PACIFIC SALMON COMMISSION

JOINT CHINOOK

TECHNICAL COMMITTEE REPORT

CHAPTER 3 PERFORMANCE EVALUATION REPORT

TCCHINOOK (16)-02

ERRATA

Soon after the June 1, 2016 publication, errors were identified in the TCChinook (16)-02 document. Corrections to tables, figures, and text with currently accepted metrics of the Chinook Technical Committee are provided in Appendix D.

Revised November 14, 2016

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List of Acronyms and Abbreviations

AABM	Aggregate Abundance Based Management
ADF&G	Alaska Department of Fish and Game
Agreement	June 30, 1999 PST Annex and the Related Agreement
AUC	Area-Under-the-Curve
BC	British Columbia
CBC	Central British Columbia (Kitimat to Cape Caution)
CDFO	Canadian Department of Fisheries and Oceans
CI	Confidence Interval
CR	Columbia River
CPUE	Catch per unit effort
CRITFC	Columbia River Intertribal Fish Commission
CTC	Joint Chinook Technical Committee
CV	Coefficient of Variation
CWT	Coded Wire Tag
CWTIP	Coded Wire Tag Improvement Program
CWTIT	Coded Wire Tag Implementation Team
CY	Calendar Year
ER	Exploitation Rate
ESA	U.S. *Endangered Species Act*
FN	First Nations
FNC	First Nations Caucus
FR	Fraser River
FSC	Food, Social & Ceremonial
GM	Geometric Mean
GMR	Genetic Mark–Recapture
GSI	Genetic Stock Identification
HPCP	High Priority Chinook Projects
IM	Incidental Mortality
ISBM	Individual Stock Based Management
JDF	Juan De Fuca
LAT	Low Abundance Threshold
LC	Landed Catch
LGS	Lower Strait of Georgia
LIM	Legal Incidental Mortality
MA	Management Agreement
MOC	Mid-Oregon Coast
MR	Mark–Recapture
MRE	Mature-Run Equivalent
MSF	Mark Selective Fisheries
MSY	Maximum Sustainable Yield for a stock, in adult equivalents
NA	Not Available
NBC	Northern British Columbia (Dixon Entrance to Kitimat including Queen Charlotte Islands)
NMFS	National Marine Fisheries Service
NOC	North Oregon Coast
NWIFC	Northwest Indian Fisheries Commission
ODFW	Oregon Department of Fish and Wildlife
ORC	Oregon Coast
PS	Puget Sound
PSC	Pacific Salmon Commission
PST	Pacific Salmon Treaty
QCI	Haida Gwaii (Queen Charlotte Islands)
SE	Standard Error
SMSY	Escapement producing MSY
SEAK	Southeast Alaska Cape Suckling to Dixon Entrance
SSP	Sentinel Stocks Program
SUS	Southern U.S.
TBR	Transboundary Rivers (Alsek, Taku, Stikine)
TM	Total Mortality
UAF	University of Alaska Fairbanks
UGS	Upper Strait of Georgia
UMT	Upper Management Threshold
UMSY	Exploitation Rate at MSY
U.S.	United States
WAC	Washington Coast
WCVI	West Coast Vancouver Island excluding Area 20
WDFW	Washington Department of Fish and Wildlife

List of Acronyms for Current CWT Exploitation Rate Indicator Stocks

AKS	Alaska Spring
ATN	Atnarko
BQR	Big Qualicum
CHI	Chilliwack
CHK	Chilkat
COW	Cowichan
CWF	Cowlitz Tule
CWS	Cowlitz Falls
DOM	Dome
ELK	Elk River
GAD	George Adams Fall Fingerling
GRN	Green River Fingerling
HAN	Hanford Wild
HAR	Harrison
KLM	Kitsumkalum
LRH	Columbia Lower River Hatchery
LRW	Lewis River Wild
LYF	Lyons Ferry
MSH	Middle Shuswap
NAN	Nanaimo
NIC	Nicola
NIS	Nisqually Fall Fingerling
NKS	Nooksack Spring Yearling
NSF	Nooksack Spring Fingerling
PPS	Puntledge
QUI	Quinsam
RBT	Robertson Creek
SAM	Samish Fall Fingerling
SHU	Lower Shuswap
SKF	Skagit Spring Fingerling
SKS	Skagit Spring Yearling
SKY	Skykomish
SPR	Spring Creek Tule
SPS	South Puget Sound Fall Fingerling
SPY	South Puget Sound Fall Yearling
SQP	Squaxin Pens Fall Yearling
SRH	Salmon River
SSF	Skagit Summer Fingerling
STI	Stikine
STL	Stillaguamish Fall Fingerling
SUM	Columbia Summers
TAK	Taku
UNU	Unuk
URB	Columbia Upriver Bright
UWA	Univ. of Washington Accelerated Fall
WRY	White River Spring Yearling
WSH	Willamette Spring

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EXECUTIVE SUMMARY

The Commission tasked the CTC with undertaking a review of the performance of the Chinook Chapter in 2014 to enable science-based decision making by the Parties during upcoming negotiations toward a revised Treaty annex. This review is presented in four sections: Stock performance, Fishery performance, Model performance, and Implementation matters.

Chapter 3 of the PST Agreement outlines a coast-wide approach to management of Chinook fisheries that was designed to provide a healthy and productive Chinook resource that imparts sustainable benefits to both Parties through implementation of abundance based fishery regimes that meet maximum sustainable yield (MSY) or other agreed biologically-based escapement and/or harvest rate objectives for stocks originating from Cape Suckling in Alaska south to Humbug Mountain in Oregon. U.S. and Canadian fisheries that harvest Chinook salmon from Cape Suckling in Alaska south to Cape Falcon in Oregon are classified as either aggregate abundance based management (AABM) fisheries or individual stock based management (ISBM) fisheries.

The Chinook Chapter is complex, including 13 major paragraphs (and many sub-paragraphs), Table 1, two appendices, and five attachments. The Chapter identifies the Parties aspirations for Chinook, lists individual stocks or stock groups with specific management and monitoring measures, identifies several specific funding mechanisms to augment agency programs, and lists extensive duties and assignments to the CTC. The management regime described in Chapter 3 is data intensive, and as such, it is difficult and costly to fully implement. Further, ambiguity in the language contained in Chapter 3 makes interpretation and evaluation challenging.

This report summarizes the performance of stocks, fisheries, and the PSC Chinook Model. The CTC has also examined the degree to which each Party has developed escapement goals, instituted and maintained the stock assessment programs required to support the management regime, and impediments to implementing Chapter 3 as prescribed in the 2009 Agreement. **Section 1** describes the task of this report.

Section 2 of this report evaluates the performance of Chinook stocks by examining escapements. Average escapements during the 1999 and 2009 Agreements, changes between these periods, recent brood geometric mean escapements, and agreed PSC objectives (or in a few cases agency objectives) are provided for 63 Chinook stocks or groups of stocks in Table 1. All 4 Southeast Alaska (SEAK) and 3 Transboundary River (TBR) stocks have CTC-accepted objectives, while only 2 of the 29 Canadian stocks and 13 of 27 southern U.S. stocks have CTC-accepted objectives. Of the 22 stocks with CTC-accepted objectives, 4 stocks are herein classified as stocks of concern if either the average escapement from 2009–2015 or the recent geometric mean was below 85% of the goal. These stocks are Situk, Cowichan, Harrison, and Queets spring-summer timed Chinook (see Appendix A for diagnostics for each). 25 escapement indicator stocks had a mean escapement during 2009–2015 that decreased by at least 15% from the 1999–2008 mean, 21 stocks increased by at least 15% and 12 stocks had varied by less than 15%. Table 2 provides additional information for annual escapement performance relative to CTC-accepted goals. The CTC was unable to reach consensus on how to empirically evaluate the status of stocks without CTC-accepted objectives.

Statistics concerning annual rate of change in escapements and in mature run equivalent (MRE) total exploitation rates are presented in Figure 1 and Figure 2, respectively. Escapements increased for more escapement indicator stocks than decreased (Figure 1). MRE rates also increased for more stocks than decreased (Figure 2), indicating that generally, exploitation was increasing for more stocks than decreasing. The distribution of total mortality in AABM fisheries, ISBM fisheries, and escapements are presented for 27 exploitation rate indicator stocks in the 2009 Agreement, along with percent change relative to the 1999 Agreement. For AABM fisheries, average exploitation rates decreased for 20 indicator stocks and increased for 7 indicator stocks. For ISBM fisheries, average mortality distribution percentages decreased on average for 9 indicator stocks, increased for 14 indicator stocks, and did not change for 3 from the 1999 Agreement (Table 3).

Color coded summary statistics for escapement, survival, and fishery impacts for escapement indicator stocks are provided in Table 4. Better quality escapement and exploitation rate data are needed to generate escapement goals and to assess stock performance, particularly in British Columbia and Washington. Evaluation of stock status would be facilitated by development of CTC-accepted biologically-based escapement objectives to better understand the effectiveness of the PST Chinook Regime.

Section 3 of this report reviews the performance of AABM and ISBM fisheries. The total landed catch in PST fisheries averaged 1,400,593 Chinook during the 1999 annex and 1,604,241 during the 2009 annex up to and including 2015, an increase of about 15%. Average U.S. ISBM landed catch increased by approximately 239,000 Chinook (+41%) relative to the 1999 Agreement, while averages for the other three fishery groups all decreased; about 18,000 Chinook (-6%) in the U.S. AABM fishery, about 16,000 Chinook (-7%) in the Canadian ISBM fisheries and about 1,000 Chinook (<-1%) in Canadian AABM fisheries. During the 1999 annex, the U.S. ISBM averaged 42%, the Canadian ISBM averaged 17%, the U.S. AABM averaged 21%, and the two Canadian AABM fisheries averaged 20% of the total annual PST catch. During the first seven years of the 2009 Agreement, percentages of the total PST landed catch averaged 51% in the U.S. ISBM (9% increase relative to the 1999 Agreement), 14% in the Canadian ISBM (4% decrease), 17% in the U.S. AABM (4% decrease) and 18% in the Canadian AABM (2% decrease) (Figure 3).

The PST Chinook model performs poorly in terms of providing preseason ISBM indices (Figure 4 and Figure 5), so poorly that agencies cannot rely upon those metrics when planning ISBM fisheries preseason. The considerable efforts invested by the CTC on investigations of AABM indices have partly precluded in-depth investigations of preseason ISBM indices. For example, it is unclear to what extent the performance of the Chinook Model ISBM indices are a consequence of insufficient attention to calibration settings. Improvements to the PSC Chinook Model are necessary to generate more useful preseason ISBM fishery indices, such as finer spatial-temporal fishery stratification, representation of MSFs, and finer scale stock representation. The CTC is working on several improvements to the model to improve the representation of stocks, fisheries, and Chinook population dynamics. Better quality input data (e.g. escapement by age, forecasts of escapement or terminal run) are needed for the large stocks to improve model performance. Attachments IV and V of Chapter 3 identify stocks to be monitored for ISBM performance. Evaluations were not possible for many of the stocks in Attachments

IV and V because they were not represented by a CWT indicator stock or they did not have base period exploitation rates to calculate the ISBM index. As Table 5 and Table 6 show, a CWT-based ISBM index cannot be calculated for 40% of the Canadian stocks and 25% of the U.S. stocks. In the case of several Canadian Attachment IV stocks, the ISBM statistic is not stock specific, but rather a rate for a single stock is widely applied to other stocks, even though terminal fisheries may vary among them. Of the 41 listed stocks, 17 could not have ISBM indices generated in any year, and six of the stocks could not have ISBM indices generated in all the years. Southern U.S. ISBM indices are not available until two years after the fishery which substantially reduces the responsiveness and effectiveness of ISBM provisions. Further, the CWT data necessary to compute postseason CWT-based ISBM indices become available with a 2-year lag for U.S. stocks and 1-year lag for Canadian stocks. This inability to specifically monitor performance for many Attachment stocks is another challenge to fully implementing the provisions of Chapter 3. Since 2009, the obligations for the Canadian ISBM fisheries were met for all stocks except WCVI (2 years), whereas for U.S. fisheries the ISBM obligations were met for all stocks except Nooksack spring (4 years), Grays Harbor fall (4 years), Queets fall (1 year), Deschutes (1 year), Nehalem (1 year) and Siletz (1 year). Figure 6 and Figure 7 illustrate Canadian and U.S. ISBM performance with respect to PST obligations.

The PST Chinook model has been used to determine preseason catch targets and post-season allowable catch limits for AABM fisheries since the start of the abundance-based management regime in 1999 (Table 7). Tables 8 to 10 (and Figures 8-10) show management and model errors. Average management error was 7% (range -1% to 43%) for SEAK during the 2009 Agreement while model error ranged from -38% to +30%. Deviation of the actual catch in SEAK from post-season allowable catch 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 5 of the 7 years from 2009–2015. Since 2009, the SEAK AABM fishery exceeded the post-season limit in 6 of the 7 years with the cumulative overage being about 75,000 Chinook. Average management error was -20% (range -1% to -33%) for NBC during the 2009 annex while model error ranged from -35% to 16%. Management errors in NBC were the result of Canada's domestic efforts to reduce impacts on WCVI Chinook. Management actions in NBC outweigh model errors in most years. Since 2009, the NBC AABM fishery has never exceeded the post-season limit and the cumulative underage is about 385,000 Chinook. Average management error was -1% (range -8% to 16%) for WCVI during the 2009 annex while model error ranged from -36% to 40%. Deviation of the actual catch in WCVI from post-season allowable catch was driven by model error. The WCVI management error and model error were in a common direction in 5 of 7 years from 2009–2013 and only in opposite directions in 2010 and 2014 when both model and management errors were small. Since 2009, the WCVI AABM fishery exceeded the post-season limit in 3 of the 7 years with the cumulative underage being about 11,000 Chinook. Relative to the 1999 Agreement, the 2009 Agreement called for 15% and 30% reduction of catches in the SEAK and WCVI AABM fisheries, respectively. From 2009–2015, average realized reductions were 10% in the SEAK AABM fishery and 27% in the WCVI AABM fishery.

The Commission requested the CTC to compare expected impacts of the 1999 versus the 2009 AABM fishery regimes through a "what if" simulation analysis. The CTC employed two sets of PSC Chinook Model simulation runs to produce a set of statistics that were used to compare stock performance and expected impacts under two scenarios: (1) expected results had the provisions of the 1999 Agreement been continued through 2015 and (2) expected results of the 1999 Agreement through 2008 and provisions of the 2009 Agreement beginning in 2009. The simulation indicated that implementation of the 2009 Agreement provisions beginning in 2009 resulted in a projected decrease of 11% in AABM catches, a projected increase of 2% in ISBM catches, and an increase in escapements that averaged 3% yearly. The projected increase in escapements ranged from 1.5% to 9.0%.

Section 4 of this report assesses the performance of the PSC Chinook Model and the model inputs. 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 coast-wide. Since the 1999 annex, the model has been used to enable abundance-based management in the PST through the production of AABM fishery abundance indices and ISBM indices. The three AABM fishery regime relationships relate fishery specific catch and fishery indices to AIs using a proportionality constant that varies annually but is assumed constant based on the 1979 to 1997 average harvest rates and the assumption that stock distribution and fishing patterns remain relatively stable.

Table 14 provides information on forecast origins, and the bias and error of forecasts used as inputs to the Chinook model. For AABM fishery planning, the error in the preseason AI generated by the model was the largest source of error for implementation of the AABM fisheries since 2009. Generally, the preseason AIs exceeded the post season AIs, except in 2013 and 2015. Of the six stocks with solely model-produced forecasts, 3 (50%) had a mean percent error that was less than the 7.5% bias guideline recommended by the CTC in 2013 for implementation of Paragraph 13. Of the 17 stocks with solely agency-provided forecasts summarized in Table 14, only six (35%) met that same performance criterion. None of the four stocks that use a combination of agency and model forecasts met this performance guideline. Of seven stocks that contribute 10% or more to at least one of the AABM fisheries, forecasts for five stocks (Northern BC, Fraser Late, Bonneville and Cowlitz Hatcheries, Upriver Brights, and Oregon Coast) had a mean percent error less than the 7.5% guideline and two did not (WCVI Natural and Hatchery and Puget Sound Fingerlings). Differences in forecast performance between the two Agreement periods occurred to some extent for all stocks with a few changes being more notable than others. For example, the Model-produced Lower Georgia Strait Natural and Upper Georgia Strait forecasts has increased in tendency to over-forecast the spawning escapements. The Commission has initiated an independent scientific review panel with the intent to provide additional insight into forecast performance and will make recommendations to the Commission prior to 2017.

Section 5 of this report discusses the successes and challenges associated with implementing the 2009 Agreement. The Chapter 3 management regime is data intensive, and requires that substantial fiscal resources be invested and coordinated across jurisdictions to provide data on catches, incidental mortality, and escapements as well as maintenance of a quality CWT system. During the negotiations, the Parties recognized that fiscal resources greater than those available at the time were required for implementing Chapter 3. In response, the Parties included additional funding to improve escapement assessments in specific regions, the CWT system, and the PSC Chinook Model. These additional resources totaled approximately $26 million over five years in order to augment annual expenditures of approximately $5 million. Information on progress for these specific items is included in Section 5.4 of this report.

The availability and quality of data used for the coast-wide Chinook indicator stock program is evaluated in Section 5.2. The CTC defined 11 attributes of the indicator stock program and three data quality levels for each of these attributes during the current annex period (Table 15). The CTC scored these attributes for each indicator stock against data quality criteria as a means of evaluating the efficacy of indicator stocks used to monitor stock status of Chinook (Table 16). The evaluation demonstrates that the information currently available ranges from high quality information available for some stocks to poor quality and/or a lack of quantitative information available for many others. Specific data needs are highlighted under regional headings.

At the conclusion of the negotiations for the 1999 Agreement, the lead Canadian and U.S. negotiators wrote a memorandum, dated 23 June 1999, to the Honorable Lloyd Axworthy, Honorable David Anderson, and Secretary of State Madame Albright stating:

> *"The Agreement represents a commitment to abundance-based management for the salmon fisheries covered by the Treaty. This important, new conservation-based approach will require adequate resources by each Party to ensure that the necessary scientific and management needs are met. In particular, the coastwide Chinook Chapter (Annex IV, Chapter 3) which represents a departure from previous Annexes, is dependent upon high quality fishery and stock assessment data being collected by management agencies coupled with time-consuming analysis of the data by the Chinook Technical Committee. Management agencies are urged to provide adequate resources, both staff and time, to the Chinook Technical Committee for successful implementation."*

The CTC encountered numerous information gaps and issues with data quality during the development of this report which prevented a comprehensive, certain assessment of stocks and evaluation of fisheries within the jurisdiction of the PSC. A large increase in funding for agencies is required to ensure data of appropriate quality can be provided for implementation of Chapter 3. The CTC recommends that the Parties fully fund the stock and fishery data collection programs that are necessary to implement the abundance-based management regime, as identified in the aforementioned letter of transmittal. The Commission cannot meet the goal of providing for a healthy and productive Chinook resource without adequate and timely stock assessments implemented by management agencies.

Section 5.3 identifies that there are only 22 CTC-accepted escapement goals in place 17 years after implementation of the abundance-based regime that is dependent upon having goals for performance monitoring. A scientifically-based management regime cannot be expected to be fully evaluated when less than half of the identified stocks have biologically-based escapement (or harvest rate) objectives. Section 5.3.1 identifies concerns with Attachments I to V of the Agreement. Implementation of precautionary management actions defined in paragraph 13 is also hampered by the lack of stock-specific objectives, and by an overly complex implementation scheme.

The 2009 Agreement includes a series of technical assignments to the CTC. While many tasks have been completed, many others are only partially complete or are on hold due to the need for policy clarification, or have not yet been started (Table 18). The quantity and complexity of assignments has placed an unrealistic work load on the CTC, and many are intertwined with policy related issues that the Commission, to date has not resolved. Section 5.5 identifies the CTC's concern about the eroding capacity of agencies to fully implement Chapter 3 of the Agreement. Fiscal pressures have already, and continue to erode the capacity of management agencies in both the U.S. and Canada to provide the basic data and other vital information for implementation of the current PSC fishing regime. In response to austerity demands, agencies are increasingly turning to Northern and Southern Endowment Funds to conduct work that would previously have been considered core stock and fishery management and assessment programs. In addition the CTC is increasingly concerned that due to staff and other fiscal limitations, the CTC is not able to meet the expectations of the Commission with regard to completing assignments, due to the extensive work load versus time and funding limitations that are imposed through the agencies. Succession planning in the CTC is needed in order to provide continuing capacity to implement and evaluate the requirements of Chapter 3.

The stocks in Attachments I-V need review as many stocks are not monitored for escapement or monitored inadequately, do not have escapement objectives, or do not have a representative CWT indicator stock to calculate ISBM indices and impacts in AABM fisheries. Deficiencies in many of the stock assessment and fishery evaluation programs make parts of Chapter 3 impractical for the majority of stocks and consequently few of the components of Chapter 3 were implemented fully during the 2009 Agreement.

Lastly, Section 5.6 discusses the current adequacy of computer models, tools, and assumptions that are used for implementation of Chapter 3 and identifies specific areas in need of improvement.

1. INTRODUCTION

This document provides a review of the performance of Chapter 3, the Chinook Chapter, of the 2009 Pacific Salmon Treaty. Specifically, this assignment evolved from the following text within Chapter 3:

In Paragraph 6 (c),

> "*In 2014, the Commission will review the performance of the conservation program established by this Chapter to evaluate the effectiveness of, and continuing need for, the harvest measures taken for the AABM fisheries, including the provisions for application of paragraph 13.*"

In Appendix A, Paragraph 9: Five-year review criteria,

> *"The CTC will develop a framework to evaluate the effectiveness of, and continuing need for, the harvest reduction measures taken for the AABM fisheries as outlined in Paragraph 9. Factors to be considered include abundance, exploitation rates (fishery harvest rates), and estimates of productivity for individual stocks and stock groups including, but not limited to, those included under the Sentinel Stock Program."*

This task remained unaddressed through 2014, at which stage U.S. and Canadian Commissioners initiated discussions suggesting that the CTC undertake a complete review of the performance of Chapter 3 to enable science-based decision making by the Commission during upcoming negotiations toward a revised Treaty annex. In early 2015, the CTC developed a draft outline for the report which was then submitted to the Commissioners, who subsequently instructed the CTC to proceed with this review, and to provide a draft report by June 2016.

In undertaking this review, the CTC has examined the status of stocks within the Treaty, the performance of AABM and ISBM fisheries, and how the PSC Chinook Model has performed in advising the management of fisheries. The CTC has also examined the degree to which each of the Parties has developed escapement goals, and instituted and maintained stock assessments required to support the management regime, and discussed other impediments to implementation of Chapter 3 as prescribed in the 2009 Agreement.

This report contains 6 sections: introduction, stock performance, fishery performance, model performance, implementation of Chapter 3, and key findings and recommendations.

2. STOCK PERFORMANCE

Paragraph 2(a)(ii) provides the first indication of what the 2009 Agreement regime means by conservation:

> "*continues harvest regimes based on annual estimates of abundance that are responsive to changes in production, take into account all fishery induced mortalities and designed to meet MSY or other agreed biologically-based escapement and/or harvest rate objectives; with the understanding that harvest rate management is designed to provide a desired range of escapements over time*".

Paragraph 2(a)(iv) provides a further understanding by stating: "*seeks to sustain stocks at healthy and productive levels by ensuring that stocks achieve MSY or other agreed biologically-based escapement and/or harvest rate objectives*".

Chapter 3 lists a specific set of stocks for which these escapement objectives apply; Attachments I-V of Chapter 3 list 41 indicator stocks.

Stock status performance is an important measure of AABM and ISBM fishery evaluations. These fisheries harvest a broad mixture of stocks. Negotiated catch levels for AABM fisheries are based on stepped harvest rate indices applied to the overall aggregate abundance according to the specific AABM fishery regime relationship. Since these harvest rate indices are set on the basis of the aggregate abundance, they are sensitive to the status of the abundant stocks and they are less sensitive to the status of less abundant stocks. To manage the entire Chinook resource effectively among AABM and ISBM fisheries, a relevant and timely stock status evaluation is critical.

As the Parties enter into the 18th year of the abundance based management regime for coast-wide Chinook salmon, only 13 of 41 (32%) stocks of Chinook salmon specifically listed in the attachments to Chapter 3 have CTC-accepted escapement or harvest rate objectives. This includes 2 of 22 (9%) Canadian stocks and 11 of 19 (58%) U.S. stocks. This lack of stock specific agreed upon objectives makes evaluation of stock conservation status challenging and incomplete.

2.1 Escapement Evaluation

The CTC provides an annual evaluation of estimated spawning escapements for a set of Chinook salmon indicator stocks. Table 1 provides a summary of escapement information for these stocks by providing averages during the 1999 Agreement, the 2009 Agreement, and the geometric mean for the most recent brood. For stocks with CTC-accepted escapement objectives (22 of the 61 unique stocks or stock groups in Table 1), these averages are divided by the point value or the lower end of the range and presented as percentages. Percentages of CTC-accepted escapement objectives are colored blue if the average percentage is greater than 200% for point value or above the upper end of the range, green if the average percentages are 100-200% of a point value or within the range, yellow if the average percentages are 85-100% of the escapement objective, and red if less than 85% of the escapement objective. The upper limit of the red zone (85%) is specifically identified in Chapter 3 as the benchmark level below an escapement objective for assessment of whether a stock merits additional management actions to assist with increasing the abundance of returning spawners (see Chapter 3, paragraph 13(c)). For stocks without escapement objectives, average spawning escapements during the 1999 Agreement and the 2009 Agreement were compared; if average escapements increased by more than 15%, the escapement trends were labeled as increasing (depicted by arrows), if average escapements decreased by more than 15%, the escapement trends were labeled as decreasing, and if within 15% between the two time periods, labeled as unchanged. Escapements include hatchery and natural origin fish.

Table 1– Status of PST Escapement Indicator stocks in the 1999 and 2009 Agreements.

All escapement percentages are calculated as a percent of either the point goal or the lower end of the escapement goal range. The geometric mean (Recent GM) is given for the most recent number of years (# Yrs) that represent the stock's predominant age of maturation.

Legend	
Esc Goal Ranges	Esc Point Goals
Above Range	>200%
Within Range	100-200%
85-100% Lower End	85-100%
< 85% Lower End	< 85%

Stock	CTC Goal	Other Goal	Average Escapements							
			1999-2008		2009-2015		Change	Recent GM		# Yrs
Alsek	3,500-5,300		169%	5,920	162%	5,670	-4%	130%	4,564	5
Taku	19,000-36,000		204%	38,723	132%	25,129	-35%	121%	23,070	5
Stikine	14,000-28,000		253%	35,475	130%	18,166	-49%	139%	19,491	5
Situk	500-1,000		203%	1,017	91%	456	-55%	79%	395	4
Chilkat	1,750-3,500		186%	3,255	133%	2,329	-28%	113%	1,971	5
Unuk	1,800-3,800		311%	5,598	132%	2,370	-58%	96%	1,727	5
Chickamin	2,150-4,300		211%	4,527	146%	3,138	-31%	123%	2,638	5
Nass[1]		10,000	195%	19,518	156%	15,626	-20%	118%	11,757	5
Skeena				45,133		35,654	-21%		33,141	5
Kitsumkalum[2]		8,600	204%	17,507	136%	11,661	-33%	132%	11,312	5
Dean				2,703		1,555	-42%		NA	4
Wannock				3,180		4,085	28%		4,117	4
Chuckwalla/Kilbella				1,339		388	-71%		410	4
Atnarko[2]		5,000	276%	13,797	354%	17,708	28%	390%	19,483	4
WCVI Index 14				9,559		12,686	33%		13,023	4
WCVI 6 - Marble				2,536		3,293	30%		2,483	4
WCVI 6 - Burman				732		3,562	386%		3,540	4
WCVI 6 - Tahsis				596		436	-27%		366	4
WCVI 6 - Artlish				242		309	28%		275	4
WCVI 6 - Kaouk				336		289	-14%		241	4
WCVI 6 - Tahsish				356		372	5%		395	4
U. Georgia St. Index				10,907		14,997	37%		19,956	4
UGS - Nimpkish				540		1,656	207%		2,310	4
UGS - Klinaklini				9,874		13,064	32%		17,297	4
UGS - Kakweiken				147		189	29%		263	4
UGS - Kingcome				251		95	-62%		31	4
UGS - Wakeman				85		79	-8%		43	4
Cowichan	6,500		56%	3,639	51%	3,319	-9%	74%	4,796	3
Nanaimo[2]		3,000	61%	1,834	67%	2,014	10%	49%	1,466	3
Fraser Sp 1.3				26,537		20,791	-22%		18,420	5
Fraser Sp 1.2				9,499		5,362	-44%		6,292	4
Nicola[2]		9,500	81%	7,658	45%	4,233	-45%	54%	5,100	4
Fraser Sum 1.3				25,725		18,182	-29%		16,172	5
Fraser Sum 0.3				82,273		114,447	39%		60,953	4
Lower Shuswap		12,300	251%	30,905	271%	33,370	8%	174%	21,423	4
Harrison	75,100-98,500		137%	102,688	101%	75,822	-26%	72%	54,254	4

Table 1– Page 2 of 2.

Stock	CTC Goal	Other Goal	Average Escapements							
			1999-2008		2009-2015		Change	Recent GM		# Yrs
Nooksack Spring[3]		4,000	56%	2,256	45%	1,783	-21%	36%	1,457	4
Skagit Spring[3]		2,000	61%	1,224	78%	1,567	28%	94%	1,885	4
Skagit Summer/Fall[3]		14,500	106%	15,308	68%	9,857	-36%	83%	12,029	4
Stillaguamish[3]		900	142%	1,274	97%	869	-32%	79%	714	4
Snohomish[3]		4,600	146%	6,735	76%	3,518	-48%	86%	3,978	4
Lake Washington[3]		1,680	76%	1,274	72%	1,212	-5%	82%	1,381	4
Green[3]		5,800	100%	5,804	39%	2,246	-61%	50%	2,897	4
Quillayute Summer[3]		1,200	76%	912	60%	716	-21%	64%	769	4
Hoh Spring/Summer	900		129%	1,164	95%	859	-26%	96%	860	4
Queets Spring/Summer	700		57%	399	68%	474	19%	76%	531	4
Grays Harbor Spring[3]		1,400	165%	2,307	142%	1,993	-14%	113%	1,584	4
Hoko[3]		850	82%	699	115%	975	39%	118%	1,006	4
Quillayute Fall	3,000		161%	4,822	120%	3,592	-26%	111%	3,322	4
Hoh Fall	1,200		215%	2,578	151%	1,815	-30%	138%	1,658	4
Queets Fall	2,500		124%	3,106	146%	3,647	17%	144%	3,608	4
Grays Harbor Fall	13,326		119%	15,836	120%	15,933	1%	111%	14,848	4
Col R Spring				19,704		24,955	27%		25,404	4
Col R Summer	12,143		412%	50,058	498%	60,456	21%	580%	70,485	4
Col Upriver Bright	40,000		230%	92,010	560%	224,089	144%	685%	273,846	4
Coweeman				644		1,011	57%		1,095	4
Lewis Fall	5,700		189%	10,766	225%	12,843	19%	276%	15,706	4
Deschutes	4,532		242%	10,950	327%	14,797	35%	390%	17,685	4
Nehalem	6,989		124%	8,649	137%	9,566	11%	156%	10,876	5
Siletz	2,944		214%	6,309	185%	5,432	-14%	201%	5,907	5
Siuslaw	12,925		218%	28,208	192%	24,817	-12%	209%	26,960	4
S Umpqua				4,941		8,187	66%		9,257	4
Coquille				6,888		14,191	106%		9,152	4

Legend	
Esc Goal Ranges	Esc Point Goals
Above Range	>200%
Within Range	100-200%
85-100% Lower End	85-100%
< 85% Lower End	< 85%

[1]*Nass minimum escapement target = 10,000 fish.*

[2]*Habitat-based estimate of S_{MSY}.*

[3]*State–tribal management goal (upper management threshold for Puget Sound stocks).*

The 22 stocks with CTC-accepted escapement objectives, on average, generally met or exceeded the point value or the lower bound of the range during both annex time periods with few exceptions (Table 1 and Table 2). For the regional stock groups on average, all 3 TBR stocks and 3 of 4 SEAK stocks met escapement objectives; none of 1 Georgia Strait stock and none of 1 Fraser stock met escapement objectives; 5 out of 6 Washington Coast stocks met objectives; and all 4 Columbia River stocks and all 3 Oregon coast stocks met objectives. TBR and SEAK stocks experienced poor production and escapement in 2007–2008 and again from 2012–2014, but have improved recently. The Cowichan River stock has failed to meet its escapement objective annually since 2005. The Harrison River has met its goal 60% of the time with escapements varying from high to low over the time series. Hoh River spring/summer and Queets River spring/summer stocks have failed to meet their respective escapement objectives in the majority of years since 2004. All Columbia River stocks demonstrated increased escapements during the 2009 Agreement. Washington and Oregon coastal stocks had poor escapement in 2007–2009, when escapement objectives were missed.

