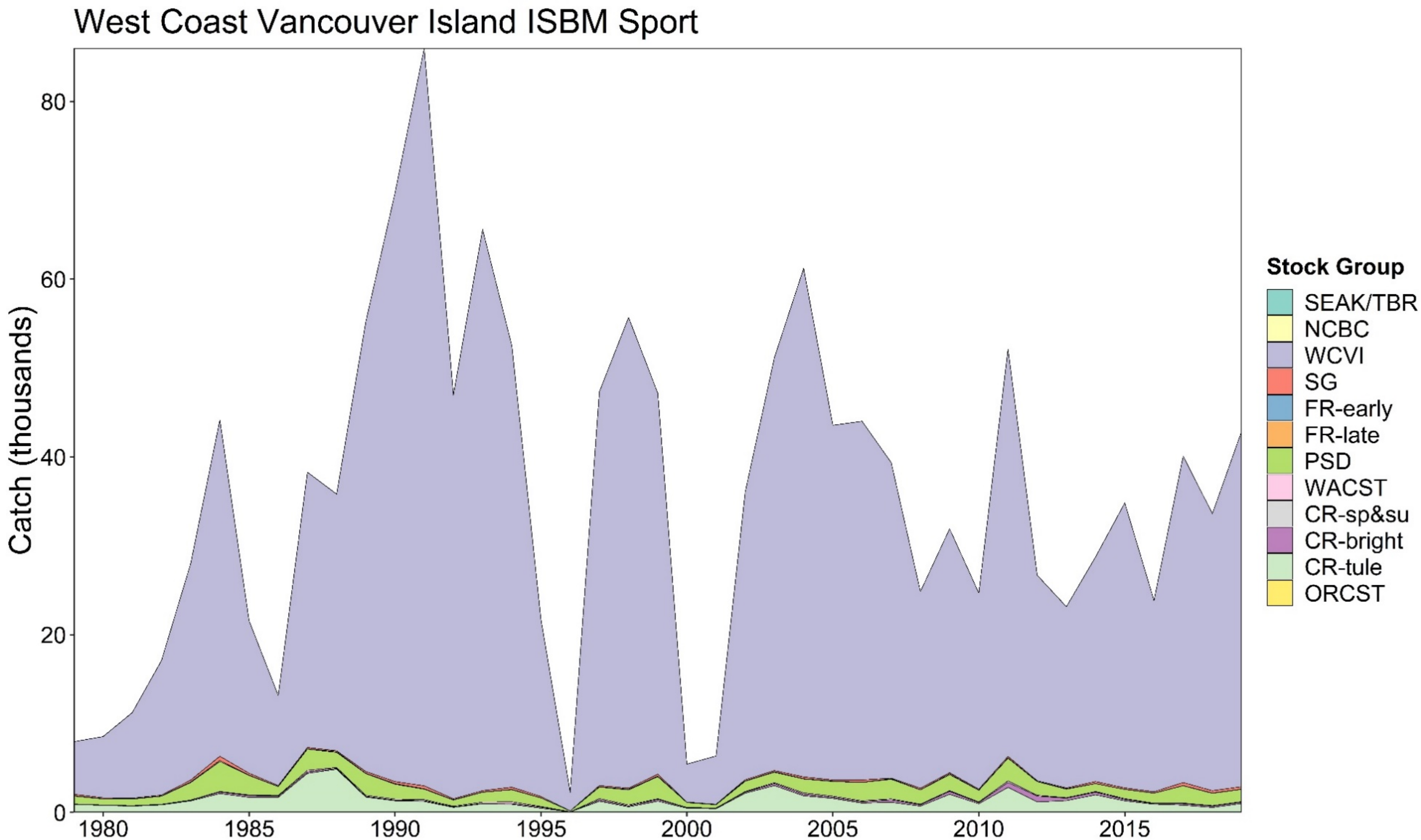
Appendix C29— PSC Chinook Model estimates of landed catch stock composition for North British Columbia ISBM Sport 1979–2019.



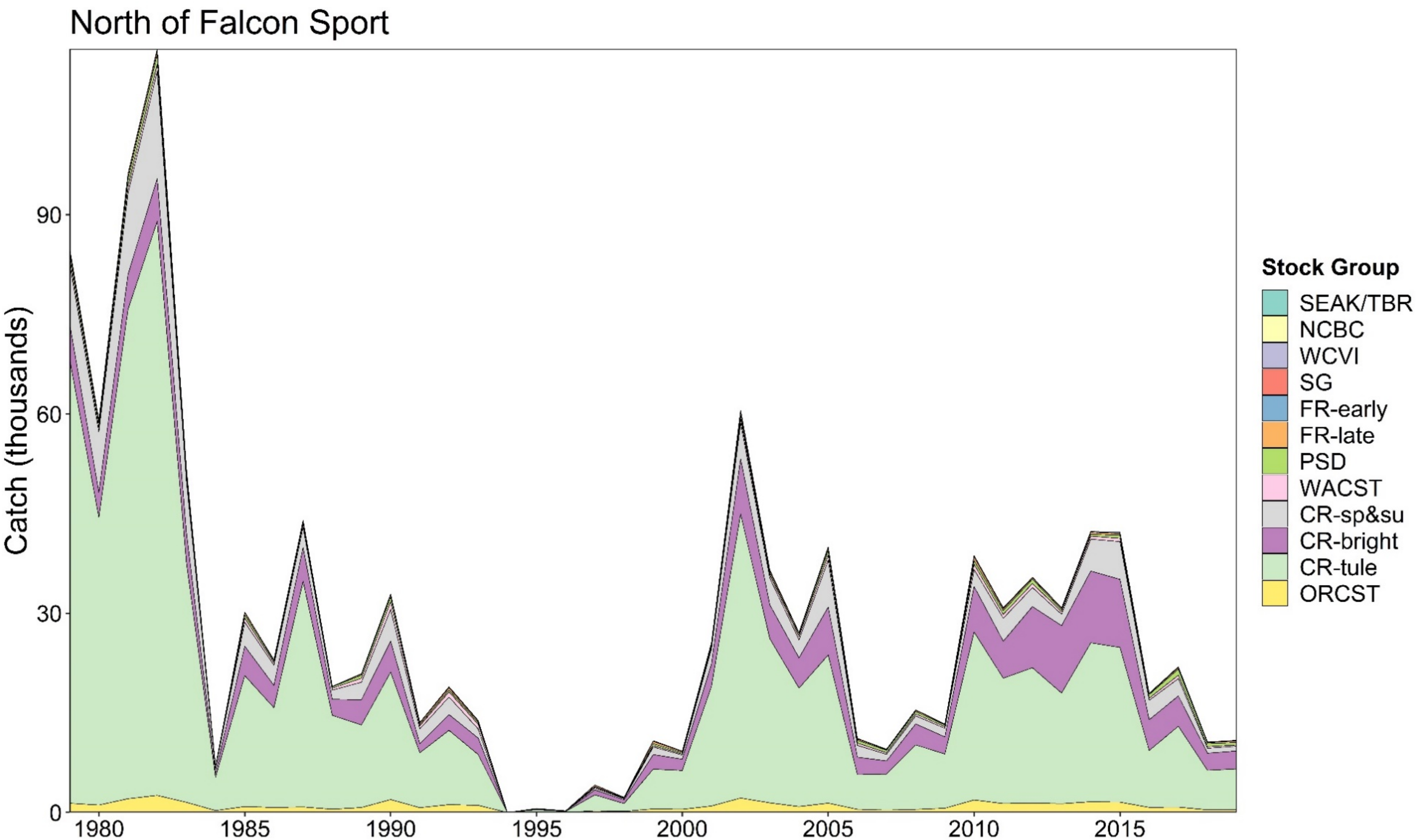
Appendix C30— PSC Chinook Model estimates of landed catch stock composition for West Coast Vancouver Island AABM Sport, 1979–2019.



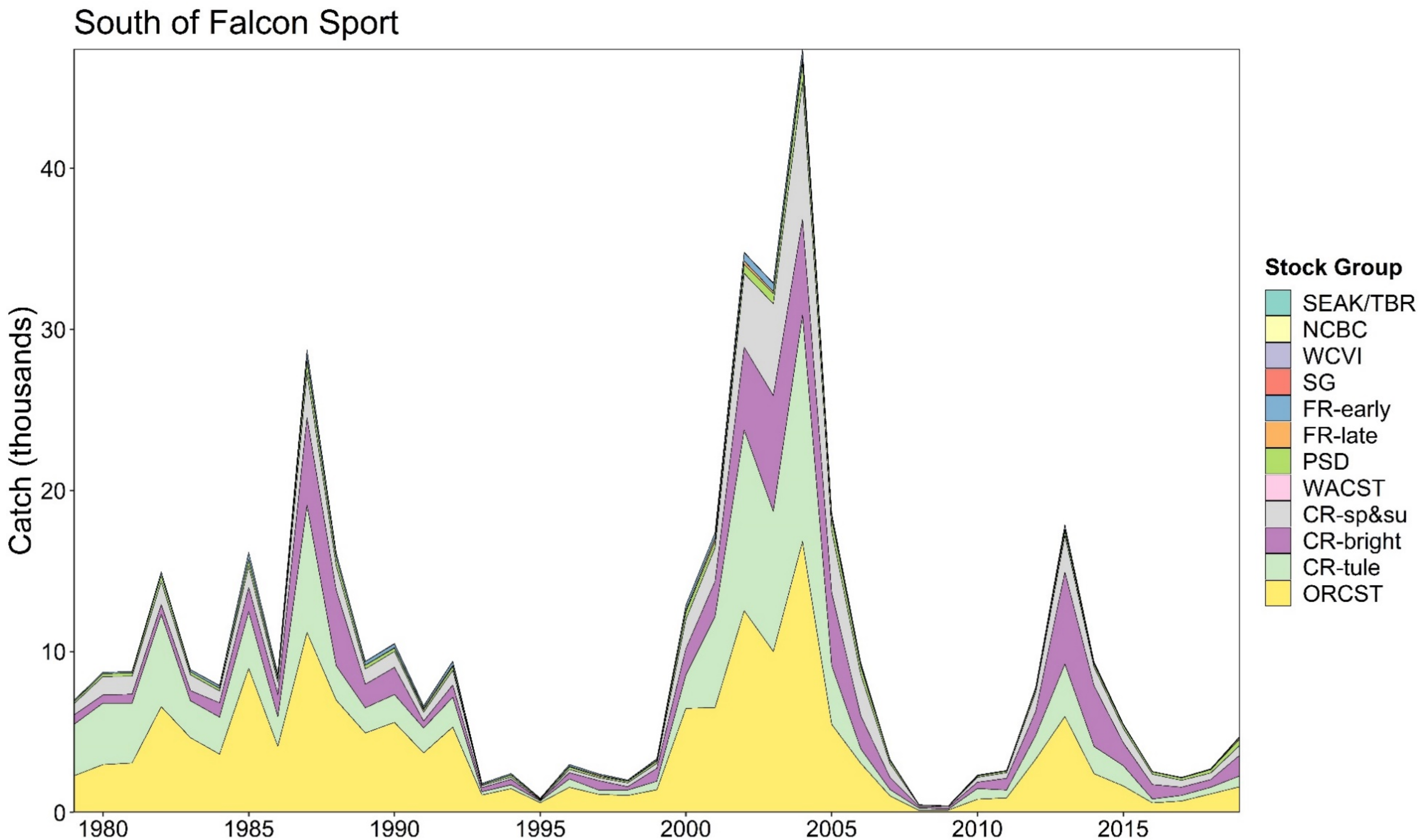
Appendix C31— PSC Chinook Model estimates of landed catch stock composition for West Coast Vancouver Island ISBM Sport, 1979–2019.



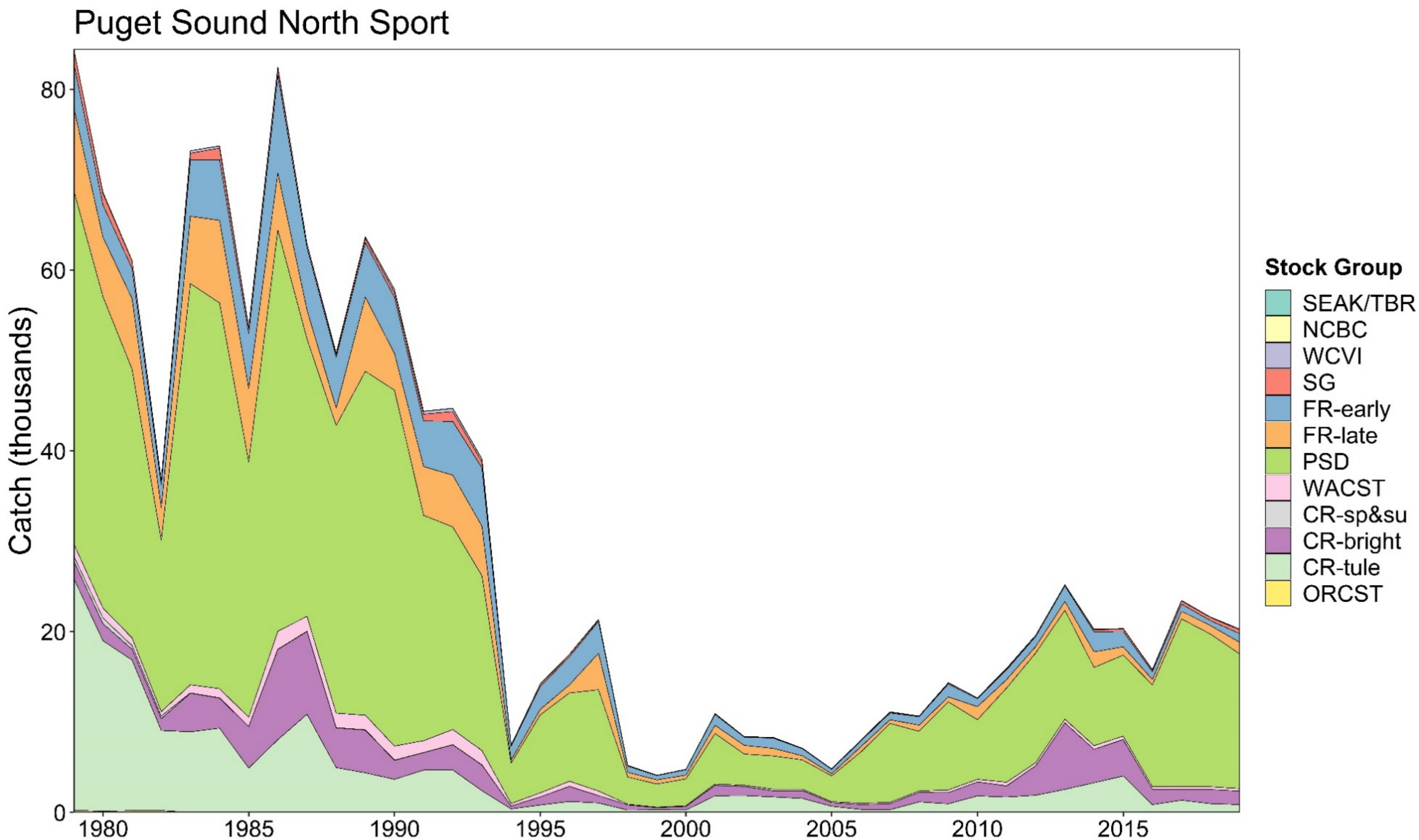
Appendix C32— PSC Chinook Model estimates of landed catch stock composition for North of Falcon Sport, 1979–2019.



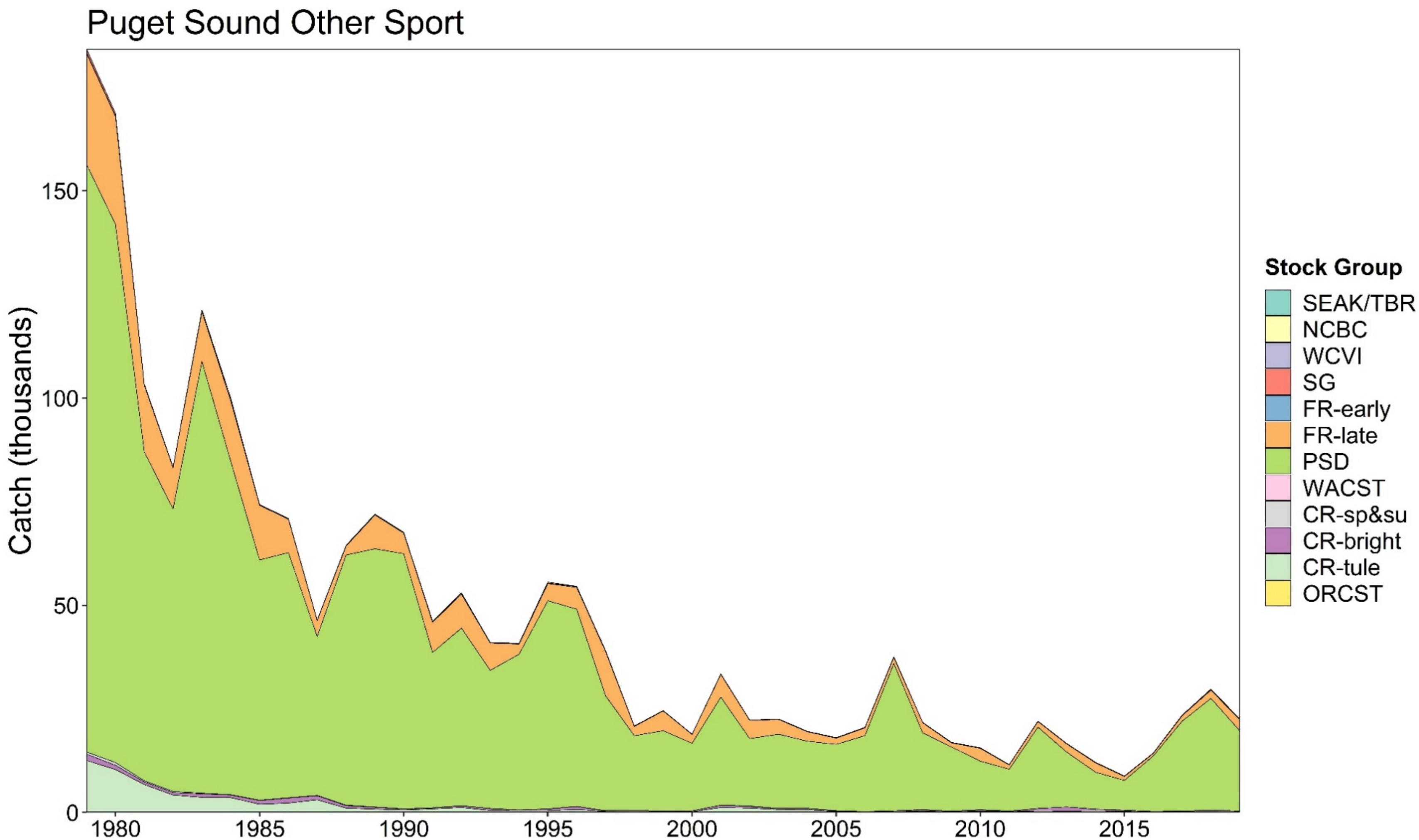
Appendix C33— PSC Chinook Model estimates of landed catch stock composition for South of Falcon Sport, 1979–2019.



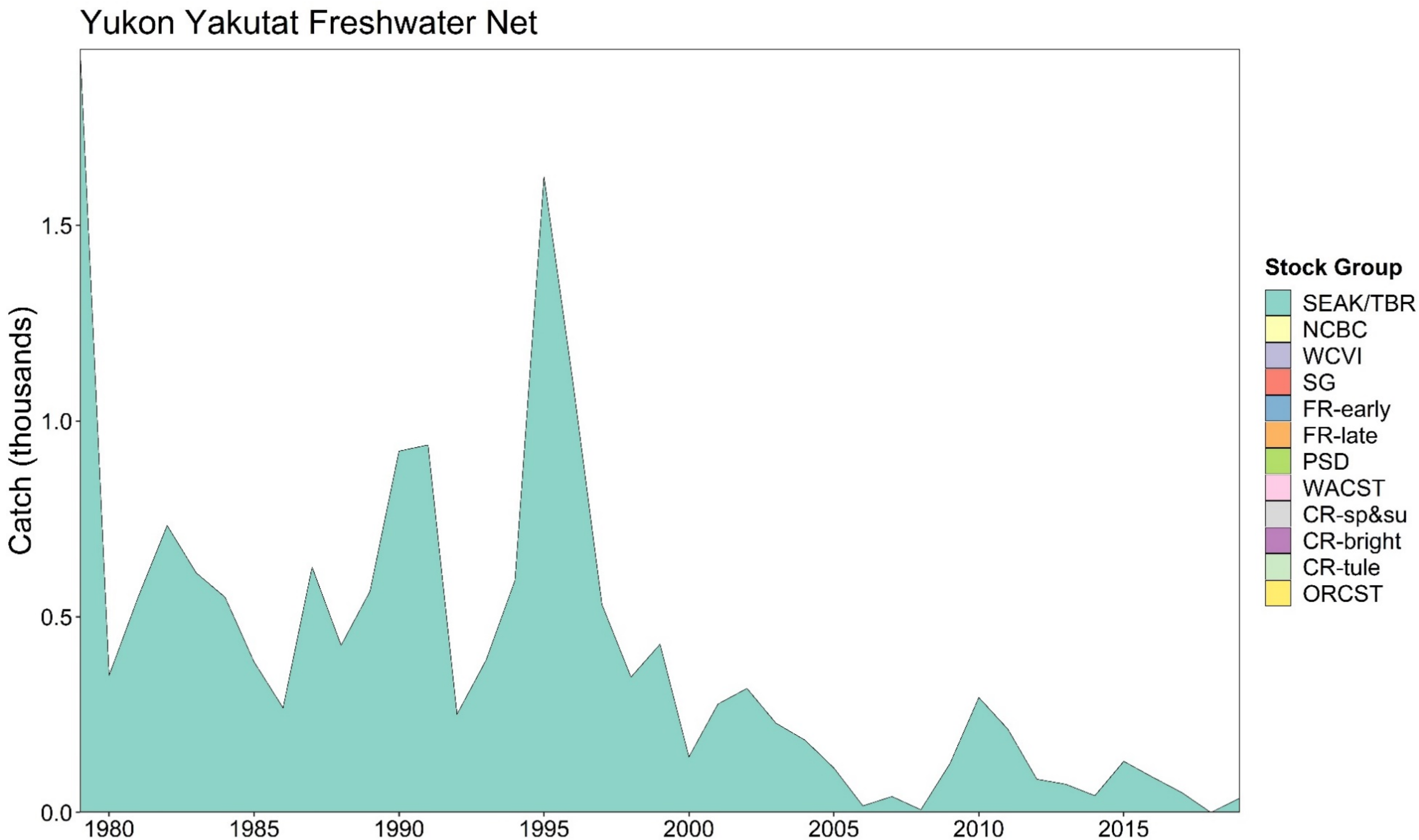
Appendix C34— PSC Chinook Model estimates of landed catch stock composition for Puget Sound North Sport, 1979–2019.