For indicator stocks without CTC-accepted goals, the pattern of increases or decreases varied regionally. Escapements in 5 of the 7 stocks in the NBC/CBC region decreased, with the exception of two stocks, which increased. On average, the WCVI 14-stream indicator stock group increased (+33%) between the two time periods. For the WCVI 6-stream indicator stock group, 3 of 6 constituent stocks increased, one decreased, and two had minor changes (range of -27% to +386%). Variation in the enhanced production among rivers and years affects the variability in patterns for the WCVI stocks. Average escapements to the Upper Georgia Strait group increased on average, and among the five constituent stocks, three increased, one decreased, and one showed minimal change (range of -62% to 207%). Escapement data quality is very poor for these rivers. The Fraser River stocks had diverse patterns; the three yearling spring and summer stock groups decreased, and conversely, the Summer 0.3 aggregate increased. Five of the 7 Puget Sound stocks decreased, one increased, and one had minor change (range of -61% to +28%). The two spring and summer-run Washington Coast stocks decreased, while the only Washington Coast fall stock without an accepted goal increased. The two Columbia River stocks also increased– Columbia River springs and Coweeman River Tules. Average escapements for the two mid Oregon coastal stocks both increased.

The number of stocks meeting their CTC agreed escapement objectives decreased from 90% during the 1999 Agreement period to 82% during the current period (Table 2). Note that the number of CTC-accepted objectives has increased from 11 stocks in 1999 to 22 stocks currently. Annual performance of the escapement in Table 2 shows that from 1999 to 2005, the percentage of stocks that met CTC- agreed objectives only fell below 90% in one year (1999). In 2005, the number of indicator stocks with CTC agreed objectives increased to 20, however, the proportion met decreased to 75%. This decreasing trend continued through 2007, when only 9 of 20 stocks met escapement objectives (45%). Since 2007, the percentages of stocks meeting objectives has remained above 50%, and increased in 2015 when 19 of 22 stocks met them (86%).

Table 2– Annual performance of indicator stocks for stocks with CTC agreed escapement goals.

Gray cells are cases where an escapement goal was not in place, green cells = where an escapement goal was reached or exceeded, yellow cells = where an escapement was within 85% *of the point or lower end of a range, and red cells = where an escapement was more than 15% under a point goal or lower end of an escapement goal range.*

Stock	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	% Met
Alsek[1]																		71%
Taku[2]																		82%
Stikine																		94%
Situk																		65%
Chilkat																		67%
Unuk																		82%
Chickamin																		94%
Nass																		
Skeena																		
Kitsumkalum																		
Wannock																		
Chuckwalla/Kilbella																		
Atnarko																		
WCVI Index - 14 stream																		
Upper Georgia St. Index																		
Cowichan																		0%
Nanaimo																		
Fraser Sp 1.3																		
Fraser Sp 1.2																		
Nicola																		
Fraser Sum 1.3																		
Fraser Sum 0.3																		
Lwr. Shuswap																		
Harrison																		60%
Nooksack Sp																		
Skagit Sp																		
Skagit Sum/Fa																		
Stillaguamish																		
Snohomish																		
Lake Washington																		
Green																		
Hoko																		
Quillayute Sum																		
Quillayute Fall																		92%
Hoh Sp/Sum																		42%
Hoh Fall																		100%
Queets Sp/Sum																		8%
Queets Fall																		83%
Grays Harbor Sp																		
Grays Harbor Fall																		50%
Col R Spring																		
Col R Summer																		100%
Col R Upriver Bright																		100%
Coweeman																		
Lewis																		76%
Deschutes																		100%
Nehalem																		65%
Siletz																		82%
Siuslaw																		88%
S Umpqua																		
Coquille																		

[1] From 1999–2009 the Alsek River escapement goal range was 1,100– 2,300 Chinook counted at the Klukshu River weir.

[2] From 1999–2009 the Taku River escapement goal range was 30,000– 55,000 large Chinook salmon.

2.2 ESCAPEMENT TREND ANALYSIS

Chinook salmon escapement trends from 1999 to 2015 were estimated using a state-space exponential growth model (Dennis et al. 2006) parameterized through restricted maximum likelihood (Humbert et al. 2009). Escapement trends were characterized by the long-term mean rate of change (μ) and corresponding 80% confidence intervals, where $\mu = 0$ indicates equilibrium (i.e. escapement is stable), $\mu > 0$ indicates escapement is increasing and $\mu < 0$ indicates escapement is decreasing. The confidence intervals represent the inter-annual variability in escapement rates of change (hereafter trends). Because μ is in the log scale, finite rates of change are computed as e^{μ} and percent changes as (e^{μ} -1). Similarly in the escapement evaluations section, these trends include escapements of hatchery and natural origin fish.

There were 51 escapement indicator stocks included in the analysis, of which 22 stocks had CTC-accepted escapement goals (Figure 1). Of the 51 stocks examined, 19 exhibited a negative trend (-12.1% to -0.6%) of which 5 were significantly different from 0. The remaining 32 stocks exhibited a positive trend (+0.2% to +17.9%), 5 of which had trends different from 0. Inter-annual variability in annual rates of change was large for many stocks leaving only few cases of clearly positive or clearly negative trends.

Of the stocks with CTC-accepted escapement goals, three exhibited significant negative mean percent changes in escapement – Situk (-9.8%), Harrison (-4.1%), Hoh Fall (-2.8%), and one stock exhibited a significant positive mean percent change in escapement – Columbia River URB (+14.7%). Of the stocks without CTC-accepted escapement goals, two stocks exhibited significant negative trends in escapement– Stillaguamish (-5.0%), Snohomish (-4.9%), and four stocks exhibited significant positive trends in escapement– WCVI6-stream index (+3.0%), Skagit Spring (+3.9%), Fraser Summer 0.3 (+4.6%), Wannock (+6.9%). Stocks showing the largest inter-annual variability in rates of change, judging by the width of their rate of change confidence intervals, were Siletz, Coquille, Columbia River Upriver Spring, and Coweeman.

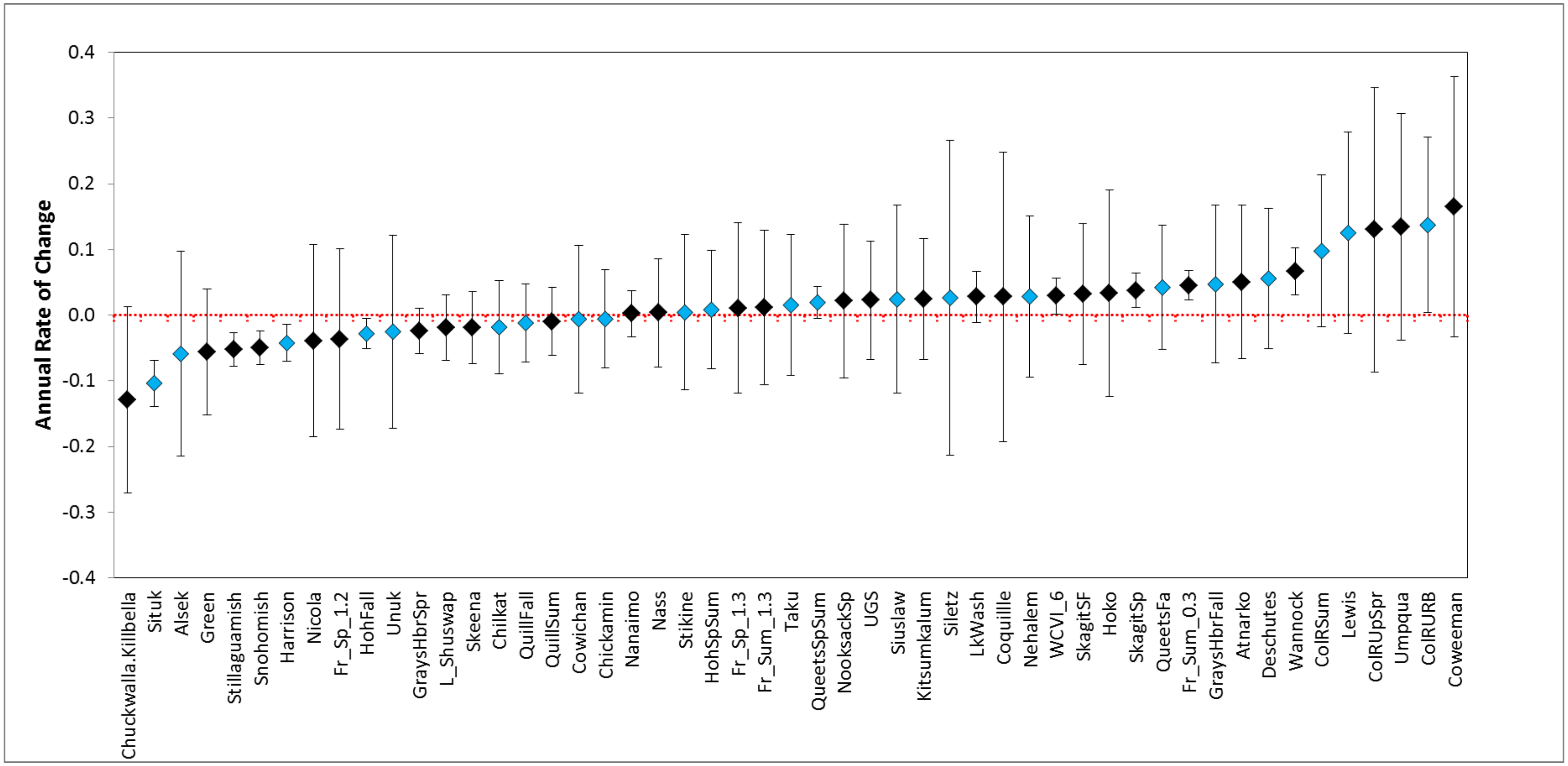

Figure 1—Annual rate of change for escapement for Chinook salmon indicator stocks, 1999–2015.

Diamonds represent mean rates of change (μ) and bars represent 80% confidence intervals. Stocks are ordered from the smallest to the largest μ value with stocks with CTC-accepted escapement goals highlighted in blue. The red line at zero represents equilibrium (i.e. no change).

2.3 Stock-Specific Fishery Impacts

The CTC provides "mortality distribution tables" in the annual Model Calibration and Exploitation Rate Analysis reports (appendix C in TCChinook (15)-1 V. 2). These tables are designed to reflect the percent of estimated total mortality on individual stocks attributed to specific fisheries and assessed through the CTC-Analytical Working Group's (AWG) annual cohort analysis. A different approach is presented in Table 3 using those mortality distribution tables, to show differences in impacts between the two annex periods, 1999–2008 and 2009–2015, in much broader categories, namely the three AABM fisheries, U.S. and Canadian ISBM fishery impacts and escapement. In addition, those differences are displayed both graphically and numerically in this table. Positive changes are noted with up arrows, negative changes with down arrows and no changes are noted with level arrows. For each CWT indicator stock used to represent each of the escapement indicator stocks within a region, the percent distribution of CWT recoveries are displayed with percent change between the periods. For indicator stocks without appropriate CWT representation in fisheries or a subset of fisheries, the corresponding cells are blank and shaded.

Table 3 features the distribution of total mortality from 27 exploitation rate indicators. During the 2009 Agreement, annual fishery mortality ranged from 13% to 65% .For AABM fisheries the change in annual fishery mortalities from the 1999 Agreement decreased on average for 20 indicator stocks, increased for 7 stocks. For ISBM fisheries, average mortality distribution percentages decreased on average for 9 indicator stocks, increased for 14 indicator stocks, and did not change for 3 from the 1999 Agreement.

TBR

The Alsek, Taku, and Stikine rivers comprise the transboundary river production group and these stocks are managed as per Chapter 1 of the PST. These stocks rear in the Gulf of Alaska and Bering Sea and as a result are not exposed to PSC fisheries as rearing fish; almost all harvest on these stocks is on returning, mature adults in SEAK and in-river in Canada in various ISBM fisheries. Tabulation of these catches (by age from scales) provides the basis for estimating exploitation metrics presented in this report for TBR stocks because Canadian ISBM fisheries in these rivers are not routinely sampled to recover CWTs. Incidental mortality estimates by age were not estimated for any of the three TBR stocks. Incidental mortality is believed to be minor for these stocks and there is no agreement concerning appropriate rates to apply to Canadian terminal harvests. No adjustment was made for adult equivalents in these harvests as they are ≥99% mature.

For the Alsek River stock, timing of nearby fisheries and recovery of CWTs historically implanted in smolt from the Alsek River indicate that significant harvest has been limited to terminal fisheries on the Alsek River (McPherson et al. 1998). Harvest primarily occurs as incidental harvest during the traditional sockeye salmon fishery in the lower river in Dry Bay in the U.S. and in Canadian sport and aboriginal fisheries in a few select tributaries in the upper drainage.

Table 3– Average mortality distributions during 2009–2015 and % change from 1999–2008 average, based on CWT indicator stocks[1].

Escapement Indicator Stock	Expl. Rate Ind.	AABM						ISBM				ESC	
		SEAK		NBC		WCVI		US		CAN			
		% Mort	% Chg	% Mort	% Chg	% Mort	% Chg	% Mort	% Chg	% Mort	% Chg	% Esc	% Chg
Alsek[2]		11%	↑ 1%							2%	→ 0%	87%	↓ -1%
Taku[2]	TAK	14%	↓ -7%							10%	↓ -1%	77%	↑ 9%
Stikine[2]	STI	7%	↓ -22%							16%	↓ -10%	77%	↑ 32%
Situk[2]		22%	↓ -21%									78%	↑ 21%
Chilkat	CHK	23%	↑ 7%	0%	→ 0%	0%	→ 0%	0%	→ 0%	0%	→ 0%	77%	↓ -7%
Unuk	UNU	35%	↑ 12%	0%	→ -1%	0%	→ 0%	0%	→ 0%	0%	→ 0%	64%	↓ -11%
Chickamin	AKS[3]	33%	↓ -2%	1%	→ 0%	0%	→ 0%	0%	→ 0%	0%	→ 0%	67%	↑ 2%
Nass	KLM	15%	↓ -3%	12%	↑ 1%	0%	→ 0%	0%	→ 0%				
Skeena (Kitsumkalum)										5%	↓ -3%	67%	↑ 5%
Dean	ATN	9%	→ 0%	5%	→ -1%	0%	→ 0%	0%	→ 0%				
Wannock													
Chuckwalla/Kilbella													
Atnarko										30%	↑ 3%	55%	↓ -2%
WCVI Hatchery	RBT	18%	→ 1%	6%	→ 0%	3%	↑ 2%	0%	→ 0%	25% Max	↓ -5%	48%	↑ 1%
WCVI Adjusted[4]		19%	→ 0%	6%	→ 0%	3%	↑ 2%	0%	→ 0%	9% Min	↑ 3%	63%	↓ -5%
WCVI 6 - Marble													
WCVI 6 - Burman													
WCVI 6 - Tahsis													
WCVI 6 - Artlish													
WCVI 6 - Kaouk													
WCVI 6 - Tahsish													

Table 3– Page 2 of 3.

Escapement Indicator Stock	Expl. Rate Ind.	AABM						ISBM				ESC	
		SEAK		NBC		WCVI		US		CAN			
		% Mort	% Chg	% Mort	% Chg	% Mort	% Chg	% Mort	% Chg	% Mort	% Chg	% Esc	% Chg
UGS - Nimpkish UGS - Klinaklini UGS - Kakweiken UGS - Kingcome UGS - Wakeman	QUI[5]	20%	↓ -2%	2%	→ 0%	0%	→ 0%	0%	→ 0%	12%	→ -1%	67%	↑ 3%
LGS - Cowichan	COW	1%	→ 0%	0%	→ -1%	9%	↓ -5%	13%	→ 1%	40%	↑ 3%	37%	↑ 2%
LGS - Nanaimo	NAN												
Fraser Sp 1.3	DOM												
Fraser Sp 1.2 (Nicola)	NIC	0%	→ 0%	1%	→ -1%	0%	↓ -1%	4%	↑ 3%	17%	↓ -4%	77%	↑ 3%
Fraser Sum 1.3 (Chilko)													
Fraser Sum 0.3 (Lower Shuswap)	SHU	10%	↓ -6%	10%	↓ -2%	2%	↑ 1%	2%	↑ 2%	20%	↑ 4%	55%	↑ 1%
Harrison	HAR	0%	→ 0%	0%	→ 0%	5%	↓ -12%	7%	↓ -6%	10%	↑ 2%	77%	↑ 16%
Nooksack Spring	NSF	6%	↓ -1%	0%	→ 0%	27%	↓ -17%	15%	↑ 6%	21%	↑ 5%	32%	↑ 7%
Skagit Spring[6]	SKS	1%	→ 0%	0%	→ 0%	6%	↓ -6%	28%	↑ 11%	8%	↓ -5%	58%	↓ -1%
Skagit Summer/Fall	SSF	10%	↑ 1%	1%	→ -1%	9%	↓ -3%	19%	↑ 13%	9%	↑ 2%	51%	↓ -13%
Stillaguamish	STL	3%	→ 0%	0%	→ 0%	13%	→ 1%	19%	↑ 9%	13%	↑ 5%	51%	↓ -16%
Snohomish													
Lake Washington													
Green	SPS	0%	→ 0%	0%	→ 0%	10%	↓ -5%	25%	↓ -6%	5%	→ 1%	61%	↑ 10%

Table 3– Page 3 of 3.

Escapement Indicator Stock	Expl. Rate Ind.	AABM						ISBM				ESC	
		SEAK		NBC		WCVI		US		CAN			
		% Mort	% Chg	% Mort	% Chg	% Mort	% Chg	% Mort	% Chg	% Mort	% Chg	% Esc	% Chg
Quillayute Summer													
Hoh Spring/Summer													
Queets Spring/Summer													
Grays Harbor Spring													
Hoko	HOK	14%	↓ -3%	8%	↓ -2%	3%	↑ 2%	6%	↑ 5%	4%	↑ 1%	66%	↓ -3%
Quillayute Fall Hoh Fall Queets Fall Grays Harbor Fall	QUE	28%	↑ 6%	11%	→ 0%	1%	→ 0%	24%	↑ 11%	1%	→ 1%	36%	↓ -18%
Col R Spring													
Col R Summer	SUM	12%	↓ -7%	3%	↓ -3%	9%	↓ -3%	41%	↑ 19%	1%	→ 0%	35%	↓ -6%
Col Upriver Bright	URB	13%	↓ -4%	5%	→ -1%	3%	→ 0%	32%	↑ 6%	1%	→ 0%	47%	↓ -2%
Coweeman	CWF	3%	↓ -3%	1%	→ -1%	3%	↓ -7%	18%	↓ -13%	1%	→ 1%	75%	↑ 23%
Lewis Fall	LRW	11%	↓ -3%	7%	↑ 2%	9%	↑ 3%	25%	↑ 8%	1%	→ 0%	47%	↓ -10%
Deschutes Fall	LYF	2%	→ -1%	1%	→ 0%	7%	↑ 4%			0%	→ 0%		
Nehalem Siletz Siuslaw	SRH	14%	↓ -6%	10%	→ 0%	2%	→ 1%	30% Max	↑ 3%	0%	→ 0%	43%	↑ 2%
S Umpqua Coquille	ELK	6%	↓ -3%	4%	→ -1%	3%	→ 0%	32% Max	↓ -5%	0%	→ 0%	55%	↑ 9%

[1]*Results for Alaskan and Canadian stocks are based on data from 2009–2015. For southern U.S. stocks, results from 2015 were not yet available.*

[2]*Data are based on landed catch accounting program and run reconstruction.*

[3]*Alaska Spring hatchery stock group includes hatchery information from Neets Bay, Whitman Lake, Little Port Walter, and Deer Mountain hatcheries.*

[4]*Unadjusted and adjusted mortality estimates are given for the RBT CWT indicator to bound the likely range of ISBM (and other) fishery impacts applicable to the escapement indicator stocks comprising the aggregate. The adjusted estimates were obtained by subtracting the terminal fishery CWT estimates specific to RBT from the ISBM fishery total and adding them to the escapement. Recalculation of the percentage distribution of mortality results in some adjustment to each category.*

[5] *Mortality estimates for the QUI CWT indicator were adjusted to better represent the mortality distribution of the associated escapement indicators by removing the terminal north Georgia Strait impacts targeting Quinsam River Chinook from the Canadian ISBM fishery impact total and adding them to the escapement total.*

[6] *Adjusted to account for in-river mark selective fishery.*

For the Taku and Stikine rivers stocks, CWT based harvest estimates in pre-terminal areas was combined with terminal U.S. and Canadian terminal harvests to estimate the exploitation rates. Although smolt are coded-wire tagged in each system annually, marked fractions are low and harvest estimates based on recovery of CWTs can have poor accuracy in small terminal fisheries where a few hundred fish are sampled for CWTs. As a result, more accurate genetic stock identification programs were implemented beginning in 2005 to estimate harvests of these stocks in the U.S. terminal area mixed stock fisheries, along with continuing collection of scales to provide harvest by age. For the Taku stock, U.S. terminal fisheries include the traditional sport and gillnet fisheries; for the Stikine stock, U.S. terminal fisheries include the traditional sport, spring troll, and gillnet fisheries. For both stocks, in years of surplus production, directed Chinook salmon fisheries using net, troll, and liberalized sport gears are prosecuted. Even though the tagged rate for CWT's is relatively low for both of these stocks, estimated harvests in the pre-terminal areas (SEAK troll and sport primarily) is expected to be estimated with a mean error of zero over time, as 70,000 to 100,000 Chinook are sampled for CWT recovery in these fisheries annually through the region-wide commercial and sport catch sampling programs (McPherson et al. 2010; Bernard et al. 2000). Outside of the terminal area, harvest for both stocks is limited as these stocks are outside rearing and display rapid migration times through SEAK AABM fisheries on their way to the terminal areas; annual pre-terminal harvests typically range from 500 to 1,500 Chinook. Terminal harvests in the U.S., less than the total base level harvests, described in Chapter 1 of the PST are accounted for as part of the SEAK AABM fishery regime; harvests in excess of these base levels are accounted for as part of Chapter 1 of the PST. For both stocks, harvests occur as incidental harvests in the traditional sockeye gillnet fisheries and as directed harvests in test, assessment, commercial, sport and aboriginal fisheries in terminal and in-river waters in Canada; all of which have age data. However, the in-river terminal commercial, sport, and aboriginal fisheries in Canada are not sampled for CWTs and only sporadic sampling has occurred in the test fisheries, as these data are not deemed necessary to implement Chapter 1 provisions for these stocks. Hence, pre-terminal impacts are estimated via expanded CWT recoveries (by age) while terminal harvests by age are estimated with genetic methods in the U.S. fisheries and reported harvests by age are used for the Canadian in-river fisheries.

Average mortality distributions in the SEAK AABM fishery for Alsek Chinook salmon in the current annex (2009–2015) versus the previous annex (1999–2008) increased by 1% (from 10% to 11%), while average mortality for Taku Chinook declined by 7% (21% to 14%) and Stikine Chinook declined by 22% (29% to 7%). The decline for the Taku and Stikine rivers stocks in the SEAK AABM fishery is primarily the result of a lack of directed Chinook salmon fisheries in the current annex period. Mortality distributions in the Canadian inriver ISBM fishery remained relatively stable for the Alsek, decreased for the Taku by 1%, and decreased by 10% for the Stikine.

SEAK

The Situk, Chilkat, Unuk and Chickamin rivers Chinook salmon stocks comprise the SEAK production group. The Situk River stock of Chinook rears in the Gulf of Alaska and Bering Sea and as a result is not exposed to SEAK fisheries as rearing fish; harvest on this stock is of mature adults. The Chilkat, Unuk and Chickamin rivers stocks rear in both SEAK and the Gulf of Alaska and Bering Sea and therefore are exposed to SEAK fisheries as rearing fish. As a result, harvests of these stocks are comprised of both mature adults in addition to rearing fish. The Situk River stock of Chinook is exclusively harvested in the terminal estuary and inriver fisheries (McPherson et al. 2005). A small portion of the annual harvest of the Situk River stock is excluded from the SEAK Chinook all-gear PST harvest limit. Average mortality distributions dropped from 43% to 22% and this is mostly due to very conservative management measures in place to reduce harvests and increase escapement. For the Chilkat and Unuk rivers stocks, smolt are coded-wire tagged annually in each system at adequate mark fractions (8-9%) that provide accurate and precise measures of harvest in SEAK mixed stock fisheries. (Ericksen and McPherson 2004; Hendrich et al. 2008). Average mortality distributions for both the Chilkat and Unuk stocks increased from 16% to 23% and 23% to 35%, respectively between the previous and current Agreement periods. During the current annex, both stocks have experienced reduced productivity requiring additional conservative management measures to reduce harvest in the effort to pass fish to escapement. For the Chickamin River stock, the Alaska spring hatchery (AKS) stock group is used as a surrogate. Average mortality distributions were stable between 33% and 34% during this Agreement period versus the previous period.

NBC

The northern British Columbia production area encompasses Dixon Entrance to Kitimat; it includes Haida Gwaii and the Nass and Skeena watersheds, and it is represented by the Kitsumkalum River (KLM) CWT indicator stock. Fishing mortality for this stock aggregate occurs mainly in the SEAK and NBC AABM fisheries and in northern Canadian ISBM fisheries. Reductions in total mortality for SEAK AABM fishery (-3%) and in the Canadian ISBM fishery NBC (-3%) and a small increase in the NBC AABM fishery (+1%) have occurred during the 2009 Agreement. On average, 67% of Kitsumkalum Chinook recruited to escapement which is an increase of 5% relative to the 1999 annex. Canadian ISBM impacts to the Kitsumkalum River stock differ from other NBC stocks because there are different terminal fisheries both in the marine and freshwater environments. Further, Chinook stocks in the Skeena River watershed upstream of the Kitsumkalum River also experience additional exploitation although impacts have not been included in the assessments.

CBC

The central British Columbia production area encompasses Kitimat to Cape Caution and includes the Dean and Bella Coola watersheds as well as Rivers Inlet. It is represented by the Atnarko River (ATN) CWT indicator stock. Fishing mortality for this stock aggregate occurs mainly in Canadian ISBM fisheries followed by the SEAK and NBC AABM fisheries. There have been essentially no changes on average total mortality between the two annex periods for SEAK or NBC, but an increase in the Canadian ISBM fishery (+3%) occurred during the 2009 Agreement. On average, 55% of Atnarko Chinook recruited to escapement, which is a decrease of 2% relative to the 1999 Agreement. In-river catch from commercial, First Nations, and sport fisheries in the Bella Coola and Atnarko rivers are monitored and sampled to different degrees for CWTs. Terminal fisheries targeting returning Atnarko River spawners result in greater impacts on the ATN CWT indicator than occur on associated escapement indicator stocks in the aggregate. Consequently, certain ISBM fishery impacts on ATN generated with the mortality distribution data are not representative of other CBC natural escapement indicator stocks. The Dean, Wannock and Chuckwalla/Kilbella rivers are remote and have unique life histories (e.g. run timing and maturation patterns) and experience different terminal fisheries thus the ATN CWT data requires adjustment to represent these other stocks as an indicator. Those adjustments have not been made with the stock.

WCVI

The WCVI stock aggregate is far-north migrating and the Robertson Creek Hatchery (RBT) is the CWT indicator stock that represents WCVI escapement indicator stocks. The escapement indicator stocks spawn in river systems entering into separate inlets occurring northward from Barkley Sound where the RBT CWT indicator is located. Inlet-specific terminal fisheries differentially impact the stocks in this aggregate compared to the RBT indicator. For this reason, the RBT mortality distribution data was summarized using two approaches: 1) all terminal fishery impacts targeting RBT were included as ISBM impacts, and 2) the CWT estimates of terminal fishery impacts specific to RBT were subtracted from the ISBM fishery total and added to escapement which required recalculation of percentage distribution of mortality. These two approaches provide approximate minimum and maximum values (see Table 3 and rows for 'WCVI Hatchery' and 'WCVI Adjusted'). Fishing mortality for the WCVI stock group is mainly in the AABM fisheries with SEAK having the most impact (18-19%) followed by NBC (6%). There have not been noticeable changes in AABM harvest rates for SEAK (0-1%) or NBC (0%) fisheries under the two annex periods. Lack of change in impacts in the NBC AABM is an expected outcome of the management approach applied to the commercial troll portion of the NBC AABM. Since 1999, impacts on the WCVI aggregate have been managed annually to a specified cap. Impacts in the WCVI AABM troll fishery have also been constrained through time- and area-based management but harvest (+2%) has increased slightly between the two time periods. The RBT indicator is noted for CWT recoveries in near-shore areas in many areas where recoveries have occurred, thus the escapement indicators are subject to ISBM fishery impacts. Canadian ISBM fishery impacts are a significant component of the total mortality with an estimated range of 9-25%. Under the 2009 Agreement, these impacts may have decreased slightly by as much 3% or increased slightly by as much as 3%. The percentage of fish accounted for in the escapement ranges between 48-63% with somewhere between a 1% increase to a 3% decrease noted under the 2009 Agreement.

Upper Georgia Strait

The Upper Georgia Strait (UGS) production area consists of five rivers (Klinaklini, Kakweiken, Wakeman, Kingcome, Nimpkish). Four rivers are in Johnstone Strait mainland inlets and the Nimpkish River is on northeast Vancouver Island. The stocks in the upper Georgia Strait aggregate are represented by a hatchery CWT indicator stock from Quinsam Hatchery (QUI). Fishing mortality for this stock group is mainly in the AABM SEAK fisheries (20%) with some mortality in NBC AABM (2%). AABM harvest rates have decreased (-2%) in SEAK and did not change in NBC (0%) compared to the 1999 annex period. UGS stocks are not impacted in the WCVI AABM fisheries. Impacts occur in Canadian ISBM fisheries although there is a directed near-terminal sport fishery on the CWT indicator that does not impact the escapement indicator stocks. To better reflect the total ISBM fishery impacts on the escapement indicator stocks, the impacts of this fishery were subtracted from the ISBM mortality category and included with the escapement category. The mortality distribution data show that the majority of fish pass through fisheries to the escapement (67%) and a small increase has occurred under the 2009 Agreement.