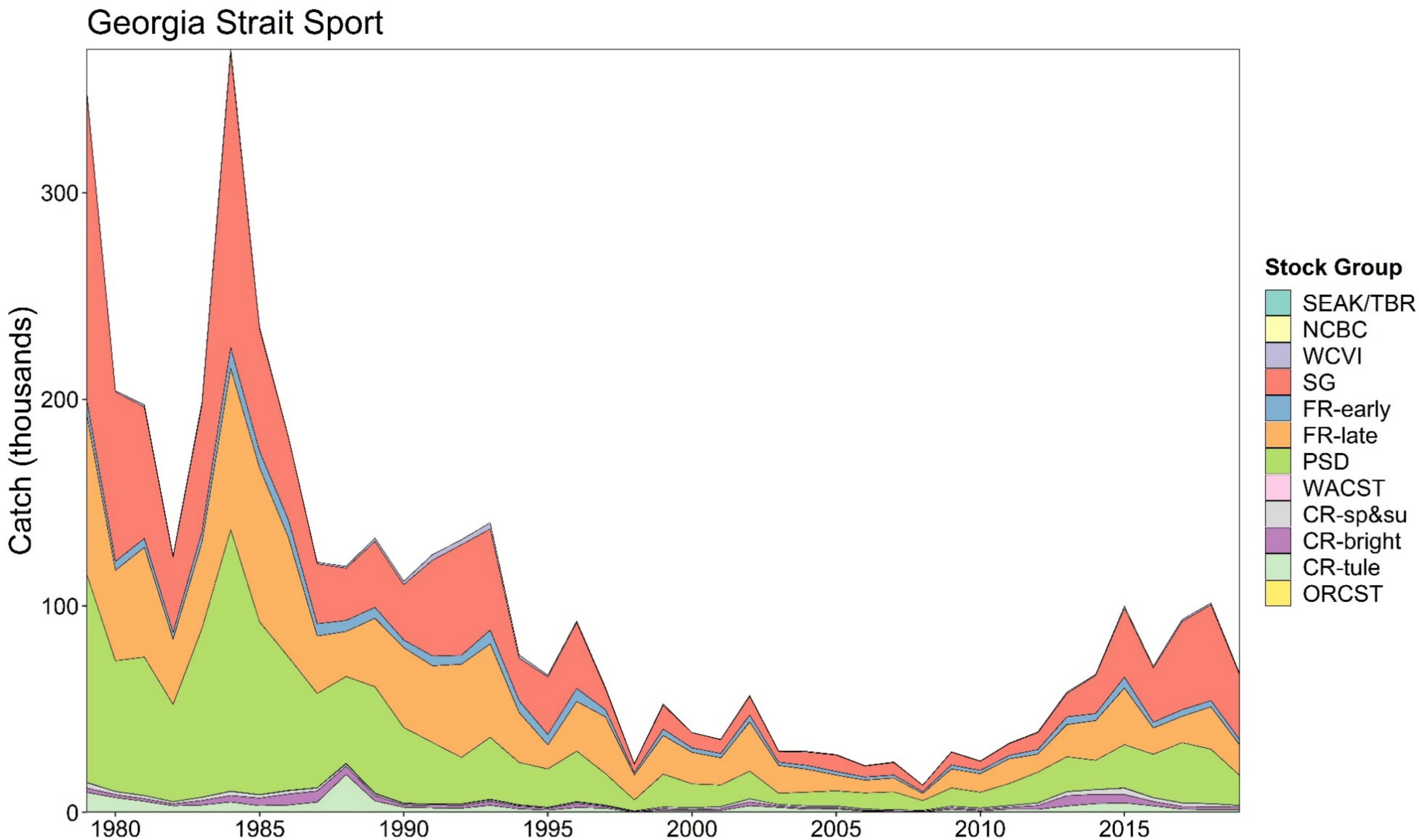
Appendix C35— PSC Chinook Model estimates of landed catch stock composition for Puget Sound Other Sport, 1979–2019.



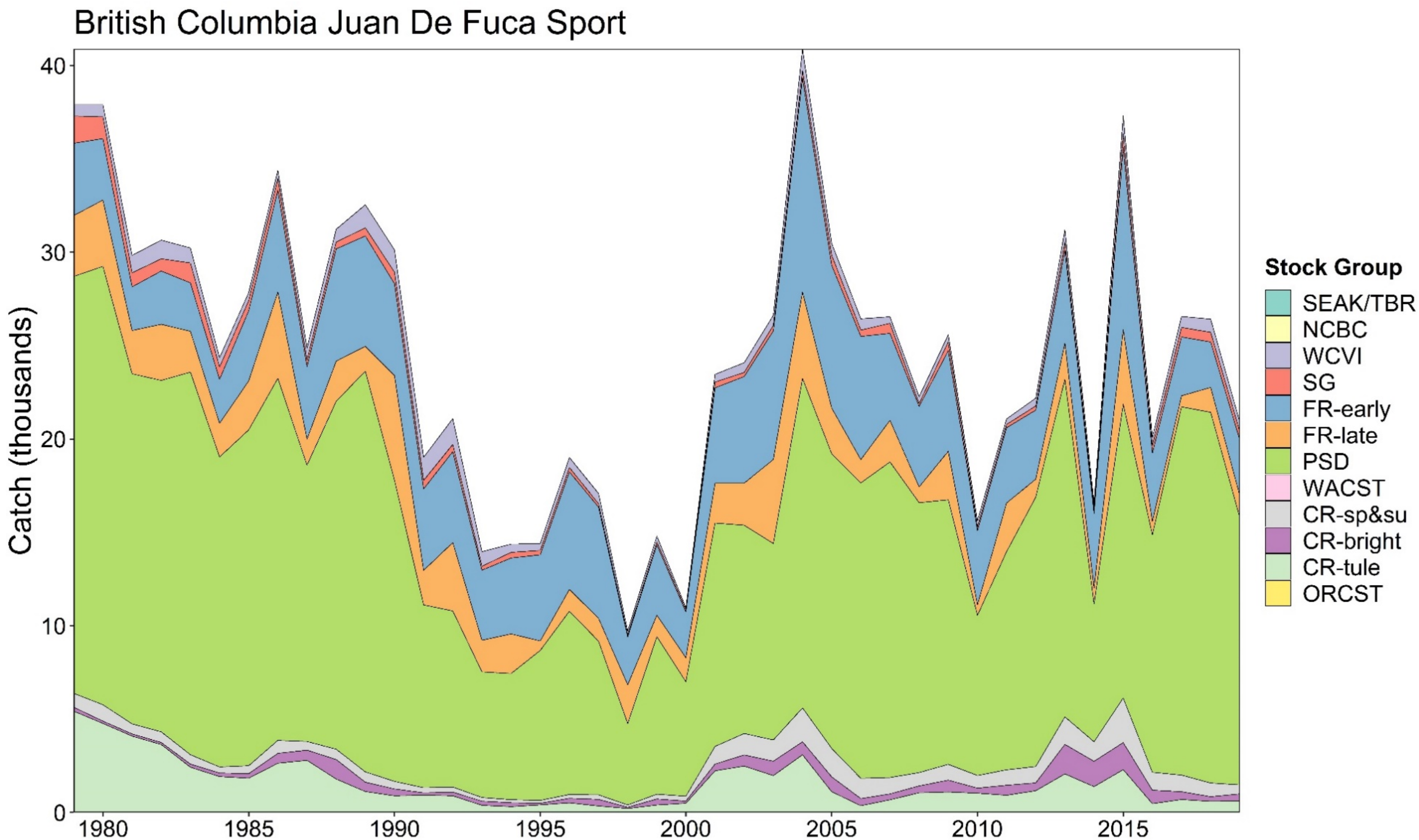
Appendix C36— PSC Chinook Model estimates of landed catch stock composition for Terminal Yukon Alsek Freshwater Net, 1979–2019.



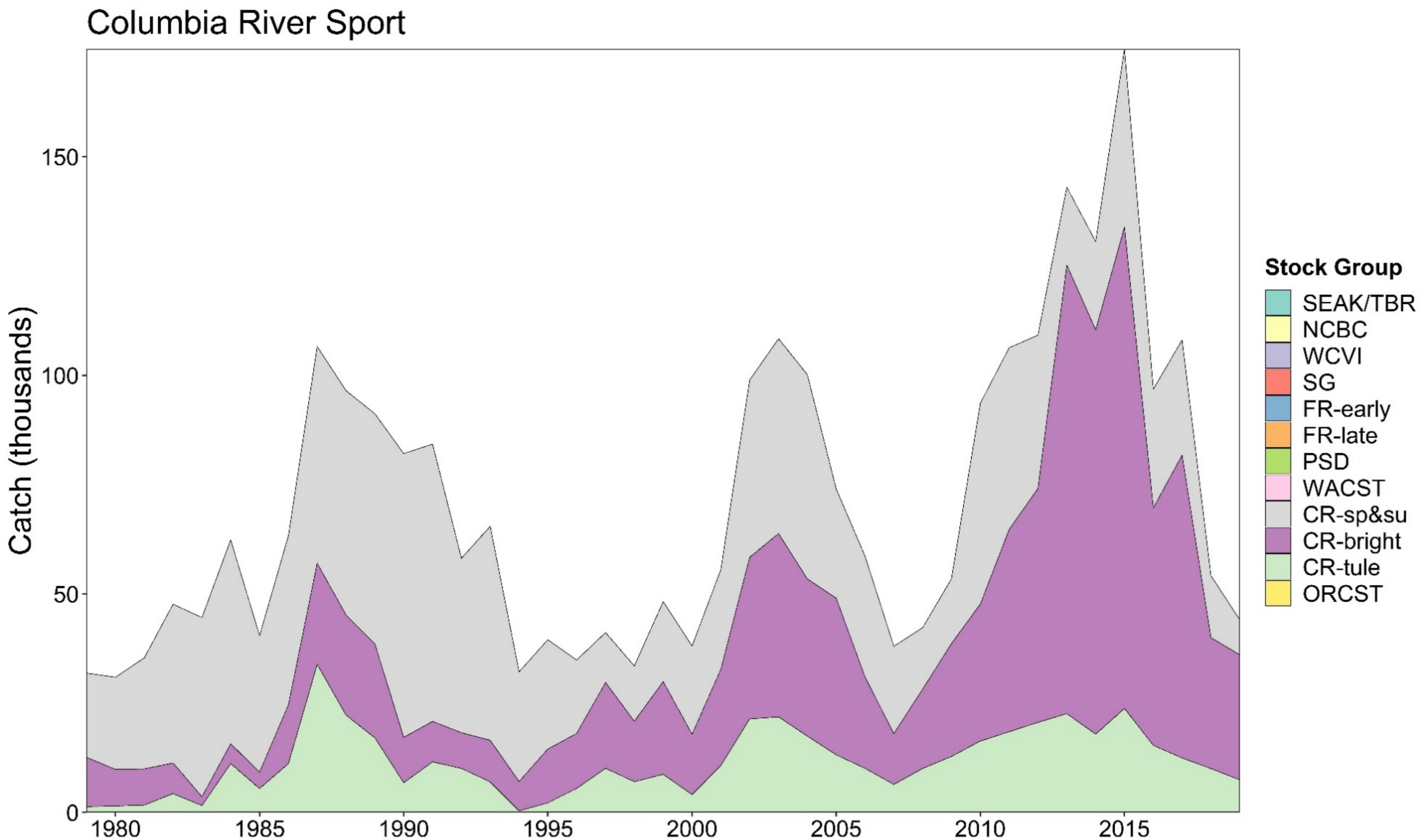
Appendix C37— PSC Chinook Model estimates of landed catch stock composition for Strait of Georgia Sport, 1979–2019.



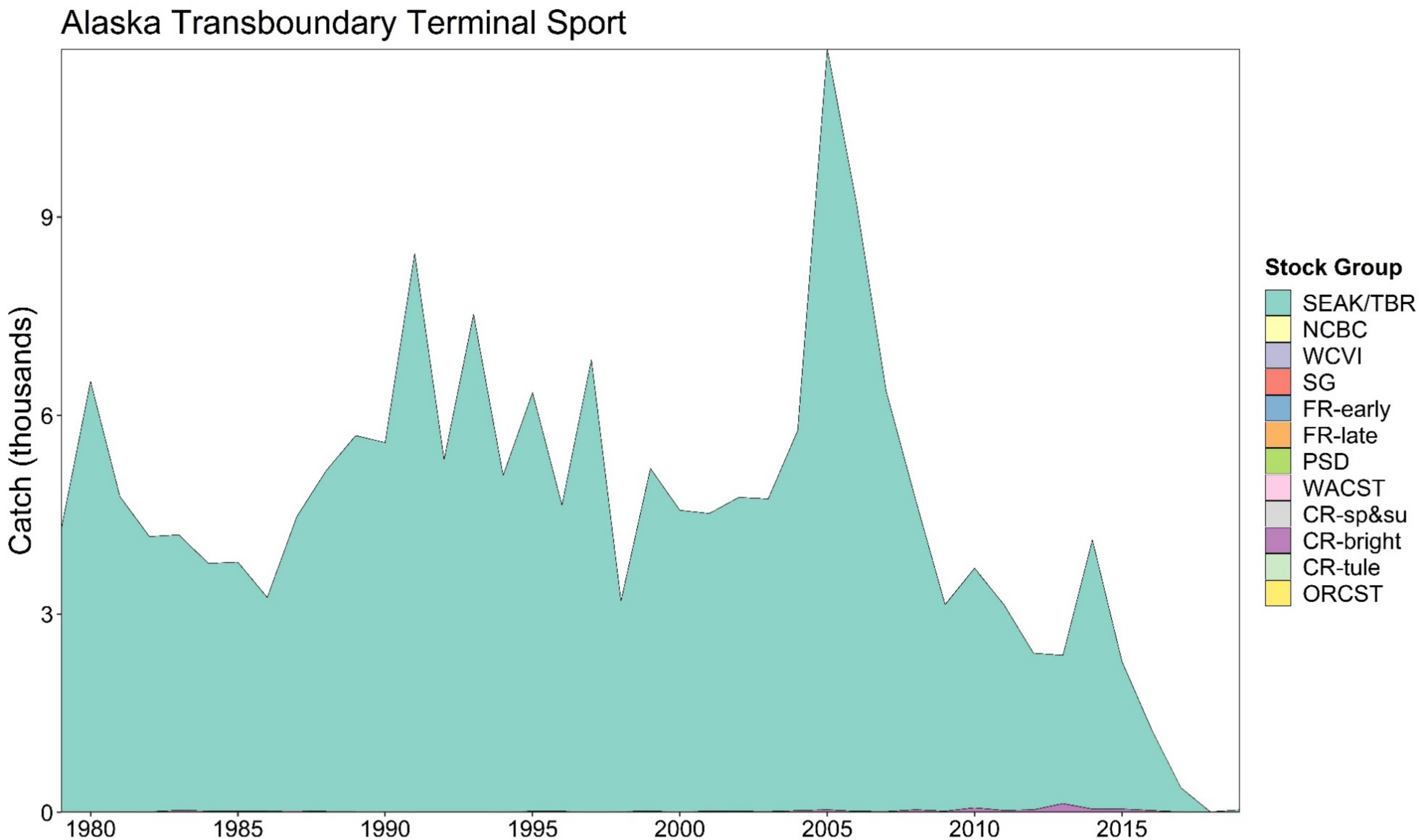
Appendix C38— PSC Chinook Model estimates of landed catch stock composition for British Columbia Juan De Fuca Sport, 1979–2019.



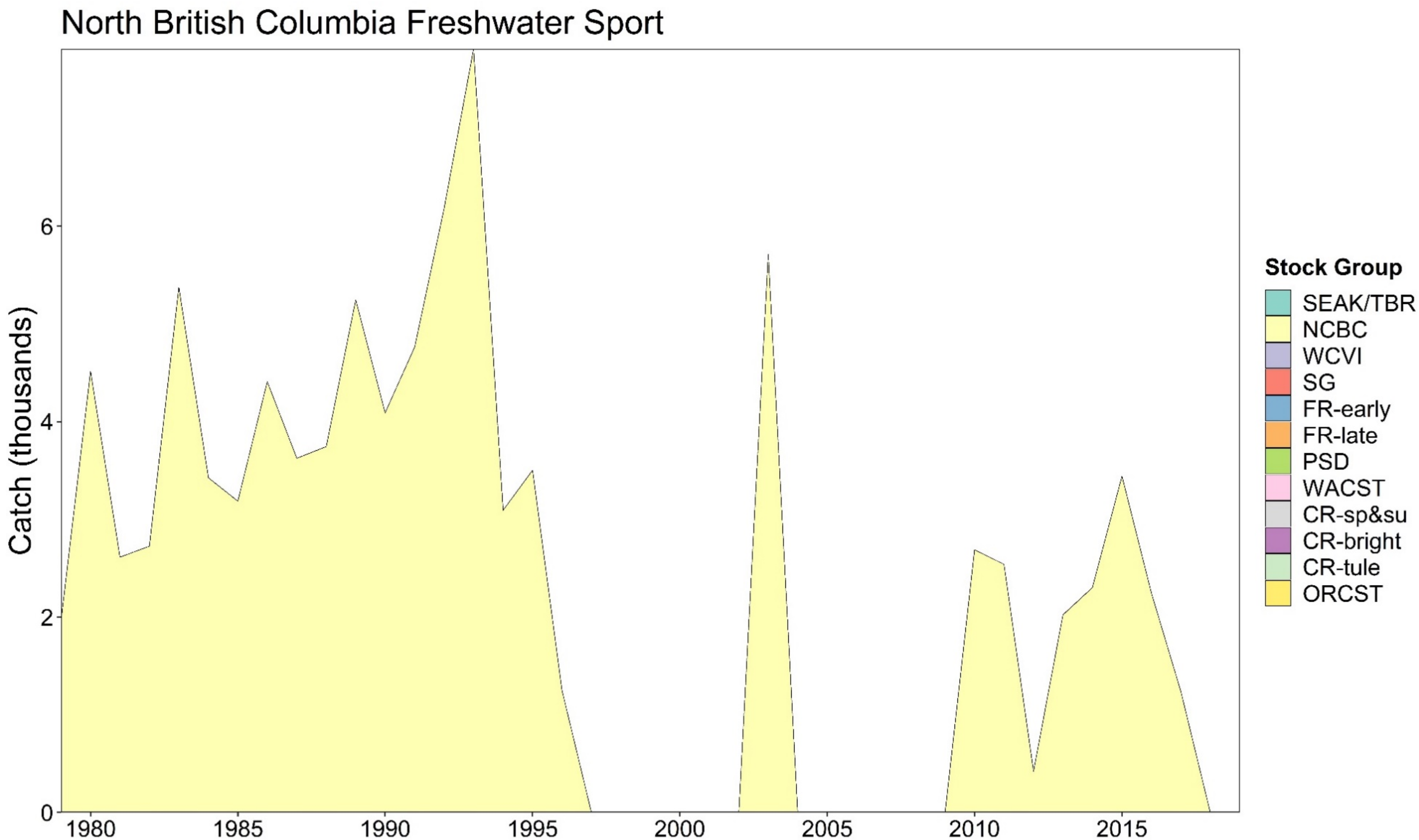
Appendix C39— PSC Chinook Model estimates of landed catch stock composition for Columbia River Sport, 1979–2019.



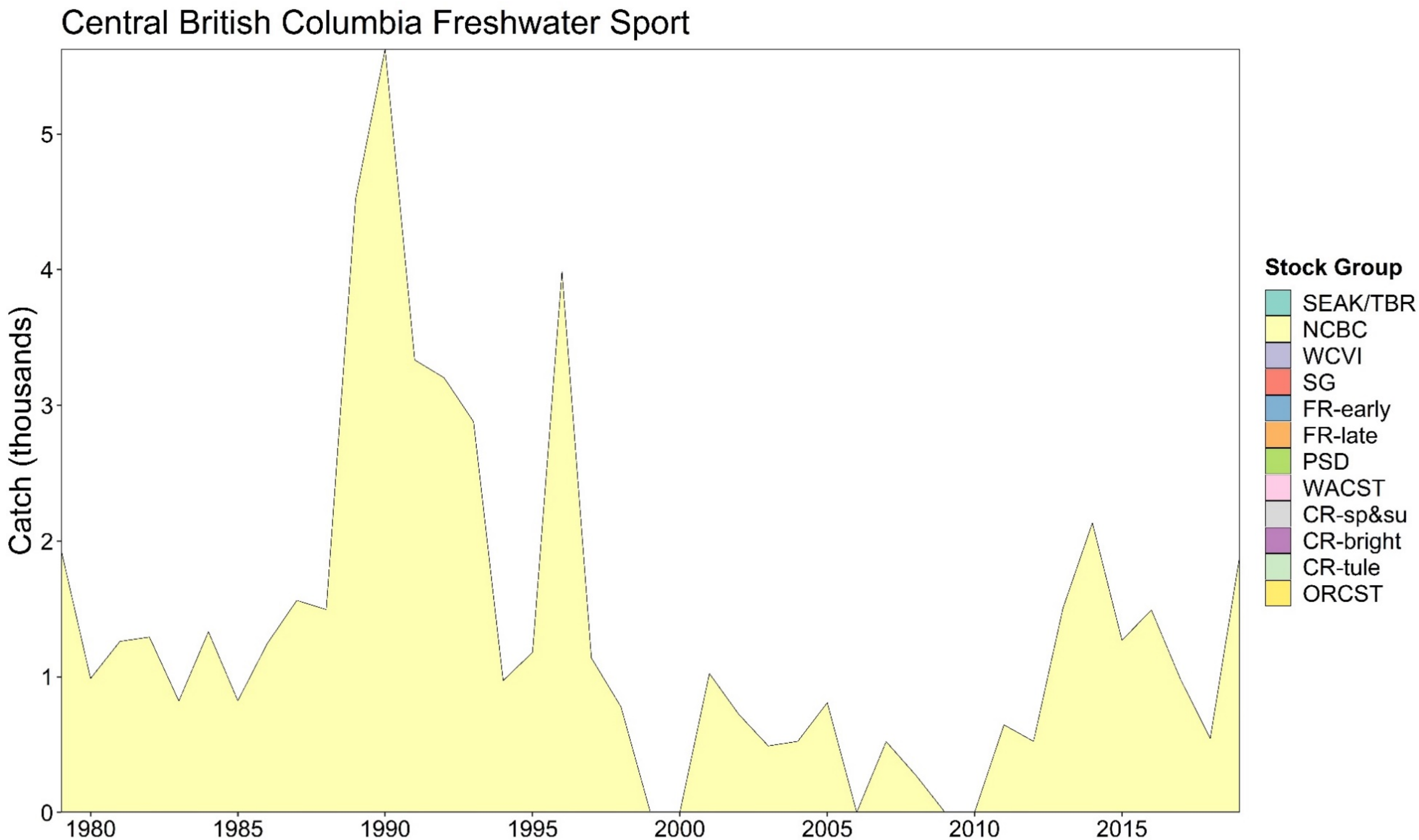
Appendix C40— PSC Chinook Model estimates of landed catch stock composition for Alaska Transboundary River Terminal Sport, 1979–2019.