Lower Georgia Strait

The two stocks comprising the lower Georgia Strait stock group, Cowichan River fall run and Nanaimo River fall run, are primarily caught in fisheries in southern BC and Washington state. Both do occur in northern fisheries, with the Nanaimo stock showing an increased northerly tendency. CWT releases from the Nanaimo River Hatchery CWT indicator program ended with the 2005 brood and thus, comparisons of fishery impacts under the 1999 and 2009 PSTs are not possible. CWT releases from the Cowichan River Hatchery have been continuous under the two Agreements with the exception of brood 2004. Impacts on the Cowichan River stock in the WCVI AABM fishery decreased by over one-third of the total (from 14% to 9%) under the 2009 Agreement. The majority of impacts occur in Canadian (40%) and US ISBM fisheries (13%). Impacts increased modestly by 4% in Canadian fisheries and remained about the same in US fisheries with no adjustment for impacts occurring on adipose-clipped hatchery production caught in MSFs in Puget Sound sport fisheries. The Cowichan River is one of the stocks for which the total fishery impacts exceed 50% and the CTC-accepted escapement goal has not been met since its' inception in 2005. Fishery closures in terminal and near-terminal areas have been implemented and extensive work has been underway in recent years to improve riverine and estuarine habitat for juveniles and spawners. The estimate of adult (age 3-5) spawners exceeded 85% lower bound of the escapement goal for the first time in 2015.

Fraser

The Fraser River production includes the four stock groups that previously comprised the Fraser-Early model stock (Fraser Spring Age 1.2, Fraser Spring Age 1.3, Fraser Summer Age 1.3 and Fraser Summer Age 0.3), plus the Fraser Late – Harrison fall Chinook stock. The Fraser Spring and Summer 1.3 groups are currently unrepresented by any CWT indicator, thus we are unable to assess differences in total mortality among Agreements. Concerns about the abundance of the Fraser Spring 1.2 aggregate led to modifications of the WCVI AABM fishery and during the recent Annex period, the stock was caught primarily in southern Canadian and US ISBM fisheries. Canadian impacts decreased while US impacts increased somewhat, amounting to a small increase in escapement under the 2009 PST. The Fraser Summer 0.3 stock group, represented by the Lower Shuswap CWT indicator, is caught in all three AABM fisheries though impacts in the two northern AABMs are each five times greater than impacts in the WCVI AABM fishery. There has been essentially no change in average total mortality over all fisheries between the two annex periods although impacts decreased in the AABM fisheries but were offset by increases in the ISBM fisheries. Under the 2009 PST, the number of CWT smolts was more than doubled at the Lower Shuswap indicator and CWT sampling effort increased in terminal fisheries and escapement as part of the CWTIP, SSP and HPCP. These efforts increased the quality, in terms of accuracy and precision, of the mortality distribution statistics relative to those under the 1999 PST.

Harrison River fall Chinook is the sole escapement indicator for the Fraser Late stock group in the lower Fraser River. Fishery impacts occur mainly in southern BC and WA state areas. On average, there was a 12% decrease in the impacts in WCVI and a 16% increase in escapement in the 2009 Agreement period. Under the 2009 PST, efforts to recover CWTs in the Harrison River escapement and terminal fisheries have been increased. Starting with the 2004 brood, the tagged smolts released from the Chehalis River Hatchery have been released at a larger size in an attempt to improve the historically poor survival rates relative to those at the nearby Chilliwack River. These changes to the CWT indicator program could have affected results for the HAR CWT indicator under the 2009 Agreement but any relative change is difficult to determine.

Puget Sound

There are seven escapement indicators for Puget Sound but only five are represented by CWT groups for the specific basin and run-time of stocks for the 1999–2015 period. A CWT group from Wallace Hatchery in the Snohomish basin does not cover the entire period from 1999 onward. The Lake Washington escapement indicator can be represented by the south Puget Sound aggregate CWT indicator (SPS) for marine area fisheries, but the terminal fishery impacts are much lower for Lake Washington than for the SPS tag groups. Consequently, there is not a CWT indicator that can represent the mortality and escapement distribution for this stock without modifying the tag recoveries. Mortality and escapement distribution for all the CWT indicator tag groups are affected by recoveries in the mark selective sport fisheries within Puget Sound. The tag groups used are all adipose clipped and these are retained in mark selective fisheries. Unmarked Chinook salmon must be released. The mortality and escapement distribution for the marked fish would differ from the distribution of unmarked and natural stocks that the tag groups were representing. In recent years, most of the sport fisheries in Puget Sound and in many of the rivers have been under mark selective regulations. The CTC has not developed a comprehensive method of analyzing CWT recoveries and making adjustments to accommodate the differential harvest of marked and unmarked tag groups. Adjustments to tag recoveries in river sport fisheries are relatively easy to do by converting most of sport fishery recoveries to "escapement" as would be the case for release of unmarked fish. Adjustments to tag recoveries in preterminal mark selective fisheries are much more complicated because of the uncertainty of the level of subsequent catch and escapement in the future.

Of the five CWT indicator groups, percentage to escapement increased slightly for two of the stocks (up 7% and 10%) and decreased by 1% to 16% for the others. Distribution to U.S. fisheries, some of which were under mark selective regulations, was up for 4 of the 5 CWT indicators. As expected, contribution in SEAK and NBC AABM fisheries was minor. The percentage in WCVI was higher and decreased for four of the CWT indicators during the time period.

Washington Coast

Of the nine escapement indicator stocks on the Washington coast, only two have CWT indicator tag groups for the specific basin and run time (Hoko and Queets fall run). The fall run stocks on the Washington coast are considered to be "far-north migrating" to SEAK and northern B.C. and do not contribute significantly to Washington ocean fisheries. The difference in fishery distribution for the Washington coastal stocks is in the proportion of the impacts in terminal fisheries. Terminal fisheries are closed or very minor for the spring run stocks and in the Hoko. Terminal fisheries for the other fall run stocks differ between basins depending on forecasts for each with some level of terminal fishing every year. The comparison of mortality distribution the Hoko and Queets CWT tag groups for the two agreement periods shows a somewhat mixed picture, but average terminal impacts in other coastal fall stocks have been comparable to, or less than, terminal impacts for the Queets. Distribution in fisheries and escapement shows little change for Hoko. For the Queets tag groups, percentage in SEAK and U.S. ISBM fisheries is up in the 2009–2015 period and correspondingly, escapement percentage is down. These two stocks have CTC accepted goals and the goals have been achieved every year for the Hoh and all but two years for the Queets during 1999–2015.

Columbia River

Columbia River Chinook production is represented by Columbia spring, Columbia summers (SUM), Columbia Upriver Brights (URBs), Coweeman (CWF), Lewis (LRW), and Lyons Ferry (LYF) indicators. Overall, terminal fishery access of returning runs was improved compared to the 1999 Annex period, while still meeting escapement goals and managing for ESA-listed stock components. However, meeting ESA constraints for some stock components and other co-migrating species, such as steelhead, poses formidable challenges in shaping terminal fisheries. For Columbia River summers, percent total mortality decreased in SEAK (-7%), NBC (-3%) and WCVI (-3%) AABM fisheries, and increased 19% in the U.S. ISBM fishery, while 35% of mortality accrued to escapement, meeting the escapement goal in all years. For the Columbia Upriver Bright fall Chinook stock aggregate, percent total mortality decreased slightly in SEAK (-4%) and NBC (-1%) AABM fisheries, and increased 6% in the U.S. ISBM fishery, while 47% of mortality accrued to escapement, meeting the escapement goal in all years. The CWT representation used for the assessment of impacts to the Deschutes fall stock has been shared between LYF and URB exploitation rate indicators for its escapement goal derivation. It is likely that either exploitation rate indicator (either LYF or URB) accurately represent those ocean impacts incurred by the Deschutes fall stock, but impacts upstream of zone 5 are based on broad assumptions of the URB stock's representation of this stock's harvest above the Bonneville dam. Current terminal fisheries management is based on those assumptions gained by utilizing those pre-terminal impacts represented by the Lyons Ferry exploitation rate indicator stock. Small to no changes were observed between the different management regimes in both SEAK and NBC AABM fisheries for LYF. Curiously, even though total TAC in the WCVI AABM fishery was reduced by 30% in the current management period, an increase of 4% in the impact of this fishery was observed for this stock. For the ESA-listed Coweeman River stock (as represented by the Cowlitz Fall CWT indicator), percent total mortality decreased 3%, 1% and 7% in SEAK, NBC, and WCVI AABM fisheries respectively, and decreased 13% in the U.S. ISBM fishery, partially as a result of reduced exploitation rate limits for ESA impacts. These fishery reductions resulted in 75% of total mortality accruing to escapement, a 23% increase from the 1999 Annex period. For Lewis River fall stock, total mortality decreased in SEAK AABM (-3%), increased in the NBC (+2%) and WCVI (+3%) AABM fisheries, and increased 8% in the U.S. ISBM fishery, while 47% of mortality accrued to escapement and the escapement goal was met in all years except 2009.

North Oregon Coast

Those fishery changes which have impacted the Northern Oregon Coastal (NOC) aggregate are represented by the CWT indicator stock originating from the Salmon River Hatchery (SRH). SRH represents the entire production area for the NOC, which includes, but is not limited to those escapement indicators in the Nehalem, Siletz and Siuslaw rivers. Those impacts that are calculated using the SRH CWT group are overestimates of ISBM fishery impacts on other stocks from this stock group. An intensive terminal fishery is in place in the Salmon River which is unlike any other basin within the aggregate. Consequently those estimates made from those mortality distribution tables shown earlier represent the maximum values which could be attributed to the terminal ISBM fishery. Fishery reductions enacted since 2009 in SEAK have resulted in an observed 6% (average) reduction of the total mortality occurring in the SEAK AABM fishery on this stock group. No appreciable changes have been observed in the exploitation of this stock aggregate in either the NBC or WCVI AABM fisheries. The two primary AABM fisheries which have historically had substantive impacts on the NOC stock aggregate are limited to the SEAK and NBC AABM fisheries. Small changes are observed in the distribution of this stock's recruitment into both ISBM fisheries (+3%) and escapement (+2%) between the two annex periods.

Mid Oregon Coast

The production area encompassed by the Mid-Oregon Coast (MOC) aggregate is represented by the CWT indicator stock from the Elk River (ELK). Much like in the NOC, an intensive terminal fishery is in place on the Elk River which is unlike those other basins which comprise the rest of the MOC. Those estimates provided for in the aforementioned mortality distribution table are maximal values which are the upper bound of those impacts which this aggregate's production encounters. The MOC is presumptively represented by two escapement indicator stocks, the South Umpqua and the Coquille. Neither has a CTC-accepted escapement goal yet. The MOC is not currently an annex stock to the treaty. Nonetheless, those fishery metrics for this stock aggregate do yield some interesting observations of changes between the two annex periods. Similar to the NOC, a small decrease was observed in this stock aggregate's exploitation in SEAK AABM fisheries (-3%). No appreciable changes in total mortality between the two time periods are noted in either NBC or WCVI AABM fisheries. For ISBM fisheries, ELK displays a decrease in U.S. ISBM impacts (-5%). This is only one of three U.S. ISBM decreases observed for U.S. origin stocks (the others being the Coweeman and Green). There has been an increased recruitment to escapement (+9%) for the MOC during the 2009 Agreement period.

2.4 Exploitation Rate Trends

The methodology to estimate rates of change in mature run equivalent (MRE) based total exploitation rates (MRE Total ERs) was the same used in analysis of escapement trends. While MREs represent the probability that a fish of a given age would have survived to spawn in a given year in the absence of fishing, MRE Total ERs represent the proportion of potential spawners in a given year that can be attributed to fishing. Therefore, MRE Total ERs is an annual statistic that includes data from the several broods contributing to escapement in a given year. Forty CWT indicator stocks were included in the evaluation of trends in MRE Total ERs. Some CWT indicator stocks were not included in this analysis because of missing data (Figure 2).

Trends concerning annual rate of change in MRE total exploitation rates show that MRE total exploitation rates increased for more indicator stocks than decreased. Twenty-nine of the 40 indicator stocks exhibited positive mean percent change in MRE Total ERs ranging from +0.2% to +12.1%, with 11 of the remaining stocks exhibiting negative percent changes ranging from -4.2% to -1.4%, and one stock, SAM exhibiting no change on average during the time period. Inter-annual variability in annual rates of change was broad for many stocks leaving only few cases of clearly positive or clearly negative trends. Seven stocks exhibited clearly positive trends in MRE Total ERs – URB (+1.6%), GAD (+2.5%), WSH (+2.8%), LRH (+5.0%), QUE (+5.3%), SKF (+7.1%), and PPS (+7.6%).Only 2 stocks exhibited a clearly negative trend – NSF (-2.1%) and NIS (-1.8%). Stocks showing the largest inter-annual variability in rates of change, judging by the width of their rate of change confidence intervals, were HOK, SOO, TAK, and RBT.

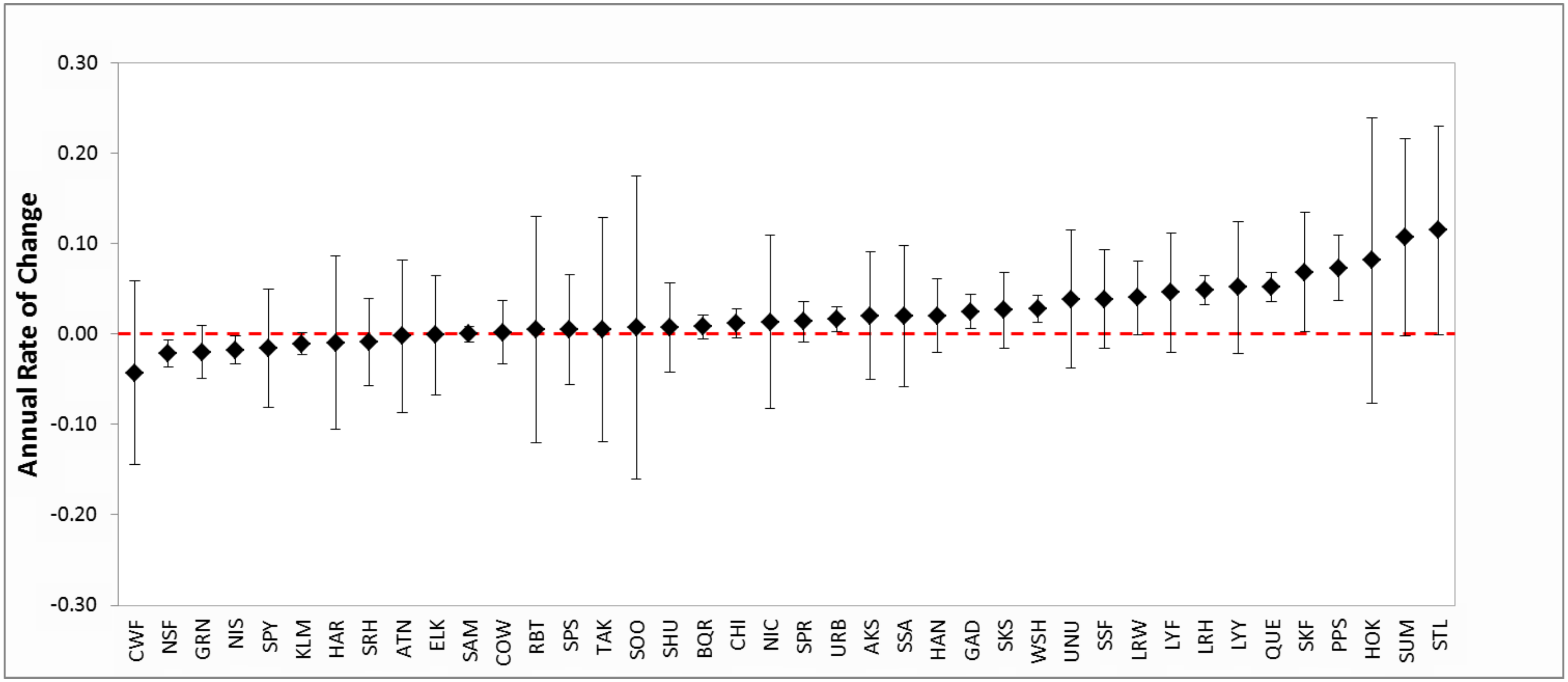

Figure 2—Annual rate of change for mature run equivalent (MRE) total exploitation rates, 1999—2015.

Diamonds represent mean rates of change (μ) and bars represent 80% confidence intervals. Stocks are ordered from the smallest to the largest μ value. The red line at zero represents equilibrium (i.e. no change).

2.5 Stocks of Concern

Statistics for escapement indicator stocks and CWT exploitation rate indicators (early marine survival rates and MRE exploitation rates) are presented in Table 4 for information purposes. Four stocks (Situk River in Southeast Alaska, the Cowichan River and Harrison River in British Columbia and the Queets River Spring-Summer stock in Washington) were identified as stocks of concern because either the average or recent geometric mean escapement from 2009–2015 was below 85% of a CTC-accepted escapement objective . A summary of information, including evaluations of escapement, exploitation, survival and other environmental factors is provided for each stock of concern in Appendix A.

Specifically for these four stocks:

- The Situk River stock where estimated escapements decreased from 203% of the lower bound during the 1999 Agreement to 91% during the current Agreement (Table 1), and the 4-year geometric mean is 79%. In the 17 years since 1999, this stock has been above goal 10 years, and below 85% in 6 years (Table 2; Appendix A.1). The Situk is not an indicator stock identified in Attachments I-V.

- The Cowichan River stock failed to meet the lower bound of the objective in the 11 years since 2005 (Table 2). Averages during the two Agreement periods were 56% and 51% of the goal, whereas the geometric mean for the recent 3 years was 74%. Estimated Cowichan river escapements have increased since 2010 and were over 90% of the objective in 2015 (Appendix A.3). The Cowichan is an indicator stock identified only in Attachment IV (Canadian ISBM fisheries).

- The Harrison River stock estimated escapements averaged 137% and 101%of the lower bound in the two Agreement periods. However, the geometric mean for the recent 4 years was 72% and it was less 85% of the objective for three consecutive years in the current Agreement (Appendix A.6). The Harrison is an indicator stock identified in Attachments III, IV and V (WCVI AABM, Canadian and U.S. ISBM fisheries).

- The Queets River spring/summer stock also failed to meet the escapement goal of 700 during both Agreement periods, averaging 57% and 68% of the goal, and the recent 4-year geometric mean was 76%. Since the goal was accepted in 2004, 10 of 12 escapement estimates were below 85% of the goal (Appendix A.9). The Queets spring/summer is not an indicator stock identified in Attachments I-V.

Several criteria (changes in average escapement between agreements, number of years not meeting escapement goal during the current agreement, average standardized survival since BY 1996, and changes in average MRE ERs between agreements) are also displayed in Table 4 to evaluate the status of stocks with CTC-accepted escapement goals. Three additional escapement indicator stocks (i.e. Unuk, Hoh spring/summer, and Nehalem) had two or more consecutive years during 2009 to 2015 that were less than 85% of the CTC-accepted escapement objectives. The 2009 Agreement uses the condition of having two consecutive years with escapements of less than 85% of the objective to identify an indicator stock has not met its escapement objective. Although these same metrics are provided in Table 4 for stocks without CTC-accepted escapement objectives, there is no objective way to evaluate status of these stocks at this time. Evaluation of stock status would be facilitated by development of CTC-accepted biologically-based escapement goals and generation of suitable quality escapement data to better understand the underlying production relationships and evaluate trends.

The negotiations leading to the 2009 Agreement also included consideration for “stocks of concern.” Fisheries regimes were constrained in the 2009 Agreement in part to address some of those issues associated with stocks of concern. The “stocks of concern” identified in the previous negotiations with CTC-accepted escapement goals included Cowichan, Lewis, Columbia summers, Columbia URBs, and Deschutes, and those without CTC-accepted escapement objectives included Nanaimo (LGS), WCVI, Puget Sound, and early timed spring-run populations of the Fraser Early stock group. The Nehalem, Siletz and Siuslaw stocks had gained attention in the US Section in the latter part of the negotiations as a concern, but concerns were not discussed bilaterally. Subsequently the North Oregon Coast along with other stocks of concern from Puget Sound, WCVI and Fraser River stocks were included in the suite of stocks to be studied by the sentinel stocks program. Information on each of these stocks can be found in Table 4.

None of the Chinook stocks listed under the U.S. ESA have been delisted. Annual changes in jeopardy guidelines and uncertain recovery goals are not considered by the CTC’s status assessments for ESA listed stocks. No Canadian stocks are presently listed under the Canadian *Species at Risk Act* (SARA).

Table 4– Summary of escapement, survival and fishery information for CTC escapement indicator stocks.

					Escapement						Standardized Survival			Exploitation Rate	
Escapement Indicator	Expl. Rate Ind. Stk	Attachments	CTC Goal	Agency Goal	Esc. Data meet CTC data standard	1999 Agreement Mean	2009 Agreement Mean	Recent Brood Geo Mean	Years missing goal in current agreement	Change over previous agreement	Average since 1996 BY	Recent Brood average	3 poor broods in a row (<-1 stnd survival)	Avg. % MRE 1999-08	Avg. % MRE 2009-15
Alsek			3,500-5,300		Y	5,920	5,670	4,564	1R, 1Y	-4%				10%	10%
Taku	TAK		19,000-36,000		Y	38,723	25,129	23,070	1Y	-35%	0.017	-0.351		22%	24%
Stikine	STI		14,000-28,000		Y	35,475	18,166	19,491	1Y	-49%				30%	19%
Situk			500-1,000		Y	1,017	456	395	4R, 1Y	-55%				43%	22%
Chilkat	CHK		1,750-3,500		Y	3,255	2,329	1,971	3Y	-28%	0.000	-0.621		19%	16%
Unuk	UNU		1,800-3,800		Y	5,598	2,370	1,727	2R, 1Y	-58%	-0.306	-0.718	2006-09	22%	38%
Chickamin	AKS		2,150-4,300		Y	4,527	3,138	2,638	1Y	-31%	-0.163	-0.633		22%	25%
Nass		1,2,4		10,000	Y	19,518	15,626	11,757		-20%					
Skeena	KLM	1,2,4			Y	45,133	35,654	33,141		-21%	0.005	-0.543	2008-10	32%	26%
Kitsumkalum				8,600	Y	17,507	11,661	11,312		-33%					
Dean		4			N	2,703	1,555	NA		-42%					
Wannock	ATN				N	3,180	4,085	4,117		+28%	-0.275	0.314		39%	40%
Chuckwalla/Kilbella					N	1,339	388	410		-71%					
Atnarko		4		5,000	Y	13,797	17,708	19,483		+28%					
WCVI Index					N	9,559	12,686	13,023		+33%					
WCVI 6 - Marble		1,2,4			N	2,536	3,293	2,483		+30%					
WCVI 6 - Burman		1,2,4			N	732	3,562	3,540		+386%					
WCVI 6 - Tahsis	RBT	1,2,4			N	596	436	366		-27%	-0.299	-0.119		50%	47%
WCVI 6 - Artlish		1,2,4			N	242	309	275		+28%					
WCVI 6 - Kaouk		1,2,4			N	336	289	241		-14%					
WCVI 6 - Tahshish		1,2,4			N	356	372	395		+5%					

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Table 4—Page 2 of 3.

					Escapement						Standardized Survival			Exploitation Rate	
Escapement Indicator	Expl. Rate Ind. Stk	Attachments	CTC Goal	Agency Goal	Esc. Data meet CTC data standard	1999 Agreement Mean	2009 Agreement Mean	Recent Brood Geo Mean	Years missing goal in current agreement	Change over previous agreement	Average since 1996 BY	Recent Brood average	3 poor broods in a row (<-1 stnd survival)	Avg. % MRE 1999-08	Avg. % MRE 2009-15
U. Georgia St.	QUI				N	10,907	14,997	19,956		+37%	-0.549	-1.090	2009-11	24%	35%
UGS - Nimpkish		1,2,4			N	540	1,656	2,310		+207%					
UGS - Klinaklini		1,2,4			N	9,874	13,064	17,297		+32%					
UGS - Kakweiken		1,2,4			N	147	189	263		+29%					
UGS - Kingcome		1,2,4			N	251	95	31		-62%					
UGS - Wakeman		1,2,4			N	85	79	43		-8%					
Cowichan	COW	4	6,500		Y	3,639	3,319	4,796	6R,1Y	-9%	-0.519	-0.068		62%	58%
Nanaimo	NAN	4		3,000	N	1,834	2,014	1,466		+10%					
Fraser Sp 1.3	DOM	1,2,4			N	26,537	20,791	18,420		-22%	-0.004	-0.280		25%	22%
Fraser Sp 1.2	NIC	1,2,4			N	9,499	5,362	6,292		-44%					
Nicola				9,500	Y	7,658	4,233	5,100		-45%					
Fraser Sum 1.3	SHU				N	25,725	18,182	16,172		-29%	0.012	0.111		45%	43%
Fraser Sum 0.3		1,2,4			N	82,273	114,447	60,953		+39%					
Lwr. Shuswap				12,300	Y	30,905	33,370	21,423		+8%					
Harrison	CHI	3,4,5	75,100-98,500		Y	102,688	75,822	54,254	3R,1Y	-26%	0.086	0.254		26%	28%
Nooksack Sp		4,5		4,000	N	2,256	1,783	1,457		-21%					
Skagit Sp	SKS	4,5		2,000	N	1,224	1,567	1,885		+28%	0.044	0.162		27%	36%
Skagit Sum/Fa	SSF	3,4,5		14,500	N	15,308	9,857	12,029		-36%	0.320	-0.318		23%	41%
Stillaguamish	STL	3,4,5		900	N	1,274	869	714		-32%	-0.131	-0.304		25%	35%
Snohomish		4,5		4,600	N	6,735	3,518	3,978		-48%					
Green		3,4,5		5,800	N	5,804	2,246	2,897		-61%					

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Table 4—Page 3 of 3

					Escapement						Standardized Survival			Exploitation Rate	
Escapement Indicator	Expl. Rate Ind. Stk	Attachments	CTC Goal	Agency Goal	Esc. Data meet CTC data standard	1999 Agreement Mean	2009 Agreement Mean	Recent Brood Geo Mean	Years missing goal in current agreement	Change over previous agreement	Average since 1996 BY	Recent Brood average	3 poor broods in a row (<-1 stnd survival)	Avg. % MRE 1999-08	Avg. % MRE 2009-15
Quillayute Su				1,200	N	912	716	769		-21%					
Hoh Sp/Sum			900		N	1,164	859	860	2R,3Y	-26%					
Queets Sp/Sum			700		N	399	474	531	6R	+19%					
Grays Harbor Sp				1,400	N	2,307	1,993	1,584		-14%					
Hoko	HOK	1,2,5		850	N	699	975	1,006		+39%	0.041	0.307		24%	24%
Quillayute Fa	QUE	1,2,5	3,000		N	4,822	3,592	3,322	1Y	-26%	0.512	1.169		40%	59%
Hoh Fall		1,2,5	1,200		N	2,578	1,815	1,658		-30%					
Queets Fall		1,2,5	2,500		N	3,106	3,647	3,608	1Y	+17%					
Grays Harbor Fall		1,2,5	13,326		N	15,836	15,933	14,848	1Y	+1%					
Col R Spring					Y	19,704	24,955	25,404		+27%					
Col R Summer	SUM	1,2,3,5	12,143		Y	50,058	60,456	70,485		+21%	0.607	0.474		47%	59%
Col Upriver Bright	URB	1,2,3,5	40,000		Y	92,010	224,089	273,846		+144%	-0.260	0.682		47%	54%
Coweeman	CWF				Y	644	1,011	1,095		+57%	-0.157	0.395		43%	19%
Lewis	LRW	1,2,3,5	5,700		Y	10,766	12,843	15,706		+9%	-0.333	-0.341		33%	41%
Deschutes		1,2,3,5	4,532		Y	10,950	14,797	17,685		+35%					
Nehalem	SRH	1,2,5	6,989		Y	8,649	9,566	10,876	1R	+11%	-0.023	0.665		53%	52%
Siletz		1,2,5	2,944		Y	6,309	5,432	5,907		-14%					
Siuslaw		1,2,5	12,925		Y	28,208	24,817	26,960		-12%					
S Umpqua	ELK				N	4,941	8,187	9,257		+66%	-0.164	-0.239		50%	43%
Coquille					N	6,888	14,191	9,152		+106%					

3. Fishery Performance

The 2009 Agreement extends the provisions from the 1999 Agreement for abundance based management in two regimes: Aggregate Abundance Based Management (AABM) and Individual Stock-based Management (ISBM). Management of AABM fisheries constrains catch to a numerical limit in Table 1 of Chapter 3 corresponding to an abundance index (AI). ISBM regimes constrain fishery impacts for naturally spawning stocks or stock groups. ISBM management regimes apply to all Chinook salmon fisheries subject to the Treaty that are not AABM fisheries.

Paragraph 9(a) states that the Parties agreed to reduce catch limits for AABM fisheries listed in Table 1 of Chapter 3 of the 2009 Agreement by 15% in southeast Alaska (SEAK) and by 30% in West Coast Vancouver Island (WCVI) for the period 2009–2018 relative to the 1999 Agreement levels. These reductions are incorporated into the Chapter 3 Table 1.

The SEAK AABM catch limit is adjusted by three factors subtracted from the total harvests to determine the PST catch component that is compared with the PST allowable catch in the Agreement Table 1. These are hatchery add-on fish (minus 5,000 base period enhancement fish and a 1 in 20 risk adjustment factor to account for uncertainty in hatchery contribution estimates) fish caught in terminal exclusion areas, and Chinook caught in districts 108 (affronting the Stikine River) and 111 (affronting the Taku River) of transboundary origin in excess of base levels when directed fisheries are allowed as provisions of Chapter 1 of the Agreement. These adjustments account for local production and/or catch sharing of transboundary stocks as per Chapter 1 and are stock components not caught in PST fisheries of NBC or further south.

Canada and the U.S. agreed to limit their total adult equivalent mortality rates in the aggregate of their ISBM fisheries to no greater than 63.5% and 60.0%, respectively, relative to the mortality that occurred in the base period. This “general obligation” applies to stock groups identified in Attachments IV and V for stocks not achieving their agreed escapement and/or harvest rate objectives.

In addition to the general obligation, the 2009 PST Agreement has an additional obligation consisting of further fishery restrictions which apply to the Party in whose river the stock originates to meet the agreed-to escapement objectives (Paragraph 8 (c)):

> *“For those stocks for which the general obligation is insufficient to meet the agreed MSY or other biologically-based escapement objectives, the Party in whose waters the stock originates shall further constrain its fisheries to the extent necessary to achieve the agreed MSY or other biologically-based escapement objectives, provided that a Party is not required to constrain its fisheries to an extent greater than the average of that which occurred in the years 1991 to 1996”*

Landed catch in PST fisheries since 1999 is summarized over the four broad categories of AABM and ISBM fisheries for both parties in Figure 3. The total landed catch across all four fishery groups averaged 1,400,593 Chinook during the 1999 Agreement (1999–2008) and averaged 1,604,241 during the 2009 Agreement (2009–2015), an average yearly increase of 203,648 fish (15%). The U.S. ISBM landed catch average increased approximately 239,000 fish (41%), while the average for the other three fishery groups all decreased, about 18,000 (6%) in U.S. AABM fisheries, about 16,000 (7%) fish in Canadian ISBM fisheries and 1,000 (<1%) fish in Canadian AABM fisheries. During the 1999 Agreement, catch percentages of the total annual PST catch averaged 42% U.S. ISBM, 17% Canadian ISBM, 21% U.S. AABM and 20% Canadian AABM. During the first seven years of the 2009 Agreement, percentages of total PST landed catch averaged 51% U.S. ISBM, 14% Canadian ISBM, 17% U.S. AABM and 18% Canadian AABM.