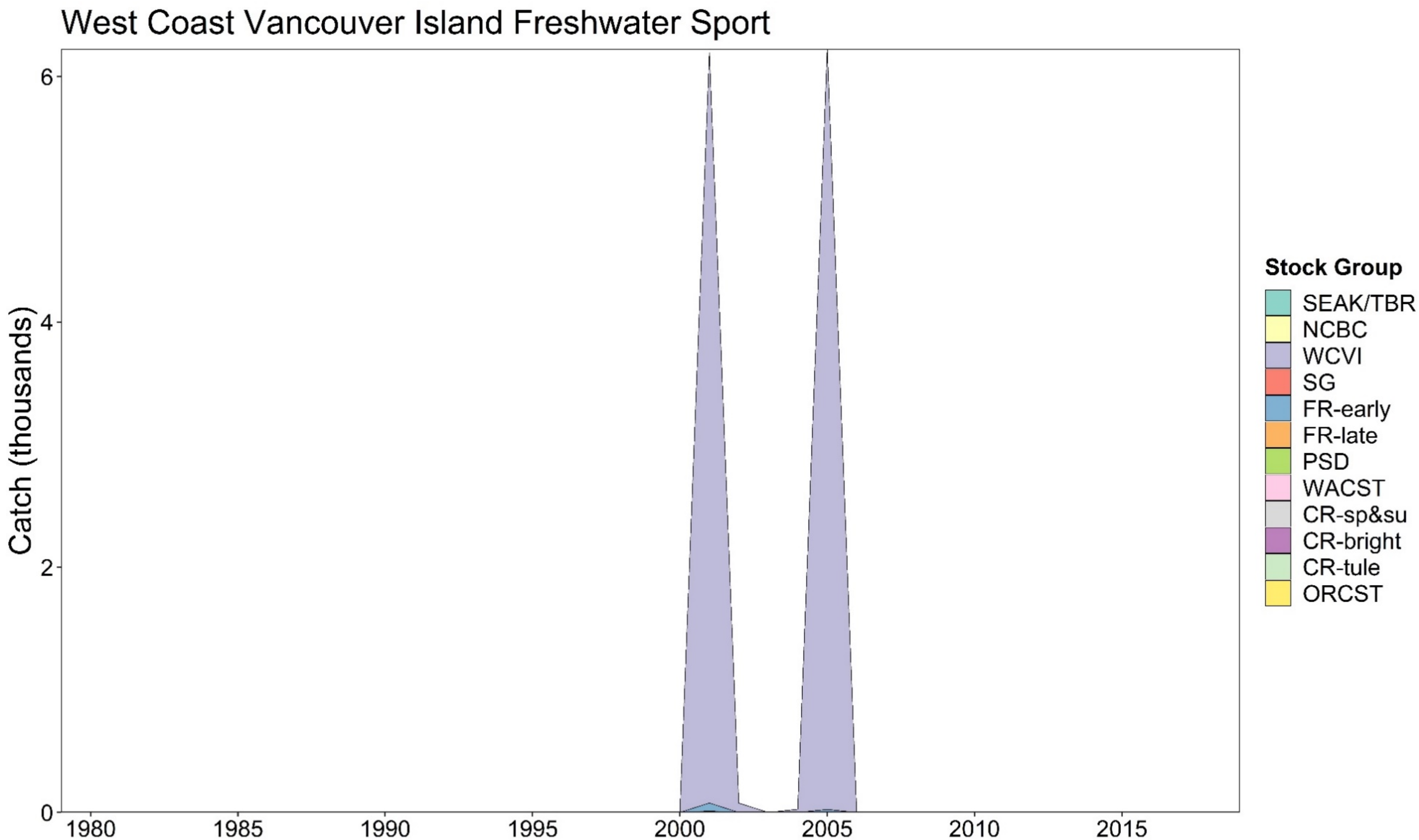
Appendix C41— PSC Chinook Model estimates of landed catch stock composition for North British Columbia Freshwater Sport, 1979–2019.



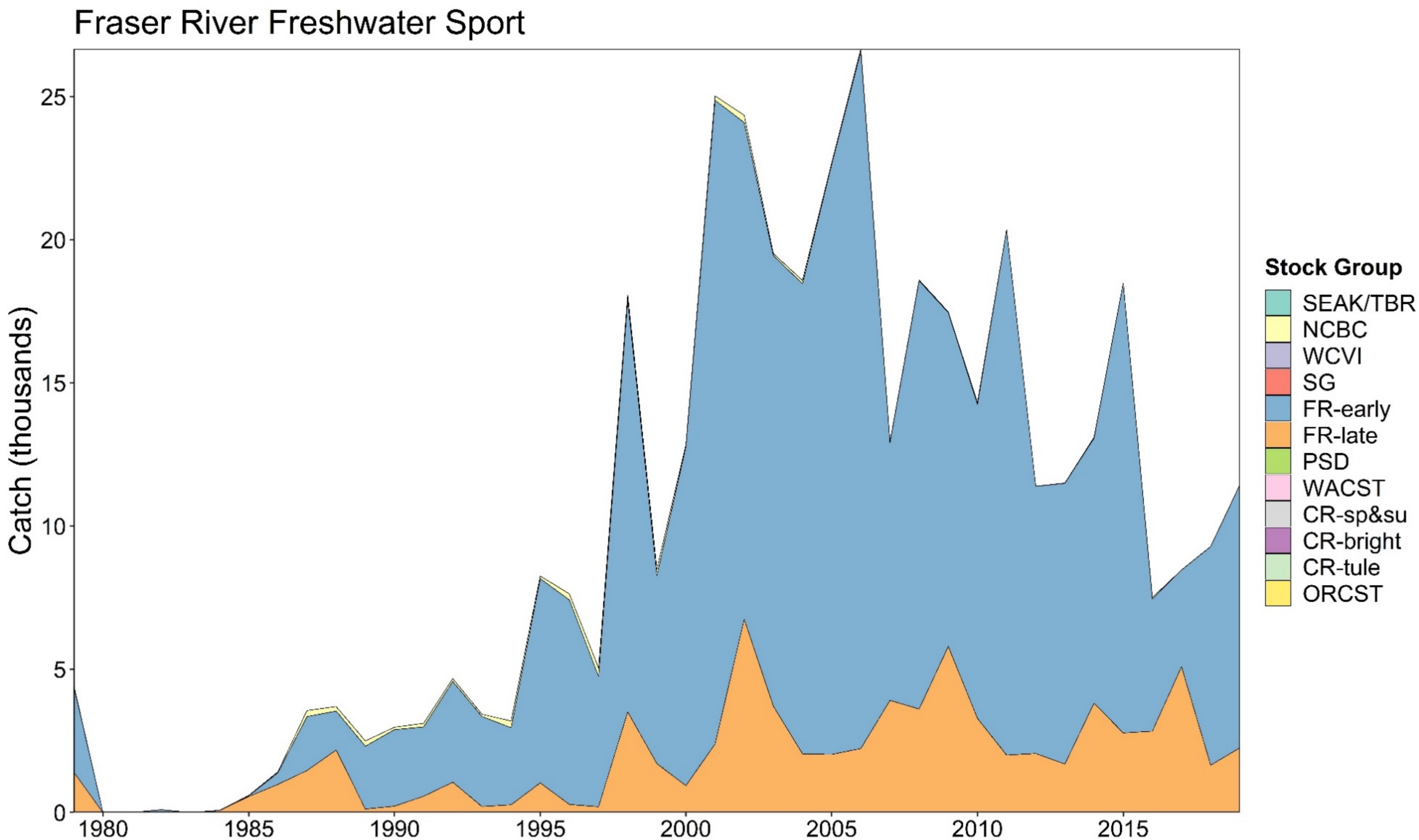
Appendix C42— PSC Chinook Model estimates of landed catch stock composition for Central British Columbia Freshwater Sport, 1979–2019.



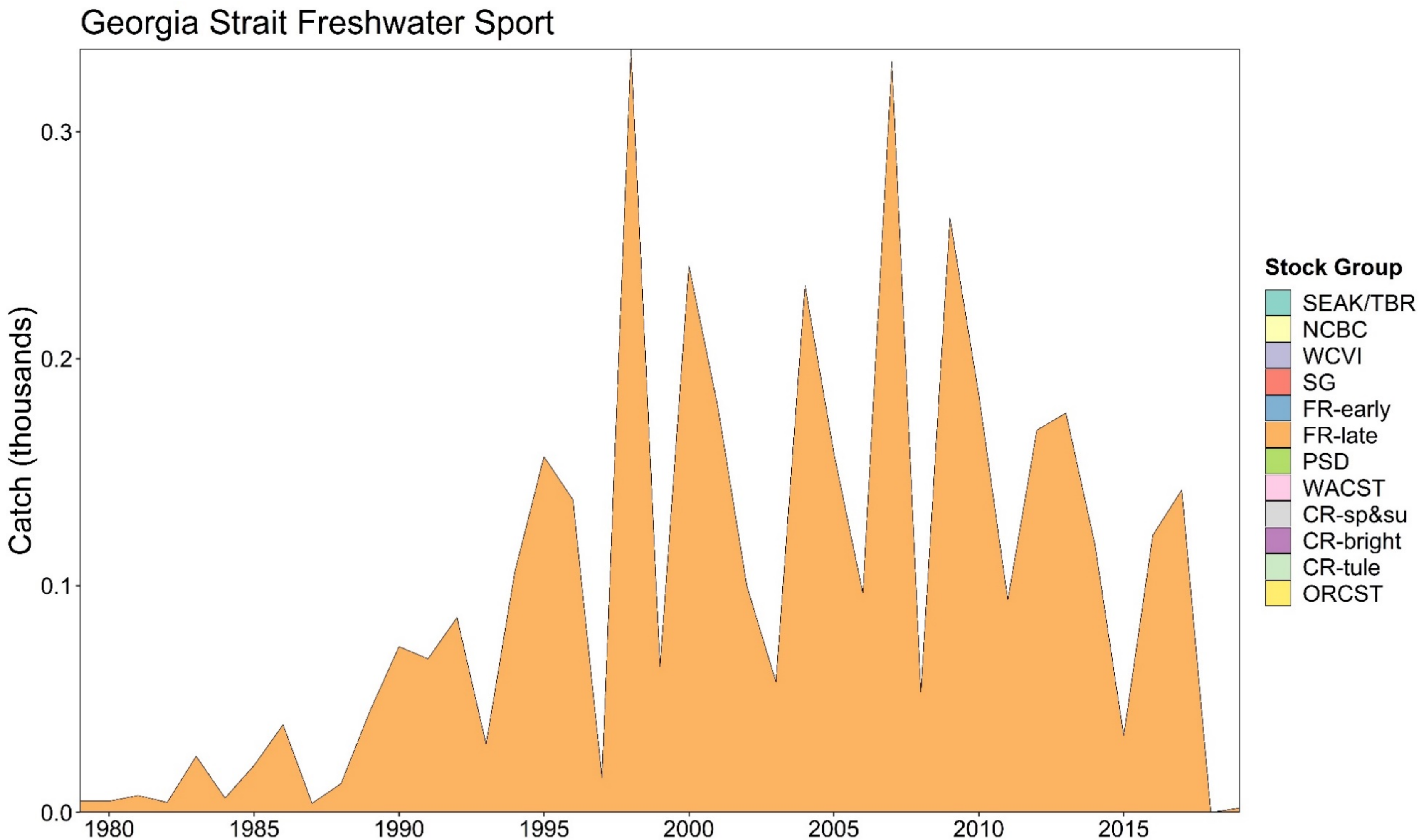
Appendix C43— PSC Chinook Model estimates of landed catch stock composition for West Coast Vancouver Island Freshwater Sport, 1979–2019.



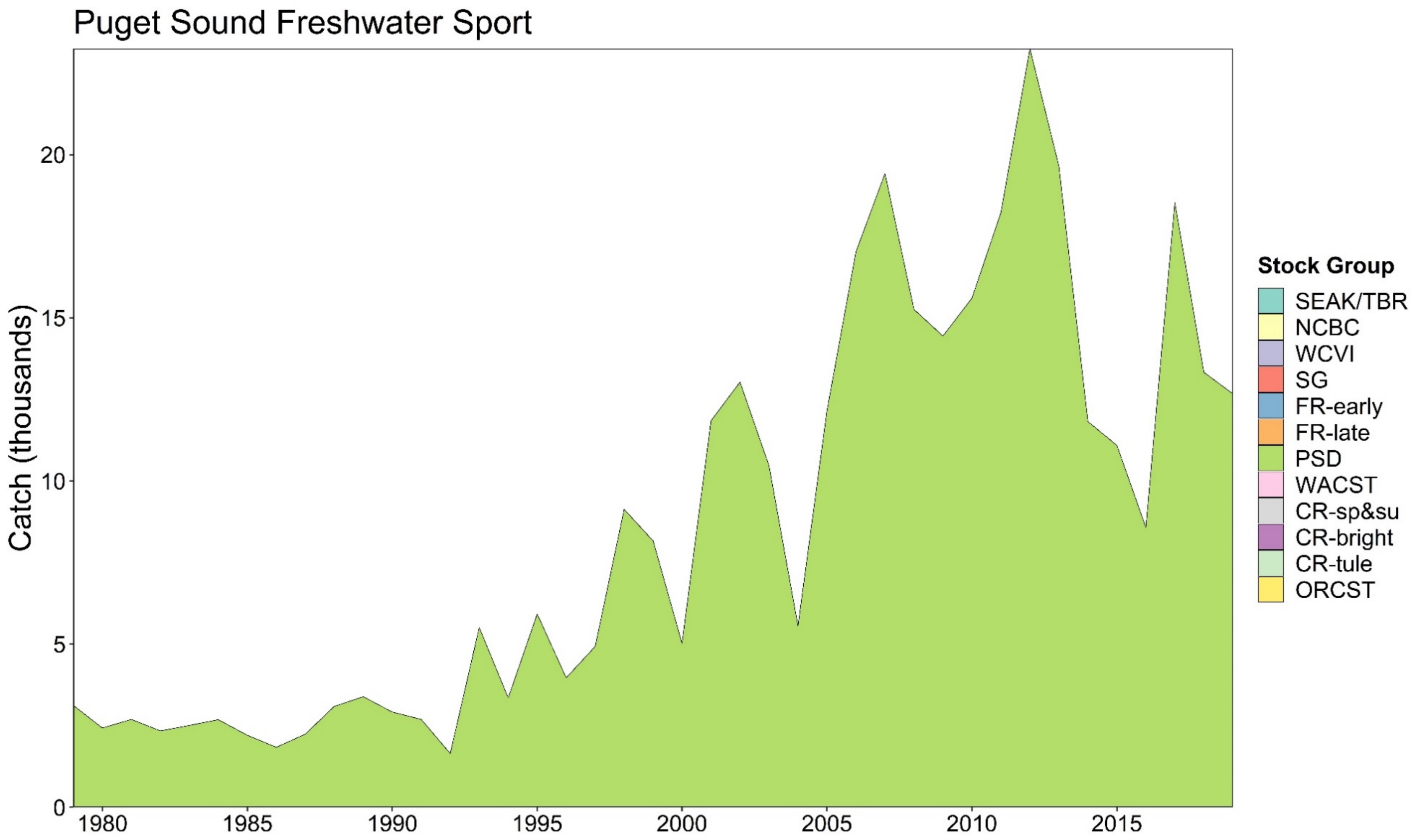
Appendix C44— PSC Chinook Model estimates of landed catch stock composition for Fraser River Freshwater Sport, 1979–2019.



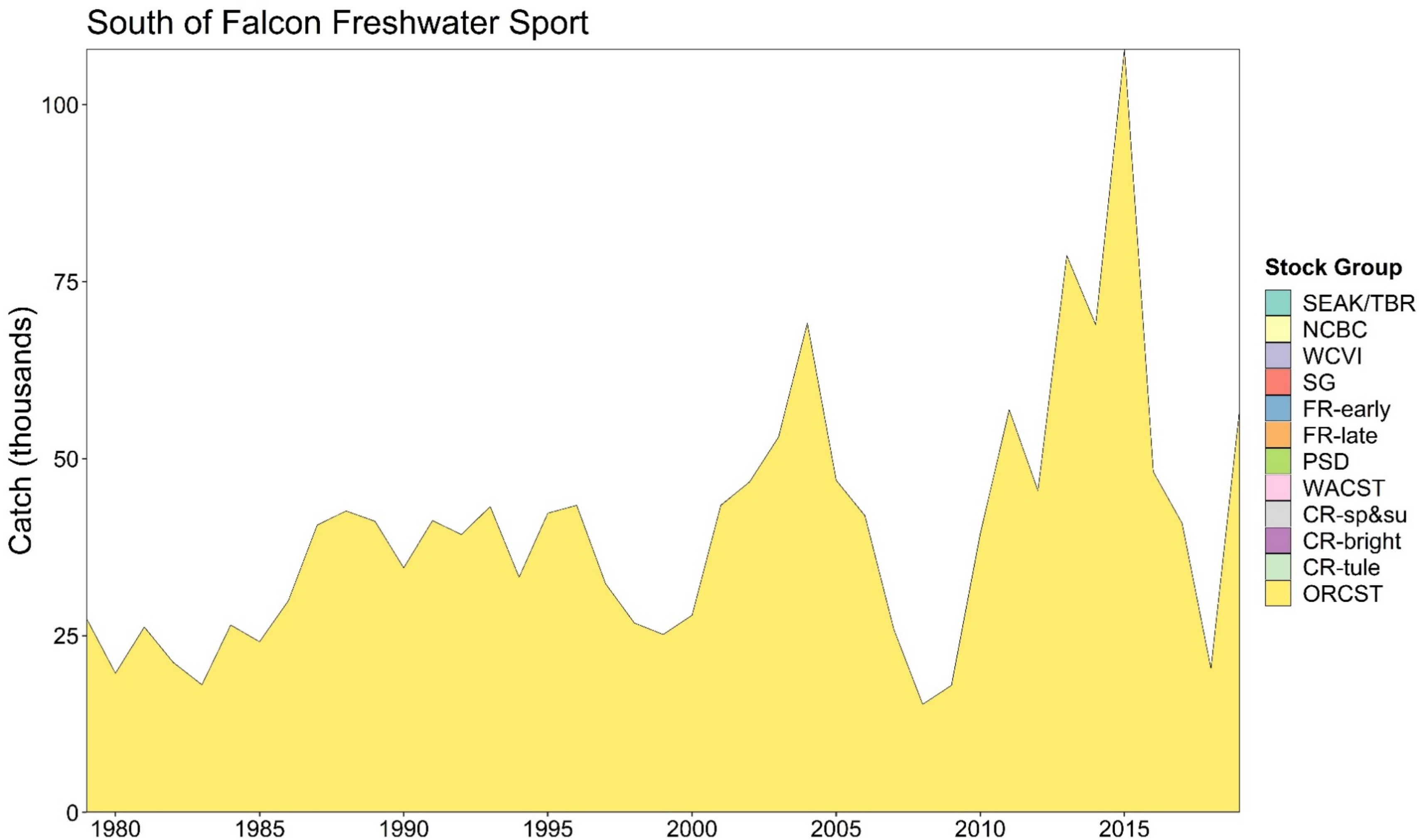
Appendix C45— PSC Chinook Model estimates of landed catch stock composition for Strait of Georgia Freshwater Sport, 1979–2019.



Appendix C46— PSC Chinook Model estimates of landed catch stock composition for Puget Sound Freshwater Sport, 1979–2019.



Appendix C47— PSC Chinook Model estimates of landed catch stock composition for South of Falcon Freshwater Sport, 1979–2019.



APPENDIX D: INCIDENTAL MORTALITY RATES APPLIED IN THE PSC CHINOOK MODEL

Appendix D— Incidental mortality rates applied in the Phase II PSC Chinook Model. Rates in original model were applied to all years. In the current model, rates in some fisheries vary in accordance to changes in management regulations.

Fishery Number	Fishery	Rates applied in Model CLB 2003 Sublegal Rate	Legal Rate	Dropoff	Applicable Years
1	Alaska Troll	0.255	0.211	0.008	All
2	Alaska Yakutat Terminal Net	0.9	0.9	0	All
3	North Troll	0.255	0.211	0.017	1979-1995
3	North Troll	0.22	0.185	0.016	1996–Current
4	Central Troll	0.255	0.211	0.017	1979–1995
4	Central Troll	0.22	0.185	0.016	1996–Current
5	West Coast Vancouver Island Troll	0.255	0.211	0.017	1979–1997
5	West Coast Vancouver Island Troll	0.22	0.185	0.016	1998–Current
6	North of Falcon Troll	0.255	0.211	0.017	1979–1983
6	North of Falcon Troll	0.22	0.185	0.016	1984–Current
7	South of Falcon Troll	0.255	0.211	0.017	1979–1983
7	South of Falcon Troll	0.22	0.185	0.016	1984–Current
8	Strait of Georgia Troll	0.255	0.211	0.017	1979–1985, 1987–1997
8	Strait of Georgia Troll	0.22	0.185	0.016	1986, 1998–Current
9	Alaska Net	0.9	0.9	0	All
10	North Net	0.9	0.9	0	All
11	Central Net	0.9	0.9	0	All
12	West Coast Vancouver Island Net	0.9	0.9	0	All
13	Juan de Fuca Net	0.9	0.9	0	All
14	Puget Sound North Net	0.9	0.9	0	All
15	Puget Sound Other Net	0.9	0.9	0	All
16	Washington Coast Net	0.9	0.9	0	All
17	Columbia River Net	0.9	0.9	0	All
18	Alaska Transboundary River Terminal Net	0.9	0.9	0	All
19	Canada Transboundary River Freshwater Net	0.9	0.9	0	All
20	Central B.C. Freshwater Net	0.9	0.9	0	All
21	Strait of Georgia Freshwater Net	0.9	0.9	0	All
22	Fraser Freshwater Net	0.9	0.9	0	All
23	Puget Sound Freshwater Net	0.9	0.9	0	All
24	Washington Coast Freshwater Net	0.9	0.9	0	All
25	Johnstone Strait Net	0.9	0.9	0	All
26	Fraser Net	0.9	0.9	0	All

Appendix D continued. Incidental mortality rates applied in the Phase II PSC Chinook Model. Rates in original model were applied to all years. In the current model, rates in some fisheries vary in accordance to changes in management regulations.

Fishery Number	Fishery	Rates applied in Model CLB 2003 Sublegal Rate	Legal Rate	Dropoff	Applicable Years
27	Alaska Sport	0.123	0.123	0.036	All
28	Central B.C. Sport	0.123	0.123	0.036	All
29	North B.C. AABM Sport	0.123	0.123	0.036	All
30	North B.C. ISBM Sport	0.123	0.123	0.036	All
31	West Coast Vancouver Island AABM Sport	0.123	0.123	0.069	All
32	West Coast Vancouver Island ISBM Sport	0.123	0.123	0.069	All
33	North of Falcon Sport	0.123	0.123	0.069	All
34	South of Falcon Sport	0.123	0.123	0.069	All
35	Puget Sound North Sport	0.123	0.123	0.145	All
36	Puget Sound Other Sport	0.123	0.123	0.145	All
37	Canada Yakutat Freshwater Net	0.9	0.9	0	All
38	Strait of Georgia Sport	0.322	0.322	0.069	1979–1981
38	Strait of Georgia Sport	0.123	0.123	0.069	1982–Current
39	B.C. Juan de Fuca Sport	0.322	0.322	0.069	All
40	Columbia River Sport	0.123	0.123	0.069	All
41	Alaska Transboundary River Terminal Sport	0.123	0.123	0.069	All
42	North B.C. Freshwater Sport	0.123	0.123	0.069	All
43	Central B.C. Freshwater Sport	0.123	0.123	0.069	All
44	West Coast Vancouver Island Freshwater Sport	0.123	0.123	0.069	All
45	Fraser River Freshwater Sport	0.123	0.123	0.069	All
46	Strait of Georgia Freshwater Sport	0.123	0.123	0.069	All
47	Puget Sound Freshwater Sport	0.123	0.123	0.069	All
48	South of Falcon Freshwater Sport	0.123	0.123	0.069	All

APPENDIX E: TIME SERIES OF ABUNDANCE INDICES

Appendix E— Time series of abundance indices from 1979–2020 for Southeast Alaska (SEAK), Northern British Columbia (NBC), and West Coast Vancouver Island (WCVI) AABM fisheries as estimated by PSC Chinook Model calibrations CLB 2003.