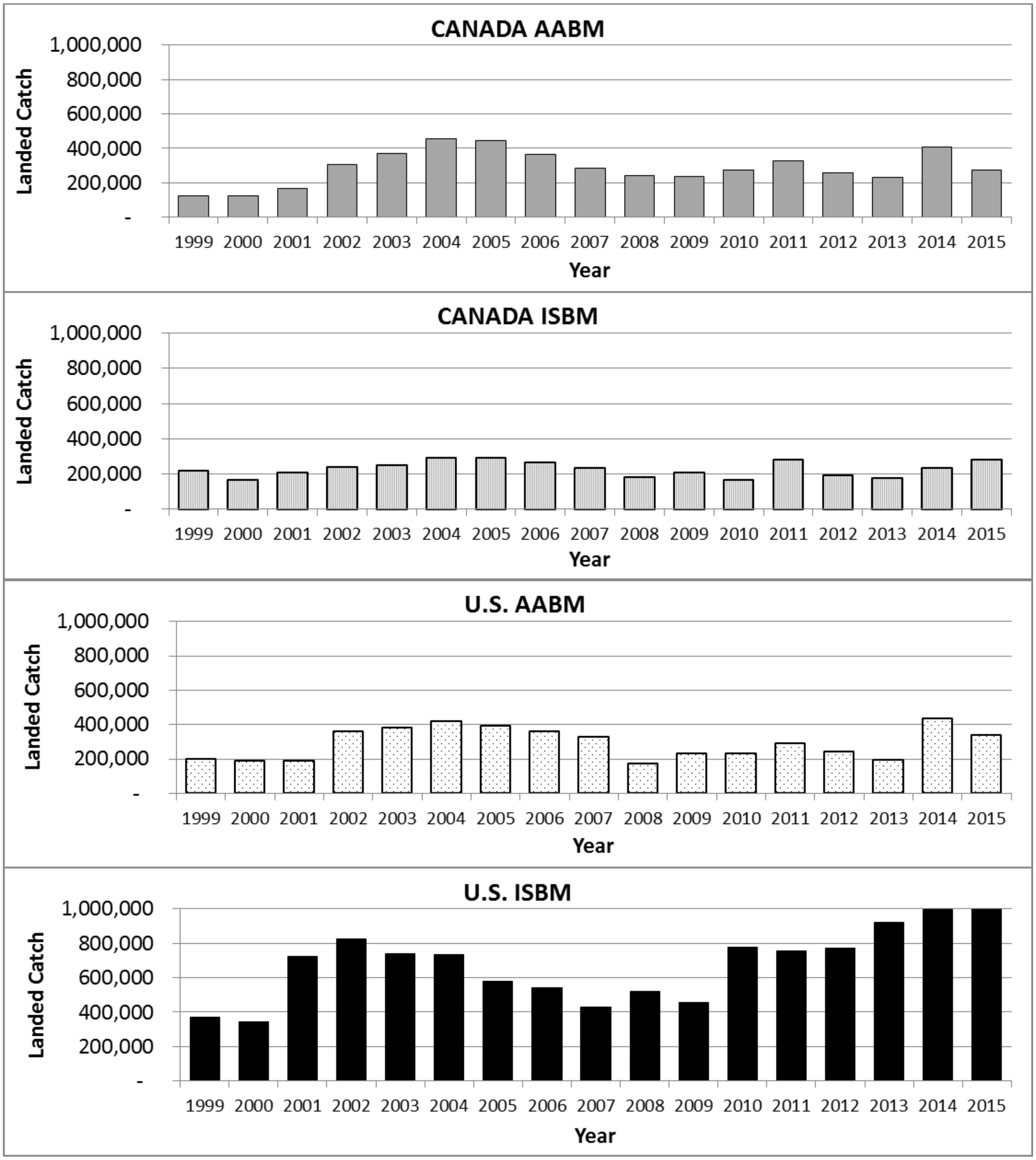

Figure 3—Estimates of landed catch for US and Canada AABM and ISBM fisheries, 1999–2015.

3.1 ISBM Fishery Performance

Chapter 3 obligations for ISBM fisheries are described in introductory language of Section 3.0 of this report. For U.S. origin stocks with agreed-to escapement objectives, the general obligation effectively serves as the management threshold for U.S. ISBM fisheries. Whereas, in the case of Canadian ISBM fisheries, the 1991–1996 average criterion effectively serves as a threshold for the two Canadian origin stocks with CTC agreed goals.

The metric applicable to ISBM obligations is the ISBM index, either computed by the model for preseason purposes or with CWT data for post-season purposes. A variety of problems have been identified with the current ISBM index. Generally, these problems concern (1) poor correspondence between the pre- and post-season ISBM indices, (2) a two-year time lag for the CWT-based U.S. ISBM index (post season), (3) incomplete broods, (4) absence of Chinook non-retention mortalities represented in base period exploitation rates, (5) absent or incomplete base period data, (6) large changes in some ISBM fisheries since the base period, (7) representation of natural indicator stocks, and (8) an inability to separate ISBM and AABM fishery impacts for WCVI and NBC fisheries. Several of these issues are manifest in the data represented for those pre and post season indices for both the Fraser Late and the Columbia Upriver Bright stocks that demonstrate a very wide divergence between model-based and CWT-based estimates (Figure 4 and Figure 5).

Alternatives to the current ISBM indices and approaches to address the almost complete disconnect between the model and CWT based ISBM indices have been examined in a CTC report submitted to the CIG/Commission (TCChinook 11-4). Alternative and viable methodologies to improve the quality of preseason ISBM indices were identified in that report, but have not yet been implemented.

3.1.1 Canada and U.S. ISBM postseason performance

To evaluate ISBM postseason fishery performance across years and fisheries, data are needed on escapement and CWT ISBM indices, along with average 1991–1996 ISBM indices for stocks with escapement goals. Postseason ISBM indices are computed with a lag of 2 years in the U.S. and 1 year in Canada using CWT data; hence, the most recent years in which ISBM performance can be judged is 2013 for the U.S. ISBM fishery and 2014 for the Canadian ISBM fishery in the current reporting cycle for 2015 fisheries.

Color coded ISBM performance metrics for the U.S. ISBM fishery and the Canadian ISBM fishery are provided in Table 5 and Table 6 and graphically in Figure 6 and Figure 7. Cases wherein the fishery met the obligation are colored in green whereas cases where the obligation was exceeded are colored in red. Cells in Table 5 and Table 6 are not colored in cases where a stock-year ISBM statistic cannot be calculated. The ISBM performance metrics reflect the combination of presence of an escapement goal and if so, whether or not it was met, and the CWT-based evaluation of exploitation rate as compared to the base years.

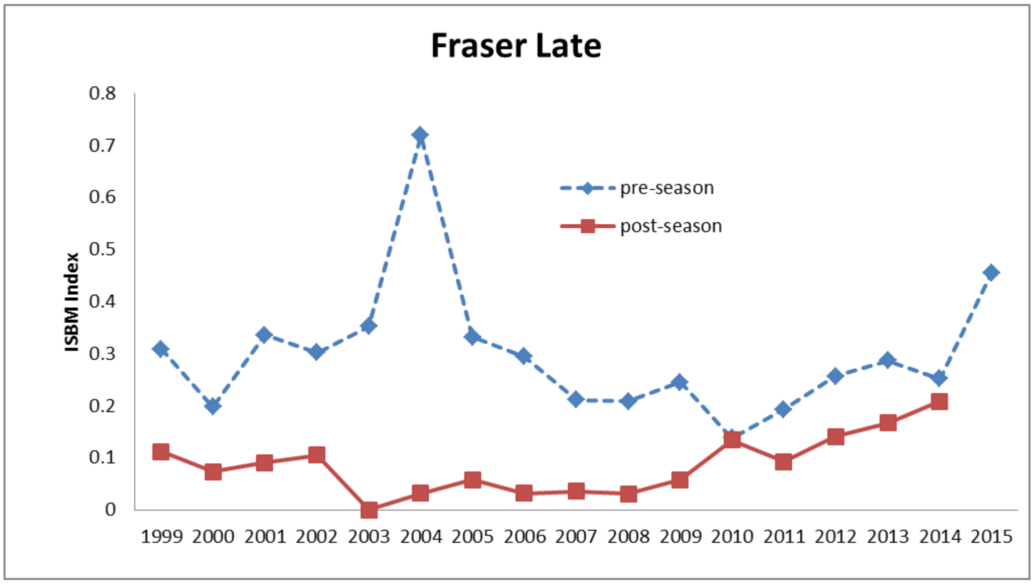

Figure 4— Model based (preseason) and CWT based (post season) estimates of the ISBM index for the Fraser Late stock.

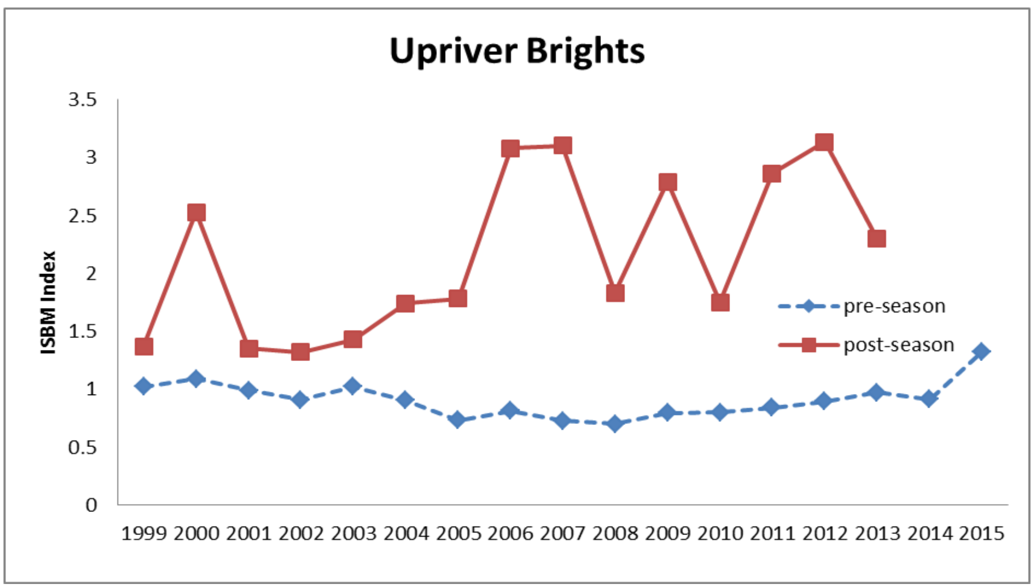

Figure 5— Model based (preseason) and CWT based (post season) estimates of the ISBM index for the Columbia Upriver Bright stock.

Table 5– Summary of ISBM Indices for Canadian fisheries based upon CWT-based exploitation rate analysis, 1999–2014.

Stock Group	Stock (CTC agreed goal year)	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
North/ Central B.C.	Yakoun, Nass, Skeena, Atnarko, Dean (no goal)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
WCVI Falls	Artlish, Burman, Kauok, Tahsis, Tashish, Marble, Gold (no goal)	0.431	0.083	0.060	0.248	0.496	0.488	0.267	0.267	0.906	0.652	0.464	0.178	0.650	1.017	0.351	0.324
L. Georgia Strait	Cowichan (2005)	0.517	0.196	0.260	0.247	0.363	0.284	0.132	0.191	0.043	0.242	0.400	0.261	0.147	0.262	0.289	0.429
	Nanaimo (no goal)	0.163	0.154	0.260	0.247	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
U. Georgia Strait	Klinaklini, Kakweikan, Wakeman, Kingcome, Nimpkish (no goal)	0.021	0.123	0.040	0.063	0.006	0.018	0.028	0.079	0.268	0.073	0.247	0.182	0.032	0.175	0.109	0.170
Fraser Late	Harrison (2001)	0.112	0.073	0.090	0.105	0.055	0.032	0.058	0.032	0.035	0.031	0.058	0.314	0.092	0.141	0.167	0.208
Fraser Early (spring & summers)	Upper Fraser, Mid-Fraser, Thompson	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Puget Sound Spring	Nooksack (no goal)	0.183	1.176	0.040	0.023	0.046	N.A.	N.A.	N.A.	N.A.	N.A.	0.106	0.014	0.144	0.137	0.105	N.A.
	Skagit (no goal)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Puget Sound Falls	Skagit (no goal)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
	Stillaguamish (no goal)	0.194	0.111	0.145	N.A.	N.A.	0.027	0.057	0.074	0.192	N.A.	0.252	0.083	0.246	0.158	0.273	N.A.
	Snohomish (no goal)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
	Lake Wash. (no goal)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
	Green River (no goal)	0.171	0.154	0.350	0.323	0.328	0.162	0.085	0.109	0.076	0.106	0.208	0.151	0.300	0.346	0.322	N.A.

Table 6– Summary of the first postseason ISBM Indices for U.S. fisheries based upon CWT-based exploitation rate analysis, 1999–2013.

Stock Group	Stock (CTC agreed goal in year)	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Fraser Late	Harrison (2001)	0.470	0.130	0.310	0.410	0.640	0.320	N.A.	N.A.	N.A.	0.260	0.150	0.470	N.A.	0.405	0.410
Puget Sound Spring	Nooksack (no goal)	0.440	0.000	0.040	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	0.210	0.520	0.700	0.795	2.758	1.137
	Skagit (no goal)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Puget Sound Fall	Skagit (no goal)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
	Stillaguamish (no goal)	0.120	0.040	0.890	N.A.	N.A.	0.010	0.220	0.080	0.120	N.A.	0.200	0.380	0.195	0.213	N.A.
	Snohomish (no goal)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
	Lake Wash. (no goal)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
	Green (no goal)	0.500	0.700	1.180	1.070	1.030	1.010	0.170	0.370	0.380	0.280	0.290	0.340	0.439	0.544	0.320
WA Coast Falls	Hoko (no goal)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
	Grays (2014)	0.430	1.630	0.860	0.540	0.150	0.530	0.560	0.520	0.790	0.390	0.700	0.690	0.923	0.591	0.670
	Queets (2004)	1.000	0.850	1.440	0.840	0.850	0.840	2.050	0.600	*1.050*	0.610	0.450	0.670	N.A.	0.951	0.745
	Hoh (2004)	1.540	2.750	1.660	0.950	1.340	1.220	1.030	1.290	2.230	0.950	1.220	1.000	2.003	1.593	2.263
	Quillayute (2004)	1.300	2.470	1.480	1.420	0.990	1.150	1.030	1.180	1.470	1.160	1.970	0.670	N.A.	2.140	0.776
Columbia Fall	Brights (2002)	1.370	2.530	1.350	1.320	1.430	1.740	1.780	3.080	3.100	1.830	2.790	1.750	2.862	3.133	2.298
	Deschutes (2010)	0.510	0.710	0.520	0.590	0.049	0.510	0.670	0.580	0.510	1.860	2.360	0.790	0.798	1.045	0.830
	Lewis (1999)	0.000	0.360	0.580	0.560	1.030	0.170	0.980	1.330	0.790	0.630	0.140	0.430	0.432	0.895	0.656
Columbia Summers	Summers (1999)	1.640	4.820	5.320	7.250	10.040	2.690	6.080	0.480	1.840	6.800	1.310	9.810	5.376	5.192	7.166
N. Oregon Coast	Nehalem (1999)	1.960	1.970	1.940	2.170	3.110	1.800	2.000	3.480	2.010	0.920	0.590	1.210	1.210	2.267	2.291
	Siletz (1999)	0.820	1.160	1.190	1.310	1.590	2.290	1.190	2.340	1.600	0.670	0.730	0.500	1.068	0.997	1.054
	Siuslaw (1999)	1.220	2.450	2.180	2.560	3.820	1.030	1.630	2.230	1.000	0.640	1.070	0.770	1.108	1.603	2.145

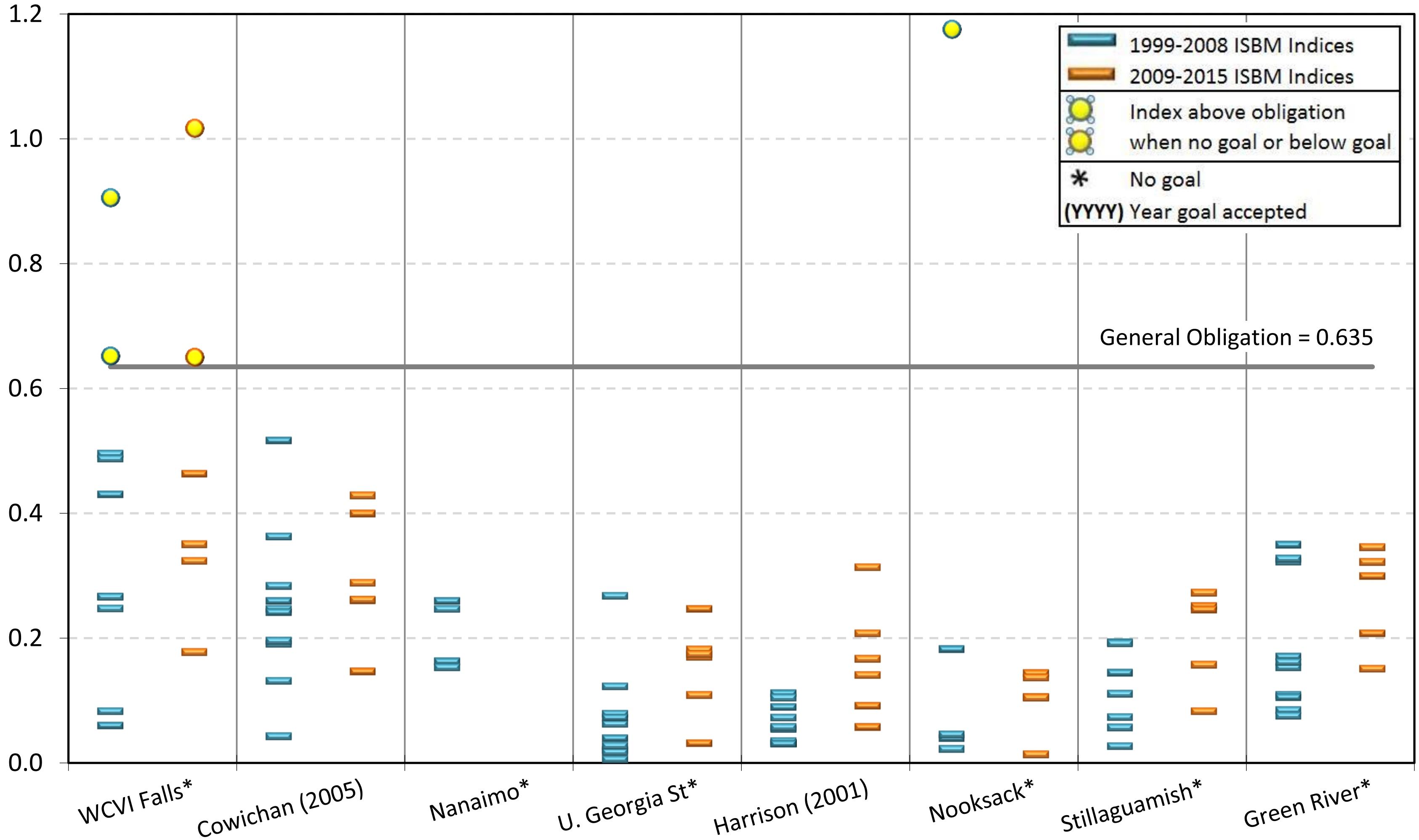

Figure 6—Performance of Canada ISBM fishery, 1999–2014 for Canadian stocks and 1999–2013 for U.S. stocks.

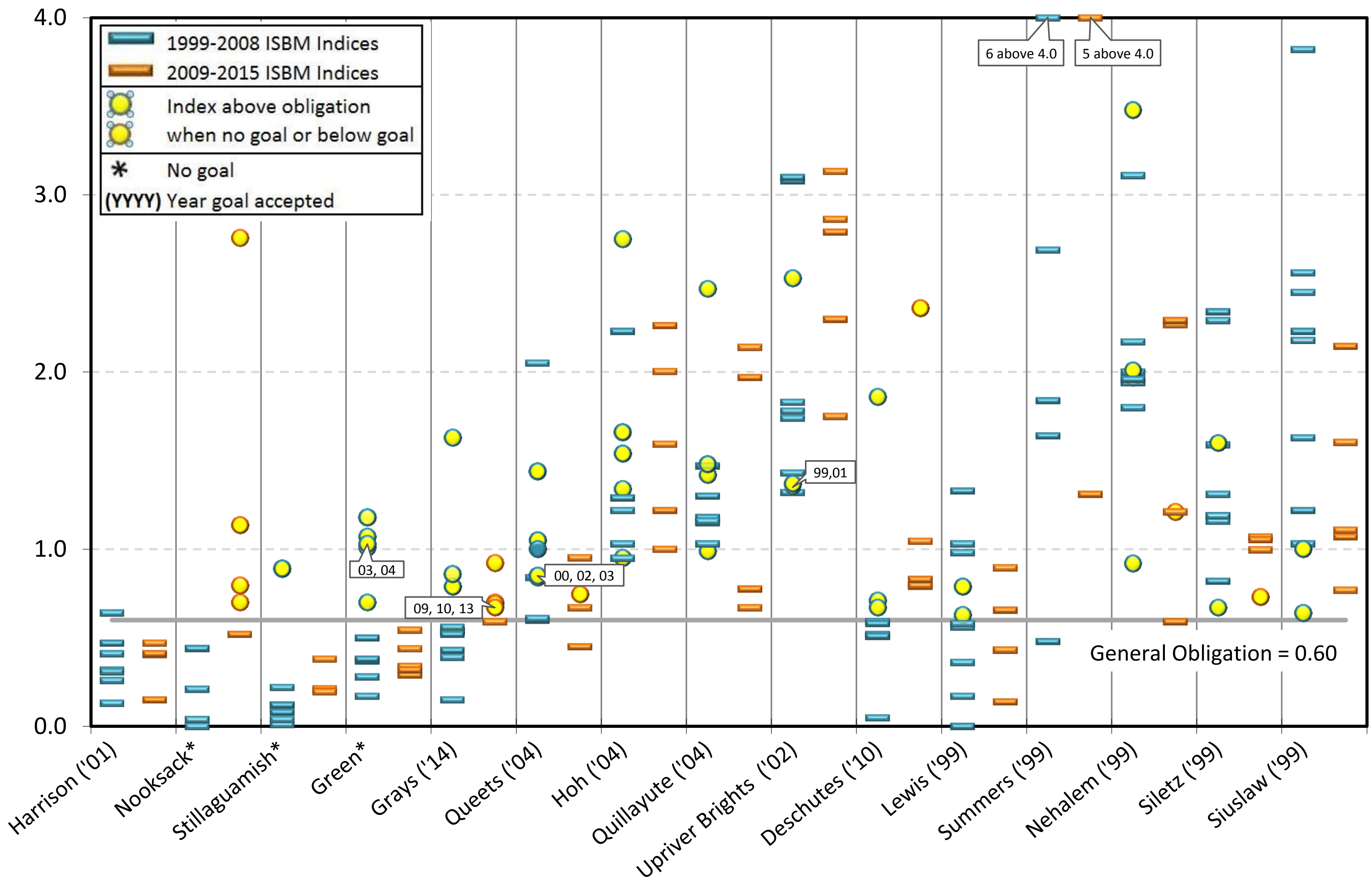

Figure 7—Performance of U.S. ISBM fishery, 1999–2013.

3.1.2 ISBM performance metrics

The ISBM performance metric cannot be calculated for any year since 1999 for 12 of the intended 30 stocks in the Canadian ISBM fishery (40% of the stocks). For three of the Canadian ISBM stocks, the metrics are available for only a portion of the years since 1999 (10%). Of the remaining 15 Canadian ISBM stock index data sets, a single value per year is used for all 7 WCVI stocks and a single value per year is used for all 5 Upper Strait of Georgia stocks (12 of the 30 stocks or 40%). Only 3 of the 30 Canadian ISBM stock cases (10%; through 2014 for 2 Canadian origin stocks and through 2013 for 1 U.S. origin stock) have annual data available through 2014.

There are 20 specific stocks for which the ISBM general obligation applies to the U.S. ISBM fishery as per the Agreement. Of those, the statistic cannot be calculated for any year for 5 of the stocks (25% of the stocks). Data are available for only a portion of the years for 5 additional stocks (25%), while the remaining 10 stocks (50%) have annual ISBM metrics for each year since 1999.

For several stocks caught in ISBM fisheries, the data needed to calculate the current postseason index are not available at the time the index must be computed for reporting. Catch and CWT recovery estimates for some U.S. ISBM fisheries may not be available for at least one year after a fishery has occurred, either because the catch data are unavailable or because multiple agencies cannot reach timely agreement on the ‘final’ catch estimate. This means that CWT recoveries from those fisheries cannot be reported until catch estimates have been finalized. Consequently, CWT-based ISBM indices cannot be computed in a timeframe that can inform fishing plans for the upcoming season. In contrast, estimates of escapement are usually available to inform fishing plans for the next season.

A total of 49 Canadian CWT-based ISBM indices were calculated during the period of the 1999 Annex, of which 46 met the obligation (95%) and 3 did not. During the 2009 Agreement to date, 39 Canadian ISBM indices have been calculated, of which 37 met the obligation (95%) and two did not; performance similar to the prior Agreement. The only Canadian ISBM fishery metrics that failed to meet the obligation more than once were the metric associated with the WCVI stock, which missed twice during the 1999 Annex and twice more during the 2009 Agreement (Table 5).

For U.S. ISBM metrics, 138 were calculated during the 1999 Agreement, of which 97 met the obligation (70%) and 41 did not. During the 2009 Agreement, to date, a total of 76 metrics were reported of which 64 met the obligation (84%) and 12 did not, an improvement compared to the prior Agreement (Table 6). For the U.S. ISBM fishery, the Washington Coast group was the most frequent stock not meeting the obligation; however, after escapement goals were accepted by the CTC for four of the constituent stocks in 2004, the stock group that most often failed to meet the ISBM general obligation was the North Oregon Coast stock group, due to a several year period of lower productivity that centered around 2008. During the 2009 Agreement period to date, the stock most frequently missing the ISBM obligation is the Nooksack Spring stock, which has failed to meet the general obligation in each year since 2010.

3.2 AABM Fisheries Performance

The AABM fishery management regime relies on relationships that are based on data for catches and incidental mortality, fishery impacts (CWT indices), and the abundance indices (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 performance of the AABM fishery management regimes is evaluated based on a comparison of actual catches to allowable postseason catch levels derived from Table 1 of Chapter 3 based upon the first postseason AIs estimated by the PSC Chinook Model (*Paragraph 11(a)(i))*.

3.2.1 Actual catches vs preseason and postseason allowable catches

The differences between observed catches and the catches prescribed by the AIs from the first postseason CTC model calibration are the result of two processes: 1) management error, defined here as the difference between the actual catch and the catch target set using the preseason AI; and 2) model error which is the difference between catches prescribed by the preseason AIs and those prescribed by the first post postseason AIs. We use the term management *error* but recognize it as a misnomer in many situations as the deviations of observed catch from the preseason allowable catch may have been the result of deliberated actions. Preseason allowable catches are included with the postseason allowable catches and observed catches in Table 7.

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 8, Table 9, and Table 10). Overall, the performance of AABM fisheries, as measured by the deviation of observed catches from the postseason allowable catches, had deviations ranging from -74% to 52% (Table 8, Table 9, and Table 10). Poor performance was greatest when management error and model error were in the same direction as in NBC in 2000, the maximum negative error, and WCVI in 2011, the maximum positive error. Improved performances, with deviations near zero, were the result of preseason AIs close to the postseason value and relatively small management errors like SEAK in 2006, NBC in 2005 and WCVI in 2010. Improved performances were also the result of management errors in the opposite direction of model errors, thereby cancelling out portions of these different deviations. The most extreme example of management and model errors cancelling each other out was for SEAK in 2015. The SEAK, NBC, and WCVI AABM fisheries have exceeded the postseason allowable catch in 12 (SEAK), 3 (NBC), and 8 (WCVI) of the last 17 years.

AABM catches prescribed for 2009–2015 include the negotiated reductions of 15% in SEAK, 30% in WCVI, and no change associated with NBC. Model error was largely responsible for catch reductions not being met in 5 of 7 years in SEAK and in 3 of 7 years in WCVI. The reductions realized by the AABM fisheries were assessed against the postseason TAC's that would have been allowed without the negotiated reductions. To generate the TAC's without the reductions the WCVI postseason TAC's were adjusted upward by 30% (WCVI postseason TAC / 0.70) and the SEAK postseason TAC's were adjusted upward by 15% (SEAK postseason TAC / 0.85). No adjustment was required for NBC. Actual catches were then subtracted from the adjusted TAC's to provide a measure of the reductions realized by the management changes. Actual reductions realized from the negotiated reductions in AABM catches averaged 10% in SEAK and 27% in WCVI from the 2009–2015 limitations. In addition, NBC realized an average reduction of 27% over the current annex period. Total catch reductions associated with the 2009 annex adjustments for AABM fisheries from 2009–2015 were 710,527 fish; including 256,787 fish from SEAK and 453,784 fish from WCVI. There was an additional foregone catch of 384,532 from NBC for a total reduction of 1,095,104 fish.

Table 7– Preseason allowable, postseason allowable, and observed catches for AABM fisheries, 2009–2015. Postseason values each year are from the first postseason calibration following the fishing year[1].

	SEAK (T, N, S)			NBC (T, S)			WCVI (T, S)		
Year	Pre-season Allowable Catch	Post-season Allowable Catch	Observed Catch	Pre-season Allowable Catch	Post-season Allowable Catch	Observed Catch	Pre-season Allowable Catch	Post-season Allowable Catch	Observed 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	157,886
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	388,637	246,600	240,700	243,606	188,200	179,700	199,479
2006	346,800	354,500	360,066	223,200	200,000	215,985	160,400	145,500	145,485
2007	329,400	259,200	328,197	178,000	143,000	144,235	143,300	121,900	140,614
2008	170,000	152,900	172,841	124,800	120,900	95,647	162,600	136,900	145,726
2009	218,800	176,000	228,033	143,000	139,100	109,470	107,800	91,300	124,617
2010	221,800	215,800	230,750	152,100	160,400	136,613	143,700	142,300	139,047
2011	294,800	283,300	290,669	182,400	186,800	122,660	196,800	134,800	204,232
2012	266,800	205,100	242,549	173,600	149,500	120,307	133,300	113,800	134,468
2013	176,000	284,900	191,428	143,000	220,300	115,914	115,300	178,800	113,598
2014	439,400	378,600	435,166	290,300	262,600	216,901	205,400	191,700	188,374
2015	237,000	337,500	337,794	160,400	246,600	158,903	127,300	179,700	116,737

[1] Observed catch in SEAK 2004 is represented by the lower of two values which resulted from subtracting a disputed terminal exclusion catch for the Stikine River. Catch accounting has since been defined in the Transboundary Agreement.

[2] SEAK observed catch values increased by 500 fish from 2005 to 2012 and by 740 fish in 2013 because the method used to partition gillnet catch into large and non-large fish changed.