Year	Alaska Troll	North Troll	WCVI Troll
1979	0.92	1.05	1.12
1980	1.01	0.98	0.99
1981	1.01	0.98	0.92
1982	1.05	0.98	0.96
1983	1.12	1.09	0.91
1984	1.36	1.25	0.97
1985	1.29	1.28	0.91
1986	1.42	1.34	1.04
1987	1.81	1.74	1.43
1988	2.17	1.82	1.28
1989	2.01	1.77	1.02
1990	1.88	1.63	0.89
1991	1.84	1.58	0.81
1992	1.79	1.56	0.82
1993	1.83	1.55	0.72
1994	1.69	1.34	0.54
1995	1.04	1.02	0.48
1996	1.10	1.00	0.57
1997	1.56	1.25	0.67
1998	1.37	1.07	0.61
1999	1.06	0.86	0.58
2000	0.90	0.83	0.59
2001	1.20	1.17	0.98
2002	1.89	1.85	1.43
2003	2.26	1.98	1.38
2004	2.07	1.96	1.21
2005	1.85	1.69	0.95
2006	1.71	1.54	0.74
2007	1.21	1.05	0.60
2008	0.95	0.90	0.68
2009	1.14	1.03	0.65
2010	1.23	1.33	0.89
2011	1.43	1.38	0.83
2012	1.16	1.27	0.82
2013	1.52	1.59	1.14
2014	2.14	1.89	1.20
2015	2.07	1.93	1.17
2016	1.50	1.36	0.78
2017	1.12	1.06	0.66
2018	0.74	0.84	0.61
2019	1.03	0.98	0.64
2020	1.02	1.00	0.69

Note: This time series is NOT the first post-season AI for each year and is for trend analysis only. For evaluation of overage and underage, use the first post-season AI instead (Source CLB 2003 PABD file).

Appendix F: Abundance indices in total and by model stock for AABM fisheries, from Calibration 2003

LIST OF APPENDIX F TABLES

Appendix F1– Acronyms used in Abundance Indices (AIs) tables in Appendix F.

Stock Name	Acronym	Stock Name	Acronym
Southern Southeast Alaska	SSA	Puget Sound Yearling	PSY
Northern Southeast Alaska	NSA	Nooksack Spring	NKS
Alsek	ALS	Skagit Wild	SKG
Taku and Stikine	TST	Stillaguamish Wild	STL
Northern British Columbia	NBC	Snohomish Wild	SNO
Central British Columbia	CBC	Washington Coastal Hatchery	WCH
Fraser Spring 1.2	FS2	Washington Coastal Natural	WCN
Fraser Spring 1.3	FS3	Willamette River Spring	WSH
Fraser Ocean-type 0.3	FSO	Cowlitz Spring Hatchery	CWS
Fraser Summer Stream-type 1.3	FSS	Columbia River Summer	SUM
Fraser Harrison Fall	FHF	Upriver Brights	URB
Fraser Chilliwack Fall Hatchery	FCF	Spring Creek Hatchery	SPR
West Coast Vancouver Island Hatchery	WVH	Lower Bonneville Hatchery	BON
West Coast Vancouver Island Natural	WVN	Fall Cowlitz Hatchery	CWF
Upper Strait of Georgia	UGS	Lewis River Wild	LRW
Puntledge Summers	PPS	Lyons Ferry	LYF
Lower Strait of Georgia	LGS	Mid-Columbia River Brights	MCB
Middle Strait of Georgia	MGS	North Oregon Coast	NOC
Nooksack Fall	NKF	Mid-Oregon Coast	MOC
Puget Sound Fingerling	PSF	Yakutat Forelands	YAK
Puget Sound Natural Fall	PSN		

Appendix F2– Abundance indices (AIs) for the Southeast Alaska troll fishery by model stock and year, from CLB 2003. Numbers shown represent the portion of the AI total estimated for each model stock; the summation across all 41 stock groups equals the AI total for each calendar year.

Year	SSA	NSA	ALS	TST	NBC	CBC	FS2	FS3	FSO	FSS	FHF	FCF	WVH	WVN	UGS	PPS	LGS	MGS	NKF	PSF	PSN	AI Total
2009	0.04	0.03	0.00	0.03	0.07	0.01	0.00	0.00	0.13	0.00	0.00	0.00	0.11	0.03	0.01	0.00	0.00	0.01	0.00	0.00	0.00	1.14
2010	0.04	0.02	0.00	0.03	0.07	0.01	0.00	0.00	0.18	0.00	0.00	0.00	0.13	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	1.23
2011	0.03	0.02	0.00	0.04	0.03	0.00	0.00	0.00	0.14	0.00	0.00	0.00	0.28	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	1.43
2012	0.02	0.02	0.00	0.04	0.02	0.01	0.00	0.00	0.08	0.00	0.00	0.00	0.15	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	1.16
2013	0.03	0.02	0.00	0.04	0.03	0.01	0.00	0.00	0.08	0.00	0.00	0.00	0.17	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	1.52
2014	0.03	0.02	0.00	0.04	0.04	0.01	0.00	0.00	0.11	0.00	0.00	0.00	0.21	0.04	0.01	0.00	0.00	0.00	0.00	0.00	0.00	2.14
2015	0.03	0.02	0.00	0.04	0.03	0.01	0.00	0.00	0.18	0.00	0.00	0.00	0.22	0.05	0.01	0.00	0.00	0.01	0.00	0.00	0.00	2.07
2016	0.02	0.01	0.00	0.02	0.04	0.01	0.00	0.00	0.10	0.00	0.00	0.00	0.24	0.05	0.01	0.00	0.00	0.00	0.00	0.00	0.00	1.50
2017	0.02	0.01	0.00	0.01	0.02	0.00	0.00	0.00	0.09	0.00	0.00	0.00	0.21	0.05	0.01	0.00	0.00	0.00	0.00	0.01	0.00	1.12
2018	0.02	0.01	0.00	0.01	0.02	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.18	0.03	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.74
2019	0.02	0.02	0.00	0.01	0.02	0.00	0.00	0.00	0.14	0.00	0.00	0.00	0.32	0.04	0.01	0.00	0.00	0.00	0.00	0.00	0.00	1.03
2020	0.02	0.02	0.00	0.02	0.01	0.00	0.00	0.00	0.12	0.00	0.00	0.00	0.27	0.05	0.00	0.00	0.00	0.01	0.00	0.00	0.00	1.02

Year	PSY	NKS	SKG	STL	SNO	WCH	WCN	WSH	CWS	SUM	URB	SPR	BON	CWF	LRW	LYF	MCB	NOC	MOC	YAK	AI Total
2009	0.00	0.00	0.00	0.00	0.00	0.03	0.05	0.01	0.00	0.04	0.32	0.00	0.00	0.02	0.01	0.00	0.11	0.05	0.02	0.00	1.14
2010	0.00	0.00	0.00	0.00	0.00	0.04	0.08	0.02	0.00	0.05	0.28	0.00	0.00	0.02	0.01	0.00	0.07	0.09	0.03	0.00	1.23
2011	0.00	0.00	0.00	0.00	0.00	0.06	0.08	0.02	0.00	0.05	0.31	0.00	0.00	0.03	0.01	0.00	0.09	0.14	0.04	0.00	1.43
2012	0.00	0.00	0.00	0.00	0.00	0.07	0.09	0.01	0.00	0.05	0.26	0.00	0.00	0.02	0.01	0.00	0.09	0.14	0.03	0.00	1.16
2013	0.00	0.00	0.00	0.00	0.00	0.04	0.05	0.01	0.00	0.05	0.51	0.00	0.00	0.02	0.01	0.00	0.21	0.16	0.03	0.00	1.52
2014	0.00	0.00	0.00	0.00	0.00	0.06	0.06	0.01	0.00	0.07	0.88	0.00	0.00	0.03	0.02	0.00	0.28	0.16	0.04	0.00	2.14
2015	0.00	0.00	0.00	0.00	0.00	0.06	0.07	0.02	0.00	0.09	0.78	0.00	0.00	0.03	0.02	0.00	0.19	0.14	0.05	0.00	2.07
2016	0.00	0.00	0.00	0.00	0.00	0.04	0.04	0.01	0.00	0.08	0.51	0.00	0.00	0.03	0.01	0.00	0.11	0.14	0.02	0.00	1.50
2017	0.00	0.00	0.00	0.00	0.00	0.04	0.04	0.01	0.00	0.05	0.31	0.00	0.00	0.01	0.01	0.00	0.06	0.12	0.02	0.00	1.12
2018	0.00	0.00	0.00	0.00	0.00	0.03	0.04	0.01	0.00	0.04	0.12	0.00	0.00	0.01	0.00	0.00	0.03	0.07	0.01	0.00	0.74
2019	0.00	0.00	0.00	0.00	0.00	0.04	0.04	0.01	0.00	0.03	0.16	0.00	0.00	0.01	0.01	0.00	0.06	0.06	0.01	0.00	1.03
2020	0.00	0.00	0.00	0.00	0.00	0.03	0.04	0.01	0.00	0.03	0.17	0.00	0.00	0.01	0.02	0.00	0.09	0.09	0.01	0.00	1.02

Appendix F3– Abundance indices (AIs) for the Northern BC troll fishery by stock and year, from CLB 2003. Numbers shown represent the portion of the AI total estimated for each model stock; the summation across all 41 stock groups equals the AI total for each calendar year.

Year	SSA	NSA	ALS	TST	NBC	CBC	FS2	FS3	FSO	FSS	FHF	FCF	WVH	WVN	UGS	PPS	LGS	MGS	NKF	PSF	PSN	AI Total
2009	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.19	0.01	0.00	0.00	0.06	0.02	0.01	0.00	0.00	0.01	0.00	0.01	0.00	1.03
2010	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.26	0.01	0.00	0.00	0.12	0.02	0.01	0.00	0.00	0.01	0.00	0.01	0.00	1.33
2011	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.21	0.01	0.00	0.00	0.14	0.02	0.01	0.00	0.00	0.01	0.00	0.01	0.00	1.38
2012	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.12	0.00	0.00	0.00	0.08	0.02	0.01	0.00	0.00	0.00	0.00	0.01	0.00	1.27
2013	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.01	0.00	0.00	0.12	0.02	0.01	0.00	0.00	0.01	0.00	0.01	0.00	1.59
2014	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.16	0.01	0.00	0.00	0.11	0.02	0.01	0.00	0.00	0.01	0.00	0.01	0.00	1.89
2015	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.26	0.01	0.00	0.00	0.15	0.03	0.01	0.00	0.00	0.01	0.00	0.01	0.00	1.93
2016	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.00	0.00	0.00	0.14	0.03	0.01	0.00	0.00	0.01	0.00	0.01	0.00	1.36
2017	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.00	0.00	0.00	0.12	0.02	0.01	0.00	0.01	0.01	0.00	0.01	0.00	1.06
2018	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.00	0.00	0.00	0.15	0.02	0.01	0.00	0.01	0.01	0.00	0.01	0.00	0.84
2019	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.00	0.00	0.00	0.17	0.03	0.01	0.00	0.01	0.01	0.00	0.01	0.00	0.98
2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.18	0.00	0.00	0.00	0.16	0.03	0.00	0.00	0.01	0.01	0.00	0.01	0.00	1.00

Year	PSY	NKS	SKG	STL	SNO	WCH	WCN	WSH	CWS	SUM	URB	SPR	BON	CWF	LRW	LYF	MCB	NOC	MOC	YAK	AI Total
2009	0.00	0.00	0.00	0.00	0.00	0.05	0.08	0.04	0.00	0.07	0.19	0.00	0.00	0.01	0.00	0.01	0.06	0.11	0.07	0.00	1.03
2010	0.00	0.00	0.00	0.00	0.00	0.06	0.11	0.04	0.00	0.09	0.19	0.00	0.00	0.01	0.00	0.01	0.05	0.18	0.10	0.00	1.33
2011	0.00	0.00	0.00	0.00	0.00	0.09	0.11	0.03	0.00	0.10	0.20	0.00	0.00	0.02	0.01	0.01	0.06	0.23	0.11	0.00	1.38
2012	0.00	0.00	0.00	0.00	0.00	0.10	0.12	0.02	0.01	0.10	0.20	0.00	0.00	0.01	0.00	0.01	0.07	0.26	0.08	0.00	1.27
2013	0.00	0.00	0.00	0.00	0.00	0.06	0.08	0.02	0.00	0.11	0.42	0.00	0.00	0.02	0.01	0.01	0.15	0.28	0.09	0.00	1.59
2014	0.00	0.00	0.00	0.00	0.00	0.08	0.08	0.04	0.00	0.14	0.57	0.00	0.00	0.02	0.01	0.01	0.17	0.27	0.13	0.00	1.89
2015	0.00	0.00	0.00	0.00	0.00	0.09	0.10	0.03	0.01	0.16	0.47	0.00	0.00	0.02	0.01	0.01	0.11	0.28	0.14	0.00	1.93
2016	0.00	0.00	0.00	0.00	0.00	0.06	0.06	0.02	0.01	0.15	0.31	0.00	0.00	0.01	0.00	0.01	0.07	0.22	0.06	0.00	1.36
2017	0.00	0.00	0.00	0.00	0.00	0.06	0.06	0.02	0.01	0.10	0.17	0.00	0.00	0.01	0.00	0.01	0.03	0.19	0.04	0.00	1.06
2018	0.00	0.00	0.00	0.00	0.00	0.04	0.06	0.02	0.00	0.07	0.09	0.00	0.00	0.01	0.00	0.01	0.02	0.14	0.03	0.00	0.84
2019	0.00	0.00	0.00	0.00	0.00	0.06	0.05	0.02	0.00	0.06	0.11	0.00	0.00	0.01	0.01	0.01	0.05	0.12	0.03	0.00	0.98
2020	0.00	0.00	0.00	0.00	0.00	0.05	0.06	0.03	0.00	0.06	0.12	0.00	0.00	0.01	0.01	0.01	0.05	0.15	0.04	0.00	1.00

Appendix F4– Abundance indices (AIs) for the West Coast Vancouver Island troll fishery by stock and year, from CLB 2003. Numbers shown represent the portion of the AI total estimated for each model stock; the summation across all 41 stock groups equals the AI total for each calendar year.

Year	SSA	NSA	ALS	TST	NBC	CBC	FS2	FS3	FSO	FSS	FHF	FCF	WVH	WVN	UGS	PPS	LGS	MGS	NKF	PSF	PSN	AI Total
2009	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.03	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.02	0.11	0.01	0.65
2010	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.01	0.04	0.06	0.04	0.01	0.00	0.00	0.00	0.00	0.02	0.11	0.01	0.89
2011	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.05	0.04	0.05	0.01	0.00	0.00	0.00	0.00	0.02	0.12	0.01	0.83
2012	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.02	0.03	0.00	0.00	0.00	0.00	0.00	0.02	0.13	0.01	0.82
2013	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.04	0.04	0.01	0.00	0.00	0.00	0.00	0.02	0.12	0.01	1.14
2014	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.03	0.05	0.04	0.01	0.00	0.00	0.01	0.00	0.02	0.09	0.01	1.20
2015	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.01	0.05	0.04	0.05	0.01	0.00	0.00	0.01	0.00	0.01	0.09	0.01	1.17
2016	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.03	0.05	0.01	0.00	0.00	0.01	0.00	0.01	0.14	0.01	0.78
2017	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.02	0.04	0.01	0.00	0.00	0.01	0.00	0.01	0.19	0.01	0.66
2018	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.02	0.03	0.05	0.01	0.00	0.00	0.01	0.00	0.01	0.18	0.01	0.61
2019	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.02	0.05	0.06	0.01	0.00	0.00	0.01	0.00	0.01	0.16	0.01	0.64
2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.02	0.03	0.05	0.01	0.00	0.00	0.01	0.00	0.01	0.17	0.01	0.69

Year	PSY	NKS	SKG	STL	SNO	WCH	WCN	WSH	CWS	SUM	URB	SPR	BON	CWF	LRW	LYF	MCB	NOC	MOC	YAK	AI Total
2009	0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.00	0.05	0.11	0.05	0.01	0.06	0.00	0.01	0.03	0.02	0.02	0.00	0.65
2010	0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.00	0.06	0.12	0.13	0.03	0.07	0.01	0.01	0.03	0.03	0.03	0.00	0.89
2011	0.01	0.00	0.01	0.00	0.00	0.01	0.01	0.01	0.01	0.06	0.11	0.08	0.03	0.07	0.01	0.02	0.03	0.03	0.02	0.00	0.83
2012	0.01	0.00	0.01	0.00	0.00	0.01	0.01	0.00	0.01	0.06	0.14	0.08	0.04	0.06	0.01	0.02	0.05	0.03	0.02	0.00	0.82
2013	0.00	0.00	0.01	0.00	0.00	0.01	0.01	0.00	0.00	0.07	0.33	0.11	0.02	0.08	0.01	0.02	0.11	0.04	0.03	0.00	1.14
2014	0.00	0.00	0.01	0.00	0.00	0.01	0.01	0.01	0.01	0.08	0.33	0.15	0.03	0.10	0.01	0.02	0.09	0.03	0.03	0.00	1.20
2015	0.00	0.00	0.01	0.00	0.00	0.01	0.01	0.01	0.01	0.10	0.26	0.18	0.03	0.11	0.01	0.02	0.06	0.04	0.04	0.00	1.17
2016	0.00	0.00	0.01	0.00	0.00	0.01	0.01	0.00	0.01	0.07	0.16	0.04	0.01	0.07	0.00	0.01	0.03	0.03	0.01	0.00	0.78
2017	0.00	0.00	0.01	0.00	0.00	0.01	0.01	0.00	0.01	0.05	0.08	0.05	0.02	0.04	0.00	0.01	0.02	0.02	0.01	0.00	0.66
2018	0.00	0.00	0.01	0.00	0.00	0.01	0.01	0.00	0.00	0.04	0.06	0.03	0.02	0.03	0.00	0.01	0.02	0.02	0.01	0.00	0.61
2019	0.00	0.00	0.01	0.00	0.00	0.01	0.01	0.00	0.00	0.03	0.07	0.03	0.01	0.03	0.01	0.01	0.03	0.02	0.01	0.00	0.64
2020	0.00	0.00	0.01	0.00	0.00	0.01	0.01	0.00	0.00	0.03	0.08	0.07	0.03	0.04	0.01	0.01	0.03	0.02	0.01	0.00	0.69

Appendix G: Pre-season forecasts and post-season estimates for PSC model stocks, 1999–Present

LIST OF APPENDIX G TABLES

> Note: there was no CTC consensus on the 2015 and 2016 model calibrations (CLB 1503 and 1601). Outputs from CLB 1503 were used by the Commission to configure AABM fisheries in 2015. Abundances indices for AABM fisheries generated from CLB 1601 were accepted by the Commission. For each stock group in Appendix G, pre-season PSC Model forecasts for 2015 are from CLB 1503 and forecasts for 2016 are from CLB 1601.

Data in Appendix G are used to evaluate PSC Chinook Model and Agency Forecasts. The following terminology is used:

- Model Forecast. The Model forecast for a stock is from that year's calibration (e.g., 2020 is from CLB 2002). These data do not change from year-to-year and can be found in a given year's model calibration out files. [source: stage 2 checkCLB.out file]
- Agency Forecast. The Agency forecast (FCS) for a stock is what was provided to the CTC for use with that year's Model calibration. These data do not change from year-to-year and can be found in a given year's model calibration input file. [source: OCNyear.FCS files]
- Post-season Return. The post-season return is the most up to date estimate of either the terminal return or the escapement, depending on how the stock is reported in the FCS file. [source: checkCLB.out or FCS file]

In the Appendix G tables, the column labeled *Model Fcst/Agency Fcst* shows the ratio of the model prediction and the agency forecast as a percentage. The column labeled *Agency Fcst/Post-season* shows the ratio of the agency forecast and the actual return as a percentage. The column labeled *Model Fcst/Post-season* shows the ratio of the model prediction and the actual return as a percentage. A value of 100% would indicate that the predicted and actual values were the same.

With the transition to the Phase II PSC Chinook Model base period, the stock structure and number of stocks represented in the model have changed. The old model stock structure is represented in Appendix G1, which contains pre-season forecasts used in model calibrations from 1999–2020, in addition to the actual post-season returns through 2019. The new model stock structure is represented in Appendix G2. As 2020 was the first year this model was employed, only 2020 forecasts are provided here.

Appendix G1— Forecasts and post-season returns for old model stocks, 1999–2020.

Stock	Year	Model Forecast	Agency Forecast	Post-season	Model Fcst/ Agency Fcst	Agency Fcst/ Post-season	Model Fcst/ Post-season
AKS[1] (Alaska SSE)	1999	11,866	NA	12,219	NA	NA	97%
	2000	18,967	NA	16,164	NA	NA	117%
	2001	22,130	NA	21,590	NA	NA	103%
	2002	15,650	NA	18,679	NA	NA	84%
	2003	22,316	NA	14,576	NA	NA	153%
	2004	11,880	NA	17,107	NA	NA	69%
	2005	25,204	NA	15,235	NA	NA	165%
	2006	17,966	NA	20,730	NA	NA	87%
	2007	25,653	NA	15,012	NA	NA	171%
	2008	14,626	NA	13,780	NA	NA	106%
	2009	14,362	NA	10,463	NA	NA	137%
	2010	16,445	NA	15,674	NA	NA	105%
	2011	17,065	NA	11,808	NA	NA	145%
	2012	12,557	NA	6,731	NA	NA	187%
	2013	4,838	NA	8,175	NA	NA	59%
	2014	4,239	NA	10,587	NA	NA	40%
	2015	6,812	NA	9,961	NA	NA	68%
	2016	7,099	NA	5,997	NA	NA	118%
	2017	4,896	NA	4,600	NA	NA	106%
	2018	4,971	NA	8,875	NA	NA	56%
	2019	8,185	NA	8,567	NA	NA	96%
	2020	5,470	NA	NA	NA	NA	NA
	AVG				NA	NA	108%
NTH[2] (North/ Central BC)	1999	149,387	NA	154,294	NA	NA	97%
	2000	159,818	NA	188,482	NA	NA	85%
	2001	189,088	NA	212,075	NA	NA	89%
	2002	228,073	NA	147,769	NA	NA	154%
	2003	154,103	NA	165,223	NA	NA	93%
	2004	171,070	NA	153,494	NA	NA	111%
	2005	154,552	NA	132,480	NA	NA	117%
	2006	132,710	NA	151,915	NA	NA	87%
	2007	156,017	NA	123,388	NA	NA	126%
	2008	131,262	NA	112,038	NA	NA	117%
	2009	119,761	NA	126,901	NA	NA	94%
	2010	136,998	NA	114,904	NA	NA	119%
	2011	119,323	NA	95,091	NA	NA	125%
	2012	98,010	NA	81,097	NA	NA	121%
	2013	86,819	NA	96,349	NA	NA	90%
	2014	94,878	NA	97,188	NA	NA	98%
	2015	95,587	NA	154,141	NA	NA	62%
	2016	146,607	NA	102,126	NA	NA	144%
	2017	108,254	104,935	55,918	103%	188%	194%
	2018	90,891	101,362	98,984	90%	102%	92%
	2019	86,376	84,033	90,440	103%	93%	96%
	2020	87,807	83,165	NA	106%	NA	NA
	AVG				100%	128%	110%

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Stock	Year	Model Forecast	Agency Forecast	Post-season	Model Fcst/ Agency Fcst	Agency Fcst/ Post-season	Model Fcst/ Post-season
RBH+RBT[2] (WCVI Hatchery + Natural)	1999	77,836	68,400	104,859	114%	65%	74%
	2000	21,040	15,040	38,484	140%	39%	55%
	2001	33,702	30,633	88,285	110%	35%	38%
	2002	128,068	109,882	166,001	117%	66%	77%
	2003	111,430	105,801	216,544	105%	49%	51%
	2004	166,548	144,180	264,754	116%	54%	63%
	2005	244,768	218,840	157,480	112%	139%	155%
	2006	152,483	138,878	197,651	110%	70%	77%
	2007	151,925	117,321	120,804	129%	97%	126%
	2008	67,347	60,255	98,453	112%	61%	68%
	2009	76,063	58,382	91,644	130%	64%	83%
	2010	75,748	61,586	94,673	123%	65%	80%
	2011	98,929	74,708	158,123	132%	47%	63%
	2012	70,838	54,765	80,896	129%	68%	88%
	2013	32,180	NA[4]	175,440	NA	NA	18%
	2014	205,989	216,727	115,149	95%	188%	179%
	2015	91,710	105,003	189,058	87%	56%	49%
	2016	235,776	224,119	168,656	105%	133%	140%
	2017	172,885	163,568	177,199	106%	92%	98%
	2018	154,182	158,357	170,644	97%	93%	90%
	2019	208,973	195,095	188,731	107%	103%	111%
	2020	175,725	174,758	NA	101%	NA	NA
	AVG				113%	79%	85%
GSQ[1] (Upper Strait of Georgia)	1999	16,450	NA	26,783	NA	NA	61%
	2000	19,452	NA	35,101	NA	NA	55%
	2001	25,828	NA	42,436	NA	NA	61%
	2002	41,492	NA	41,022	NA	NA	101%
	2003	36,882	NA	40,500	NA	NA	91%
	2004	39,766	NA	31,803	NA	NA	125%
	2005	38,798	NA	28,490	NA	NA	136%
	2006	39,171	NA	50,989	NA	NA	77%
	2007	41,711	NA	24,877	NA	NA	168%
	2008	30,065	NA	19,392	NA	NA	155%
	2009	26,173	NA	31,323	NA	NA	84%
	2010	26,624	NA	22,480	NA	NA	118%
	2011	23,998	NA	18,751	NA	NA	128%
	2012	25,756	NA	42,830	NA	NA	60%
	2013	31,498	NA	40,341	NA	NA	78%
	2014	30,162	NA	41,418	NA	NA	73%
	2015	26,699	NA	37,253	NA	NA	72%
	2016	26,084	NA	38,648	NA	NA	67%
	2017	40,981	39,106	52,535	105%	74%	78%
	2018	50,676	49,654	33,608	102%	148%	151%
	2019	35,642	36,991	37,834	96%	98%	94%
	2020	37,758	37,859	NA	100%	NA	NA
	AVG				101%	107%	97%

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Stock	Year	Model Forecast	Agency Forecast	Post-season	Model Fcst/ Agency Fcst	Agency Fcst/ Post-season	Model Fcst/ Post-season
GSH[2] (Lower Strait of Georgia Hatchery)	1999	22,896	NA	23,015	NA	NA	99%
	2000	19,165	NA	21,322	NA	NA	90%
	2001	17,547	NA	29,633	NA	NA	59%
	2002	25,051	NA	22,064	NA	NA	114%
	2003	21,222	NA	21,496	NA	NA	99%
	2004	16,573	NA	20,852	NA	NA	79%
	2005	21,046	NA	25,941	NA	NA	81%
	2006	18,169	NA	22,109	NA	NA	82%
	2007	24,378	NA	12,733	NA	NA	191%
	2008	11,765	NA	12,011	NA	NA	98%
	2009	17,551	NA	13,380	NA	NA	131%
	2010	7,999	NA	11,605	NA	NA	69%
	2011	14,671	NA	11,480	NA	NA	128%
	2012	10,104	NA	8,462	NA	NA	119%
	2013	5,568	NA	8,242	NA	NA	68%
	2014	6,116	NA	15,665	NA	NA	39%
	2015	18,566	NA	9,888	NA	NA	188%
	2016	5,475	NA	10,236	NA	NA	53%
	2017	10,414	11,820	14,524	88%	81%	72%
	2018	13,423	11,353	11,731	118%	97%	114%
	2019	8,708	10,207	15,398	85%	66%	57%
	2020	14,104	15,081	NA	94%	NA	NA
	AVG				96%	81%	97%
GST[1] (Lower Strait of Georgia	1999	14,236	NA	8,715	NA	NA	163%
	2000	11,094	NA	8,223	NA	NA	135%
	2001	7,955	NA	8,569	NA	NA	93%
	2002	8,833	NA	7,812	NA	NA	113%
	2003	8,088	NA	5,903	NA	NA	137%
	2004	5,157	NA	3,642	NA	NA	142%
	2005	4,459	NA	4,870	NA	NA	92%
	2006	4,070	NA	4,880	NA	NA	83%
	2007	7,782	NA	4,778	NA	NA	163%
	2008	6,823	NA	5,646	NA	NA	121%
	2009	5,701	NA	3,106	NA	NA	184%
	2010	2,972	NA	5,763	NA	NA	52%
	2011	10,778	NA	7,595	NA	NA	142%
	2012	11,433	NA	6,291	NA	NA	182%
	2013	8,267	NA	5,440	NA	NA	152%
	2014	11,910	NA	6,579	NA	NA	181%
	2015	13,177	NA	9,840	NA	NA	134%
	2016	7,469	NA	10,639	NA	NA	70%
	2017	11,163	10,639	14,270	105%	75%	78%
	2018	16,186	12,162	19,417	133%	63%	83%
	2019	25,521	22,630	21,433	113%	106%	119%
	2020	16,696	14,821	NA	113%	NA	NA
	AVG				116%	81%	125%

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Stock	Year	Model Forecast	Agency Forecast	Post-season	Model Fcst/ Agency Fcst	Agency Fcst/ Post-season	Model Fcst/ Post-season
FRE[2] (Fraser Early)	1999	162,865	NA	105,473	NA	NA	154%
	2000	118,058	NA	116,233	NA	NA	102%
	2001	122,333	NA	154,175	NA	NA	79%
	2002	170,232	NA	189,335	NA	NA	90%
	2003	202,363	NA	191,700	NA	NA	106%
	2004	185,450	NA	147,813	NA	NA	125%
	2005	151,591	NA	135,177	NA	NA	112%
	2006	141,517	NA	203,460	NA	NA	70%
	2007	196,060	NA	110,555	NA	NA	177%
	2008	128,347	NA	149,048	NA	NA	86%
	2009	153,593	NA	136,201	NA	NA	113%
	2010	144,214	NA	203,948	NA	NA	71%
	2011	174,183	NA	161,748	NA	NA	108%
	2012	175,729	NA	77,285	NA	NA	227%
	2013	83,719	NA	165,166	NA	NA	51%
	2014	176,008	NA	159,656	NA	NA	110%
	2015	173,286	NA	236,551	NA	NA	73%
	2016	258,884	NA	126,975	NA	NA	204%
	2017	180,300	184,349	105,275	98%	175%	171%
	2018	147,972	156,877	84,373	94%	186%	175%
	2019	127,373	138,333	218,957	92%	63%	58%
	2020	194,044	179,120	NA	108%	NA	NA
	AVG				98%	141%	117%
FRL[1] (Fraser Late)	1999	84,686	82,650	188,873	102%	44%	45%
	2000	187,970	220,400	133,998	85%	164%	140%
	2001	141,745	131,800	192,693	108%	68%	74%
	2002	132,946	160,100	172,451	83%	93%	77%
	2003	127,144	114,780	308,769	111%	37%	41%
	2004	104,597	97,227	206,892	108%	47%	51%
	2005	121,315	108,061	130,229	112%	83%	93%
	2006	115,489	116,682	116,985	99%	100%	99%
	2007	122,402	107,311	110,736	114%	97%	111%
	2008	125,100	116,038	88,667	108%	131%	141%
	2009	119,892	91,391	97,541	131%	94%	123%
	2010	119,953	118,891	196,175	101%	61%	61%
	2011	353,646	284,604	182,269	124%	156%	194%
	2012	107,738	93,652	70,029	115%	134%	154%
	2013	70,178	73,584	104,476	95%	70%	67%
	2014	131,118	118,361	113,568	111%	104%	115%
	2015	88,165	72,037	141,296	122%	51%	62%
	2016	57,236	51,903	95,170	110%	55%	60%
	2017	112,272	107,065	61,074	105%	175%	184%
	2018	93,126	96,147	81,399	97%	118%	114%
	2019	114,809	126,343	129,346	91%	98%	89%
	2020	96,806	90,822	NA	107%	NA	NA
	AVG				106%	94%	100%

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Stock	Year	Model Forecast	Agency Forecast	Post-season	Model Fcst/ Agency Fcst	Agency Fcst/ Post-season	Model Fcst/ Post-season
NKS[1] (Nooksack Spring)	1999	1,048	NA	1,111	NA	NA	94%
	2000	834	NA	1,615	NA	NA	52%
	2001	982	NA	2,629	NA	NA	37%
	2002	1,216	NA	4,366	NA	NA	28%
	2003	1,301	NA	3,448	NA	NA	38%
	2004	1,708	NA	1,891	NA	NA	90%
	2005	1,549	NA	2,279	NA	NA	68%
	2006	583	677	1,716	86%	39%	34%
	2007	582	575	1,786	101%	32%	33%
	2008	371	378	1,714	98%	22%	22%
	2009	336	315	2,360	107%	13%	14%
	2010	374	390	2,596	96%	15%	14%
	2011	340	309	1,101	110%	28%	31%
	2012	271	243	1,027	112%	24%	26%
	2013	1,331	NA	1,565	NA	NA	85%
	2014	1,361	1,273	1,308	107%	97%	104%
	2015	1,192	1,119	1,761	107%	64%	68%
	2016	1,308	1,324	1,141	99%	116%	115%
	2017	1,297	1,291	2,016	100%	64%	64%
	2018	1,342	1,389	1,389	97%	100%	97%
	2019	1,419	1,508	1,508	94%	100%	94%
	2020	1,409	1,479	NA	95%	NA	NA
	AVG				101%	55%	58%
NKF[2] (Nooksack/ Samish Fall Fingerling)	1999	27,206	27,000	43,709	101%	62%	62%
	2000	21,277	19,000	35,630	112%	53%	60%
	2001	33,974	36,450	71,437	93%	51%	48%
	2002	50,361	54,420	62,519	93%	87%	81%
	2003	48,259	45,750	33,339	105%	137%	145%
	2004	37,980	34,200	18,118	111%	189%	210%
	2005	19,808	19,523	20,703	101%	94%	96%
	2006	16,795	16,899	38,455	99%	44%	44%
	2007	22,086	18,834	39,390	117%	48%	56%
	2008	34,392	35,271	33,750	98%	105%	102%
	2009	26,072	23,014	25,884	113%	89%	101%
	2010	32,061	32,627	41,239	98%	79%	78%
	2011	39,144	37,902	40,678	103%	93%	96%
	2012	45,719	43,973	41,557	104%	106%	110%
	2013	50,065	48,257	37,525	104%	129%	133%
	2014	46,771	44,046	32,053	106%	137%	146%
	2015	40,315	39,739	23,696	101%	168%	170%
	2016	29,171	28,611	21,226	102%	135%	137%
	2017	21,922	21,997	24,590	100%	89%	89%
	2018	26,637	25,231	23,402	106%	108%	114%
	2019	23,105	21,339	9,143	108%	233%	253%
	2020	15,680	16,858	NA	93%	NA	NA
	AVG				103%	106%	111%

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Stock	Year	Model Forecast	Agency Forecast	Post-season	Model Fcst/ Agency Fcst	Agency Fcst/ Post-season	Model Fcst/ Post-season
SKG[2] (Skagit Summer/ Fall Wild)	1999	8,967	7,600	5,139	118%	148%	174%
	2000	6,988	7,300	16,266	96%	45%	43%
	2001	9,064	9,183	14,193	99%	65%	64%
	2002	12,635	13,455	18,114	94%	74%	70%
	2003	11,906	11,348	10,583	105%	107%	113%
	2004	18,761	20,359	22,144	92%	92%	85%
	2005	16,220	19,493	22,784	83%	86%	71%
	2006	22,402	21,811	21,246	103%	103%	105%
	2007	12,324	14,252	12,646	86%	113%	97%
	2008	18,598	18,302	14,254	102%	128%	130%
	2009	22,193	20,400	10,977	109%	186%	202%
	2010	9,894	11,853	7,926	83%	150%	125%
	2011	12,556	13,044	8,382	96%	156%	150%
	2012	10,020	8,337	15,422	120%	54%	65%
	2013	7,287	13,018	13,312	56%	98%	55%
	2014	15,221	17,874	12,777	85%	140%	119%
	2015	9,820	11,387	13,315	86%	86%	74%
	2016	14,336	14,361	17,426	100%	82%	82%
	2017	15,947	14,429	14,800	111%	97%	108%
	2018	11,765	12,565	12,178	94%	103%	97%
	2019	13,639	13,630	12,208	100%	112%	112%
	2020	12,329	12,877	NA	96%	NA	NA
	AVG				96%	106%	102%
STL[1] (Stillaguamish Summer/Fall Wild)	1999	1,303	NA	1,436	NA	NA	91%
	2000	1,370	1,500	2,074	91%	72%	66%
	2001	1,328	1,360	1,729	98%	79%	77%
	2002	1,372	1,449	2,007	95%	72%	68%
	2003	1,860	2,050	1,307	91%	157%	142%
	2004	1,795	NA	1,912	NA	NA	94%
	2005	1,377	NA	1,363	NA	NA	101%
	2006	1,113	1,169	1,612	95%	73%	69%
	2007	1,424	1,510	870	94%	174%	164%
	2008	689	637	1,914	108%	33%	36%
	2009	1,268	1,086	1,061	117%	102%	120%
	2010	898	817	1,358	110%	60%	66%
	2011	812	783	1,345	104%	58%	60%
	2012	569	395	1,750	144%	23%	33%
	2013	1,393	1,328	1,469	105%	90%	95%
	2014	1,000	850	721	118%	118%	139%
	2015	514	525	709	98%	74%	72%
	2016	346	299	1,053	116%	28%	33%
	2017	360	266	1,070	135%	25%	34%
	2018	1,421	1,474	966	96%	153%	147%
	2019	460	376	503	122%	75%	91%
	2020	692	762	NA	91%	NA	NA
	AVG				107%	81%	86%

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Stock	Year	Model Forecast	Agency Forecast	Post-season	Model Fcst/ Agency Fcst	Agency Fcst/ Post-season	Model Fcst/ Post-season
SNO[2] (Snohomish Wild)	1999	5,804	5,600	2,524	104%	222%	230%
	2000	5,997	6,000	3,269	100%	184%	183%
	2001	5,876	5,760	6,742	102%	85%	87%
	2002	6,524	6,700	7,422	97%	90%	88%
	2003	6,033	5,450	5,786	111%	94%	104%
	2004	12,845	15,700	10,994	82%	143%	117%
	2005	10,161	NA	4,963	NA	NA	205%
	2006	7,824	8,729	7,180	90%	122%	109%
	2007	11,153	12,289	2,832	91%	434%	394%
	2008	6,103	6,541	6,986	93%	94%	87%
	2009	8,503	8,410	1,830	101%	460%	465%
	2010	8,050	9,858	3,488	82%	283%	231%
	2011	8,281	7,600	1,414	109%	537%	586%
	2012	2,506	2,775	3,361	90%	83%	75%
	2013	3,835	3,161	2,684	121%	118%	143%
	2014	3,416	3,327	2,375	103%	140%	144%
	2015	3,809	4,159	2,329	92%	179%	164%
	2016	3,586	3,339	3,455	107%	97%	104%
	2017	3,775	3,412	4,369	111%	78%	86%
	2018	3,825	3,460	3,275	111%	106%	117%
	2019	3,013	2,780	1,024	108%	271%	294%
	2020	2,539	2,978	NA	85%	NA	NA
	AVG				99%	191%	191%
PSF+PSY[2,4] (Puget Sound Fingerling + Yearling)	1999	66,260	69,285	146,471	96%	47%	45%
	2000	67,306	69,800	100,425	96%	70%	67%
	2001	102,899	105,955	145,822	97%	73%	71%
	2002	114,889	124,608	147,447	92%	85%	78%
	2003	114,275	133,850	144,177	85%	93%	79%
	2004	127,902	132,300	143,731	97%	92%	89%
	2005	104,084	110,542	155,325	94%	71%	67%
	2006	107,292	113,486	191,623	95%	59%	56%
	2007	127,115	135,714	221,341	94%	61%	57%
	2008	166,071	159,200	160,626	104%	99%	103%
	2009	138,299	133,187	136,695	104%	97%	101%
	2010	138,238	140,074	144,296	99%	97%	96%
	2011	172,415	168,642	155,941	102%	108%	111%
	2012	153,462	153,989	192,714	100%	80%	80%
	2013	189,645	184,783	182,276	103%	101%	104%
	2014	191,307	188,039	80,047	102%	235%	239%
	2015	128,255	131,300	96,003	98%	137%	134%
	2016	109,207	96,430	166,953	113%	58%	65%
	2017	142,320	144,238	286,815	99%	50%	50%
	2018	214,806	202,186	212,245	106%	95%	101%
	2019	208,195	187,516	206,068	111%	91%	101%
	2020	200,537	190,176	NA	105%	NA	NA
	AVG				100%	90%	90%

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Stock	Year	Model Forecast	Agency Forecast	Post-season	Model Fcst/ Agency Fcst	Agency Fcst/ Post-season	Model Fcst/ Post-season
PSN[2,4] (Puget Sound Natural)	1999	28,536	28,400	23,215	100%	122%	123%
	2000	15,364	10,000	17,882	154%	56%	86%
	2001	19,938	18,900	26,107	105%	72%	76%
	2002	20,008	19,801	25,009	101%	79%	80%
	2003	25,743	26,600	9,233	97%	288%	279%
	2004	24,616	23,200	16,023	106%	145%	154%
	2005	22,208	17,715	10,903	125%	162%	204%
	2006	20,182	21,301	13,095	95%	163%	154%
	2007	18,964	17,014	12,094	111%	141%	157%
	2008	23,118	21,100	18,637	110%	113%	124%
	2009	24,698	23,073	10,066	107%	229%	245%
	2010	14,734	15,128	8,139	97%	186%	181%
	2011	18,115	15,997	8,033	113%	199%	226%
	2012	14,396	13,860	10,578	104%	131%	136%
	2013	12,079	8,767	8,407	138%	104%	144%
	2014	9,253	8,125	8,201	114%	99%	113%
	2015	7,797	7,478	10,439	104%	72%	75%
	2016	7,801	7,066	9,590	110%	74%	81%
	2017	8,901	8,040	13,470	111%	60%	66%
	2018	10,149	9,045	14,471	112%	63%	70%
	2019	10,479	10,163	3,688	103%	276%	284%
	2020	6,992	7,132	NA	98%	NA	NA
	AVG				110%	135%	146%
WCH[2] (Washington Coastal Hatchery)	1999	35,221	42,752	13,535	82%	316%	260%
	2000	16,244	NA	22,571	NA	NA	72%
	2001	15,792	NA	23,166	NA	NA	68%
	2002	23,678	NA	34,243	NA	NA	69%
	2003	20,755	18,222	41,766	114%	44%	50%
	2004	28,900	NA	39,651	NA	NA	73%
	2005	28,626	NA	40,458	NA	NA	71%
	2006	36,950	NA	51,155	NA	NA	72%
	2007	41,801	40,497	22,669	103%	179%	184%
	2008	34,841	31,251	26,397	111%	118%	132%
	2009	41,756	42,595	38,162	98%	112%	109%
	2010	38,347	NA	41,498	NA	NA	92%
	2011	38,208	NA	63,942	NA	NA	60%
	2012	45,128	44,300	40,311	102%	110%	112%
	2013	33,629	25,304	44,091	133%	57%	76%
	2014	40,866	42,907	51,226	95%	84%	80%
	2015	42,604	38,120	54,902	112%	69%	78%
	2016	57,443	52,174	31,983	110%	163%	180%
	2017	47,587	47,079	43,191	101%	109%	110%
	2018	49,042	47,194	43,359	104%	109%	113%
	2019	35,258	25,521	25,521	138%	100%	138%
	2020	34,402	32,802	NA	105%	NA	NA
	AVG				108%	121%	105%

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Stock	Year	Model Forecast	Agency Forecast	Post-season	Model Fcst/ Agency Fcst	Agency Fcst/ Post-season	Model Fcst/ Post-season
WCN[2] (Washington Coastal Natural)	1999	42,107	43,780	25,065	96%	175%	168%
	2000	34,741	NA	26,507	NA	NA	131%
	2001	34,563	35,306	34,747	98%	102%	99%
	2002	33,902	33,489	36,183	101%	93%	94%
	2003	32,785	NA	39,947	NA	NA	82%
	2004	28,185	NA	57,917	NA	NA	49%
	2005	34,857	NA	41,461	NA	NA	84%
	2006	43,866	NA	38,246	NA	NA	115%
	2007	35,695	32,362	26,270	110%	123%	136%
	2008	32,187	26,923	31,219	120%	86%	103%
	2009	35,485	31,318	27,215	113%	115%	130%
	2010	39,215	NA	40,293	NA	NA	97%
	2011	32,205	NA	49,824	NA	NA	65%
	2012	45,153	41,500	40,637	109%	102%	111%
	2013	35,464	34,023	34,086	104%	100%	104%
	2014	44,952	46,275	32,459	97%	143%	138%
	2015	48,297	50,360	52,225	96%	96%	92%
	2016	48,034	41,095	27,085	117%	152%	177%
	2017	39,456	36,705	36,854	107%	100%	107%
	2018	37,884	33,973	38,721	112%	88%	98%
	2019	37,364	30,768	30,768	121%	100%	121%
	2020	34,552	30,130	NA	115%	NA	NA
	AVG				108%	112%	110%
CWS[2] (Cowlitz Spring)	1999	3,363	3,950	4,799	85%	82%	70%
	2000	4,922	6,050	6,132	81%	99%	80%
	2001	3,684	4,849	7,182	76%	68%	51%
	2002	5,534	6,800	11,644	81%	58%	48%
	2003	9,550	11,700	25,584	82%	46%	37%
	2004	20,802	27,350	28,696	76%	95%	72%
	2005	18,349	24,850	16,227	74%	153%	113%
	2006	12,838	15,250	19,685	84%	77%	65%
	2007	9,945	10,600	19,519	94%	54%	51%
	2008	9,544	12,400	6,838	77%	181%	140%
	2009	6,413	14,400	7,867	45%	183%	82%
	2010	18,927	19,409	12,211	98%	159%	155%
	2011	9,654	10,602	7,946	91%	133%	121%
	2012	9,287	8,724	15,429	106%	57%	60%
	2013	9,348	7,727	11,244	121%	69%	83%
	2014	9,569	9,400	11,452	102%	82%	84%
	2015	15,530	14,100	27,941	110%	50%	56%
	2016	35,176	30,977	26,786	114%	116%	131%
	2017	24,763	21,300	18,917	116%	113%	131%
	2018	11,384	10,400	9,419	109%	110%	121%
	2019	4,605	4,152	3,607	111%	115%	128%
	2020	3,744	3,843	NA	97%	NA	NA
	AVG				92%	100%	89%