3.2.1.1 SEAK AABM Fishery

Average management error was 3% for SEAK across the 1999 to 2015 time series and ranged between -9% and 43%. Average management error was 7% across the 2009–2015 time period and 1% in the 1999–2008 time period (Table 8). The difference in the average management error in the recent period was driven by the large deviation in 2015 (43%). Model error ranged from -38% to 30% but averaged near zero for the time periods examined. Deviation of actual catch in SEAK from post-season allowable catch 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 5 of the 7 years 2009–2015 (Figure 8).

Table 8– Summary of SEAK AABM fishery performance and deviations from post-season allowable catch, 1999–2015. The summaries present cumulative numbers of fish and average percent error for the period.

Year	Mgmt error Obs - Pre #	Mgmt error Obs - Pre %	Model error Pre - Post #	Model error Pre - Post %	Total error Obs - Post #	Total error Obs - Post %
1999	6,042	3%	8,600	5%	14,642	8%
2000	-3,407	-2%	11,400	6%	7,993	4%
2001	-2,981	-2%	-60,400	-24%	-63,381	-25%
2002	633	0%	-15,400	-4%	-14,767	-4%
2003	14,052	4%	-73,500	-17%	-59,448	-14%
2004	33,519	9%	-34,800	-8%	-1,281	0%
2005	-27,763	-7%	29,000	7%	1237	0%
2006	13,266	4%	-7,700	-2%	5,566	2%
2007	-1,203	0%	70,200	27%	68,997	27%
2008	2,841	2%	17,100	11%	19,941	13%
2009	9,233	4%	42,800	24%	52,033	30%
2010	8,950	4%	6,000	3%	14,950	7%
2011	-4,131	-1%	11,500	4%	7,369	3%
2012	-24,251	-9%	61,700	30%	37,449	18%
2013	15,428	9%	-108,900	-38%	-93,472	-33%
2014	-4,234	-1%	60,800	16%	56,566	15%
2015	100,794	43%	-100,500	-30%	294	0%
Sum 1999-2015	136,788	3%	-82,100	1%	54,688	3%
Sum 1999-2008	34,999	1%	-55,500	0%	-20,501	1%
Sum 2009-2015	101,789	7%	-26,600	1%	75,189	6%

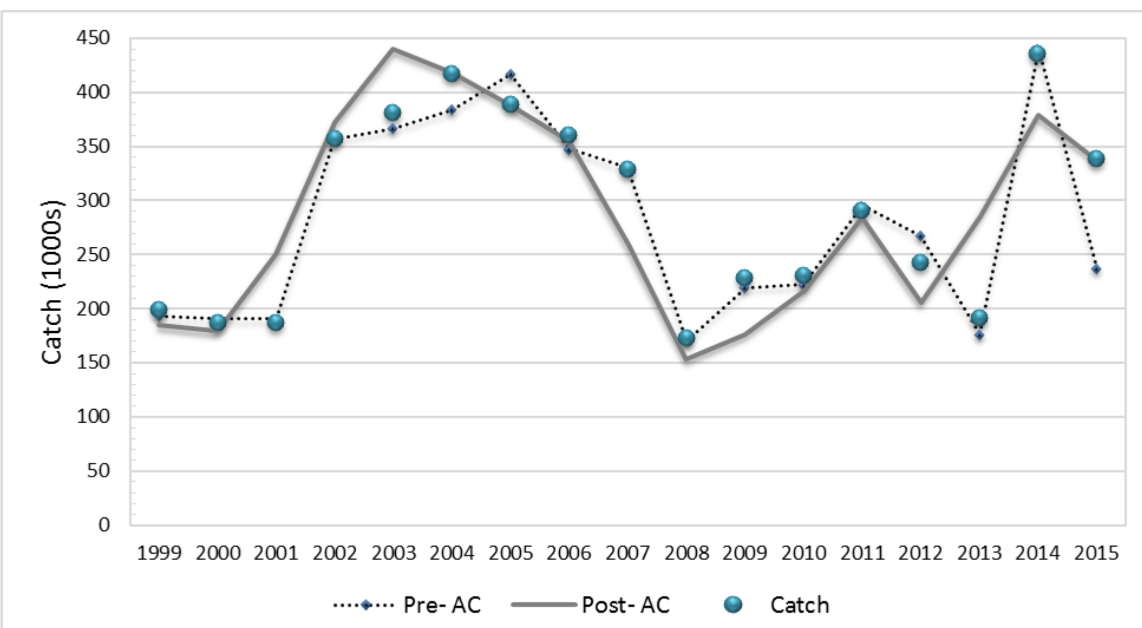

Figure 8—Performance of SEAK AABM fishery, 1999–2015.

'AC' in the legend refers to 'allowable catch'.

3.2.1.2 NBC AABM Fishery

NBC catch was consistently below the preseason allowable catch with an average of -23% from 1999–2015 (range -1% to -75%; Table 9). The average NBC catch was -26% from 1999–2008 and -20% from 2009–2015. Management errors in NBC were the result of Canada's domestic efforts to reduce impacts on WCVI Chinook. Management error in the NBC fishery was near zero from 2003 to 2006 and 2015 but catches were significantly below the allowable catch in all other years (Figure 9). Management actions in NBC outweigh model errors in most years and the average error between the observed catch and the post-season allowance was -27%.

Table 9– Summary of NBC AABM fishery performance and deviations from post-season allowable catch, 1999–2015. The summaries present cumulative numbers of fish and average percent error for the period.

	NBC (T, S)					
Year	Mgmt error Obs - Pre #	Mgmt error Obs - Pre %	Model error Pre - Post #	Model error Pre - Post %	Total error Obs - Post #	Total error Obs - Post %
1999	-61,276	-42%	19,500	15%	-41,776	-33%
2000	-97,952	-75%	6,500	5%	-91,452	-74%
2001	-89,266	-67%	-26,300	-17%	-115,566	-73%
2002	-42,869	-22%	-45,100	-19%	-87,969	-37%
2003	-2,303	-1%	-80,100	-29%	-82,403	-30%
2004	-2,092	-1%	-23,400	-9%	-25,492	-10%
2005	-2,994	-1%	5,900	2%	2,906	1%
2006	-7,215	-3%	23,200	12%	15,985	8%
2007	-33,765	-19%	35,000	24%	1,235	1%
2008	-29,153	-23%	3,900	3%	-25,253	-21%
2009	-33,530	-23%	3,900	3%	-29,630	-21%
2010	-15,487	-10%	-8,300	-5%	-23,787	-15%
2011	-59,740	-33%	-4,400	-2%	-64,140	-34%
2012	-53,293	-31%	24,100	16%	-29,193	-20%
2013	-27,086	-19%	-77,300	-35%	-104,386	-47%
2014	-73,399	-25%	27,700	11%	-45,699	-17%
2015	-1,497	-1%	-86,200	-35%	-87,697	-36%
Sum 1999-2015	-632,917	-23%	-201,400	-3%	-834,317	-27%
Sum 1999-2008	-368,885	-26%	-80,900	-1%	-449,785	-27%
Sum 2009-2015	-264,032	-20%	-120,500	-7%	-384,532	-27%

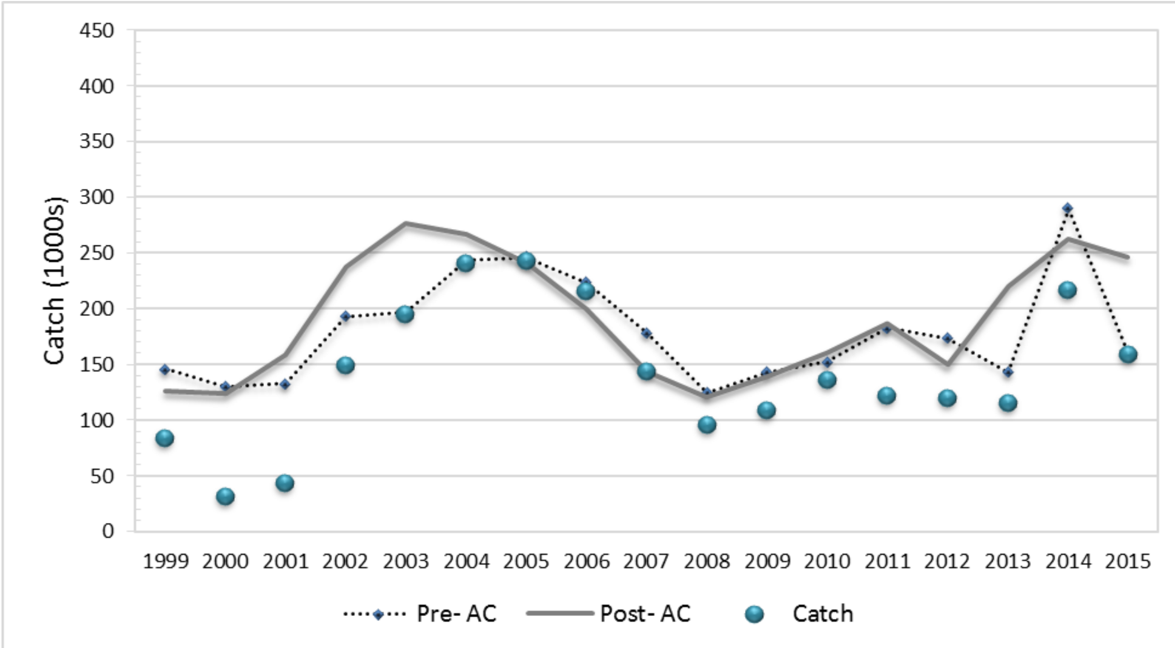

Figure 9—Performance of NBC AABM fishery, 1999–2015.

'AC' in the legend refers to 'allowable catch'.

3.2.1.3 WCVI AABM Fishery

Average management error in WCVI was -8% from 1999–2015 with more negative values in the beginning of the time series resulting in averages of -14% from 1999–2008 and 0% from 2009–2015 (Table 10). The positive to negative swings in the deviation of observed catch from the post-season allowable catch in WCVI were more dramatic, ranging from -36% to 52%. While management error in WCVI played a larger role in the deviation from the post-season allowable catch, model errors made up the largest component of the deviations. The WCVI management error and model error was in a common direction in 5 of 7 years from 2009–2013 and only in opposite directions in 2010 and 2014 when both model and management errors were small (Figure 10).

Table 10– Summary of WCVI AABM fishery performance and deviations from post-season allowable catch, 1999–2015. The summaries present cumulative numbers of fish and average percent error.

WCVI (T, S)						
Year	Mgmt error Obs - Pre #	Mgmt error Obs - Pre %	Model error Pre - Post #	Model error Pre - Post %	Total error Obs - Post #	Total error Obs - Post %
1999	-89,760	-70%	21,300	20%	-68,460	-64%
2000	-26,883	-23%	29,300	34%	2,417	3%
2001	-20,896	-15%	-4,300	-3%	-25,196	-17%
2002	-45,314	-22%	6,400	3%	-38,914	-20%
2003	-8,239	-5%	-87,100	-32%	-95,339	-35%
2004	22,752	12%	-17,100	-8%	5,652	3%
2005	11,279	6%	8,500	5%	19,779	11%
2006	-14,915	-9%	14,900	10%	-15	0%
2007	-2,686	-2%	21,400	18%	18,714	15%
2008	-16,874	-10%	25,700	19%	8,826	6%
2009	16,817	16%	16,500	18%	33,317	36%
2010	-4,653	-3%	1,400	1%	-3,253	-2%
2011	7,432	4%	62,000	46%	69,432	52%
2012	1,168	1%	19,500	17%	20,668	18%
2013	-1,702	-1%	-63,500	-36%	-65,202	-36%
2014	-17,026	-8%	13,700	7%	-3,326	-2%
2015	-10,563	-8%	-52,400	-29%	-62,963	-35%
Sum 1999-2015	-200,063	-8%	16,200	5%	-183,863	-4%
Sum 1999-2008	-191,536	-14%	19,000	6%	-172,536	-10%
Sum 2009-2015	-8,527	0%	-2,800	4%	-11,327	4%

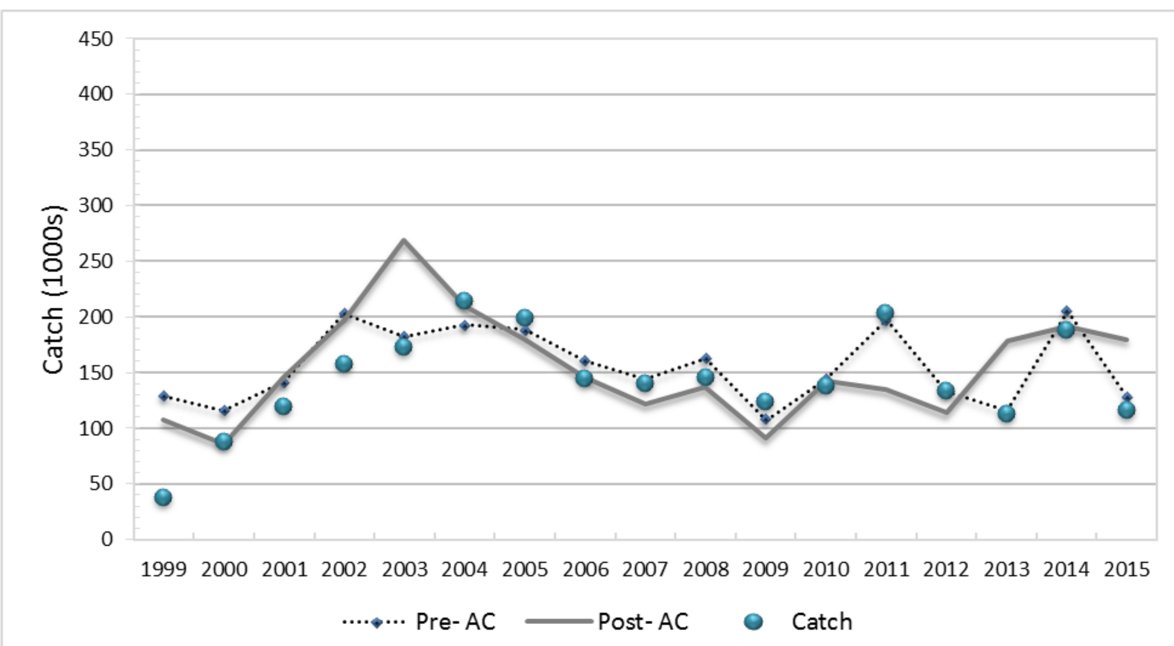

Figure 10—Performance of WCVI AABM fishery, 1999–2015.

'AC' in the legend refers to 'allowable catch'.

3.2.1.4 Relationship of Total Error on Aggregate Forecast Return Error

For the aggregates of the stocks of Attachment I–III, linear regression analyses were conducted of the dependence of Total Error (observed catch minus post-season TAC) on aggregate forecast return error proportion (aggregate observed return minus aggregate forecast return)/aggregate observed return) in the three AABM fisheries from 1999 to 2014. The 2015 calibration was not included in this analysis. The aggregate forecasts for the Attachment stocks were made up of the agency or model forecasts that were used in the annual model calibrations. Aggregate forecasts that were less than observed return were associated with underages (observed catch less than post-season TAC) and aggregate forecasts that were greater than observed return were associated with overages (observed catch greater than post-season TAC). The relationships were significant for NBC (p=0.0149), highly significant for WCVI (p=0.0031) and extremely significant for SEAK (p=0.00008). The regression analyses indicated that the proportion of Total Error associated with forecast error proportion was 77% for the SEAK, 35% for the NBC, and 48% for the WCVI AABM fisheries over these years.

3.3 Expected catches and escapements if the provisions of the 1999 Agreement were still in effect

The assignment to the CTC was stated as *"expected catches and escapements in the AABM and ISBM fisheries if the provisions of the 1999 Agreement were in effect from 2008 onward."*

To perform this assignment, the CTC used two sets of PSC Chinook Model projection runs to produce statistics that were used to compare expected impacts under two scenarios: (1) expected results had the provisions of the 1999 Agreement been continued through 2015, labeled "PST1999"; and (2) expected results had the provisions of the 1999 Agreement been perfectly implemented through 2008 and provisions of the 2009 Agreement been perfectly implemented beginning in 2009, labeled "PST2009".

Compared to PST1999, PST2009 was expected to differ in respect to several inter-related factors: (1) Post 2008 TACs for AABM fishery complexes would be lower for SEAK and WCVI because of adjustments to Table 1; (2) simulated harvests by ISBM fisheries and escapements would be higher; and (3) AIs in subsequent years would be higher since some of the immature fish that were not caught would survive to contribute to future fisheries and escapements and production would be expected to increase. In this section, selected comparisons are provided; the operational approach and data inputs for the simulation are detailed in Appendix B.

3.3.1 Results of the Simulation

The results from this simulation are presented below. These include allowable catches in AABM fisheries, expected catches in ISBM fisheries, and escapements and terminal runs under the scenarios described above. Comparisons with actual catch and escapement data covered elsewhere in this report are not appropriate because "model catches" differ due to the algorithms in the Model and the projections assumed fisheries were managed to achieve either Table 1 catches (i.e., preseason allowable catches) or the general ISBM obligation harvest rate. These assumptions may differ from the actual management regimes that were employed for the various AABM and ISBM fisheries. For example, the management approach used for the NBC AABM fishery resulted in an underage of catch relative to the preseason allowable catch in all years and the underage was substantial in many years. Another example is that Canadian ISBM fishery impacts have typically been lower in reality than the Canadian general obligation level. The consequence of the assumption applied to the NBC AABM fishery is that fewer fish would pass through the fishery in the simulation relative to reality. The consequence of the assumption used for the ISBM fisheries is that more or less fish would pass through to the escapement depending on collective impacts on specific stocks.

3.3.1.1 Modeled Catches

Under the two scenarios in the simulation, AIs and yearly total allowable catches (TACs) were estimated for PST fisheries (Table 11 and Figure 11). Compared to PST1999, the TACs for the three AABM fisheries in catch years 2009–2014 under PST2009 were 30% lower in the WCVI fishery and 14% lower in the SEAK fishery; this is the expected result given that respective reductions of 30% and 15% for the WCVI and SEAK fisheries were negotiated as part of PST2009. They were nearly the same under both scenarios for the NBC AABM fishery because no reduction in the NBC fishery occurred from PST1999 to PST2009.

Table 11– Summary of the projected total abundance indices (AIs) and total allowable catch (TAC) *expected under the PST1999 and PST2009 scenarios for years 2009–2014.*

Output from the annual model calibrations actually used 'Actual Preseason' is provided for comparison.

		Actual Preseason		PST1999		PST2009	
AABM	**Year**	**AI**	**TAC**	**AI**	**TAC**	**AI**	**TAC**
SEAK	2009	1.33	218,800	1.01	152,850	1.01	129,923
	2010	1.35	221,800	1.07	169,950	1.08	146,880
	2011	1.69	294,800	1.39	268,109	1.41	230,927
	2012	1.52	266,800	1.04	161,400	1.06	142,035
	2013	1.20	176,000	1.46	280,603	1.47	240,030
	2014	2.57	439,400	2.14	433,812	2.16	372,026
	2015[1]	1.45	237,000	1.87	381,602	1.90	329,292
NBC	2009	1.10	143,000	0.91	118,300	0.91	118,300
	2010	1.17	152,100	1.06	137,800	1.07	139,100
	2011	1.38	182,400	1.14	148,200	1.15	149,500
	2012	1.32	173,600	1.00	130,000	1.02	132,600
	2013	1.10	143,000	1.38	182,400	1.39	183,867
	2014	1.99	290,300	1.71	249,476	1.73	252,394
	2015[1]	1.23	160,400	1.61	234,887	1.63	237,805
WCVI	2009	0.72	107,800	0.51	109,095	0.51	76,367
	2010	0.96	143,700	0.74	158,295	0.74	110,807
	2011	1.15	196,800	0.77	164,712	0.78	116,796
	2012	0.89	133,300	0.64	136,904	0.65	97,330
	2013	0.77	115,300	0.93	198,938	0.94	140,755
	2014	1.20	205,400	1.09	266,474	1.09	186,532
	2015[1]	0.85	127,300	1.00	213,912	1.01	172,841

[1]The TACs corresponding to the indicated AIs were used to manage the AABM fisheries in 2015 under direction from the PSC, without consensus from the CTC for the calibration (CLB1503).

Average 2009–2014 model catches for ISBM fisheries are depicted in Table 12. For Canadian ISBM fisheries, increases in catches from PST1999 to PST2009 were projected to be less than 1%, except for a projected 2% increases in North and WCVI net. U.S. ISBM fisheries showed larger increases (up to 3%) between the two scenarios, with PST2009 being higher. The Model fisheries 'Terminal net' and 'Terminal sport' were each projected to have 3% increases; these fisheries include the collective terminal sport and net fishery catches in Canada and the U.S.

Table 12– Average 2009–2014 landed catch generated for the 25 Model fisheries from the 2015 Model projection under the PST1999 and PST2009 scenarios.

Output from CLB1601 is provided for comparison. The value in the'% Diff' column is the percentage difference between the PST1999 and PST2009 scenario relative to the PST1999 scenario. Positive values indicate that a decrease occurred under the PST2009 scenario whereas negative values would indicate the opposite.

Country	Fishery Type	Fishery	CLB1601	PST1999	PST2009	% Diff
CA	AABM	NBC T	88,417	121,632	122,839	1.0
		NCBC S	197,583	165,562	166,482	0.6
		WCVI T	70,284	113,910	80,232	-29.6
		WCVI S	29,155	15,835	11,153	-29.6
	AABM Total		96,360	104,235	95,176	-8.7
	ISBM	North N	1,637	35,299	36,048	2.1
		Central T[1]	0	0	0	0.0
		Central N	3,832	41,246	41,377	0.3
		WCVI N	9,368	14,171	14,447	1.9
		John St N[1]	220	220	220	0.0
		Geo St T[1]	1	1	1	0.0
		Geo St S	60,808	52,744	52,767	0.0
		Fraser N	66,091	71,456	71,780	0.5
		J De F N[1]	104	104	104	0.0
	ISBM Total		15,784	23,916	24,083	0.7
US	AABM	SEAK N	8,602	11,036	9,380	-15.0
		SEAK T	171,154	150,690	129,777	-13.9
		SEAK S	38,400	34,319	29,556	-13.9
	AABM Total		72,719	65,348	56,238	-13.9
	ISBM	PS Nth N	3,561	19,182	19,455	1.4
		PS Nth S	15,523	17,085	17,208	0.7
		PS Sth N	116,459	49,479	50,868	2.8
		PS Sth S	8,461	23,131	23,231	0.4
		WA/OR T	93,665	94,252	94,443	0.2
		WA Coast N	30,136	22,586	23,231	2.9
		WA Ocean S	28,192	35,125	35,184	0.2
	ISBM Total		42,285	37,263	37,660	1.1
CA and US	ISBM	Terminal N	264,512	246,304	254,106	3.2
		Terminal S	92,544	32,489	33,306	2.5
	ISBM Total		178,528	139,396	143,706	3.1

[1] The catches in four Canadian ISBM fisheries were modeled as the observed catches because these fisheries had not been prosecuted since the start of, or within a few years of the start of the 1999 PST. Any reported catch was the result of small numbers of fish retained as bycatch in fisheries targeting other salmon species. Model catches for other Canadian ISBM fisheries can differ substantially from observed catches due to the FP (fishery scalar) assumptions used in the Model projection.

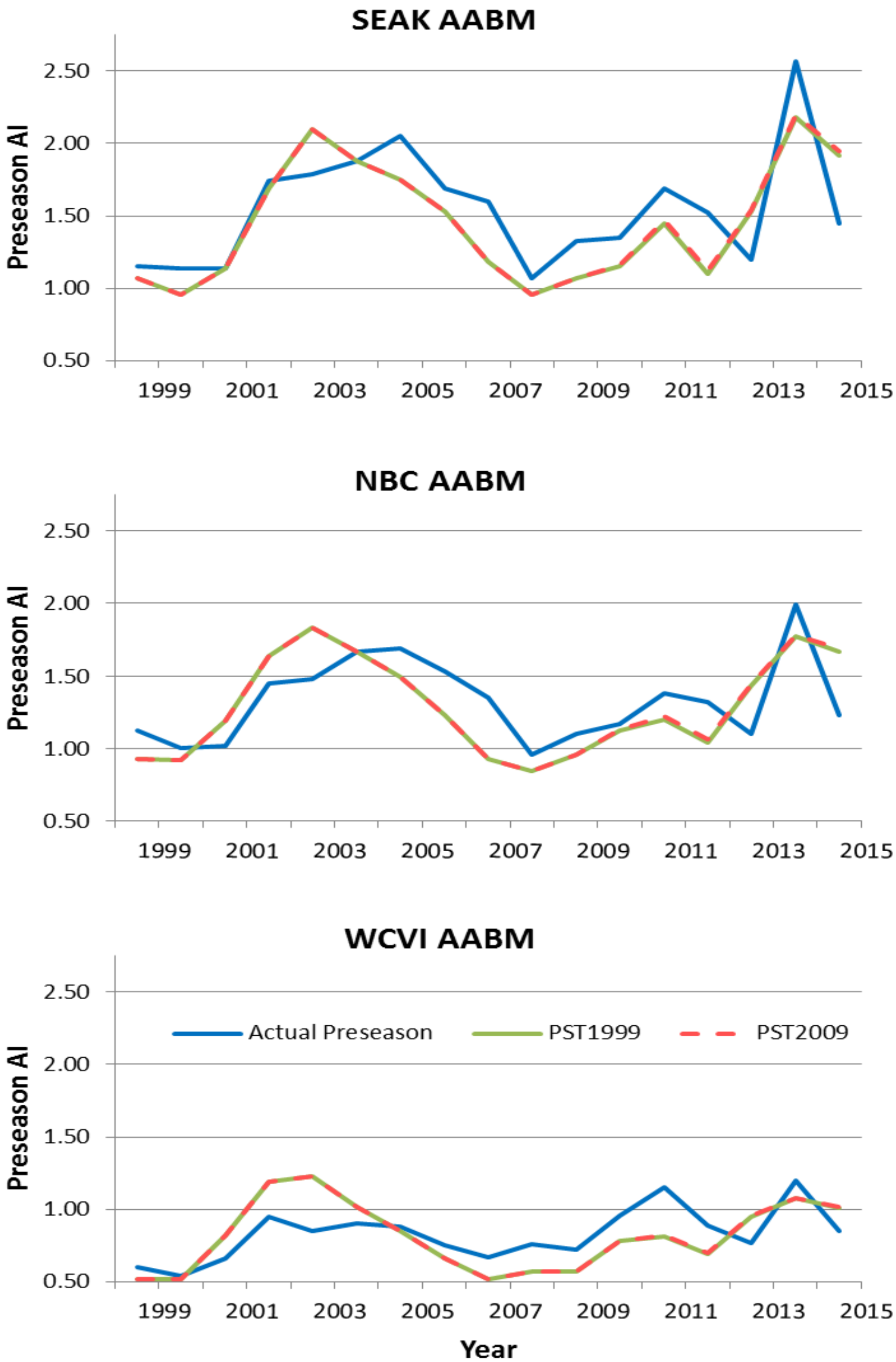

Figure 11— Preseason AIs for the SEAK, NBC and WCVI AABM fisheries from the two modeled scenarios, PST1999 and PST2009.

The blue series labeled 'Actual Preseason' are the observed AIs generated by the annual calibration procedure, from Table 11. The 2009—2015 AIs for PST2009 were slightly higher than those for PST1999 but the difference is largely imperceptible due to the scale of the y-axis.

3.3.1.2 Modeled Escapement and Terminal Runs

Compared to PST1999, the combined escapement of all 30 model stocks was projected to be higher under PST2009 by 2.4% on average for Canadian stocks and 3.4% for U.S. stocks (Table 13). Among individual model stocks, the increase ranged from a low of 1.5% (Fraser early stocks) to a high of about 9% (Lower Bonneville hatchery stock). The total projected increased escapement for the 30 model stocks was comprised of about 50% from the Columbia River, 29% from BC, 10% from PS, 7% from OR coast, 3% from WA coast, and 1% from SEAK south/central inside model stocks. Terminal runs were projected to be higher by about 3% across all 30 model stocks, with projections for individual model stocks ranging from 1.5% to 8.9%.

Table 13– Average 2009–2014 escapements and terminal runs generated by the 2015 Model projection for the 30 Chinook Model stocks grouped by country and region of origin for the PST1999 and PST2009 scenarios.

Output from CLB1601 is provided for comparison. The values in the '% Diff' column are the percentage difference between the PST1999 and PST2009 scenarios relative to the PST1999 scenario. Positive values indicate an occurred under the PST2009 scenario.

		Average Model Escapement				Average Model Terminal Run			
Region	Stock	CLB1601	PST1999	PST2009	% Diff	CLB1601	PST1999	PST2009	% Diff
NCBC	NTH	103,585	113,836	116,694	2.5%	103,585	113,836	116,694	2.5%
WCVI	RBH	93,714	85,245	88,421	3.7%	106,469	95,062	98,650	3.8%
	RBT	11,645	7,349	7,681	4.5%	12,916	8,181	8,553	4.5%
FR	FRE	144,308	76,878	78,002	1.5%	154,194	124,569	126,492	1.5%
	FRL	115,242	137,260	140,251	2.2%	171,130	170,509	173,468	1.7%
GS	GSH	10,849	11,241	11,421	1.6%	10,849	11,241	11,421	1.6%
	GSQ	20,908	15,638	16,507	5.6%	20,908	15,638	16,507	5.6%
	GST	6,023	6,342	6,470	2.0%	6,023	6,342	6,470	2.0%
CA Total		**506,274**	**453,788**	**465,447**	**2.6%**	**586,074**	**545,376**	**558,254**	**2.4%**
SEAK	AKS	10,476	10,101	10,581	4.8%	10,476	10,101	10,581	4.8%
PS	NKF	14,557	17,169	17,639	2.7%	36,118	34,809	35,752	2.7%
	NKS	1,619	925	938	1.5%	1,627	940	954	1.5%
	PSF	54,634	80,158	82,663	3.1%	123,816	109,213	112,587	3.1%
	PSN	6,653	4,425	4,592	3.8%	8,206	5,983	6,207	3.7%
	PSY	11,225	14,164	14,569	2.9%	28,270	20,294	20,853	2.8%
	SKG	10,236	8,660	8,899	2.8%	11,669	10,139	10,421	2.8%
	SNO	2,768	1,032	1,059	2.6%	2,837	1,648	1,691	2.6%
	STL	968	361	375	4.1%	979	416	433	4.0%
WAC	WCH	25,931	15,375	15,928	3.6%	38,248	26,165	27,082	3.5%
	WCN	20,696	22,208	22,927	3.2%	34,656	31,775	32,789	3.2%

~continued~

Table 13– Page 2 of 2.