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Stock	Year	Model Forecast	Agency Forecast	Post-season	Model Fcst/ Agency Fcst	Agency Fcst/ Post-season	Model Fcst/ Post-season
WSH[2] (Willamette Spring)	1999	46,181	49,875	54,202	93%	92%	85%
	2000	57,202	61,211	57,455	93%	107%	100%
	2001	59,207	59,600	80,366	99%	74%	74%
	2002	73,151	77,434	121,708	94%	64%	60%
	2003	108,530	112,521	126,583	96%	89%	86%
	2004	113,708	112,701	144,446	101%	78%	79%
	2005	105,111	122,280	60,976	86%	201%	172%
	2006	48,880	52,388	59,662	93%	88%	82%
	2007	44,542	61,071	40,468	73%	151%	110%
	2008	20,185	40,851	27,357	49%	149%	74%
	2009	44,161	41,205	39,410	107%	105%	112%
	2010	70,960	66,360	110,536	107%	60%	64%
	2011	117,375	109,600	80,254	107%	137%	146%
	2012	105,098	88,202	65,115	119%	135%	161%
	2013	58,436	65,982	47,311	89%	139%	124%
	2014	58,496	64,189	51,794	91%	124%	113%
	2015	54,162	55,440	87,071	98%	64%	62%
	2016	73,333	70,100	49,768	105%	141%	147%
	2017	38,756	40,190	53,653	96%	75%	72%
	2018	48,533	56,000	39,660	87%	141%	122%
	2019	43,866	42,490	29,314	103%	145%	150%
	2020	41,287	43,430	NA	95%	NA	NA
	AVG				95%	112%	105%
SUM[2] (Columbia River Summer)	1999	21,653	20,900	21,867	104%	96%	99%
	2000	27,214	28,038	22,595	97%	124%	120%
	2001	27,029	24,500	52,960	110%	46%	51%
	2002	70,290	77,700	89,524	90%	87%	79%
	2003	97,280	87,600	83,058	111%	105%	117%
	2004	83,246	78,569	65,623	106%	120%	127%
	2005	66,190	62,400	60,272	106%	104%	110%
	2006	75,848	78,512	77,573	97%	101%	98%
	2007	56,948	45,555	37,035	125%	123%	154%
	2008	50,171	52,000	55,532	96%	94%	90%
	2009	68,114	70,700	53,881	96%	131%	126%
	2010	81,403	88,800	72,364	92%	123%	112%
	2011	89,000	91,900	80,574	97%	114%	110%
	2012	91,202	91,200	58,300	100%	156%	156%
	2013	72,042	73,500	67,603	98%	109%	107%
	2014	69,644	67,500	78,304	103%	86%	89%
	2015	76,664	73,000	126,882	105%	58%	60%
	2016	105,748	93,300	91,048	113%	102%	116%
	2017	75,738	63,100	68,200	120%	93%	111%
	2018	70,635	67,300	42,120	105%	160%	168%
	2019	39,774	35,900	34,619	111%	104%	115%
	2020	38,584	38,300	NA	101%	NA	NA
	AVG				104%	106%	110%

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Stock	Year	Model Forecast	Agency Forecast	Post-season	Model Fcst/ Agency Fcst	Agency Fcst/ Post-season	Model Fcst/ Post-season
BON+CWF[2] (Bonneville + Cowlitz Hatcheries)	1999	26,112	34,800	39,829	75%	87%	66%
	2000	17,095	23,700	26,945	72%	88%	63%
	2001	28,732	32,200	94,149	89%	34%	31%
	2002	100,401	137,600	156,378	73%	88%	64%
	2003	100,196	115,900	155,413	86%	75%	64%
	2004	64,696	77,100	107,614	84%	72%	60%
	2005	65,971	74,100	68,288	89%	109%	97%
	2006	49,173	55,800	59,361	88%	94%	83%
	2007	49,219	54,900	32,789	90%	167%	150%
	2008	58,557	59,000	58,970	99%	100%	99%
	2009	91,519	88,800	76,839	103%	116%	119%
	2010	95,581	90,600	102,774	105%	88%	93%
	2011	139,873	133,430	108,793	105%	123%	129%
	2012	132,629	126,999	84,618	104%	150%	157%
	2013	86,456	94,600	101,649	91%	93%	85%
	2014	98,459	110,000	101,748	90%	108%	97%
	2015	84,204	94,900	128,534	89%	74%	66%
	2016	131,890	133,700	82,228	99%	163%	160%
	2017	85,726	92,400	64,629	93%	143%	133%
	2018	58,162	62,450	52,961	93%	118%	110%
	2019	53,077	54,460	48,914	97%	111%	109%
	2020	48,879	51,000	NA	96%	NA	NA
	AVG				91%	105%	97%
SPR[2] (Spring Creek Hatchery)	1999	63,203	65,800	50,189	96%	131%	126%
	2000	17,335	21,900	20,528	79%	107%	84%
	2001	56,089	56,600	124,951	99%	45%	45%
	2002	153,070	144,400	158,300	106%	91%	97%
	2003	89,116	96,900	180,592	92%	54%	49%
	2004	124,820	138,000	175,245	90%	79%	71%
	2005	92,021	114,100	103,467	81%	110%	89%
	2006	43,421	50,000	27,918	87%	179%	156%
	2007	19,421	21,800	14,549	89%	150%	133%
	2008	87,109	87,200	93,848	100%	93%	93%
	2009	46,652	59,300	48,966	79%	121%	95%
	2010	167,251	169,000	128,554	99%	131%	130%
	2011	105,900	116,400	70,531	91%	165%	150%
	2012	72,135	63,800	56,947	113%	112%	127%
	2013	36,276	38,000	86,703	95%	44%	42%
	2014	108,724	115,100	126,991	94%	91%	86%
	2015	145,389	160,500	166,450	91%	96%	87%
	2016	84,230	89,600	41,423	94%	216%	203%
	2017	158,396	158,400	48,125	100%	329%	329%
	2018	49,921	50,100	28,862	100%	174%	173%
	2019	46,728	46,000	28,953	102%	159%	161%
	2020	47,965	47,500	NA	101%	NA	NA
	AVG				94%	127%	120%

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Stock	Year	Model Forecast	Agency Forecast	Post-season	Model Fcst/ Agency Fcst	Agency Fcst/ Post-season	Model Fcst/ Post-season
URB[2] (Columbia Upriver Bright)	1999	173,712	147,500	165,889	118%	89%	105%
	2000	212,317	171,100	156,595	124%	109%	136%
	2001	150,973	127,200	232,367	119%	55%	65%
	2002	249,721	281,000	279,547	89%	101%	89%
	2003	246,890	280,400	374,153	88%	75%	66%
	2004	246,943	292,200	362,804	85%	81%	68%
	2005	318,535	352,200	277,240	90%	127%	115%
	2006	231,319	253,900	230,390	91%	110%	100%
	2007	168,594	182,400	114,001	92%	160%	148%
	2008	151,839	162,500	197,296	93%	82%	77%
	2009	259,415	259,900	212,103	100%	123%	122%
	2010	296,816	310,800	324,908	96%	96%	91%
	2011	388,138	398,200	322,053	97%	124%	121%
	2012	365,693	353,500	297,827	103%	119%	123%
	2013	437,422	432,500	778,254	101%	56%	56%
	2014	874,989	973,300	684,239	90%	142%	128%
	2015	489,123	500,300	795,700	98%	63%	61%
	2016	568,210	589,000	412,852	96%	143%	138%
	2017	253,016	260,000	297,423	97%	87%	85%
	2018	156,926	200,100	149,044	78%	134%	105%
	2019	140,870	158,400	212,238	89%	75%	66%
	2020	203,602	220,600	NA	92%	NA	NA
	AVG				97%	102%	98%
LYF[1, 5] (Snake River Wild) Time series reworked per TAC guidance November 2016	1999	523	NA	2,419	NA	NA	22%
	2000	1,243	NA	2,612	NA	NA	48%
	2001	733	734	14,133	100%	5%	5%
	2002	2,066	NA	3,659	NA	NA	56%
	2003	2,493	2,185	8,085	114%	27%	31%
	2004	4,323	3,725	8,157	116%	46%	53%
	2005	4,453	4,000	9,394	111%	43%	47%
	2006	8,285	3,500	13,097	237%	27%	63%
	2007	3,128	2,700	9,965	116%	27%	31%
	2008	2,718	2,534	8,929	107%	28%	30%
	2009	5,743	6,952	15,641	83%	44%	37%
	2010	2,609	2,610	12,901	100%	20%	20%
	2011	9,199	8,006	17,226	115%	46%	53%
	2012	10,401	8,683	19,277	120%	45%	54%
	2013	15,154	14,900	34,672	102%	43%	44%
	2014	31,106	31,642	20,754	98%	152%	150%
	2015	18,072	NA	24,849	NA	NA	73%
	2016	15,912	12,800	15,147	124%	85%	105%
	2017	11,091	8,100	11,750	137%	69%	94%
	2018	7,603	6,113	10,642	124%	57%	71%
	2019	6,814	5,435	15,231	125%	36%	45%
	2020	13,856	10,902	NA	127%	NA	NA
	AVG				120%	47%	54%

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Stock	Year	Model Forecast	Agency Forecast	Post-season	Model Fcst/ Agency Fcst	Agency Fcst/ Post-season	Model Fcst/ Post-season
MCB[2]	1999	37,951	38,300	50,788	99%	75%	75%
(Mid-Columbia	2000	53,460	50,600	37,191	106%	136%	144%
Bright)	2001	45,055	43,500	76,504	104%	57%	59%
	2002	102,085	96,200	108,198	106%	89%	94%
Time series	2003	126,698	104,800	150,042	121%	70%	84%
reworked per	2004	94,895	90,400	122,497	105%	74%	77%
TAC guidance	2005	93,837	89,400	99,647	105%	90%	94%
November 2016	2006	90,780	88,300	80,471	103%	110%	113%
	2007	77,470	68,000	47,621	114%	143%	163%
	2008	59,481	54,000	76,297	110%	71%	78%
	2009	99,685	94,400	73,012	106%	129%	137%
	2010	82,454	72,600	78,937	114%	92%	104%
	2011	108,005	100,000	87,235	108%	115%	124%
	2012	100,809	90,800	61,392	111%	148%	164%
	2013	113,333	105,200	249,588	108%	42%	45%
	2014	377,357	360,100	203,734	105%	177%	185%
	2015	156,711	113,300	170,585	138%	66%	92%
	2016	115,632	101,000	87,334	114%	116%	132%
	2017	62,130	45,600	51,814	136%	88%	120%
	2018	36,423	40,100	50,244	91%	80%	72%
	2019	68,146	56,700	68,066	120%	83%	100%
	2020	93,580	78,200	NA	120%	NA	NA
	AVG				111%	98%	108%
LRW[2]	1999	3,068	2,600	3,349	118%	78%	92%
(Lewis River	2000	4,053	3,500	10,234	116%	34%	40%
Wild)	2001	16,574	16,700	15,721	99%	106%	105%
	2002	18,910	18,200	25,171	104%	72%	75%
Time series	2003	25,820	24,600	25,404	105%	97%	102%
reworked per	2004	24,590	24,100	21,088	102%	114%	117%
TAC guidance	2005	21,937	20,200	16,345	109%	124%	134%
November 2016	2006	19,818	16,600	12,649	119%	131%	157%
	2007	10,306	10,100	4,854	102%	208%	212%
	2008	4,479	3,800	7,782	118%	49%	58%
	2009	9,363	8,500	8,404	110%	101%	111%
	2010	11,034	9,700	11,491	114%	84%	96%
	2011	13,429	12,500	15,376	107%	81%	87%
	2012	17,806	16,200	12,112	110%	134%	147%
	2013	16,713	14,200	25,841	118%	55%	65%
	2014	42,365	34,200	25,774	124%	133%	164%
	2015	32,374	18,900	32,403	171%	58%	100%
	2016	29,122	22,200	12,315	131%	180%	236%
	2017	19,063	12,500	7,855	153%	159%	243%
	2018	10,044	7,600	8,270	132%	92%	121%
	2019	15,345	13,700	16,661	112%	82%	92%
	2020	25,334	19,700	NA	129%	NA	NA
	AVG				118%	103%	122%

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Stock	Year	Model Forecast	Agency Forecast	Post-season	Model Fcst/ Agency Fcst	Agency Fcst/ Post-season	Model Fcst/ Post-season
ORC[1]	1999	65,249	72,084	82,084	91%	88%	79%
(Oregon	2000	61,457	63,259	67,771	97%	93%	91%
Coastal)	2001	58,062	66,412	130,795	87%	51%	44%
	2002	73,055	73,914	171,904	99%	43%	42%
Observed return	2003	101,310	85,483	183,183	119%	47%	55%
reworked per	2004	135,716	131,904	138,150	103%	95%	98%
ODFW review	2005	133,886	167,213	106,632	80%	157%	126%
November 2016	2006	125,550	136,373	109,112	92%	125%	115%
	2007	108,338	131,195	46,242	83%	284%	234%
	2008	53,417	70,101	39,887	76%	176%	134%
	2009	32,254	48,072	53,550	67%	90%	60%
	2010	51,234	59,806	72,206	86%	83%	71%
	2011	73,043	78,199	99,247	93%	79%	74%
	2012	82,789	80,749	91,655	103%	88%	90%
	2013	70,385	80,095	117,203	88%	68%	60%
	2014	81,984	109,029	133,614	75%	82%	61%
	2015	63,642	94,715	144,548	67%	66%	44%
	2016	110,710	119,374	103,788	93%	115%	107%
	2017	80,529	87,243	79,462	92%	110%	101%
	2018	48,149	68,939	58,615	70%	118%	82%
	2019	54,063	73,721	42,460	73%	174%	127%
	2020	53,458	68,830	NA	78%	NA	NA
	AVG	NA	NA	NA	87%	106%	90%

[1] Escapement

[2] Terminal Run

[3] An agency forecast was provided in 2013 for the WCVI aggregate (27,339) but the decision was made by the CTC to exclude it from the Model calibration. The Model forecast was 32,180 and both forecasts were large under-forecasts.

[4] Puget Sound returns for 2019 are preliminary post-season projections based on partial return information.

[5] Beginning in 2020 the run size units for LYF were converted from escapement to terminal run. Model and agency forecasts for 1999-2019 are still in units of escapement. 2020 forecasts and all post-season returns are in units of terminal run.

Appendix G2— 2020 Forecasts for Phase II PSC Chinook Model stocks.

Stock Acronym	Stock Name	Forecast Unit	Year	Model Forecast	Agency Forecast	Model Fcst/ Agency Fcst
YAK	Yakutat Forelands	Escapement	2020	4,377	NA	NA
ALS	Alsek	Escapement	2020	10,787	NA	NA
SSA	Southern SEAK	Escapement	2020	9,630	NA	NA
NSA	Northern SEAK	Escapement	2020	3,275	NA	NA
TST	Transboundary Rivers	Escapement	2020	41,536	NA	NA
NBC	Northern BC	Escapement	2020	21,894	34,971	63%
CBC	Central BC	Escapement	2020	7,601	11,463	66%
WVH	WCVI Hatchery	Terminal Run	2020	173,029	152,227	114%
WVN	WCVI Natural	Terminal Run	2020	26,012	22,531	115%
UGS	Upper Strait of Georgia	Escapement	2020	5,943	11,779	50%
PPS	Puntledge River Summer	Escapement	2020	647	563	115%
MGS	Middle Strait of Georgia	Escapement	2020	25,627	23,595	109%
LGS	Lower Strait of Georgia	Terminal Run	2020	13,753	14,821	93%
FS2	Fraser Early Spring 1.2	Terminal Run	2020	6,190	6,220	100%
FS3	Fraser Early Spring 1.3	Terminal Run	2020	19,145	23,332	82%
FSO	Fraser Early Summer 0.3	Escapement	2020	119,202	114,566	104%
FSS	Fraser Early Summer 1.3	Terminal Run	2020	10,046	10,737	94%
FHF	Fraser Late Natural (Harrison)	Escapement	2020	53,314	59,745	89%
FCF	Fraser Late Hatchery (Chilliwack)	Escapement	2020	44,589	31,077	143%
NKS	Nooksack Spring	Escapement	2020	1,511	1,479	102%
NKF	Nooksack/Samish Fall	Terminal Run	2020	15,769	16,858	94%
SKG	Skagit Summer/Fall Wild	Terminal Run	2020	13,971	12,877	108%
STL	Stillaguamish Summer/Fall Wild	Escapement	2020	728	762	96%
SNO	Snohomish Summer/Fall Wild	Terminal Run	2020	2,557	2,978	86%
PSF	Puget Sound Fingerling	Terminal Run	2020	206,848	186,117	111%
PSY	Puget Sound Yearling	Terminal Run	2020	4,609	4,059	114%
PSN	Puget Sound Natural	Terminal Run	2020	7,741	7,132	109%
WCH	Washington Coastal Hatchery	Terminal Run	2020	30,608	32,802	93%
WCN	Washington Coastal Natural	Terminal Run	2020	33,592	30,130	111%
CWS	Cowlitz Spring	Terminal Run	2020	3,739	3,843	97%
WSH	Willamette Spring	Terminal Run	2020	42,265	43,430	97%
SUM	Columbia River Summer	Terminal Run	2020	34,705	38,300	91%
LRW	Lewis River Wild	Terminal Run	2020	21,961	19,700	111%
BON	Lower Bonneville Hatchery	Terminal Run	2020	15,553	16,500	94%
CWF	Fall Cowlitz Hatchery	Terminal Run	2020	38,117	34,500	110%
SPR	Spring Creek Hatchery	Terminal Run	2020	48,173	47,500	101%
MCB	Mid-Columbia Bright	Terminal Run	2020	86,293	78,200	110%
URB	Columbia Upriver Bright	Terminal Run	2020	236,066	220,600	107%
LYF	Snake River Wild	Escapement	2020	13,011	10,902	119%
NOC	North Oregon Coast	Escapement	2020	59,466	44,809	133%
MOC	Mid-Oregon Coast	Escapement	2020	25,867	28,140	92%

APPENDIX H: MODEL CALIBRATION METHODS

This section describes the calibration data and procedures used. For reference, a list of indicator stocks and fisheries in the model is provided in Appendix A. Estimation of the model base period parameters is described in CTC *In prep. b*. For 2020, the new "Phase II" model previously set pre-season catches for NBC and WCVI AABM fisheries. This model was structurally similar to the new "Phase II" model adopted by the PSC in October 2019. This model was updated with the actual catches, escapements, and other data through 2019 added, along with forecasts for 2020. An additional calibration that utilized the old 9806 base period was also conducted in order to provide 2019 post-season AIs that were comparable to the 2019 pre-season AIs.

Calibration Data

The first step in the annual calibration process is to gather new or revised data to update the model input files. For example, the file containing run size data is updated as pre-season forecasts and post-season run size estimates become available. Model predictions of the AI are sensitive to pre-season forecasts and post-season estimates of terminal runs. Months in which forecasts are available for each stock, and the month the final return estimate becomes available, are presented in Appendix H1.

The model is recalibrated annually to incorporate observed data from the previous year (or years if post-season estimates are corrected) and available abundance forecasts for the current year (2020). In addition, recalibration may also occur when significant changes in one or more of the following model input files are made.

1. BSE (base): This file contains basic information describing the structure of the model (i.e., the number and names of stocks and fisheries, age classes, the base period identification of terminal fisheries, and stock production parameters). This file may be modified annually to incorporate productivity parameters that correspond to new CTC-agreed escapement goals.
2. CEI (ceiling): This file contains historical catch data for the 25 fisheries that are modeled as ceiling or catch quota fisheries (as opposed to fisheries modeled solely through control of exploitation rates) through the most recent fishing season.
3. CNR (Chinook salmon non-retention): Data used by the model to estimate mortalities during CNR periods are read from the CNR file. The data in the CNR file depends on which method is used to calculate CNR mortality. It may include direct estimates of encounters during the CNR period or indicators of fishing effort in the CNR period relative to the retention period.
4. ENH (enhancement file): For 13 hatchery stocks and one natural stock (Lower Strait of Georgia Naturals) with supplementation, this file contains productivity parameters as well as the differences (positive or negative) in annual smolt production relative to the base period. However, differences in smolt production relative to the base period have not been updated in over 10 years (other than a few stocks). The environmental variable

(EV) scalars can instead provide the functionality of matching cohort numbers of the various stocks to observed terminal return and escapement. Additional discussion of the productivity parameters may be found in the draft model documentation (CTC 1991).

5. FCS (forecast): Agency supplied annual estimates of terminal run sizes or escapements as well as pre-season forecasts are contained in the FCS file. Age-specific information is used for those stocks and years with age data (Appendix H2). For those stocks with externally-provided forecasts of abundance in 2020, management agencies used three approaches to predict terminal returns or escapements:
    a. Sibling Regression Models: Empirical time-series relationships between abundance (commonly measured as terminal run or spawner escapement numbers) of age *a* fish in CY and the comparable abundance of age *a*+1 fish in year CY+1 are used to predict age-structured abundance from estimated age-structured terminal return or escapement (forecast type S in Appendix H2).
    b. Average Return Rate Models: Return rates of adults by age from smolts or parents are averaged over past BYs, then these averages are used to discount abundance of smolts or parents for BYs that will be exploited (forecast type R in Appendix H2).
    c. CTC program ForecastR: ForecastR relies on the open-source statistical software R to generate age-specific or total-abundance forecasts of escapement or terminal run using a variety of generic models including (i) simple and complex sibling regressions with the ability to include environmental covariates, (ii) time series models such as auto regressive integrated moving average (ARIMA), exponential smoothing, and naïve models (based on preceding one year, three years or five years in abundance time series), and (iii) mechanistic models such as average return rate models. ForecastR enables users to perform the following interactive tasks: (a) the selection of forecasting approaches from a wide set of statistical and/or mechanistic models for forecasting terminal run or escapement; (b) the selection of several measures of retrospective forecast performance (e.g., mean relative error [MRE], mean absolute error [MAE], mean absolute percent error [MAPE], mean absolute scaled error [MASE], root mean squared error [RMSE]); (c) the comparison of best forecasting models and model ranking based on the selected performance metrics; and, (d) the reporting of forecasting results (point forecasts and interval forecasts) and diagnostics. For both age-structured and non-age-structured data, Akaike information criterion (AIC)-based model selection takes place within model types prior to model ranking across model types based on the above-mentioned metrics of retrospective evaluation. ForecastR has been used to produce agency forecasts in 2016–2019 for Canada and Oregon Model stocks (forecast type F in Appendix H2).
6. FP: This file contains scalars specific to year, fishery, stock, and age that are applied to base period fishery exploitation rates, primarily in terminal fisheries. The FPs are used to scale annual fishery exploitation rates relative to the model base period and can be used for a variety of purposes. For example, for the ocean areas of the Washington and Oregon North of Cape Falcon (WA/OR) troll fishery, the FPs are used to model

differential impacts on Columbia River and Puget Sound stocks as the proportion of the catch occurring in the Strait of Juan de Fuca varies. The source of the FPs is generally the reported catch fishery index (Ratio of Means approach) computed from CWT data in the annual ERA or the ratios of harvest rates computed from terminal area run reconstructions.

7. IDL (interdam loss): The IDL file contains stock-specific pre-spawning mortality for the Columbia River Summer, Columbia Upriver Bright, Spring Creek Tule, and Snake River Fall stocks provided each year by Columbia River fishery managers. The factors represent the fraction of the stock that can be accounted for after mainstem dam passage in the Columbia River; losses can be attributed to direct mortality at the various dams, mortality in the reservoirs between dams, fall-backs, tailrace spawning, and other factors (as observed through window counts at the various dams upriver). The pre-spawning mortality factor is equal to 1 minus the conversion factor.
8. IM (changes in incidental mortality rates): The IM file contains the IM rates by fishery for legal and sublegal fish. These rates differ from those used in the base period due to alterations in gear, regulations, or fishery conduct.
9. MAT (maturity and AEQ factors): The MATAEQ file has annual estimates of maturation rates and AEQ factors for 27 stocks (BON, CBC, CWF, FCF, FHF, FS2, FSO, LGS, LRW, MCB, MGS, MOC, NBC, NOC, NSA, SKG, SPR, SSA, SUM, TST, UGS, URB, WCH, WCN, WSH, WVH, WVN). These annual estimates replace the single (non-year specific) maturation schedule rates in the STK file with years specific rates. Average values are used for years beyond the last year for which estimates are available (due to incomplete broods and the one-year lag for completion of the annual ERA). The AWG anticipates changes to the file and program to estimate maturation rates in future years.
10. PNV (proportion non-vulnerable): A PNV file is created for each fishery for which a size limit change has occurred since the Model base period. Each file contains age-specific estimates of the proportion of fish not vulnerable to the fishing gear or smaller in length than the minimum size limit. The PNVs were estimated from empirical size distribution data; in some instances, independent surveys of encounter rates were used to adjust the PNV for age-2 fish to account for the proportion of the cohort that was not vulnerable to the fishing gear. Note, PNVs are not stock specific and is on the AWG's work schedule to change in future years.
11. STK (stock): This file contains the stock- and age-specific starting (base period) cohort sizes, the base period exploitation rates on the vulnerable cohort for each model fishery, and non-year specific maturation schedules and AEQ factors. This file is updated if new stocks or fisheries are added, new CWT codes are used to represent distribution patterns of existing model stocks, or a re-estimation of base period data occurs. Modification of this file will result in a model different from that used in the negotiations (CLB 9812).

The calibration is controlled through a file designated with an OP7 conversion extension.

Appendix H1— Month of the year when agencies are able to provide final return estimates for the previous year and pre-season forecasts of abundance for the next fishing year.

Model Stock	Month Final Return Estimate Available	Month(s) Forecast Available
Southern SE Alaska	January	None
Northern SE Alaska	January	None
Alsek	January	None
Taku and Stikine	January	None
Northern British Columbia	November	February
Central British Columbia	November	February
Fraser Spring 1.2	January	February
Fraser Spring 1.3	January	February
Fraser Summer Ocean-type	February	February
Fraser Summer Stream-type	February	February
Fraser Harrison Fall	December	February
Fraser Chilliwack Fall Hatchery	December	February
WCVI Natural	January	February
WCVI Hatchery	January	February
Upper Strait of Georgia	January	February
Puntledge Summers	January	February
Lower Strait of Georgia	December	February
Middle Strait of Georgia	December	February
Nooksack Spring	June	February
Nooksack Fall (Samish)	June	February
Snohomish Wild	June	February
Skagit Wild	June	February
Puget Sound Natural Fingerling	June	February
Stillaguamish Wild	June	February
Puget Sound Hatchery Fingerling	June	February
Puget Sound Hatchery Yearling	June	February
Washington Coastal Wild	June	March[1]
Washington Coastal Hatchery	June	March[1]
Cowlitz Spring Hatchery	June	December
Willamette River Hatchery	June	December
Columbia River Summer	September	February
Fall Cowlitz Hatchery	April	February, April[2]
Spring Creek Hatchery	April	February, April
Lower Bonneville Hatchery	April	February, April
Upriver Brights	April	February, April
Snake River Wild Fall	April	April
Mid-Columbia River Bright	April	February, April
Lewis River Wild	April	February, April
North Oregon Coast	February	March
Mid-Oregon Coast	February	March
Yakutat Forelands	January	None

[1] Normally forecasts are not available for the model calibration, but these were available in 2019.

[2] A preliminary ocean escapement forecast is released in February. An updated ocean escapement forecast reflecting the ocean fishery option adopted by the Pacific Fisheries Management Council is released in April.

Appendix H2— Methods used to forecast the abundance of stocks in the PSC Chinook Model.

Model Stock	Forecast Characteristics			Comments
	Forecast Type[1]	Pre-season age-specific	Post-season age-specific	
Southern SE Alaska	C	Yes	Yes	Calibrated to escapement
Northern SE Alaska	C	Yes	Yes	Calibrated to escapement
Alsek	C	Yes	Yes	Calibrated to escapement
Taku and Stikine	C	Yes	Yes	Calibrated to escapement
Northern British Columbia	F	No	No	Calibrated to escapement
Central British Columbia	F	No	No	Calibrated to escapement
Fraser Spring 1.2	F	No	No	Calibrated to terminal run
Fraser Spring 1.3	F	No	No	Calibrated to terminal run
Fraser Summer Ocean-type	F	Mixed	Yes	Calibrated to escapement
Fraser Summer Stream-type	F	No	No	Calibrated to terminal run
Fraser Harrison Fall	F	Yes	Yes	Calibrated to escapement
Fraser Chilliwack Fall Hatchery	F	Mixed	Yes	Calibrated to escapement
WCVI Natural	F	Yes	Yes	Calibrated to terminal run
WCVI Hatchery	F	Yes	Yes	Calibrated to terminal run
Upper Strait of Georgia	F	No	No	Calibrated to escapement
Puntledge Summers	F	No	No	Calibrated to escapement
Lower Strait of Georgia Hatchery	F	Yes	Yes	Calibrated to terminal run
Middle Strait of Georgia	F	Yes	Yes	Calibrated to escapement
Nooksack Spring	R	No	No	Calibrated to escapement
Nooksack Fall (Samish)	R	No	No	Recent year average return rate
Snohomish Wild	R	No	No	Recruits per Spawner
Skagit Wild	R	Yes	Yes	Average cohort return rate
Puget Sound Natural Fingerling	R	No	No	Calibrated to terminal run
Stillaguamish Wild	R	No	No	Recruits per Spawner
Puget Sound Hatchery Fingerling	R	No	No	Age-specific forecasts not available for all components
Puget Sound Hatchery Yearling	R	No	No	Age-specific forecasts not available for all components
Washington Coastal Wild	R	No	No	Average return rate
Washington Coastal Hatchery	R	No	No	Average return rate
Cowlitz Spring Hatchery	S	Yes	Yes	Prediction is to mouth of tributary streams
Willamette River Hatchery	S	Yes	Yes	Prediction is to mouth of Willamette River
Columbia River Summer	S	No	No	Run reconstruction used to estimate Columbia River mouth return
Spring Creek Hatchery	S	Yes	Yes	Run reconstruction used to estimate Columbia River mouth return
Lower Bonneville Hatchery	S	Yes	Yes	Run reconstruction used to estimate Columbia River mouth return
Upriver Brights	S	Yes	Yes	Run reconstruction used to estimate Columbia River mouth return

Model Stock	Forecast Characteristics			Comments
	Forecast Type[1]	Pre-season age-specific	Post-season age-specific	
Lyons Ferry (Snake River Wild Fall)	R	No	No	Run reconstruction used to estimate Columbia River mouth return
Mid-Columbia River Bright	S	Yes	Yes	Run reconstruction used to estimate Columbia River mouth return
Lewis River Wild	S	Yes	Yes	Run reconstruction used to estimate Columbia River mouth return
North Oregon Coast	F	Yes	Yes	Individual river age structure from by-age/size recovery probability as well as age structure in nearby rivers
Mid-Oregon Coast	F	Yes	Yes	Individual river age structure from by-age/size recovery probability as well as age structure in nearby rivers
Yakutat Forelands	F	Yes	Yes	Calibrated to escapement

[1] Externally provided forecast type codes are S = sibling; R = return rate; F = ForecastR; C = model internally estimated projection.

Calibration Procedures

The calibration uses an iterative algorithm to estimate EV scalars for each BY and model stock to account for annual variability in natural mortality in the initial year of ocean residence. The EV scalars are used to adjust age-1 abundances estimated for each stock and BY, bench-marking to observed terminal return or escapement in combination with the base period spawner-recruit function. Fishing impacts and natural mortalities are then applied through model processes. The EVs also adjust for biases resulting from errors in the data or assumptions used to estimate the base period parameters for the spawner-recruit functions.

The EVs are estimated through the following steps for stocks calibrated to age-specific terminal run sizes:

1. Predicted terminal runs/escapements are first computed for each year using the input files discussed above and the base period stock-recruitment function parameters (i.e., EV stock productivity scalars set equal to 1).
2. The ratio (SC_{BY}) of the observed terminal run/escapement and the model predicted terminal run/escapement from the previous step is computed for each BY. For example, if the estimated and model predicted terminal runs for the 1979 brood were 900 and 1,500 age-3 fish in 1982, 4,000 and 4,500 age-4 fish in 1983, and 1,000 and 1,500 age-5 fish in 1983, the ratio would be computed as:

$$SC_{BY} = \frac{\sum_{a=Minage}^{Maxage} (Observed Terminal Run)_a}{\sum_{a=Minage}^{Maxage} (Model Predicted Terminal Run)_a}$$

Equation H.1

$$SC_{BY} = \frac{900 + 4000 + 1000}{1500 + 4500 + 1500}$$

Equation H.2

In the absence of age-specific estimates of the terminal run, the components are computed by multiplying the total terminal run by the model predictions of age composition.

3. The EV for iteration *n* and brood year *BY* is computed as:

$$EV_{n,BY} = EV_{n-1,BY} * SC_{BY}$$

Equation H.3

4. Steps 1–3 are repeated iteratively, across all stocks, until the absolute change in the EVs for each stock is less than a predetermined tolerance level (0.05). The tolerance level can be changed if more precise agreement is desired:

$$\left| \frac{EV_{n,BY} - EV_{n-1,BY}}{EV_{n-1}} \right| < 0.05$$

Equation H.4

Several options for the calibration are provided in the OP7 control file. The options include the ability to control the BYs for which the EVs are estimated each iteration, and also the type of convergence criteria. For the 2018 pre-season calibration, EVs were estimated for all BYs each iteration. Convergence was defined at an EV change tolerance level of 0.05.

Stock-specific calibration options are specified in the FCS file and discussed below.

- Minimum Number of Age Classes: Data for all age classes will not be available when the EVs are estimated for recent, incomplete broods. Since considerable uncertainty may exist in a single data point, application of the calibration algorithm can be restricted to cases in which a specific minimum number of age classes are present.
- Minimum Age: Considerable uncertainty often exists in the estimates of terminal runs or escapements for younger age classes, particularly age 2. The minimum age class to include in the calibration algorithm is specified in the FCS file.
- Estimation of Age Composition: Age-specific estimates of the terminal run or escapement may not be available. An option is provided to estimate the age composition using base period maturation and exploitation rates.

The 2020 calibration was completed in two stages (as it is normally conducted) to facilitate computation of the average exploitation rates and incorporation of the agency forecasts. The Stage 1 calibration provided initial estimates of exploitation rate scalars for fishing years 1979–2019 using updated catch and escapement data through 2019. Average exploitation rate scalars ($\overline{FP}$) were then computed and used as input values for the 2019 and 2020 fisheries in the Stage 2 calibration, except that the forecasts for the WCVI and Fraser Late (FRL) stocks already accounted for changes in the ocean fisheries.

The $\overline{FP}$ for each model fishery was obtained from the Stage 1 calibration using the following formula (subscripts follow those defined in Appendix H3):

$$\overline{FP}_{a,s,CY,f} = \frac{\sum_{CY=CY_{start}}^{CY_{end}} RT_{CY} * FP_{s,a,CY,f}}{(CY_{end} - CY_{start})}$$

Equation H.5

The term RT_{CY} refers to the ratio of the catch quota in the current year to the catch that would be predicted given current abundance, current size limits, and base period exploitation rates. The range of years used to compute the $\overline{FP}$ varied between stocks and was fishery- and age-specific. The input files used in the Stage 2 calibration were identical to those used in Stage 1 with two exceptions: the average exploitation rate scale factors for each fishery were inserted into the $\overline{FP}$ file for the next to last year, and the Stage 1 EVs were used as starting values for the Stage 2 calibration.

To determine the acceptability of a calibration by the CTC (i.e., whether an annual calibration is deemed final by the CTC), several results are examined.

1. Accuracy of the reconstructed catches in the fisheries (these values will consistently differ from the actual catches if the calibration is not able to exactly recreate the actual catches in the years 1979 through 1984, the model years used prior to implementation of the ceiling algorithm);
2. Accuracy of model predicted terminal runs or escapements relative to the data used for calibration of each stock;
3. Comparison of model predicted age structure in terminal runs or escapements with the data used for calibration (consistent biases in age structure are addressed by changing maturation rates); and
4. Comparison of CWT-based and model estimates of fishery harvest rate indices.

Calibration usually involves an iterative process until a judgment is made by the CTC that an acceptable fit to all the data was achieved. This decision usually involves an inspection, discussion, and trial-and-error process. The determination of whether or not further calibrations are necessary is based principally on the significance of deviations from observed or estimated values for stocks and fisheries most relevant to the issues to be evaluated and on the time constraints established for completion of the calibration.

Changes to previous model calibration procedures for 2020 are provided in Appendix I.

Key Calibration Outputs

The PSC Chinook Model was originally constructed as a tool to evaluate the effect of fishery management actions on the rebuilding of depressed Chinook salmon stocks. However, since the implementation of the 1999 PST Agreement, the primary purpose of the model has been to enable abundance-based management in the PST through the production of fishery abundance indices. The model generates pre-season projections of AIs for the SEAK, NBC, and WCVI AABM fisheries and post-season estimates of the AIs that enable evaluations of AABM performance (i.e., pre- versus post-season AI and annual catch comparisons). For each AABM fishery (*f*), an AI is computed for the upcoming fishing year (*CY*) as:

$$AI_{f,CY} = \frac{\sum_s \sum_a Cohort_{s,a,CY} ER_{s,a,f}(1-PNV_{a,f})}{\sum_s \sum_a Cohort_{s,a,BP} ER_{s,a,f}(1-PNV_{a,f})} \qquad \text{Equation H.6}$$

where $Cohort_{s,a,CY}$ and $Cohort_{s,a,BP}$ are pre-season (projected) and base period (*BP*, fishing years

1979–1982) abundances of model stocks (*s*), by age (*a*), respectively. Thus, the AI is the ratio between the expected catch in the year of interest under base period exploitation patterns and the estimated average catch during the 1979–1982 base period. Given the pre-season AI projections, the ACLs are then set for the NBC and WCVI AABM fisheries according to the terms specified in Appendix C of Annex IV, Chapter 3 of the 2019 PST Agreement. Beginning in 2019, the ACL for the SEAK AABM fishery is based on the SEAK early winter District 113 Troll fishery CPUE metric and determined using Table 2 of Chapter 3 of the 2019 PST Agreement.

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. The fishery index (FI) provided a means to assess performance against this expectation. Relative to the 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. Although the determination of ACLs for AABM fisheries in the 2019 PST Agreement is different from the original PST catch ceilings, these fishery indices continue to provide a useful index of relative change in harvest rates in these fisheries. Fishery indices are used to measure relative changes in fishery harvest rates because it is not possible to directly estimate the fishery harvest rates.

Fishery indices are computed in adult equivalents (AEQs) for both reported catch and total mortality (reported catch plus IM). The total mortality AEQ exploitation rate is estimated as:

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

Equation H.7

whereas the reported catch AEQ exploitation rate is estimated as

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

Equation H.8

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

$$FI_{f,CY} = \frac{\sum_{s\in\{S\}}\sum_{a\in\{A\}} ER_{s,a,f,CY}}{\left(\frac{\sum_{BPYR=79}^{82}\sum_{s\in\{S\}}\sum_{a\in\{A\}} ER_{s,a,f,BPYR}}{4} \right)}$$

Equation H.9

For AABM fisheries, indices are presented for troll gear only, although the ACLs also apply to sport and net fisheries in SEAK and sport fisheries in NBC and WCVI. As in past years, CWT recoveries from the troll fisheries are used because the majority of the catch and the most reliable CWT sampling occurs in these fisheries. 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.

The CTC uses fishery indices to reflect changes in fishery impacts relative to the base period (catch years 1979–1982). The ROM estimator of the fishery index limits inclusion of stocks to those with adequate tagging during the base period, but 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). One example of a recent change in the fishing pattern is the SEAK troll fishery, where the catch during the winter season has increased, the spring fishery has been largely curtailed, and the summer season has become markedly shorter. Because stock distributions are dynamic throughout the year, stock-specific impacts of the SEAK fishery have likely changed over time.

To account for changes in stock composition and to include stocks without base period data, the CTC has created alternative derivations of fishery indices (CTC 1996[3]). The CTC determined that a useful FI should have these characteristics:

1. The index should measure changes in fishery harvest rates if the distribution of stocks is 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 alternatives, the CTC concluded that the best estimate for a fishery index would consist 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[4]) stated that for all AABM fisheries, the stratified proportional fishery index (SPFI) was the most accurate and precise index for estimating the harvest rate occurring in a fishery. However, the SPFI was never fully implemented for the NBC and WCVI Troll fisheries for reasons described in Section 4.1.4.

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 H.10), and the result is substituted into Equation H.11 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 H3 for notation description.

[3] CTC. 1996. 1994 annual report. Pacific Salmon Commission Joint Chinook Technical Committee Report TCCHINOOK (96)-1. Vancouver, BC.

[4] CTC. 2009. Special report of Chinook Technical Committee HRI Workgroup on the Evaluation of Harvest rate indices for use in Monitoring Harvest Rate Changes in Chinook AABM Fisheries Pacific Salmon Commission Joint Chinook Technical Committee Report TCCHINOOK (09)-02. Vancouver, BC.

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

Equation H.10

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

Equation H.11

The resulting unique solution is inserted into the following equations to compute the yearly harvest rates for each stratum (Equation H.14) and the overall fishery (Equation H.15).

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

Equation H.12

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

Equation H.13

$$S_{t,CY} = H_{t,CY} \Big/ \sum_{CY=1979}^{1982} H_{t,CY}$$

Equation H.14

$$S_{.CY} = H_{.CY} \Big/ \sum_{CY=1979}^{1982} H_{.CY}$$

Equation H.15

Appendix H3— Parameter descriptions for equations used for the stratified proportional fishery index (SPFI).

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

APPENDIX I: ISSUES WITH AND CHANGES TO THE PSC CHINOOK MODEL CALIBRATION

The AWG conducted two separate calibrations of the PSC Chinook Model in 2020. The first calibration took place in March and utilized the new Phase II version of the PSC Chinook Model. This Model was used to determine pre-season AIs in NBC and WCVI AABM fisheries. The second calibration took place in April and utilized the older version of the PSC Chinook Model with the 9806 base period. This Model was used to determine post-season AIs in SEAK, NBC, and WCVI AABM fisheries. This Appendix focuses on the Phase II calibration process.

The AWG decided to continue with standard naming conventions for PSC Chinook Model calibrations with the first two digits of the Model name indicating the year and the last two digits of the Model name indicating the iteration (starting with 0) of the calibration. Because two separate Models were conducted this year, a suffix of "9806" is added to the older PSC Chinook Model calibration conducted in April. Model "2002" was used to set pre-season AIs and Model "2000–9806" was used to determine post-season AIs. This is the last year that the older version of the PSC Chinook Model will be used to determine AIs.

This appendix is not meant to document changes between the Model used for management in 2019 and the Model used in 2020. Details on those changes can be found in CTC 2021a, CTC *In prep. a*, and CTC *In prep. b*.

Fishery Policy (FPA) Files

The assumptions used to determine FPs in the Strait of Georgia Sport FPA file were revised. This FPA file has a single time series of FPs that are applied to all stocks. Previous versions of this file combined recoveries from Georgia and Johnstone Strait fisheries to estimate FPs. However, the decision to combine recoveries from Johnstone Strait fisheries was based on erroneous output from the HRJ to FP program. The issue with the HRJ to FP program has been resolved. Updated output from this program indicated that there were enough recoveries solely from Strait of Georgia fisheries to estimate FPs. These FPs produced catch estimates with better fits to the actual catch and the AWG decided to remove Johnstone Strait fishery recoveries from the Strait of Georgia Sport FPA file.

In previous Phase II model calibrations, FPs in the Juan de Fuca net FPA file were derived from the HRJ to FPA program. The 1983 FP in this FPA file (which has a single series of FPs that are applied to all stocks) produced a Model catch that was over 9 times larger than the actual catch. The AWG determined that more accurate FPs could be estimated by using a ratio of actual catches defined as the catch in a year divided by the average base period catch.

Columbia River Sport FPs for the Upper Columbia River Summer (SUM) stock are determined so that the estimated Model catch equals the actual catch. The time series of actual catches for SUM in the Columbia River Sport fishery changed resulting in a different time series of FPs.

Inter-dam Loss (IDL) File

The IDL time series was revised for SUM and LYF. Sport catches of SUM occurring above Rock Island Dam (the point where the IDL is calculated to) were removed from the calculation for consistency with the ERA (also see Appendix G for a discussion of remapping fishery recoveries occurring above where the IDL is calculated to). The LYF IDL time series was revised for consistency with the IDLs used in the base period calibration. The time series of returns for Lyon's Ferry (LYF) is expressed in terms of terminal run. In order to estimate historical terminal runs (prior to 1986), the IDL is used in conjunction with terminal harvest estimates to estimate terminal run. The LYF IDL changed in this year's calibration, resulting in different historical terminal run size estimates for LYF.