		Average Model Escapement				Average Model Terminal Run			
Region	Stock	CLB1601	PST1999	PST2009	% Diff	CLB1601	PST1999	PST2009	% Diff
CR	BON	11,644	5,402	5,882	8.9%	20,139	8,925	9,716	8.9%
	CWF	49,828	48,622	50,578	4.0%	79,447	69,084	71,660	3.7%
	CWS	6,226	8,375	8,542	2.0%	10,708	10,137	10,339	2.0%
	LRW	10,393	11,786	12,143	3.0%	15,190	13,560	13,967	3.0%
	LYF	10,586	10,241	10,760	5.1%	17,913	15,962	16,792	5.2%
	MCB	90,877	83,219	86,624	4.1%	122,586	110,376	114,671	3.9%
	SPR	26,445	24,518	25,820	5.3%	86,828	79,017	83,156	5.2%
	SUM	61,707	58,418	60,559	3.7%	70,345	65,711	68,057	3.6%
	URB	285,620	273,023	281,764	3.2%	453,443	419,385	432,161	3.0%
	WSH	50,395	53,534	54,458	1.7%	70,741	68,025	69,197	1.7%
ORC	ORC	81,108	86,565	89,514	3.4%	97,009	96,082	99,394	3.4%
US Total		**844,589**	**838,279**	**866,815**	**3.4%**	**1,341,250**	**1,207,744**	**1,248,460**	**3.4%**

4. Model Performance

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 Agreement, the primary purpose of the model has been to enable abundance-based management through the production of fishery abundance indices. The model generates preseason projections of abundance indices (AIs) for the SEAK, NBC, and WCVI AABM fisheries and postseason estimates of the AIs that enable evaluations of AABM performance (i.e., pre- versus postseason AI and allowable catch comparisons).

4.1 Model Error

For the purposes of this section of the report, model error will refer to differences between model-generated preseason forecasts of abundances 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. As per the Agreement paragraph 8(e), the PSC Chinook Model also generates preseason estimates of ISBM indices. As previously discussed briefly in section 3.1 of this report and as shown in Figure 4 and Figure 5 for the Fraser Late stock and the Columbia Bright stock the model as currently implemented is not capable of providing accurate preseason estimates of ISBM indices for preseason planning. Also, inseason management of ISBM fisheries attempts to achieve escapement objectives such that the general obligation is not pertinent, and postseason indices often depend primarily on inseason management actions. ISBM fisheries comprised roughly 65% of the PSC Chinook catch during the current Agreement period.

The performance of the PSC Chinook Model to represent the abundance of Chinook in AABM fisheries is affected by the accuracy of the agency forecasts for the largest stocks and the accuracy of the escapement estimates. Model stocks that do not have annual agency-generated forecasts represent about 2/3 of the catch in the NBC fishery, 1/3 in the SEAK fishery, but only 5% in the WCVI fishery.

4.1.1 AABM preseason vs. post-season AIs

The yearly percent deviations between preseason and post-season AIs for the three AABM fisheries are illustrated in Figure 12. For each AABM fishery, the deviations between the preseason and post-season AIs have varied considerably since 1999. Large deviations can compromise the utility of preseason AIs for setting harvest objectives for each of the fisheries, and thus the intent of the 2009 Agreement.

AIs are generated without any measures of their uncertainty and while 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 to 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 enable the CTC to compare different types of abundance estimation models (e.g., statistical catch-at-age model) using a common data set of simulated abundance values. Investigations with this tool might enable the CTC to develop more accurate models for abundance prediction.

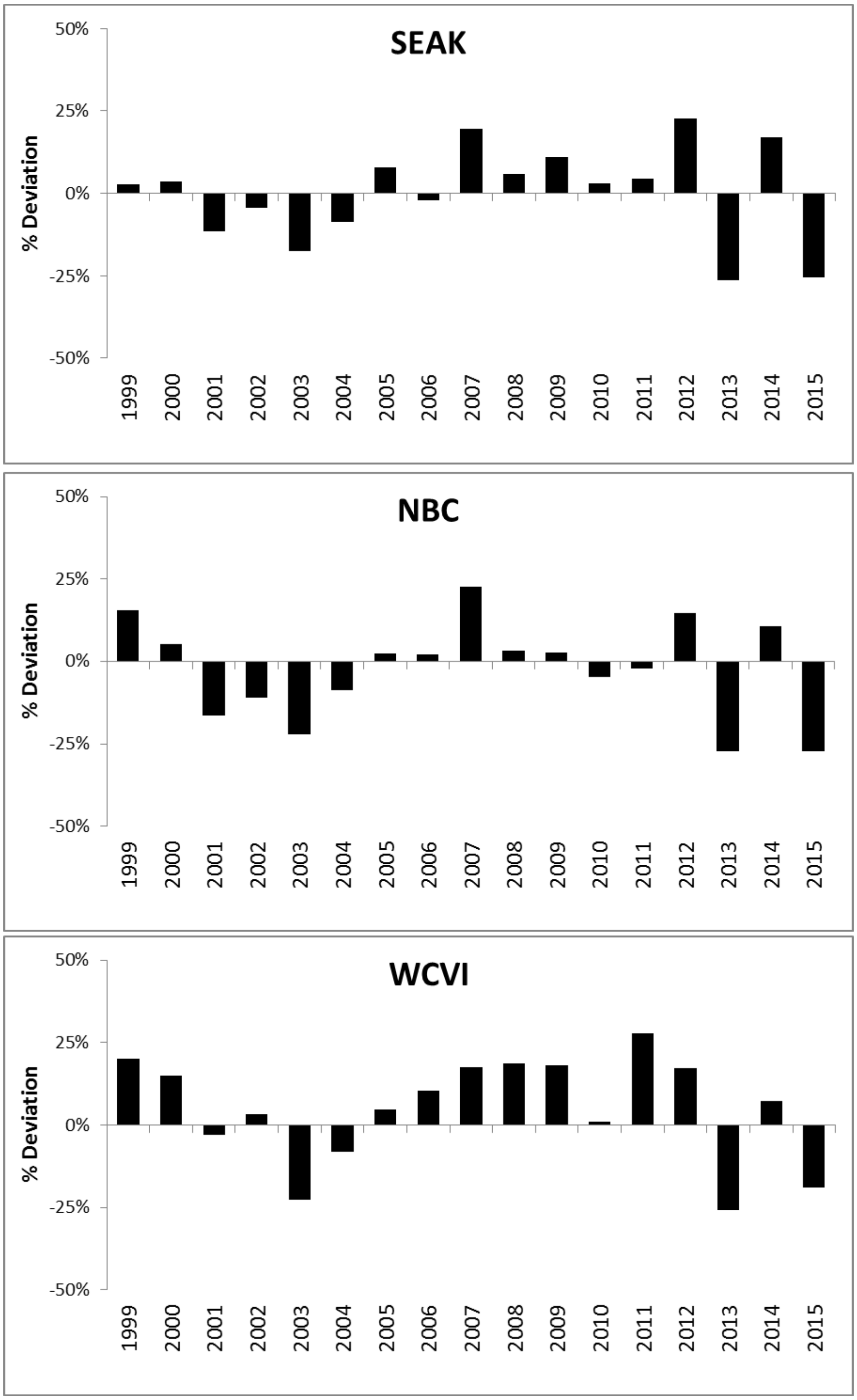

Figure 12—Difference between pre- and postseason abundance indices (AIs) for the three AABM fisheries, 1999–2015.

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 postseason AIs are from CLB 1601 and values for the 2015 preseason AI is from CLB 1503.

4.1.2 AI stabilization time frame

The CTC reports the first post-season AI, which is developed from the first calibration where the oldest cohort is complete (e.g. age-5) and escapement and terminal run estimates are available for other ages. Typically, only a small component of the total cohort matures at the oldest age, even though the maturation rate is 100%. This attribute of Chinook salmon biology dampens some of the variability between the first post-season AI and subsequent AI estimates. The maturation of incomplete cohorts during the next three years following the first post-season AI causes the final estimate of AI to change until the youngest cohort is completed (3 years). Much of the uncertainty in cohort sizes is from the youngest cohorts because they have the least amount of data available from fisheries and escapement. This may cause greater variation in post-season AIs for AABM fisheries that have a larger component of the abundance represented by younger ages, compared to AABM fisheries where younger ages represent a smaller component of the AI.

4.2 Model Inputs and Adjustments

4.2.1 Stock Forecast Performance

The accuracy and precision of agency forecasts used as inputs to the PSC Chinook Model to generate AIs have varied considerably across stocks since the 2009 Agreement (Table 14). Forecasts that are developed by the various agencies are a mixture of terminal run and escapement, depending on the stock. Model generated forecasts are used where no agency forecasts are available.

Forecast performance is assessed using the mean percent error (MPE), which is the difference between the forecast and actual return divided by the actual return. A performance guideline that the difference between the forecast and actual return be, on average, ±7.5% of the actual return was recommended by the CTC in a memo to the Chinook Interface Group dated January 8, 2013 related to the application of Paragraph 13. Table 14 presents information to assess in the performance of forecasts used as inputs to the Chinook model. Of the six stocks with solely model-produced forecasts, 3 (50%) meet the ±7.5% error guideline. Of the 17 stocks with solely agency-provided forecasts summarized in Table 14, only six (35%) meet that same performance guideline. None of the four stocks that use a combination of agency and model forecasts met this performance guideline. Of seven stocks that contribute 10% or more to at least one of the AABM fisheries, forecasts for five stocks met the ±7.5% performance guideline (NTH, FRL, BON_CWF, URB, and ORC) and two did not (RBH_RBT and PSF). Of ten stocks that contribute 3 to 10% to at least one of the AABM fisheries, forecasts for only two stocks met the 7.5% bias performance guideline (AKS and WSH) and nine did not (RBH_RBT, UGS, FRE, NKF, WCN, WCH, SUM, SPR, and MCB).

Forecast performance was also compared between the 1999 and 2009 Agreement periods using the ratio of forecast to actual return and examining the distribution of the errors (Figure 13 and Figure 14). Ratio values greater than 1 indicate an overestimate of actual return and values less than 1 are indicative of under forecasted returns. A ratio of 2, for example, means that the forecast was 2 times higher than actual return. The box plots in Figure 13 and Figure 14 provide a visual presentation of the range of forecast errors for each model stock, and whether there is a tendency to over- or underestimate the return. Differences in forecast performance between these two Agreement periods occurred for all stocks with a few changes being more notable than others. For example, there is a tendency for the Model to over-forecast returns of the Lower Georgia Strait Natural and Upper Georgia Strait stocks in the later, 2009–2015, time period relative to the previous period. The Commission has initiated a review process by an independent scientific review panel with the intent to provide additional insight into forecast performance and make recommendations to the Commission prior to the 2017 annual calibration.

Table 14–Forecasts used in PSC Chinook Model calibrations, mean percent forecast errors, range of forecast errors, and contribution of forecasted stocks to AABM fisheries since 2009.

Model Stock (Abbreviation)	Forecast Type (Primary/ Secondary)	Mean Percent Error	Range Percent Errors	Contributions to AABM		
				SEAK	NBC	WCVI
Alaska SSE (AKS)	Model	3%	*-60% to 85%*			
North/Central BC (NTH)	Model	2%	*-37% to 25%*			
WCVI Hatchery + Natural (RBH_RBT)	Agency/Model	-29%	-81% to 80%			
Upper Strait of Georgia (GSQ)	Model	32%	*6% to 44%*			
Lower Strait of Georgia Hatchery (GSH)	Model	7%	*-61% to 88%*			
Lower Strait of Georgia Natural (GST)	Model	47%	*-48% to 92%*			
Fraser Early (FRE)	Model	11%	*-49% to 138%*			
Fraser Late (FRL)	Agency	-2%	-49% to 60%			
Nooksack Spring (NKS)	Agency/Model	-27%	-80% to 8%			
Nooksack/Samish Fall Fingerlings (NKF)	Agency	26%	0% to 75%			
Snohomish Wild (SNO)	Agency	130%	-48% to 538%			
Skagit Summer/Fall Wild (SKG)	Agency	34%	-26% to 86%			
Puget Sound Natural (PSN)	Agency	36%	-22% to 178%			
Stillguamish Summer/Fall Wild (STL)	Agency	13%	-74% to 97%			
Puget Sound Fingerling + Yearling (PSF)	Agency	21%	-23% to 135%			
Washington Coastal Natural (WCN)	Agency/Model	11%	-27% to 49%			
Washington Coastal Hatchery (WCH)	Agency/Model	-8%	-41% to 15%			
Cowlitz Spring (CWS)	Agency	14%	-50% to 100%			
Willamette Spring (WSH)	Agency	4%	-44% to 30%			
Columbia River Summer (SUM)	Agency	11%	-42% to 56%			
Bonneville + Cowlitz Hatcheries (BON_CWF)	Agency	7%	-26% to 50%			
Spring Creek Hatchery (SPR)	Agency	8%	-56% to 65%			
Columbia Upriver Bright (URB)	Agency	3%	-45% to 42%			
Snake River Wild (LYF)	CTC-Modified Agency	55%	-73% to 386%			
Mid-Columbia Bright (MCB)	Agency	10%	-57% to 77%			
Lewis River Wild (LRW)	Agency	1%	-45% to 33%			
Oregon Coastal (ORC)	Agency	-6%	-25% to 15%			

Mean Percent Error Key
Forecasts within + 7.5% of Actual, on average
Forecasts not within + 7.5% of Actual, on average

Average Contribution to AABM Fisheries Key
Stock Contributes 10% or more to AABM fishery
Stock Contributes 3 to 10% to AABM fishery
Stock Contributes less than 3% to AABM fishery

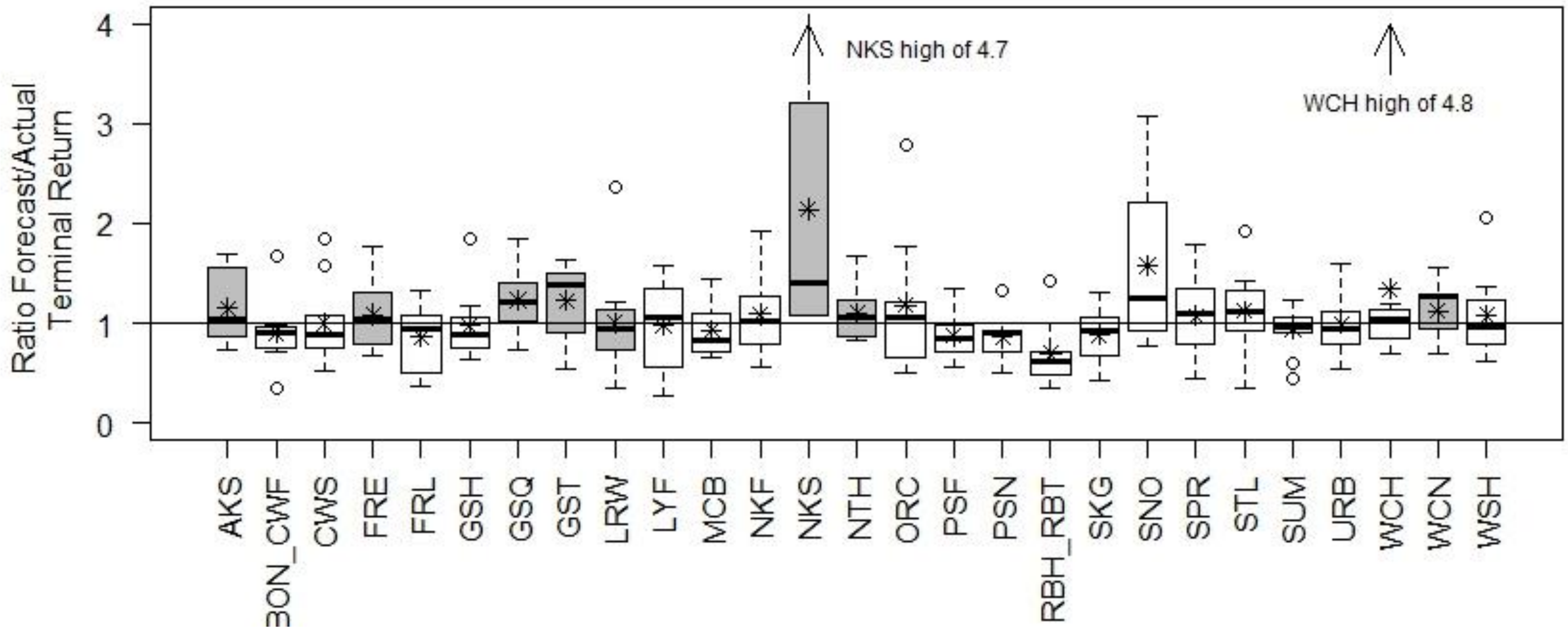

Figure 13—The ratio of the forecasted terminal return to actual terminal return from 1999–2008 for stocks used in the CTC model calibration.

*Shaded boxes are for stocks that have no agency supplied forecasts. Stock abbreviations are in Table 14. The median error bar is the middle of the box. 50% of the errors are above the line, 50% below. Lower and upper ends of the boxes are the 25th and 75th percentiles, respectively. Mean ratios are represented as *, top and lower vertical bars are values that are 1.5 greater (or less than) the values at the end of the boxes. Open circles (○) represent outliers, values that are beyond upper and lower bars.*

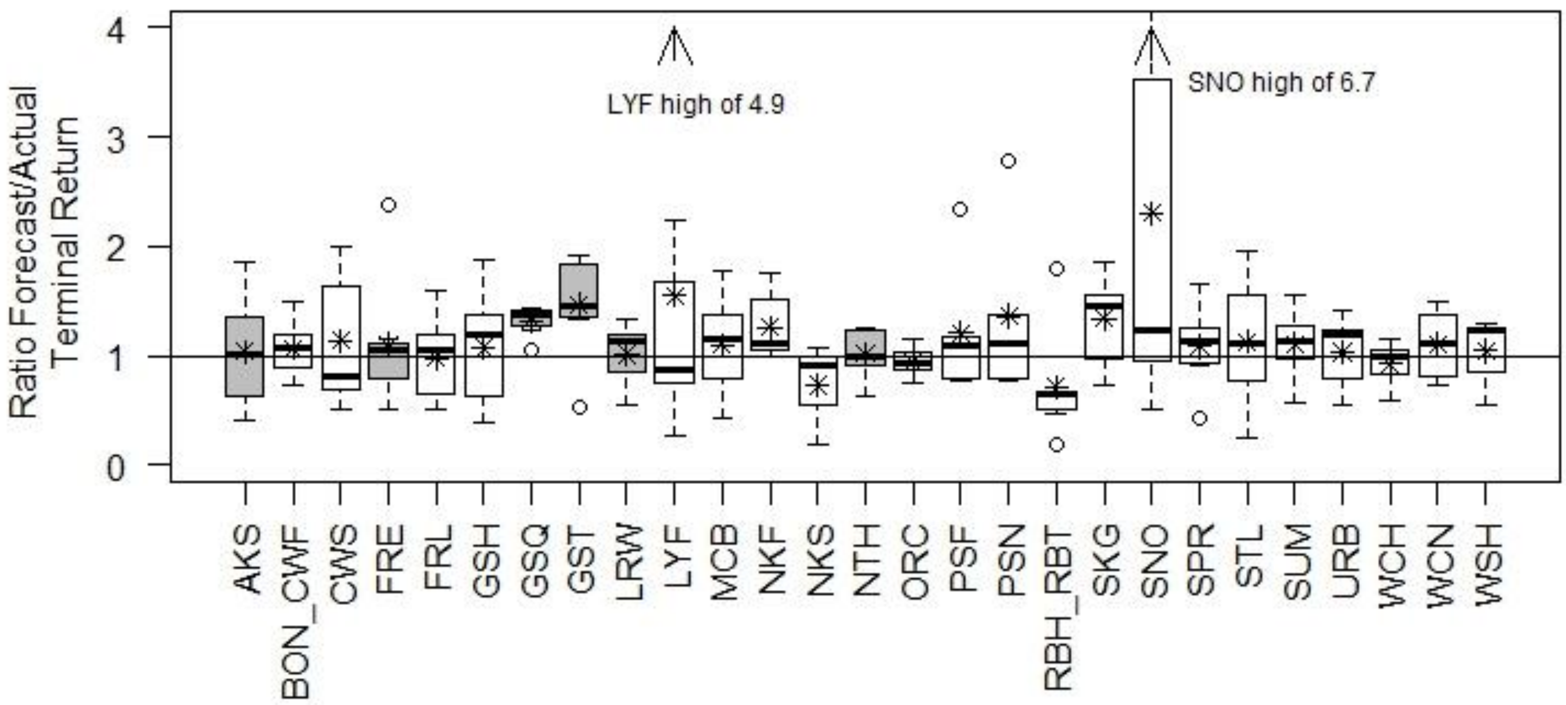

Figure 14—The ratio of the forecasted terminal return to actual terminal return from 2009–2015 for stocks used in the CTC model calibration.

*Shaded boxes are for stocks that have no agency supplied forecasts. Stock abbreviations are in Table 14. The median error bar is the middle of the box. 50% of the errors are above the line, 50% below. Lower and upper ends of the boxes are the 25th and 75th percentiles, respectively. Mean ratios are represented as *, top and lower vertical bars are values that are 1.5 greater (or less than) the values at the end of the boxes. Open circles* (○) *represent outliers, values that are beyond upper and lower bars.*

4.2.2 Timeliness of input data

AABM catch estimates are generated in-season for troll, net and sport fisheries, and are reported to the PSC in the year immediately following the fishing season. However, some sport fisheries rely on mail-in surveys to generate 'final' catch estimates, and these are typically only available one or two years after the fishery. The lack of final catch information can delay final catch estimates, impact the accuracy of agency forecasts (based on incomplete data), and delay reporting of expansion factors for CWT recoveries that are used in the exploitation rate analysis to generate PSC Chinook Model inputs.

Agencies strive to provide terminal run or escapement forecasts for model stocks to the CTC by February to facilitate model calibration. Timeframes are very tight for agencies to assemble the data used to prepare their forecasts. Delivery of agency forecasts to the CTC can be delayed by late reporting of escapements, late reading of age samples, or the late estimation and reporting of CWT recoveries in fisheries and spawning escapements. Since the calibration procedure is especially sensitive to agency forecasts for large stocks, delays in obtaining agency forecasts for large model stocks can delay the entire model calibration. Thus, forecasts for larger model stocks should receive higher priority by agencies to ensure that the CTC completes the model calibration in March.

The calibration also provides the first post-season AI for the previous year's fishing regimes. The post-season AI and associated allowable catch is used to evaluate the previous year's fishery catches, relative to PST expectations. The first post-season AI is available in a timely manner for this evaluation, but the value of the post-season AI can change over the next few years until all the contributing cohorts are complete. The CTC annual catch and escapement report compares the observed catch to preseason and postseason allowable levels. Overages and underages are monitored for systematic patterns and reported to the PSC annually.

Some escapement and terminal fishery catch CWT data are not reported for southern U.S. stocks until 2 years after the fishery. This delays calculation of CWT-based ISBM fishery indices for about 2 years after the fishing season, which precludes using those indices for planning the upcoming year's fisheries, and reduces the timeliness and accuracy of the fishery indices for AABM and ISBM fisheries. During the last three decades and beginning in 2013, CWT data analysis for Alaskan and Canadian fisheries, respectively, have been available shortly after the fishery. This enables some fishery indices to be generated in a more timely fashion, and improves planning of upcoming fisheries.

The status of escapement indicator stocks is evaluated by the CTC annually by comparing escapements to escapement objectives. Escapement data may be available in time to evaluate their status and advise the PSC regarding whether conditions are met for additional fishery reductions under provisions of Paragraph 13. However, to do so requires assumptions concerning ISBM obligations and the applicable CWT-based ISBM indices are not available within that time frame and the model-based ISBM indices have little correspondence with the CWT-based indices. With the exception of stocks that are managed inseason (e.g., Columbia River), opportunities to adjust concurrent fishing plans in years of unanticipated low escapement are limited.

5. Implementation of Chapter 3

5.1 Basic Data Needed to Implement Chapter 3 Annually

The Parties negotiated a 10-year Agreement for coast-wide management of Chinook salmon in 2009. It is data intensive, and requires that substantial fiscal resources be invested and coordinated across jurisdictions to provide data on catches and escapements, and maintain the CWT system. During the negotiations, the Parties recognized that fiscal resources greater than those available at the time were required for implementing Chapter 3. In response, the Parties included additional funding in the Agreement:

- Paragraph 3(a): A commitment by the Northern and Southern Boundary endowment funds for $2.0 million (U.S.) per year for five years beginning in 2009 for the Sentinel Stocks Program or SSP.
- Paragraph 3(b): Provide $7.5 million by each Party to implement over a 5-year period the Coded-Wire Tag Improvement Program or CWTIT.
- Paragraph 3(c): Up to $1.0 million made available by the U.S. Section to implement the PSC Chinook model improvement effort over two years.

These additional fiscal resources totaled approximately $26 million over five years in order to augment annual expenditures of approximately $5 million.

Most of the additional funding to support critical data needs associated with Chapter 3 was expended within the first five years of the Agreement. The management agencies continue to face financial challenges to meeting obligations under Chapter 3 arising from severe funding shortfalls and are unable to incorporate many of these programs into their agency budgets. There are increasing concerns for the ability of agencies to maintain the viability of the CWT system, catch and escapement monitoring programs, and exploitation rate and escapement indicator stock programs necessary to implement Chapter 3 (see Section 5.2 for greater detail).

5.2 Data Quality and Availability

The 2009 PST Agreement as specified in Chapter 3 is data intensive and requires numerous types of data and assessments of Chinook indicator stocks. The availability and quality of data used for the coast-wide Chinook indicator stock program is evaluated in this section of the report. The CTC defined 11 attributes of the indicator stock program and three data quality levels for each of these attributes during the current annex period (Table 15). The CTC scored the attributes of each indicator stock against these data quality criteria as a means of evaluating the indicator stocks used to monitor stock status of Chinook under Chapter 3 of the Agreement (Table 16). The evaluation demonstrates that the information currently available ranges from high quality information available for some stocks to poor quality and/or quantity of information available for others. Regional summaries and discussion follow below.

Table 15– Attributes and status for indicator stocks. Each escapement indicator stock is scored over the 2009–2015 period.

Attribute	Red	Yellow	Green
Escapement assessment meets CTC data standards (consider situations where estimates were generated but have not yet replaced normative estimates, e.g. SSP studies)	Standards not met for any substock (e.g. uncalibrated index)	Standards met for some substocks or years	Standards met for all substocks and years (e.g. calibrated escapement indices)
Escapement survey coverage (all spawning areas, substocks annually)	Escapements have not been estimated for some spawning areas, substocks in some years (missing estimates)	Escapements have not been estimated directly for some spawning areas, substocks in some years, but estimates have been generated indirectly (infilling methods)	Escapements have been estimated for all spawning areas, substocks in all years
Escapement estimates by age available	Escapements not estimated by age for stock, or any substock	Escapements estimated by age for at least one substock	Escapements estimated by age for stock, or all substocks
Escapement data provided in time for model calibration	Escapement data provided after CTC model calibration	On at least one occasion since 2008, escapement data provided after CTC model calibration	Escapement/ terminal run data provided before CTC model calibration
CTC Escapement Goal	No CTC or agency goal	Agency goal	CTC goal
Representative CWT indicator	No CWT indicator stock	CWT indicator stock present, but doesn't represent all substocks or naturally spawning substocks (e.g. differences in maturation rates, survival, migration timing through fisheries)	CWT indicator stock is a good representation of most substocks
CWT indicator meets CWT work group data standards for escapement	Escapement estimates are biased and CWT sampling rates <20%	Escapement estimates are biased or CWT sampling rates <20%	Escapement estimates are unbiased, CWT sampling rates >20%

~continued~

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Attribute	Red	Yellow	Green
Terminal fishery catch monitoring (catch estimate unbiased, CWTs sampled >20%)	Catch estimate biased and CWTs sampled <20%	Catch estimate biased or CWTs sampled <20%	Catch estimate unbiased and CWTs sampled >20%
ISBM CWT metrics reported, represent natural escapement indicator	ISBM CWT metrics not developed annually, no base period CWT data	ISBM CWT metrics developed annually, but adjustments have not been made yet to represent differences in terminal fisheries or MSFs	ISBM CWT metrics developed annually, represent terminal fisheries for natural escapement indicator stock
CWT indicator stock data provided in time for exploitation rate analysis	CWT data provided after CTC ERA	On at least one occasion during 2009 agreement, CWT data provided after CTC ERA	CWT data provided in time for CTC ERA annually
Annual forecast developed for model calibration	An agency forecast is not developed annually	Agency forecast is developed annually, but not by age-specific or not specific for escapement indicator stock (could be at model stock scale, but not escapement indicator stock)	Age-specific agency forecast developed annually

Table 16– Data availability and quality to support the implementation of Chapter 3.

CTC Escapement and Attachment I to V Stocks	Escapement assessment meets CTC data standards?	Escapement survey coverage (all spawning areas, substocks annually)	Escapements estimated by age	Escapement/terminal run data provided in time for CTC Model calibration	CTC agreed escapement goal?	Representative CWT Indicator?	CWT indicator meets CWT work group data standards for escapement?	Terminal fishery monitoring (catch estimate unbiased, CWT sample rate >20%)?	ISBM CWT metrics reported, represent natural escapement indicator	CWT indicator stock recovery data provided in time for Exploitation Rate Analysis	Annual forecast developed for CTC model calibration
Alsek	Green	Green	Green	Green	Green	Red	Light gray	Green	Gray	Gray	Gray
Taku	Green	Green	Green	Green	Green	Green	Green	Green	Gray	Green	Gray
Stikine	Green	Green	Green	Green	Green	Green	Green	Green	Gray	Green	Gray
Situk	Green	Green	Green	Green	Green	Red	Light gray	Green	Gray	Gray	Gray
Chilkat	Green	Green	Green	Green	Green	Green	Green	Green	Gray	Green	Gray
Unuk	Green	Green	Green	Green	Green	Green	Green	Green	Gray	Green	Red
Chickamin	Green	Green	Green	Green	Green	Green	Green	Green	Gray	Green	Red
Nass	Green	Green	Green	Green	Yellow	Yellow	Green	Yellow	Red	Green	Yellow
Skeena	Green	Green	Green	Green	Red	Green	Green	Yellow	White	Green	Red
Dean	Red	Red	Red	Green	Red	Red	Gray	Red	Red	Gray	Red
Wannock	Red	Red	Red	Green	Red	Red	Gray	Yellow	Red	Gray	Red
Chuckwalla/Kilbella	Red	Red	Red	Green	Red	Red	Gray	Yellow	Red	Gray	Red
Atnarko	Green	Green	Green	Green	Yellow	Green	Green	Yellow	White	Green	Red
Klinaklini	Red	Yellow	Red	Green	Red	Red	Yellow	Red	Red	Green	Red
Kakwiekan	Red	Yellow	Red	Green	Red	Red	Yellow	Red	Red	Green	Red
Wakeman	Red	Yellow	Red	Green	Red	Red	Yellow	Red	Red	Green	Red
Kingcome	Red	Yellow	Red	Green	Red	Red	Yellow	Red	Red	Green	Red
Nimpkish	Red	Yellow	Red	Green	Red	Red	Yellow	Red	Red	Green	Red
Cowichan	Green	Green	Green	Green	Green	Green	Green	Green	Red	Green	Red
Nanaimo	Red	Green	Green	Green	Yellow	Red	Gray	Gray	Red	Gray	Red
Artlish	Red	Green	Green	Green	Red	Yellow	Green	Red	Green	Green	Yellow
Burman	Green	Green	Green	Green	Red	Yellow	Green	Red	Green	Green	Yellow
Kaouk	Red	Yellow	Green	Green	Red	Yellow	Green	Red	Green	Green	Yellow
Tahsis	Red	Green	Green	Green	Red	Yellow	Green	Red	Green	Green	Yellow
Tashish	Red	Green	Green	Green	Red	Yellow	Green	Red	Green	Green	Yellow
Marble	Red	Green	Green	Green	Red	Yellow	Green	Red	Green	Green	Yellow
Fraser Spring 1.3	Red	Red	Red	Green	Red	Red	Gray	Red	Red	Gray	Red
Fraser Spring Age 1.2	Yellow	Green	Yellow	Green	Red	Green	Green	Red	Red	Green	Red
Fraser Summer Age 1.3	Yellow	Red	Yellow	Green	Red	Red	Gray	Yellow	Red	Gray	Red
Fraser Summer Age 0.3	Yellow	Green	Yellow	Green	Red	Yellow	Green	Yellow	Red	Green	Red
Harrison	Green	Green	Green	Green	Green	Green	Green	Yellow	Green	Green	Green

Table 16.– Page 2 of 2.