Forecast (FCS) File – U.S. Stocks

Phase II of the PSC Chinook Model Base Period was first used for the annual CTC Model calibration in 2020 (CTC 2021a, CTC *In prep. a*, and CTC *In prep. b*). In the U.S., four new model stocks were added, two were reconfigured, and 18 remained configured as before, although three of these had the method of return estimation/reporting systemically altered. Estimates of return (1979–upcoming year forecast) for each model stock are reported in the calibration FCS file, either as all ages combined or age-specific (primarily age-3, age-4, age-5).

Each of the four new Model stock groups introduced new returning fish into the Model. Three of the new Model stock groupings were spring runs: Yakutat (YAK), Alsek (ALS), Transboundary (Taku and Stikine; TST). The new Mid-Oregon Coast (MOC) are fall run stocks, (see CTC *In prep. a* for more details). The two U.S. stock groups that were reconfigured in the Phase II Model were Alaska Springs (AKS) and Puget Sound Fingerlings (PSF). More details on the reconfiguration for these stock groups can be found in CTC *In prep. a*. The Alaska SEAK Spring (AKS) stock was split into Southern SEAK Springs (SSA) and Northern SEAK Springs (NSA). Macaulay Hatchery returns were added to the NSA introducing some new fish into the Model. Puget Sound Fingerlings (PSF) were split into PSF and Puget Sound Yearlings (PSY), as the two had been combined for calibration of the 9806 Model calibration. These estimates changed only in 2018 and 2019, the latter being the forecast replaced with observed return (as occurred for all Model stocks' 2019 forecasts/estimates).

Three of the systematically re-estimated, but not reconfigured, Model stocks are Lyons Ferry Falls (LYF), North Oregon Coast (NOC), and Willamette Springs Hatchery (WSH). Estimates for Lyons Ferry Falls (LYF) were increased; the new Model reconfigures enumeration at the Columbia River mouth, where LYF was previous enumerated at Lower Granite Dam on the Snake River (see CTC *In prep. a* for more details). North Oregon Coast (NOC) falls escapement estimates were revised based on mark-recapture (MR) experiments. For many of the years and ages, the new NOC estimates were lower than the previous 9806 Model calibration (see CTC *In prep. a* for more details). In accordance with the Columbia River Technical Advisory Committee (TAC) and Endangered Species Act (ESA) population designation, Willamette Spring Hatchery (WSH) returns were re-estimated from 1979–2013 with returns from Sandy River excluded (Appendix I1). While Washington Coastal Fall Natural (WCN) and Washington Coastal Fall Hatchery (WCH) were not systematically re-estimated or reconfigured, beginning in 1992 there were consistent and relatively large changes in returns (see CTC *In prep. a* for more details).

Among the U.S. Model stocks not reconfigured or systemically re-estimated, most experienced many changes in return estimates between the 2019 and 2020 calibrations. In preparing data for the Stock Aggregate Cohort Evaluation (SACE), it was discovered that intermittently throughout the Columbia River Model stocks' time series there had been many updates or revisions that had not been previously entered into the CTC FCS files. Most changes were relatively small. The time series for Puget Sound Model stocks had very few changes to be made between the 2019 and 2020 FCS files, and these few were almost all fairly small and occurred after 2010 (Appendix I2). The time series for Columbia River stocks below (Appendix I1) and above (Appendix I3) have been updated slightly to be in line with ACL estimates.

The tables below show the differences between the 2020 and 2019 calibration FCS files' values: the 2019 value subtracted from the 2020 value; thus, a positive table entry indicates a higher estimate for 2020, in parentheses indicates a lower estimate for 2020.

Forecast (FCS) File – Canadian Stocks

With the addition and removal of stocks, the escapement or terminal run time series will differ from the Phase II Model input. Actual values for Canadian stocks were not included in Appendix I4 and Appendix I5 because some stocks have a complete time series reconstruction on an annual basis. For example, in the Fraser, the time series changes each year due to the run reconstruction method used for Fraser River systems. Also, the entire escapement time series for Kitsumkalum, based on Petersen estimates, was replaced by robust estimates based on open-population models and model selection. Stocks that were included in the 9806 base data set, but which are not included in the Phase II base data set, have been removed because escapement programs have either been discontinued or did not produce reliable observations.

The systems that made up North/Central B.C. (NTH) stock in 9806 were divided into their northern (Nass and Skeena rivers) and central systems (Atnarko, Wannock, Chuckwalla and Kilbella rivers) in the Phase II Model, becoming Northern B.C. (NBC) and Central B.C. (CBC) stocks (Appendix I5). Fraser Early in 9806 was subdivided into four stocks in the new Model to reflect their different life histories: Fraser Early Spring 1.2 (FS2), Fraser Early Spring 1.3 (FS3), Fraser Early Summer 0.3 (FSO) and Fraser Early Summer 1.3 (FSS) (Appendix I5). Birkenhead and Big Silver are examples of unique populations of spring and summer-run Chinook in the lower Fraser River with a stream-type life history. Fraser Late (FRL) was split into Harrison Fall (FHF) and Chilliwack Fall Hatchery (FCF) and have an ocean-type life history (Appendix I5). The West Coast Vancouver Island Hatchery (RBH) and Natural (RBT) stocks were represented as an aggregate in the old Model (Appendix I4). In Phase II, the hatchery and natural components are now represented separately. While the river systems included in West Coast Vancouver Island Hatchery (RBH) and Natural (RBT) remained the same after the stratification, the acronyms changed to WVH and WVN, respectively (Appendix I5). The Upper Strait of Georgia (GSQ) was split into Upper Strait of Georgia (UGS) and Puntledge Summers (PPS) (Appendix I5). Lower Strait of Georgia Natural (GST) was renamed Lower Strait of Georgia (LGS) and Lower Strait of Georgia Hatchery (GSH) was renamed Middle Strait of Georgia (MGS) (Appendix I5).

Quinsam Chinook in UGS have a far north ocean distribution pattern, while others in this stock group such as Nimpkish Chinook have a more local distribution and do not migrate as far north. The time series of annual spawner estimates for Puntledge Summers has been well documented over the years, and systems included in MGS are also closely monitored. The indicator stock for LGS, Cowichan River Fall, has a local ocean distribution pattern and has a counting fence that is utilized for abundance estimates. More details on stock stratification from the 9806 Model and the Phase II Model can be found in Table 1 of CTC *In prep. a.*

Appendix I1— FCS file values for U.S. model stock groups of Columbia River below Bonneville Dam used in the Phase II Model Calibration. Differences are corrections between the Phase II and 9806 Model calibrations (negative = decreased in Phase II Model, in parentheses). 2019 forecasts become observed in 2020.

Stock Group	**Cowlitz (WA) Tules (CWF)**			**Bonneville (OR) Tules (BON)**			**Cowlitz Springs Hatchery (CWS)**			**Lewis River Wilds (LRW)**			**Willamette Springs Hatchery (WSH)**		
9806 Model							2002-08 updated								
Phase II Model	Full Time Series Corrections			Full Time Series Corrections			2010-15 Updated			Full Time Series Corrections			1979-2013 re-estimated, Sandy R removed		
Return Year	age 3	age 4	age 5+	age 3	age 4	age 5+	age 3	age 4	age 5+	age 3	age 4	age 5+	age 3+4	age 5	age 6+
1979	-	-	-		-	-	-	-	-	-	-	-			
1980	(3)	18	(7)		15	(5)	-	-	-	28	(39)	25	429	(515)	(7)
1981	(24)	22	(27)		18	(23)	-	-	-	(17)	(3)	39	(571)	(788)	(39)
1982	(26)	(3)	(7)		(3)	(6)	-	-	-	(8)	(46)	(27)	(38)	(573)	(15)
1983	-	-	(30)		-	(26)	-	-	-	-	-	-	246	(773)	(19)
1984	(19)	2	(44)		2	(37)	-	-	-	-	-	-	(486)	(1,101)	(30)
1985	-	-	(3)		-	(2)	-	-	-	-	-	-	229	(659)	(21)
1986	14	5	(81)		4	(69)	-	-	-	-	-	-	451	(435)	(13)
1987	-	-	(3)		-	(2)	-	-	-	-	-	-	(55)	(872)	(12)
1988	-	-	(65)		-	(2)	-	-	-	-	-	-	(1,618)	(1,289)	(23)
1989	-	-	(82)		-	(3)	-	-	-	-	-	-	(764)	(1,220)	(20)
1990	-	-	(1,671)		-	(149)	-	-	-	-	-	-	(1,761)	(1,717)	(48)
1991	-	-	(110)		-	(18)	-	-	-	-	-	-	(1,293)	(2,262)	(97)
1992	-	-	(39)		-	(1)	-	-	-	-	-	-	(2,468)	(5,890)	(192)
1993	-	-	(8)		-	(1)	-	-	-	-	-	-	(2,350)	(3,898)	(121)
1994	(21)	34	(18)		13	(2)	-	-	-	-	-	-	(1,724)	(1,730)	(44)
1995	17	16	(76)		7	(8)	-	-	-	-	-	-	(988)	(1,493)	(48)
1996	19	(31)	(9)		(2)	-	-	-	-	-	-	17	(1,614)	(2,153)	(34)
1997	11	(1)	19		-	1	-	-	-	-	-	-	(2,388)	(1,978)	(44)
1998	18	8	(156)		8	(7)	-	-	-	-	-	-	(1,532)	(2,006)	(39)

Stock Group	Cowlitz (WA) Tules (CWF)			Bonneville (OR) Tules (BON)		Cowlitz Springs Hatchery (CWS)			Lewis River Wilds (LRW)			Willamette Springs Hatchery (WSH)		
1999	4	8	(55)	3	(15)	-	-	-	-	-	-	(1,785)	(1,760)	(40)
2000	(10)	(7)	(1)	(2)	-	-	-	-	-	-	-	(2,130)	(1,696)	(11)
2001	(15)	(8)	(42)	(6)	(9)	-	-	-	-	-	-	(2,800)	(2,502)	(27)
2002	(4)	(6)	(8)	(5)	(6)	-	-	-	-	-	223	(4,341)	(1,532)	(32)
2003	112	230	(47)	124	(26)	-	-	-	(423)	(133)	(61)	(2,035)	(3,566)	(15)
2004	99	(169)	(555)	(94)	(14)	-	-	-	(404)	(403)	(432)	(7,199)	(5,351)	(130)
2005	1,310	(1,248)	(5,285)	(211)	(493)	-	-	-	(122)	(218)	(82)	(2,614)	(4,990)	(62)
2006	96	507	311	72	44	-	-	-	(52)	(468)	(4,727)	(3,097)	(1,180)	(105)
2007	(1)	26	59	5	11	-	-	-	49	260	269	(1,003)	(1,756)	(74)
2008	(674)	(227)	14	(105)	6	-	-	-	(46)	675	33	(4,385)	(833)	(53)
2009	20	45	25	8	-	-	-	-	104	674	93	(2,082)	(584)	(12)
2010	(657)	453	122	19	-	-	-	-	-	-	-	(6,396)	(1,244)	(11)
2011	(228)	194	(24)	27	(1)	-	-	-	-	-	-	(4,223)	(1,471)	(27)
2012	(132)	(44)	186	(2)	2	-	-	-	-	-	-	(3,456)	(1,569)	(13)
2013	(642)	(708)	-	(59)	-	-	-	-	-	-	-	(4,255)	(1,475)	(21)
2014	(1,042)	1,665	(30)	291	-	-	-	-	-	(31)	-	-	-	-
2015	(46)	(77)	(22)	(8)	-	-	-	-	-	-	-	-	-	-
2016	300	(58)	2	(6)	-	-	-	-	-	-	(719)	-	-	-
2017	1	-	-	-	-	-	-	-	-	-	17	-	-	-
2018	(1)	-	-	-	-	-	-	-	-	(2)	-	-	-	-
2019	(3,113)	4,875	(734)	1,451	91	(981)	268	168	2,373	2,270	(1,682)	(13,795)	454	165

Appendix I2— FCS file values for U.S. model stock groups of Puget Sound used in the Phase II Model Calibration. Differences are corrections between the Phase II and 9806 Model calibrations (negative = decreased in Phase II Model, in parentheses). 2019 forecasts become observed in 2020.

Stock Group	**Nooksack Falls (NKF)**	**Nooksack Springs (NKS)**	**Puget Sound Naturals (PSN)**	**Skagit Summer/Fall Natural (SKG)**			**Stillaguamish Summer/Fall Natural (STL)**	**Snohomish Summer/Fall Natural (SNO)**
Phase II Model	Correction	Correction	Correction	Correction			Correction	Correction
Return Year	all ages	all ages	all ages	age3	age4	age5+	all ages	all ages
2011	-	(247)	-	-	-	-	-	-
2012	-	(239)	-	-	-	-	-	-
2013	-	(25)	-	-	-	-	-	-
2014	-	(298)	-	-	-	-	-	-
2015	-	(91)	-	-	-	-	-	-
2016	-	(739)	-	-	-	-	-	(931)
2017	-	725	-	-	-	-	-	170
2018	(1,829)	-	6,644	-	-	-	301	193
2019	(12,196)	-	(6,475)	(1,684)	1,522	(1,260)	127	(1,756)

Appendix I3— FCS file values for U.S. model stock groups of Columbia River above Bonneville Dam used in the Phase II Model Calibration. Differences are corrections between the Phase II and 9806 Model calibrations (negative=decreased in Phase II Model, in parentheses). 2019 forecasts become observed in 2020.

Stock Group	**Spring Creek Tules (SPR)**			**Mid Columbia R. Brights (MCB)**			**Columbia R. Upriver Brights (URB)**			**Columbia R. Summers (SUM)**
Phase II Model	Full Time Series Corrections			Full Time Series Corrections			Full Time Series Corrections			Full Time Series Corrections
Return Year	age3	age4	age5+	age3	age4	age5+	age3	age4	age5+	all ages
1979	-	-	-	-	4,500	-	-	-	-	-
1980	5	4	3	-	4,491	-	13	36	(43)	-
1981	36	(26)	5	(17)	(35)	(47)	(16)	(28)	(53)	-
1982	(30)	(45)	1	(15)	(44)	49	18	(17)	(22)	-
1983	-	-	-	9	(47)	(23)	-	-	-	-
1984	(34)	(15)	-	35	47	36	-	-	(11)	-
1985	-	-	-	42	(8)	12	-	-	-	-
1986	18	34	-	(5)	12	79	-	-	-	-
1987	-	10	(44)	(62)	3	60	-	-	-	-
1988	-	-	-	23	(46)	81	-	-	-	-
1989	-	-	-	14	42	(137)	-	-	-	-
1990	-	-	-	-	26	44	-	-	-	-
1991	-	-	-	11	(44)	18	-	-	-	-
1992	-	-	-	(45)	2	(52)	-	-	-	-
1993	-	-	-	(46)	17	(32)	-	-	-	-
1994	-	-	(1)	(11)	(16)	(61)	-	-	-	-
1995	-	-	48	(31)	(34)	(15)	-	-	-	-
1996	-	-	29	(2)	41	(8)	2	9	(49)	-
1997	-	-	48	39	(38)	31	-	-	-	-
1998	-	-	-	(9)	3	34	-	-	-	-
1999	-	-	-	38	(41)	(9)	-	-	-	-

Stock Group	Spring Creek Tules (SPR)			Mid Columbia R. Brights (MCB)			Columbia R. Upriver Brights (URB)			Columbia R. Summers (SUM)
2000	-	-	-	(3)	(18)	12	(12)	53	1	-
2001	5	(9)	1	112	(179)	(29)	387	(340)	(171)	-
2002	(2,213)	(296)	(27)	3	(239)	34	888	1,726	(15)	-
2003	-	-	-	(33)	(163)	(62)	22	766	174	-
2004	-	-	-	4	(83)	(24)	-	-	-	-
2005	5,430	4,763	129	551	1,011	185	(159)	(940)	-	-
2006	-	-	-	-	-	-	-	-	-	-
2007	-	-	-	(4)	37	13	(52)	(30)	19	-
2008	14,336	78	1	106	197	505	10	353	52	-
2009	3	(6)	(1)	(7)	(62)	12	11	8	37	-
2010	-	-	-	-	-	-	-	-	-	-
2011	-	-	-	-	-	-	(181)	-	-	-
2012	-	-	-	-	-	-	-	-	-	-
2013	-	-	-	-	-	-	-	-	-	-
2014	(203)	(381)	(11)	81	330	148	130	543	105	-
2015	74	17	-	(6)	(5)	(24)	(29)	(136)	(50)	-
2016	(2,276)	(875)	19	287	(1,718)	466	1,253	1,983	3,044	-
2017	(766)	19	(8)	71	69	108	(101)	121	279	-
2018	(62)	-	(18)	(1)	2	-	(15)	10	9	-
2019	(16,314)	(767)	34	11,365	4,331	(4,330)	21,305	41,426	(8,893)	(1,281)

Appendix I4— Canadian stock stratification for the FCS file in the old Model (9806) along with the river systems and hatcheries that comprised each stock group.

Stock Name	Stock ID	Stock Composition	Abundance Type	Total or Age-Specific
North/Central B.C.	NTH	Nass R, Skeena R, Yakoun R, Kitimat R, Atnarko R, Dean R, Wannock R, Chuckwalla and Kilbella R	Terminal Run	Total
Fraser Early	FRE	Coldwater R, Deadman R, Louis Cr, Nicola R, Spius Cr, Bessette Cr, Ahbau Cr (Cottonwood), Antler Cr (Bowron), Baezaeko R (Westroad), Birkenhead R, Bowron R, Bridge R, Captain Cr (McGregor), Chilako R, Chilcotin R (Lower), Cottonwood R, Eagle R, Endako R, Finn Cr, Fontoniko Cr (McGregor), Fraser R at Tete Jaune, Goat R, Haggen Cr (Bowron), Herrick Cr, Holmes R, Horsefly R, Horsey Cr, Indianpoint Cr (Bowron), James Cr, Lightning Cr (Cottonwood), McKale Cr, Nazko R (Westroad), Nevin Cr, Ormond Cr, Salmon R (PG), Salmon R (SA), Seebach Cr, Slim Cr, Spakwaniko Cr (McGregor), Swift Cr, Torpy R, Upper Pitt R, Walker Cr, Wansa Cr (Willow), West Road (Blackwater) R, Willow R, Barriere R, Cariboo R (Lower), Cariboo R (Lower), Chilko R, Clearwater R, Mahood R (Clearwater), North Thompson, Nechako R, Portage R, Quesnel R, Raft R, Seton R, Stellako R, Stuart R, Adams R (Lower), Little R, Maria Slough, Shuswap R (Lower), Shuswap R (Middle), South Thompson R	Terminal Run	Total
Fraser Late	FRL	Harrison R, Chilliwack R Fall	Escapement	Mixed

Stock Name	Stock ID	Stock Composition	Abundance Type	Total or Age-Specific
West Coast Vancouver Island Hatchery	RBH	Nitinat R, Somass System, Conuma R	Terminal Run	Age-specific
West Coast Vancouver Island Natural	RBT	San Juan R, Nahmint R, Sarita R, Bedwell/Ursus R, Megin R, Moyeha R, Tranquil Cr, Burman R, Gold R, Leiner R, Little Zeballos R, Tahsis R, Zeballos R, Artlish R, Kaouk R, Tahsish R, Colonial/Cayeghle Cr, Marble R	Terminal Run	Age-specific
Upper Strait of Georgia	GSQ	Quinsam R, Campbell R, Salmon R, Nimpkish R, Phillips R, Kingcome R, Wakeman R, Klinaklini R, Ahnuhati R, Kakweiken R, Orford R, Southgate R, Homathko R, Apple R, Puntledge R Summer	Escapement	Mixed
Lower Strait of Georgia Natural	GST	Nanaimo R Fall, Cowichan R Fall	Escapement	Age-specific
Lower Strait of Georgia Hatchery	GSH	Puntledge R Fall, Big Qualicum R, Little Qualicum R Fall, Capilano Hatchery (SBC Mainland), Lang Cr (SBC Mainland), Squamish R (SBC Mainland), Oyster R, Englishman R, Chemainus R	Terminal Run	Age-specific

Appendix I5— Canadian stock stratification for the FCS file in the new Model (Phase II) along with the river systems and hatcheries that comprise each stock group.

Stock Name	Stock ID	Stock Composition	Abundance Type	Total or Age-Specific
Northern B.C.	NBC	Nass R, Skeena R	Escapement	Total
Central B.C.	CBC	Atnarko R, Wannock R, Chuckwalla and Kilbella R	Escapement	Total
Fraser Early Spring 1.2	FS2	Coldwater R, Deadman R, Louis Cr, Nicola R, Spius Cr, Bonaparte R	Terminal Run	Total
Fraser Early Spring 1.3	FS3	Ahbau Cr, Antler Cr, Baezaeko R, Birkenhead R, Blue R, Bowron R, Bridge R, Captain Cr, Chilako R, Chilcotin R (Lower), Chilcotin R (Upper), Cottonwood R, East Twin Cr, Endako R, Fraser R at Tete Jaune, Goat R, Haggen Cr, Holmes R, Horsefly R, Horsey Cr, Indianpoint Cr, James Cr, Lightning Cr, McKale Cr, Nazko R, Nevin Cr, Seebach Cr, Slim Cr, Swift Cr, Swift R, Torpy R, Walker Cr, Wansa Cr, West Road (Blackwater) R, West Twin Cr, Willow R	Terminal Run	Total
Fraser Early Summer 0.3	FSO	Adams R (Lower), Little R, Maria Slough, Shuswap R (Lower), Shuswap R (Middle), South Thompson R	Escapement	Mixed
Fraser Early Summer 1.3	FSS	Barriere R, Big Silver Cr, Cariboo R (Lower), Chilko R, Clearwater R, Elkin Cr, Kuzkwa R, Mahood R, Nechako R, Portage R, Quesnel R, Raft R	Terminal Run	Total
Harrison Fall	FHF	Harrison R	Escapement	Age-specific
Chilliwack Fall Hatchery	FCF	Chilliwack R Fall	Escapement	Mixed

Stock Name	Stock ID	Stock Composition	Abundance Type	Total or Age-Specific
West Coast Vancouver Island Hatchery	WVH	Nitinat R, Somass System, Conuma R	Terminal Run	Age-specific
West Coast Vancouver Island Natural	WVN	San Juan R, Nahmint R, Sarita R, Bedwell/Ursus R, Megin R, Moyeha R, Tranquil Cr, Burman R, Gold R, Leiner R, Little Zeballos R, Tahsis R, Zeballos R, Artlish R, Kaouk R, Tahsish R, Colonial/Cayeghle Cr, Marble R	Terminal Run	Age-specific
Upper Strait of Georgia	UGS	Quinsam R, Campbell R, Salmon R, Nimpkish R, Phillips R, Kingcome R, Wakeman R	Escapement	Total
Puntledge Summers	PPS	Puntledge R Summer	Escapement	Total
Lower Strait of Georgia	LGS	Nanaimo R Fall, Cowichan R Fall	Terminal Run	Age-specific
Middle Strait of Georgia	MGS	Puntledge R Fall, Big Qualicum R, Little Qualicum R Fall, Capilano Hatchery (SBC Mainland), Lang Cr (SBC Mainland)	Escapement	Age-specific