CTC Escapement and Attachment I to V Stocks	Escapement assessment meets CTC data standards?	Escapement survey coverage (all spawning areas, substocks annually)	Escapements estimated by age	Escapement/terminal run data provided in time for CTC Model calibration	CTC agreed escapement goal?	Representative CWT Indicator?	CWT indicator meets CWT work group data standards for escapement?	Terminal fishery monitoring (catch estimate unbiased, CWT sample rate >20%)?	ISBM CWT metrics reported, represent natural escapement indicator	CWT indicator stock recovery data provided in time for Exploitation Rate Analysis	Annual forecast developed for CTC model calibration
Nooksack Spring	Red	Yellow	Yellow	Red	Yellow	Green	Red	Red	Green	Red	Yellow
Skagit Spring	Red	Green	Green	Gray	Yellow	Green	Yellow	Yellow	Green	Red	Green
Skagit Summer-Fall	Red	Green	Green	Yellow	Yellow	Yellow	Green	Yellow	Green	Red	Gray
Stillaguamish	Red	Yellow	Yellow	Green	Yellow	Green	Green	Yellow	Green	Red	Yellow
Snohomish	Red	Green	Green	Green	Yellow	Green	Green	Yellow	Green	Red	Yellow
Lake Washington	Red	Yellow	Yellow	Red	Yellow	Red	Green	Red	Red	Red	Yellow
Green	Red	Green	Green	Green	Yellow	Green	Green	Yellow	Green	Red	Yellow
Hoko	Red	Green	Green	Green	Yellow	Green	Green	Yellow	Green	Red	Yellow
Quillayute Summer	Red	Yellow	Yellow	Red	Yellow	Red	Yellow	Yellow	Gray	Red	Yellow
Quillayute Fall	Red	Green	Green	Red	Yellow	Red	Red	Yellow	Yellow	Red	Yellow
Hoh Spring	Red	Yellow	Yellow	Gray	Green	Red	Yellow	Yellow	Gray	Red	Gray
Hoh Fall	Red	Green	Green	Red	Green	Red	Red	Yellow	Yellow	Red	Yellow
Queets Spring	Red	Yellow	Yellow	Gray	Green	Red	Yellow	Yellow	Gray	Red	Gray
Queets Fall	Red	Green	Green	Red	Green	Green	Green	Yellow	Green	Red	Yellow
Grays Harbor Spring	Red	Yellow	Red	Gray	Yellow	Red	Yellow	Yellow	Gray	Red	Gray
Grays Harbor Fall	Red	Green	Green	Red	Green	Red	Green	Yellow	Yellow	Red	Yellow
Columbia Spring	Green	Green	Green	Green	Red	Red	Gray	Green	Gray	Gray	Green
Mid-Columbia Summers	Green	Green	Green	Green	Green	Yellow	Green	Green	Yellow	Red	Yellow
Deschutes Fall	Green	Green	Green	Green	Green	Yellow	Green	Green	Green	Green	Red
Upriver Brights	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green
Lewis Fall	Green	Green	Green	Green	Green	Green	Green	Green	Green	Red	Green
Coweeman Tule	Green	Green	Green	Green	Red	Yellow	Green	Green	Green	Red	Gray
Nehalem	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green
Siltetz	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green
Siuslaw	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green
South Umpqua	Yellow	Yellow	Yellow	Gray	Red	Green	Yellow	Green	Gray	Green	Gray
Coquille	Yellow	Yellow	Yellow	Gray	Red	Green	Yellow	Green	Gray	Green	Gray

Transboundary Rivers

There are currently three PSC indicator stocks that return to the TBR area. Escapement estimates for all three stocks meet CTC data standards, all have CTC agreed escapement goals, all are sampled for age composition annually, and these data are all provided in time for annual CTC model calibrations (Table 13). Naturally produced juvenile Chinook are captured and CWT'ed in the Taku and Stikine. CWT recoveries from these programs are used to document exploitation rates. This obviates the need for a proxy hatchery origin stock and the need to make an assumption concerning the representativeness of the associated CWT'ed stock. The Alsek stock does not have an associated exploitation indicator stock that is annually CWT'ed. This river is in the far north of the PST area and in prior years, direct CWT'ing of this stock demonstrated that the only significant fishing mortality occurs in terminal fisheries in-river or in their respective estuaries. Annual CWT'ing is not needed to track harvests unless major changes in fishing patterns occur in the future. Terminal fisheries for the Alsek are closely monitored. Age-specific forecasts are produced annually for all TBR stocks. In general, the TBR indicator stock program has high data quality and is implemented without the need for the assumption used for other stock groups, which assume that a hatchery indicator stock completely represents the maturity schedule and fishery distribution of the natural stock which is widely used as part of the indicator stock program coast-wide.

SEAK

There are currently four PSC escapement indicator stocks that return to the SEAK area. Escapement estimates for all four stocks meet CTC data standards, all have CTC agreed escapement goals, all are sampled for age composition annually, and these data are all provided in time for annual CTC model calibrations (Table 16). Naturally produced juvenile Chinook are captured and CWT'ed in the Chilkat and Unuk. CWT recoveries from these programs are used to document exploitation rates. This obviates the need for a proxy hatchery origin stock and the need to make an assumption concerning the representativeness of the associated CWT'ed stock. The Situk stock does not have an associated exploitation indicator stock that is CWT'ed annually. This river is in the far north of the PST area and in prior years, direct CWT'ing of this stock demonstrated that the only significant fishing mortality occurs in terminal fisheries in-river or in the estuary. Annual CWT'ing is not needed to track harvests unless major changes in fishing patterns occur in the future. Terminal fisheries for the Situk are closely monitored. The Chickamin stock is not CWT'ed as well, but data from the AKS hatchery conglomerate stock are used as a surrogate under the assumption that distribution and harvest rates from these nearby hatcheries are applicable to the Chickamin stock. The base exploitation rates from the AKS hatchery surrogate are also used to represent the six stocks that comprise the single SEAK model stock (Unuk, Chickamin, Keta, Blossom, Andrew Creek and King Salmon stocks); this model stock also includes escapement estimates by age for the six systems that comprise it. Age-specific forecasts are produced annually for all SEAK stocks except for the Unuk and Chickamin stocks. This currently precludes the generation of a forecast for the composite SEAK stock in the Model. Forecasts could be developed for Unuk and Chickamin once the PSC Chinook model is modified to allow for inclusion of such stock specific forecasts. In general, the SEAK indicator stock program has high data quality and with the exception of Chickamin is largely implemented without the need for the assumption used for other stock groups, which assume that a hatchery indicator stock completely represents the maturity schedule and fishery distribution of the natural stock. This assumption is widely used as part of the indicator stock program coast-wide.

NBC/CBC

There are currently six PSC indicator stocks that return to the NBC/CBC, however a seventh indicator stock listed in the 2009 Agreement (Yakoun) has not been used since the escapement program was discontinued in 2005. Escapement estimates meet CTC data standards for half the stocks, largely due to the Sentinel Stocks and CWT Improvement programs. None of the stocks have CTC-accepted escapement goals but two have proxy estimates of S_{MSY} developed by the agency, half are sampled for age composition annually, and these data are all provided in time for annual CTC model calibrations (Table 16). Habitat-based escapement goals have been developed for Dean, Wannock, and Chuckwalla/Kilbella, but deficiencies in the escapement estimation programs make them impractical to use to evaluate stock status. Hatchery-produced juvenile Chinook are CWT'ed in the Kitsumkalum (Skeena) and Atnarko, and CWT recoveries from these programs are used to estimate survival and exploitation rates. The Dean, Wannock and Chuckwalla/Kilbella stocks do not have associated exploitation stocks; however, these rivers are remote, and have unique terminal fisheries and life histories (e.g. run timing and maturation patterns), making the need for surrogate CWT indicators to track harvests cost prohibitive. Terminal fisheries for the Dean, Wannock, and Chuckwalla/Kilbella are not monitored sufficiently to generate ISBM indices. Age-specific forecasts are produced annually for the Nass, but forecasts could potentially be developed for Skeena and Atnarko as these stocks have escapements estimated by age and CWT indicator stocks. Further refinement of the PSC Chinook Model is underway to better represent the Chinook production in NBC and CBC, and additional modifications would be needed to allow for inclusion of a forecast for Atnarko. In general, the NBC/CBC indicator stock program has moderate to high data quality for the largest and most accessible stocks, but the smaller and more remote stocks have poor quality data.

WCVI

There are currently six PSC indicator stocks that return to the WCVI areas used by the CTC. A seventh indicator stock listed in the 2009 Agreement (Gold) has not been used since the mid-2000s due to enhanced production from the Robertson Creek Hatchery frequently straying to Gold River. The SSP generated escapement estimates for one of the stocks (Burman) that meets CTC data standards, however the five other stocks do not meet standards nor do the normative estimates to the Burman. All are sampled for age composition annually, and these data are provided in time for annual CTC model calibrations (Table 16). None of the stocks have CTC-accepted escapement goals: Habitat-based escapement goals have been developed for all of them however concerns about the accuracy of the escapement estimates and the numbers of hatchery-origin spawners have limited their utility and made it difficult to implement Chapter 3 effectively. Improving the quality of the spawner escapement estimates has received significant attention with funding from the Southern Endowment Fund, the SSP and through the Joint Fund Committee via the High Priority Chinook Projects, but with limited success. Hatchery-produced juvenile Chinook are CWT'ed at Robertson Creek Hatchery. Recoveries from this program are used to estimate pre-terminal fishery exploitation rates; however, wide variations in the intensity of terminal fisheries among locations, occasional variation in smolt-age-2 survivals and surmised differences in life history (e.g. run timing and maturation patterns) make it uncertain to assume that the CWT indicator stock is a representative surrogate for all stocks. Age-specific forecasts are produced annually for the WCVI natural and hatchery stocks for the CTC model calibration, but forecasts are not developed for specific indicator stocks to implement ISBM and weak stock provisions of Chapter 3. In general, the WCVI indicator stock program is partially supporting the implementation of Chapter 3, but some parts are ineffective due to complex issues which create problems for the indicator stock approach as used coast-wide.

Georgia Strait

There are currently seven PSC indicator stocks that return to the Georgia Strait area. Escapement estimates for four stocks do not meet CTC data standards, only one has a CTC-accepted escapement goal, two are sampled for age composition annually, and these data are all provided in time for annual CTC model calibrations (Table 16). Habitat-based escapement goals have been developed for all of these indicator stocks (except Cowichan). However, substantial deficiencies in the escapement estimation programs make them impractical for evaluation of status. Hatchery-produced juvenile Chinook are CWT'ed in the Cowichan, Quinsam (upper Georgia Strait) and Phillips, and CWT recoveries from these programs are used to estimate exploitation rates. The Nanaimo was a CWT indicator stock until the mid-2000s when it was discontinued, and no suitable surrogates exist due to differences in fishery distribution. Five stocks do not have associated exploitation indicator stocks; however, these rivers are remote and have variations among terminal fisheries, making it challenging to use surrogate CWT indicators to track harvests effectively. Terminal fisheries for the Klinaklini, Kakwiekan, Wakeman, and Kingcome are not closely monitored. Age-specific forecasts are not produced for any of the stocks, and only the Cowichan and Nanaimo have age-specific estimates of escapement. The prevalence of poor quality or non-existent data for the Upper Georgia Strait stock aggregate makes it unreliable to retain this stock group in the CTC model for the purpose of representing production dynamics. The stock group needs to be refined and escapements monitored to at least one of the stocks consistent with CTC data standards. In general, the indicator stocks in Upper Georgia Strait are inadequately monitored for implementation of Chapter 3, whereas the Cowichan has a high quality assessment program and the program in the Nanaimo is of moderate quality.

Fraser

There are currently five PSC indicator stocks that return to the Fraser area. Four of them are stock aggregates that consist of Chinook spawning in six to 30 rivers each, and the indicator stocks listed in the Attachments need to be refined to implement Chapter 3 more effectively. Escapement estimates for Harrison meet CTC data standards, but the estimates for other stocks have a wide range of data quality. Data quality ranges from escapements not being estimated at some rivers to high quality escapement data for others. Estimation of escapements by age occurs at Harrison, but for the other stock aggregates, it is limited to the CWT indicator stocks. Only Harrison has a CTC-accepted escapement goal: Habitat-based escapement goals have been developed for the other stocks, but the escapement data quality at the stock aggregate level has limited their utility for determining stock status thus far. Hatchery-produced juvenile Chinook are CWT'ed in the Harrison, Lower Shuswap (Summer Age 0.3), and Nicola (Spring Age 1.2), and CWT recoveries from these programs are used to estimate exploitation rates. Summer Age 1.3 and Spring Age 1.3 stocks do not have associated exploitation stocks. An age-specific forecast is produced annually for the Harrison, but there are insufficient age-specific data available for the other stocks to generate stock-specific forecasts. Furthermore, the CTC model needs to be refined to better represent the production dynamics (e.g. maturation schedules, fishery distribution, etc.) of the Fraser stocks and allow for inclusion of stock-specific forecasts. In general, the quality and availability of data ranges from high at Harrison, to moderate for Summer Age 0.3 and Spring Age 1.2 to poor for Summer Age 1.3 and Spring Age 1.3 stocks.

Puget Sound

The seven Puget Sound indicator stocks include Nooksack and Skagit springs, Skagit summer/fall, Stillaguamish, Snohomish, Green and Lake Washington stocks. None of these stocks have CTC-accepted escapement goals. Escapement is estimated annually by a variety of redd and fish count methods covering total spawning reach or index areas. Several mark-recapture escapement estimate studies have been PSC funded in these basins in recent years. These escapement estimates have been higher than those produced using traditional methods and are reported separately in the annual Catch and Escapement Report. Escapement estimates using traditional methods do not meet CTC data standards. Escapement estimates are combined with terminal fishery accounting to reconstruct the terminal run. The terminal run reconstruction data along with other available information are used to develop annual forecasts of these stocks for the PSC Chinook Model. CWT indicator groups from these basins are available for all except Lake Washington. Green River tag groups are combined with tag groups from other hatcheries in south Puget Sound to create an aggregate tag group for exploitation rate analysis. This aggregate tag group for south Puget Sound stocks is suitable to account for impacts in preterminal fisheries for any of the mid and south Puget Sound populations. The south Puget Sound CWT aggregate would not be suitable to represent Lake Washington in terminal fisheries as season structure and harvest levels are very different (Lake Washington has very limited terminal fishing). The fall-run segment in the Skagit has not been consistently CWT'ed. Exploitation rate analysis of CWT recoveries in one year are not available until the next year so there is a two year lag between recovery year and analysis year (e.g., CWT recoveries in 2014 are analyzed in spring 2016). A significant factor in exploitation rate analysis from CWTs for Puget Sound tag groups is the complication associated with adipose mark selective fisheries and the differential impacts on marked and unmarked (including natural) production. The CTC uses adipose marked and tagged groups in the exploitation rate analysis. Nearly the entire Puget Sound sport fishery and several river sport fisheries (including Skagit, Snohomish-Skykomish) are now under mark selective fishery regulations. The CTC has not developed a method in the exploitation rate analysis system to adjust for the differential harvest on natural stocks associated with mark selective fisheries. Without a suitable method to adjust for this differential harvest rate, the exploitation rate on the natural stock as represented by the marked tag groups would theoretically be overestimated to greater degree as the portion of the total fishery impacts in mark selective fisheries increases. This overestimation issue is greatest for Puget Sound origin tag groups because of their length of exposure in mark selective fisheries.

Washington Coast

The Washington coast is represented by nine PSC indicator stocks: Hoh, Queets, and Grays Harbor spring, Quillayute summer, and Hoko, Hoh, Quillayute, Queets, Grays Harbor fall run. Annual escapement estimates are made for all although none meet CTC data standards. The Hoh spring stock and all of the fall run stocks, with the exception of Hoko, have CTC accepted escapement goals.

Escapement estimates combined with terminal fishery run reconstruction provides the information used for annual forecasts. Post season terminal run size and forecasts are not always available for all the summer/fall stocks for the annual model calibration. Abundances in the PSC Chinook Model are in terms of “adult” fish and are not age-specific. Run sizes of spring stocks are small and they are not included in the PSC Chinook Model. There are three CWT indicator tag groups (Tsoo-yess (formerly Sooes), Hoko, Queets) for the Washington coast fall stocks; there are no CWT indicators for the spring stocks. Exploitation rate analysis on the Queets tag group is used for the annual model calibration. Exploitation rate analysis on the other groups provides catch and escapement distribution for comparison to Queets. Terminal fisheries differ substantially for the Washington coast stocks; spring and summer fisheries are very limited, fall fisheries depend on the forecast for the returns to each system. The recoveries of Queets tags in preterminal fisheries are likely representative of all the Washington coastal fall stocks. However, the terminal fishing harvest rates can differ and the ISBM indices for the other Washington coast fall stocks may not be properly reflected by using the Queets tag recoveries.

Columbia River

There are currently six PSC escapement indicator stocks that return to the Columbia River: Columbia Spring, Mid-Columbia Summers, Deschutes Fall, Upriver Brights, Lewis River Fall, and Coweeman Tule. Escapement estimates for all six Columbia River stocks likely meet or nearly meet CTC data standards. Expansion factors have been verified for Deschutes Fall, Lewis River Fall, and Coweeman Tule; whereas, annual escapement estimates for Columbia Spring, Mid-Columbia Summer, and Upriver Brights are based upon dam counts, catches, hatchery removals, and estimated inter-dam losses. Annual age-specific data is available from sampled escapements. CTC-accepted escapement goals are in place for Mid-Columbia Summers, Deschutes Fall, Upriver Brights, and Lewis River Fall stocks. Goals for Columbia Spring and Coweeman Tule stocks have not been submitted for CTC review (Table 16).

In-river pre-smolt collection programs in the Hanford Reach (Upriver Brights) and in the Lewis River are used to CWT naturally produced Chinook for fishery distribution and exploitation rate analysis. These are some of the very few cases, coast-wide, where naturally produced fish from the stock itself are used to document fishery distribution and exploitation rates. Smolts released from Priest Rapids Hatchery are also used as an exploitation rate indicator for the Upriver Brights. Representation used for the assessment of impacts to the Deschutes fall stock has been shared between the Lyons Ferry Hatchery CWT indicator, for ocean impacts, and Upriver Brights, for lower river harvest rates. Extensive historic CWT’ing of the Columbia Spring stock demonstrated that these fish do not contribute significantly to adult catch in PSC ocean fisheries. Hatchery fish from Mid-Columbia Summer broodstock are used to estimate fishery distribution and exploitation for the Mid-Columbia Summer stock; this stock is a combination of hatchery and natural origin fish. The degree of representativeness of the hatchery indicator for the natural portion of the Mid-Columbia Summer stock has not been documented. The hatchery produced Cowlitz Fall CWT indicator is used as a surrogate to represent ocean impacts for the Coweeman Tule natural escapement indicator. TAC forecasts for Columbia River stocks are provided annually for input to the PST Chinook model. In general, the Columbia River indicator stock program has some of the highest quality data available coast-wide.

North Oregon Coast

For those stocks representing the Northern Oregon coast, considerable resources have been expended to improve estimates of escapement, terminal catches, CWT sampling, forecasts and fisheries performance during this Agreement period, following many improvements that occurred during the 1999 Agreement period. Those stocks representing this aggregate, the Nehalem, Siletz and Siuslaw have benefited from the support of the SSP, the CWTIP program and the continued support of ongoing programs through the U.S.-LOA process. Consequently, data availability and quality for this geographic area is high with the across-the-board assessment of “green lights” in Table 16; an anomaly in this coast-wide assessment.

Mid-Oregon Coast

Escapement goals for the South Umpqua and Coquille indicator stocks within the MOC aggregate are needed. The MOC’s production is not currently accounted for in the PSC Chinook Model, hence its non-applicability towards providing data in time for model calibration, at present. Similarly, ISBM metrics are not calculated, as this aggregate’s stocks are not currently in either any of the attachments, or evaluated via either preseason or postseason ISBM assessment. While annual assessments of escapement are made for those stocks comprising the MOC’s production, improvement is needed for these to make data suitable for CTC assessment. Given the MOC’s incorporation in the PSC Chinook Model with the upcoming base period recalibration, forecasts of escapement will be available in time for preseason management.

5.3 ESCAPEMENT OBJECTIVES

In Chapter 3, section 2(a)(ii) commits the "Parties" to harvest regimes for Chinook salmon that are

> *“… designed to meet MSY or other agreed biologically-based escapement and/or harvest rate objectives; with the understanding that harvest rate management is designed to provide a desired range of escapements over time;*”

The CTC judges objectives as being biologically-based by reviewing biological evidence and scientific arguments that the proffered objective has the expectation of producing MSY or some other specified yield consistent with the intent of the Treaty. Escapement goals accepted by the CTC are based on analyses that followed the guidelines developed in the CTC escapement goal report (CTC 1999), with further clarification and options for escapement goal submissions to the CTC provided in CTC Technical Note 1301 (Bilateral Data Standards for MSY or Other Biologically-Based Escapement Goals, May 4, 2013; TCChinook (13)-01 Appendix E).

The CTC has accepted escapement objectives for 15 of the 41 stocks or stock groups listed in Attachments I to V of the 2009 Agreement. The accepted goals include four from SEAK, three from Transboundary Rivers, two from Canada, four from the Columbia River, six from the Washington Coast and three from the Oregon Coast.

Without accepted objectives for many stocks, the annual stock status evaluation by the CTC is incomplete. One challenge of developing escapement objectives relates to the size and complexity of some of the escapement indicator stocks; some of these model stocks consist of numerous smaller stocks that have varying migration timing, ocean distributions and maturation patterns that influence their vulnerability to fisheries. Another challenge is that nearly all the Canadian stocks are data-limited, and the necessary total escapement at age and exploitation rate data are not available to generate escapement objectives by traditional stock-recruitment analysis. Habitat-based methods are available to estimate escapement objectives for data limited stocks; however to use estimates of escapement and these objectives to evaluate stock status requires methods that produce total escapement estimates, or calibrated survey methods that frequently are not available.

5.3.1 Attachments I-V

The PST Chapter 3 Attachments I-V are organized according to three AABM regimes and two ISBM regimes that list indicator stocks and management objectives applicable to Paragraph 13 (Attachments I-III) and Paragraph 8 (Attachments IV-V). ISBM statistics are computed for preseason and post-season on escapement indicator stocks listed in Attachments IV and V to evaluate fishery performance relative to obligations in Paragraph 8.

Currently, additional management actions may be triggered in Attachment fisheries depending on the status of the stock groups with CTC agreed escapement objectives. Attachments I-V list 41 indicator stocks for 12 stock groups, and 13 of the indicator stocks have escapement objectives. In Attachments I (SEAK) and II (NBC) there are eight stock groups, and four have CTC accepted escapement goals (Far North Migrating Oregon Coastal Falls, Columbia River Falls, Columbia River Summers, and Washington Coastal Fall Naturals; Table 17). The WCVI fishery (Attachment III) is specifically exempt from provisions of Paragraph 13, and three of the four stock groups listed have escapement objectives (Columbia River Falls, Fraser Late, Columbia River Summers). Two of eight stock groups in the Canadian ISBM fishery (Attachment IV) have escapement objectives (Fraser Late, Lower Georgia Strait), whereas five of seven stock groups in the U.S. ISBM fishery have escapement goals (Washington Coastal Fall Naturals, Columbia River falls, Fraser Late, Columbia River Summers, and Far North Migrating Oregon Coastal Falls).

Chapter 3 specifies that the CTC was to complete a review of Attachments I-V by 2014 and make recommendations for changes if needed (Chapter 3 Appendix A, item 10). However, this assignment has not been completed yet (Table 18) because of both competing priorities and reliance upon completion of the CTC model Base Period calibration that include improvements to the representation of stocks and fisheries.

Table 17– The number of escapement indicator stocks identified in Attachments I–V and the numbers with escapement or exploitation rate objectives for the stock groups identified for the AABM and ISBM fisheries.

Attachment I–V Stock Group	Number of Escapement Indicator Stocks	Number of Escapement Indicator Stocks with Escapement or ER Objectives
North/Central BC	4	0
Upper Georgia Strait	5	0
Lower Georgia Strait	2	1
WCVI	7	0
Fraser Early	3	0
Fraser Late	1	1
Puget Sound Natural Summer/Falls	5	0
North Puget Sound Natural Springs	2	0
Washington Coastal Fall Naturals	5	4
Columbia River Falls	3	3
Columbia River Summers	1	1
Far North Migrating Oregon Coastal Falls	3	3

5.4 Progress on Assignments to the CTC.

A variety of analyses and tools are employed by the CTC to produce abundance estimates of Chinook salmon in several fisheries and for several stocks. Paragraph 2 and Appendix A to Annex IV, Chapter 3 lists tasks assigned to the CTC, and for some of these assignments lists time schedules for completion. Progress on various tasks is summarized in Table 18. In addition to these tasks the Parties agreed to designate investments for programs to improve monitoring, assessment and management consistent with the provisions of the 2009 Agreement as stated in the previous section of this report. Given the significance of these investments and the contributions of each to the management of fishery regimes and monitoring abundance, the Sentinel Stocks, CWT Improvements, and Model Improvement programs are described below in further detail.

Table 18– CTC Responsibilities and assignments.

Reference	Subject	Status
2(b)(i)	Evaluate management actions	There has been no direction by the PSC to evaluate specific management actions other than those annually reported upon by the CTC.
2(b)(ii)	Annual exploitation & model calibration reports	The CTC completed and published annual reports through 2014. Reports for 2015 and 2016 are in preparation.
2(b)(iii)	Annual catch & escapement reports	Beginning in 2013, the catch & escapement report was expanded to provide more comprehensive information. The report now includes coast-wide landed catch and total mortality, escapement information, and a synoptic evaluation of stock status. Six annual Catch and Escapement Reports have been published since 2009 and the report for 2015 is in preparation.
2(b)(iv)	Evaluate escapement goals	Reviewed and accepted 7 escapement goals since 2009 (Alsek, Taku, Deschutes, Unuk, Grays Harbor Falls, Keta and Blossom[1]). The CTC did not accept the RER analysis for the Skagit River summer/fall stock in 2014.
2(b)(v)	Recommend data standards	Adopted standard for escapement estimates (CV ≤ 15%) for escapement indicator stocks and the Sentinel Stocks Program in 2010 (CTC 2013–Appendix D). Published Technical Note 1301 on guidelines for escapement goal submissions in TCCHINOOK 13-1 (Appendix E). The CWT Workgroup developed standards for CWT indicator stocks (PSC Technical Report 25).Recommended Paragraph 13 standards or guidelines for escapement estimation forecasting (memo to CIG 2013).
2(b)(vi)	Review enhancement programs	The CTC has not reviewed effects of enhancement programs on abundance-based management regimes and recommend strategies for the effective utilization of enhanced stocks.
2(b)(vii)	Recommend research projects and costs	Sub-groups of the CTC bilaterally reviewed proposed projects and made recommendations concerning Model Improvement projects, the CWT Improvement Program (CWTIT), the Sentinel Stocks Program (SSC), and the Very High Priority Chinook program. The US-CTC prepared RFPs and subsequently reviewed proposals and made recommendations for annual US-LOA funding.
2(b)(viii)	Analyze alternative fishery regulatory measures	Alternate fishery regulatory measures have not been defined nor analyzed.

[1]*The Keta and Blossom rivers stocks were dropped as escapement indicator stocks in 2013.*

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Reference	Subject	Status
2(b)(ix)	Sentinel Stocks Program	Program was implemented over 6 years (2009–2014) with significant improvements to escapement estimates in specific areas. Final report will be completed by September 2016 See further information on this topic provided elsewhere in this report.
2(b)(x)	Coded-Wire Tag Improvement Program	This bilateral program was implemented successfully over 5 years (2009–2013 in Canada and 2010–2014 in the U.S.), resulting in significant improvements to the coast-wide CWT system. See the details provided elsewhere in this report.
2(b)(xi)	Mark selective fishing annual report	A section on MSFs has been included in each CLB/ERA annual report since 2010. The differential impacts of mark-selective fisheries on marked and unmarked Chinook DIT stocks are annually evaluated and adjustments to the exploitation rate analysis are implemented for a few stocks.
2(b)(xii)	Other assignments Maturation/EV Report	The Commission tasked the CTC to evaluate maturation rates and environmental variable assumptions used in the annual calibration of the model in the fall of 2015. The subsequent report was completed in the winter of 2016 and modifications were incorporated into the 2016 calibration process.
Appendix A (1)	Harvest rate metrics	The HRI report providing the technical basis for improvement was completed in 2009. The CTC is in the process of incorporating SPFIs for NBC and WCVI AABM fisheries and this will be implemented in conjunction with the new base period calibration.
Appendix A (2)	Total Mortality	The PSC Chinook Model was recoded to accept independent IM estimates where available, for both legal and sublegal Chinook salmon. The CTC published a report in 2011 "Development of the Technical Basis for a Chinook Salmon Total Mortality Management Regime for the PSC AABM Fisheries" (TCChinook (11)-1) which contains the technical basis used to convert the landed catches in Table 1 into units of total mortality. The Commission has not authorized the conversion of AABM fisheries into a total mortality framework.
Appendix A (3)	In-season adjustments	The Commission has not, to date, included in-season adjustments in approved work plans, and the CTC as a whole has yet to address this topic.
		Alaska proposed an adjustment of the SEAK preseason AI in 2016. The PSC appointed an ad-hoc subcommittee to answer questions related to the proposal that were delivered at the PSC Annual 2016 meeting. A non-consensus report was written by an Ad-hoc subcommittee and submitted to the CIG.
Appendix A (4)	Model Improvements	Several model improvements have been completed, others are pending, e.g., new BP Calibration. See the details provided below.

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Reference	Subject	Status
Appendix A (5)	Escapement goal/ management objective review	See 2(b)(iv) above.
Appendix A (6)	Precautionary management	Annual CTC reports were improved (See 2(b)(ii and iii). Precautionary management draft report was provided to CIG/Commission. Subsequent work on this assignment has not been directed through annual work plans.
Appendix A (7)	ISBM metrics	Report TCCHINOOK (11)-4 was received by the Commission on January 12, 2012 and referred to the CIG for consideration of possible policy issues implicit in the report. On February 12, 2012 the CIG received a memorandum from the CTC co-chairs setting out a series of specific and potentially problematic policy questions related to the Paragraph 13 analysis in the ISBM report. Metrics for evaluation are still not available for 2 years out with CWT data. CIG/Commission has yet to respond to CTC.
Appendix A (8)	Paragraph 13 Forecast Data Standards or Guidelines	The CTC recommended Paragraph 13 guidelines for escapement estimation forecasting (memo to CIG 2013. CIG/Commission has yet to respond to CTC.
Appendix A (9)	Five-year review	CTC developed an outline for this assignment in spring 2014; the PSC did not include proceeding with the assignment in annual work plans. In fall of 2014, the PSC dropped the assignment.
Appendix A (10)	Attachments I-V review	To date, the Commission has set the priority for this task as low and has not included the assignment in recent annual work plans.
Special Assignment	Chapter 3 Performance Review	In the fall of 2014, the PSC tasked the CTC with developing an outline for a review of Chapter 3 to aid future negotiation. The PSC included the Chapter 3 performance review in the CTC 2016 work plan. This report completes that special assignment.

5.4.1 Sentinel Stocks Program

The Parties appointed a bilateral Sentinel Stocks Committee (SSC) to provide advice and guidance on the Sentinel Stock Program (SSP). This program served to improve escapement estimates in Oregon, Washington and British Columbia. This program was intended to run over five years; however, sufficient funds remained to permit a sixth year. Projects were conducted from 2009 to 2014, and detailed progress reports were presented to the PSC annually, and included in the annual CTC catch and escapement reports beginning in 2011 (TCChinook (11)-2) through 2014 (TCChinook (15)-2). A final summary report covering six years of work will be completed in 2016 prior to the October PSC executive session. Since the completion of the SSP, several of the escapement projects initiated with SSP funds have been continued using the endowment funds.

5.4.2 Coded-Wire Tag Improvement Program

The Parties appointed a bilateral Coded-wire Tag Implementation Team (CWTIT) to recommend funding of specific actions to improve the precision and accuracy of CWT statistics used by the CTC. The CWTIT used the CWT Workgroup report (PSC TR 25) to guide the bilateral CWT Improvement Program (CWTIP). CWT improvement projects were identified and prioritized annually, recommended to the PSC and then implemented. This program was implemented successfully over five years (2009–2013 in Canada and 2010–2014 in the U.S.), resulting in significant improvements to the coast-wide CWT system, including updating reporting systems, increased tagging and indicator stocks, and improved sampling and enumeration in fisheries and escapements. Detailed progress reports were presented annually to the PSC, and were included in the CTC model calibration and exploitation rate analysis reports. A 5-year summary report was completed in 2015 (PSC Technical Report 33-PSC 2015). By the end of the CWTIP, 104 (46%) of the 244 colored data cells for stock or fishery specific data cells identified (Appendix C) were improved to either green (no data problems) or yellow (one data issue), leaving 4 cells in red status (two or more data issues; Appendix C). The CWTIT noted that improvements in the CWT program cannot be sustained without adequate, stable core funding for tagging, sampling, enumeration, processing and reporting. To address this funding shortfall, key CWT projects have been funded in the past two years using Northern and Southern Endowment Funds and U.S. funding sources.

5.4.3 PSC Chinook Model Improvements

The Parties agreed to implement specific measures to improve the bilateral PSC Chinook Model and related management tools required for implementation of Chapter 3. In 2010, the bilateral CTC convened a subcommittee of its members to form a Model Improvements Workgroup and scheduled activity in the annual workplan and has continued to do so since. The workgroup prioritized items for model improvement: a) base period model calibration, b) improvements to the CWT cohort analysis database and algorithms, and c) development of a simulation model to evaluate whether the methods used by the current Chinook model or some other methods best represent the variations in the production dynamics and abundance of Chinook salmon.

The key outputs of Model Improvements are 1) the Chinook Integration System Exploitation Rate Analysis /PSC Chinook Model Database, 2) Data Simulator/Data Generation Module, 3) SharePoint, 4)

ForecastR, 5) CWT WCVI Sport Fishery Data Recovery project, and a 6) Bayesian Workshop.

The PSC Chinook Model base period 1979–1982 (BP) is used because it represents a pre-treaty period with complete brood-year CWT data and catches that were likely unsustainable. For stocks without BP data, out-of-base algorithms are employed. The new base period calibration is an exercise to refine the original data for starting cohort sizes, base period exploitation rates, spawner-recruit functions, etc. The PSC Chinook Model relies upon the base period data to estimate aggregate stock abundance and fisheries impacts for the annual calculation of the Abundance Indices (AIs) and ISBM indices. As new CWT-indicator stocks were added, and as fisheries have changed, more data have become available to refine the base period, and have been added into a revised PSC Chinook Model.

In addition, work continues on improving the stratification of the model, and its ability to deal with finer resolution of fisheries and stocks. Improvements will seek to provide a better representation of: 1) stocks (e.g., adding stocks, removing stocks or splitting stock groups to better reflect stock differences), 2) stock dynamics (e.g., age structure, mortality distribution among fisheries, maturation and productivity rates, and life history types), 3) fisheries (e.g., effects of mark selective fisheries, consideration of multiple time periods in a year, dividing fisheries into components when size limits differ), and 4) improvement of forecasts of pre-fishery ocean abundance to be used in the model calibration procedure.

The 2016 exploitation rate/cohort analysis and Model calibration used the same model architecture employed during the past two decades (i.e., 30 model stocks and current fishery stratification). Once the new BP calibration is done, calibrations will be completed for both models (current and new). Analyses will be completed to compare key model outputs from the current Model and the expanded stock-fishery Model, and a report will be prepared that compares the results of both. Any ramifications resulting from the model changes, such as potential changes to the 'Table 1' relationships in Appendix B to Annex IV, Chapter 3 will be identified.

5.5 Eroding capacity to perform stock and fishery assessments to support Chapter 3 implementation and evaluation.

PSC fishing agreements depend critically on data and information provided by agency programs for stock and fishery assessments. Fiscal pressures have already and continue to seriously erode the capacity of management agencies in both the U.S. and Canada to provide the basic data and other vital information for implementation of the current PSC fishing regime.

The CTC is concerned about the ability of agencies to maintain the viability of the CWT system, the performance of catch and escapement sampling and monitoring, and sustaining exploitation rate and escapement indicator stock programs. In response to coast-wide austerity measures, agencies are increasingly turning to the Northern and Southern Endowment funds to conduct work that would previously have been considered core stock and fishery management and assessment programs.

The outlook for the ability to collect and analyze data vital to the PSC is becoming increasingly dire. If current fiscal conditions continue, the capacity to implement PSC fishery regimes and support future bilateral treaty negotiations will be severely compromised.

Another obstacle is the amount of time and effort required to complete the large number of tasks assigned to the CTC under the 2009 PST Agreement and the technical complexity of those tasks. Although the formation of smaller CTC workgroups to address the individual assignments to the CTC may have helped with some aspects of efficiency, the necessity of assigning CTC members to multiple workgroups creates bottlenecks. There have been scheduling conflicts for workgroup meetings and CTC members have had to prioritize workloads among the workgroups. Succession planning is needed in order to provide continuing capacity to implement and evaluate the requirements of Chapter 3 of the PST Agreement. The CTC has found that institutional knowledge of running base period calibrations is limited by the availability of members through time and the paucity of documentation for data sets and procedures. The activity is time and resource intensive that requires dedicated infrastructure support and capacity.

5.6 Models and Analytical Methods

The current PSC Chinook Model and analytical methods employed for stock and fishery assessments reflect limitations of data, information, and knowledge available in the early 1980's. These tools are founded on a set of assumptions regarding stability in stock and fishing patterns over time as a basis for comparison and predictability. The current PSC Chinook Model, for example, is deterministic and depends on algorithms that rest on a foundation of assumptions regarding stability in fishing and stock distribution patterns, data collected from a 1979–1982 base period, and limitations of data availability. Uncertainty, directional changes, and variability are not considered. The methods currently employed by the CTC to report changes in fishery harvest rates are surrogate metrics developed from exploitation rate estimates generated by the CWT cohort analyses.

There is a need to carefully evaluate the validity of such assumptions in light of increasing uncertainty and directional changes in the environment, stock productivity, alteration of stock distribution and fishing patterns, and allocation of harvest impacts among sectors.

Three additional factors are also affecting the need to revisit the PSC Chinook Model and analytical methods for stock and fishery assessments. First, the primary purpose for which the PSC Chinook Model and analytical methods were constructed has changed substantially. The purpose of the Model has changed from its original design to generate mid-term, multi-year projections under generic fishery strategies to producing single year forecasts of abundance indices and ISBM metrics to drive AABM and ISBM regimes in the coming season. CWT-based analytical methods are changing from fishery-directed assessments to stock-specific assessments. Second, computing capability and other technological advancements are rapidly altering the range of available information and possibilities for the types and complexity of the models and analytical methods that could be developed to usefully inform fishery management decisions. Third, management measures employed to regulate fisheries have become increasingly complex. For instance the PSC Chinook Model represents fisheries at a regional scale on annual time steps, but the spatial and temporal scales of regulations have become increasingly implemented at much finer levels. Mark selective fishing for example, is being implemented in very small areas (often a portion of statistical catch reporting areas) for short periods (often for just a few days), and differing retention restrictions for marked and unmarked fish. The PSC Chinook Model and analytical tools are based on large regional and seasonal aggregations of fishery impacts on stock complexes using an annual time step and have little to no capacity to evaluate mark selective fishing. Over time, information has become available indicating that stock distribution patterns, migratory behavior, fishing patterns, and regulations such as size limit changes and mark retention restrictions can substantially and differentially affect hatchery and wild stocks.

The CTC has been developing a Data Generation Model (DGM) to provide a solid foundation for evaluation of the performance of model algorithms and analytical methods. The DGM will produce simulated data sets that can be used to test precision, bias, and accuracy of estimates generated by alternative algorithms and methods.

6. KEY FINDINGS AND RECOMMENDATIONS

Stock Performance

- Four stocks of concern were identified among 22 stocks with CTC-accepted escapement objectives (Situk, Cowichan, Harrison, and Queets spring/summer). It was not possible to objectively determine the status of stocks that did not have CTC-accepted escapement objectives. Better quality escapement and exploitation rate data are needed to generate escapement goals and to assess stock performance, particularly in British Columbia and Washington.

- Most escapement indicator stocks had an increasing trend in escapement since 1999.

- 25 escapement indicator stocks had a mean escapement during 2009–2015 that decreased by at least 15% from the 1999–2008 mean, 21 stocks increased by at least 15% and 12 stocks had varied by less than 15%.

Fishery Performance

- Average U.S. ISBM landed catch increased by approximately 239,000 Chinook (41%) relative to the 1999 Agreement, while the averages for the other three fishery groups decreased; about 18,000 Chinook (6%) in the U.S. AABM fishery, about 16,000 Chinook (7%) in the Canadian ISBM fisheries and about 1,000 Chinook (<1%) in Canadian AABM fisheries.

- During the first seven years of the 2009 Agreement, percentages of the total PST landed catch averaged 51% in the U.S. ISBM (an 8% increase in the share of the total catch relative to the 1999 Agreement), 14% Canadian ISBM (3% decrease), 17% U.S. AABM (4% decrease) and 18% Canadian AABM (2% decrease).

- <u>ISBM Fisheries</u>
    - Evaluations were not possible for many of the stocks in Attachments IV and V because they were not represented by a CWT indicator stock or they did not have base period exploitation rates to calculate the ISBM index. A CWT-based ISBM index cannot be

calculated for 40% of the Canadian stocks and 25% of the U.S. stocks and further, in the case of several Canadian Attachment IV stocks, the ISBM statistic is not stock specific, but rather a rate for a single stock is widely applied to other stocks, even though terminal fisheries may vary among them. Of the 41 listed stocks, 17 could not have ISBM indices generated in any year, and six of the stocks could not have ISBM indices generated in all the years. Southern U.S. ISBM indices are not available until two years after the fishery which substantially reduces the responsiveness and effectiveness of ISBM provisions.

    - Since 2009, the obligations for the Canadian ISBM fisheries were met for all stocks except WCVI (2 years), whereas for U.S. fisheries the ISBM obligations were met for all stocks except Nooksack spring (4 years), Grays Harbor fall (4 years), Queets fall (1 year), Deschutes (1 year), Nehalem (1 year) and Siletz (1 year).

    - For ISBM fisheries, average mortality distribution percentages decreased on average for 9 indicator stocks, increased for 14 indicator stocks, and did not change for 3 from the 1999 Agreement.

- AABM Fisheries
    - During the 2009 Agreement, the cumulative difference between observed and postseason allowable catches for the SEAK, NBC and WCVI AABM fisheries were 75,189, -384,532, and -11,327 Chinook, respectively.

    - For AABM fisheries, average mortality distribution percentages decreased for 20 indicator stocks and increased for 7 indicator stocks from the 1999 Agreement.

Model Performance

- For AABM fishery planning, the error in the preseason AI generated by the model was the largest source of error for implementation of the AABM fisheries since 2009. Generally, the preseason AIs exceeded the post-season AIs, except in 2013 and 2015. Of the six solely PSC model-produced stock-based forecasts, 3 (50%) had a MPE that was less than 7.5%. Of the 17 solely agency-provided forecasts summarized in Table 14, only 6 (35%) met that same performance criterion. None of the four stocks that use a combination of agency and model forecasts met this performance standard. Of seven stocks that contribute 10% or more to at least one of the AABM fisheries, forecasts for Northern BC, Fraser Late, Bonneville Hatchery, Cowlitz Fall, Upriver Brights, and Oregon Coast had a MPE less than 7.5% and WCVI Natural and Hatchery and Puget Sound Fingerlings did not.

- The CTC model does not provide sufficiently accurate preseason ISBM indices for fishery planning. Improvements to the model are necessary to generate more useful preseason ISBM fishery indices, such as finer spatial-temporal fishery stratification, representation of MSFs, and finer scale stock representation.

- The CTC is working on several improvements to the model to improve the representation of stocks, fisheries, and Chinook population dynamics. Better quality input data (e.g. escapement by age, forecasts of escapement or terminal run) are needed for the large stocks to improve model performance.

Implementation of Chapter 3

- The CTC evaluated the indicator stock and fishery monitoring programs and found that the information currently available ranges from high quality information for some stocks to poor quality and/or a lack of quantitative information available for many others.

- At the conclusion of the negotiations for the 1999 Agreement, the lead Canadian and U.S. negotiators wrote a memorandum, dated 23 June 1999, to the Honorable Lloyd Axworthy, Honorable David Anderson, and Secretary of State Madame Albright stating:

  > *"The Agreement represents a commitment to abundance-based management for the salmon fisheries covered by the Treaty. This important, new conservation-based approach will require adequate resources by each Party to ensure that the necessary scientific and management needs are met. In particular, the coastwide Chinook Chapter (Annex IV, Chapter 3) which represents a departure from previous Annexes, is dependent upon high quality fishery and stock assessment data being collected by management agencies coupled with time-consuming analysis of the data by the Chinook Technical Committee. Management agencies are urged to provide adequate resources, both staff and time, to the Chinook Technical Committee for successful implementation."*

  The CTC encountered numerous information gaps and issues with data quality during the development of this report which prevented a comprehensive, certain assessment of stocks and evaluation of fisheries within the jurisdiction of the PSC. A large increase in funding for agencies is required to ensure data of appropriate quality can be provided for implementation of Chapter 3. The CTC recommends that the Parties fully fund the stock and fishery data collection programs that are necessary to implement the abundance-based management regime, as identified in the aforementioned letter of transmittal.

- The 2009 Agreement includes a series of technical assignments to the CTC. While many tasks have been completed, many others are only partially complete or are on hold due to the need for policy clarification, or have not yet been started. The quantity and complexity of assignments has placed an unrealistic work load on the CTC, and many are intertwined with policy related issues that the Commission, to date has not resolved. Succession planning in the CTC is needed in order to provide continuing capacity to implement and evaluate the requirements of Chapter 3.

- The stocks in Attachments I-V need review as many stocks are not monitored for escapement or monitored inadequately, do not have escapement objectives, or do not have a representative CWT indicator stock to calculate ISBM indices and impacts in AABM fisheries.

- Deficiencies in many of the stock assessment and fishery evaluation programs make parts of Chapter 3 impractical for the majority of stocks and consequently few of the components of Chapter 3 were implemented fully during the 2009 Agreement.

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APPENDICES

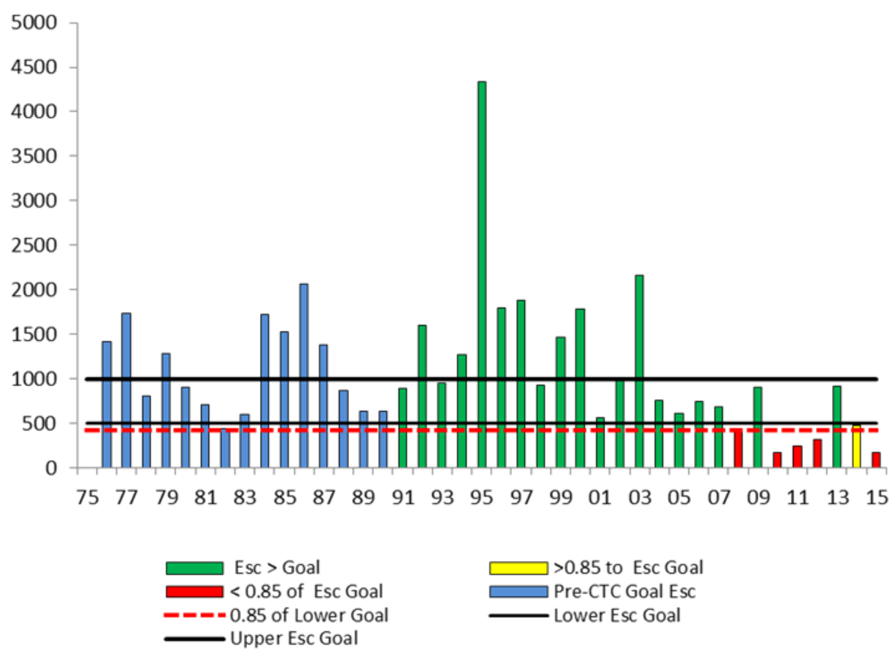
APPENDIX A: STOCK OF CONCERN PROFILES

A.1 Situk River

Annex Stock Group	N.A.
CTC Escapement Indicator	Yes
CTC Exploitation Rate Indicator	None
ISBM CWT Index	N.A.
Life History Type, Ocean Distn,	Ocean type, outside
Primary Age of Maturity	4
Escapement method	Weir
CTC escapement goal	500–1,000

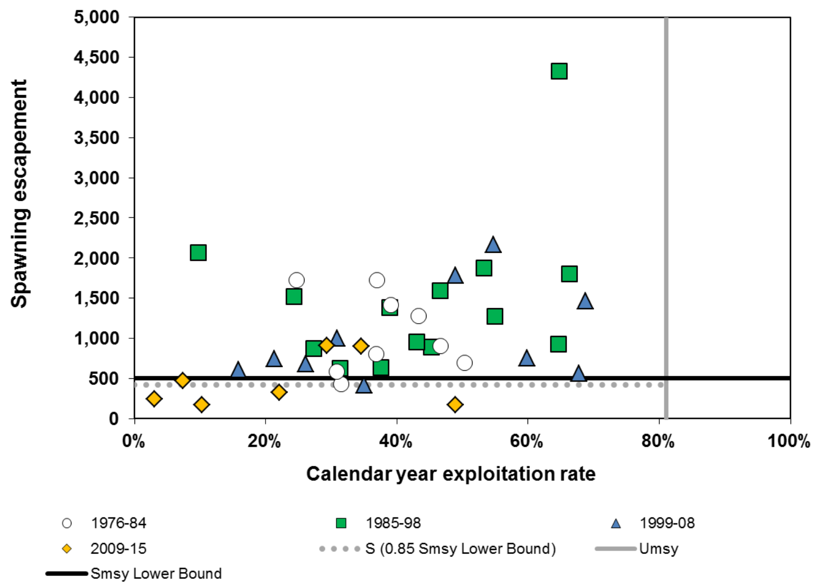
The Situk River is a non-glacial system located near Yakutat, Alaska, that supports a moderate-sized, outside-rearing stock of Chinook salmon. Situk-origin Chinook salmon are caught in directed sport, commercial, and subsistence fisheries located inriver, in the estuary, and to a minor degree in nearby terminal marine waters.

Escapement Trends: After continuously meeting or exceeding the escapement goal range from 1976–2007, the stock has failed to achieve the goal range in 6 of the last 8 years (Table 2, Appendix A.1).



Appendix A.1– Situk River escapements of Chinook salmon, 1976–2015.

Fisheries Impacting Stock: Harvests are inriver or in the estuary, and detailed catch accounting programs enumerate the harvest, which produces calendar year harvest estimates. The Situk stock does not have an associated exploitation-rate stock; however, this river is in the far north of the PST area and in prior years, direct CWT'ing of this wild stock demonstrated that the only significant fishing mortality occurs in terminal fisheries in-river or the estuary. During recent years, estimated harvest rates have averaged less than 25%, including a low rate of 3% in 2011 when estimated escapement was 48% of the goal. Overall, estimated harvest rates exerted on the Situk River stock have never approached the U_{MSY} rate (about 80%) and was 10% in 2015 (Appendix A.2).



Appendix A.2– Calendar year exploitation rate, spawning escapement, and threshold reference lines for exploitation rate and spawning escapement by CY for the Situk River stock of Chinook salmon, 1976–2015.

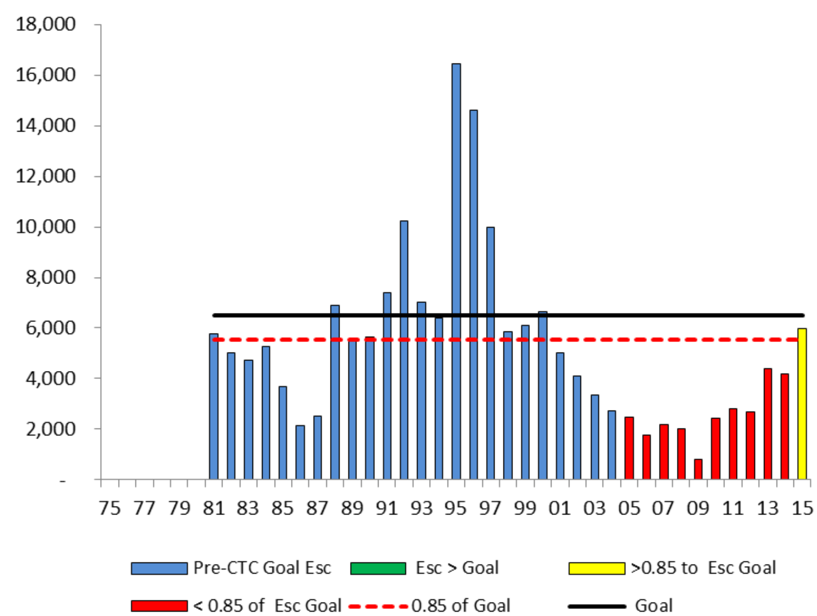
Environmental, Non-Fishing Factors and Additional Information: The poor runs and escapement primarily result from decreased productivity and mirror the very low productivity observed for other Alaska stocks that rear in the Gulf of Alaska/Bering Sea. Very restrictive management measures have been in place for the Situk River Chinook stock to reduce harvests and increase escapement in the past 8 years. Even with very restrictive management actions, however, the escapement goal for the Situk River stock will be difficult to attain until productivity improves.

A.2 Cowichan River

Annex Stock group	Lower Strait of Georgia
CTC Escapement Indicator	Yes
CTC Exploitation Rate Indicator	Cowichan (Big Qualicum for ISBM)
ISBM CWT Index	Yes
Life History Type, Ocean Distn,	Ocean-type fall-run, local
Primary Age of Maturity	3
Escapement method	Weir with upstream mark-recapture
CTC escapement goal	6,500

The Cowichan River is mid-sized clear river system flowing into the Strait of Georgia on Southern Vancouver Island. Cowichan River Chinook salmon are harvested in fisheries in the Strait of Georgia, Puget Sound, Juan de Fuca Strait and on the West Coast, mostly between the Columbia River and Northern Vancouver Island.

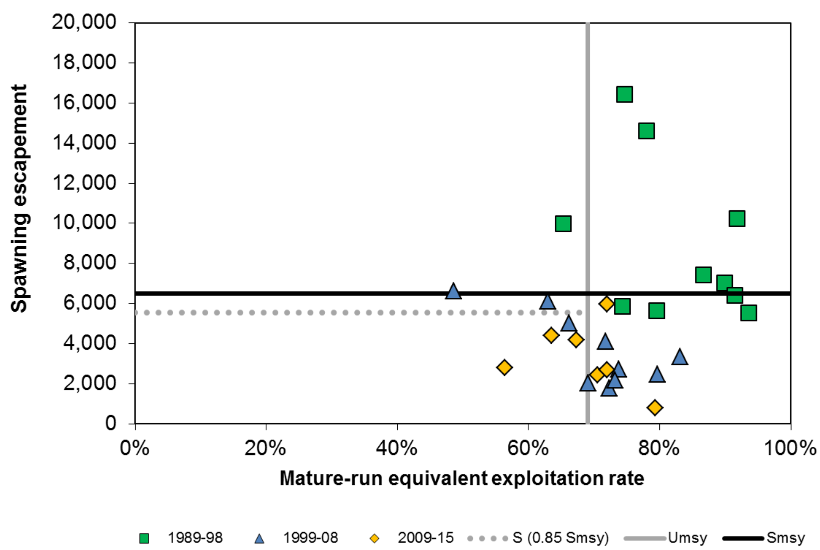
Escapement Trends: The escapement trajectory for Cowichan is illustrated in Appendix A.3. Escapements have ranged from 789 in 2009 to 14,595 in 1996. Mean escapements were below goal for 1999–2008 (3,639), below goal again for 2009 to present (3,319), and for the most recent generation (2012–2015; 4,796).



Appendix A.3– Cowichan River escapements of Chinook salmon, 1981–2015.

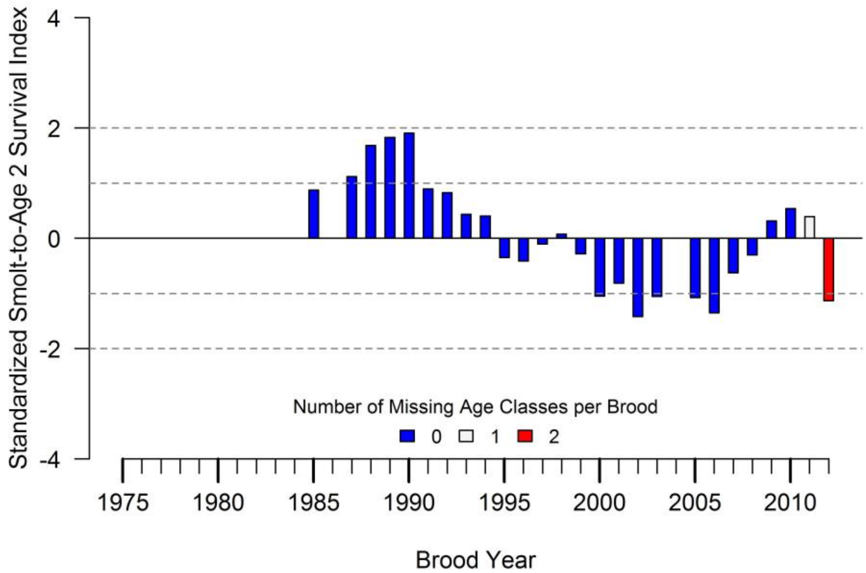
Fisheries Impacting Cowichan River Chinook: The Cowichan River stock is subjected to the highest exploitation rates of any stock monitored by the CTC. Overall, fisheries averaged 65% of all mortalities between 1999 and 2008 and 63% since 2009. For the Cowichan stock, most fishing mortality occurs in the ISBM Strait of Georgia sport fishery (1999–2015 average: 27%), but the WCVI AABM troll (1999–2015 average: 8%), the WCVI AABM sport (1999–2015 average: 4%), the ISBM Puget Sound sport (1999–2015 average: 4%), and the ISBM terminal net (1999–2015 average: 11%) fisheries are also important components. The NBC or SEAK AABM fisheries have relatively smaller impacts on the stock. The ISBM Strait of Georgia troll fishery used to be an important mortality component for Cowichan during 1985–1995, averaging 9% of the total mortality, but its contribution became effectively 0% during 1999–2015. ISBM indices for Cowichan have never exceeded the general obligation of 0.635 despite the high exploitation rates because harvest rates in the base period were also very high.

Cumulative exploitation rates have been above the threshold reference line for approximately 80% of the years assessed and escapements have been below S_{MSY} since 1997 (Appendix A.4). The stock has rarely been in the safe zone of the synoptic plot; only once during the last 26 years, with most of the recent years in the high risk zone. This stock currently experiences the highest exploitation of any stock examined by the CTC in the PST area.



Appendix A.4– Mature-run equivalent exploitation rate, spawning escapement, and threshold reference lines for exploitation rate and spawning escapement by CY for the Cowichan River stock of Chinook salmon, 1988–2015.

Environmental, non fishing factors: Marine survival declined considerably in the late 1980's, and declined below the long term average in 1993. Survival has remained below average for all subsequent brood years, except 2009–2011.



Appendix A.5– Marine survival index (standardized to a mean of zero) for the Cowichan River stock of Chinook salmon, 1985–2012 brood years. Brood years 1986 and 2004 were not represented by CWTs, thus no data are available.

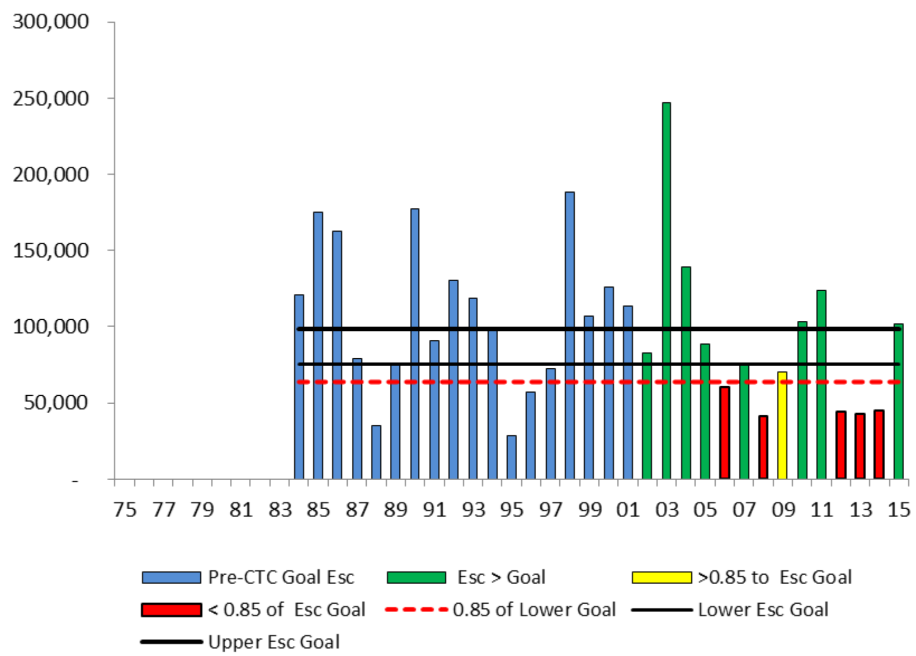
Marine survival was generally above average for brood years 1985 to 1992, was below average from 1993 to 2009, and slightly above average in 2010 and about average in 2011 (Appendix A.5).

A.3 Harrison River

Annex Stock group	Fraser Late
CTC Escapement Indicator	Yes
CTC Exploitation Rate Indicator	Chilliwack
ISBM CWT Index	Yes.
Life History Type, Ocean Distn,	Ocean type, local
Primary Age of Maturity	4 yrs
Escapement method	Mark-recapture
CTC escapement goal	75,100–98,500

The Harrison River is large, clear river flowing into the Fraser River, approximately 100 km east of Vancouver. Harrison River Chinook salmon are harvested in fisheries in the Strait of Georgia, Puget Sound, Juan de Fuca Strait and on the West Coast, mostly between the Columbia River and Northern Vancouver Island.

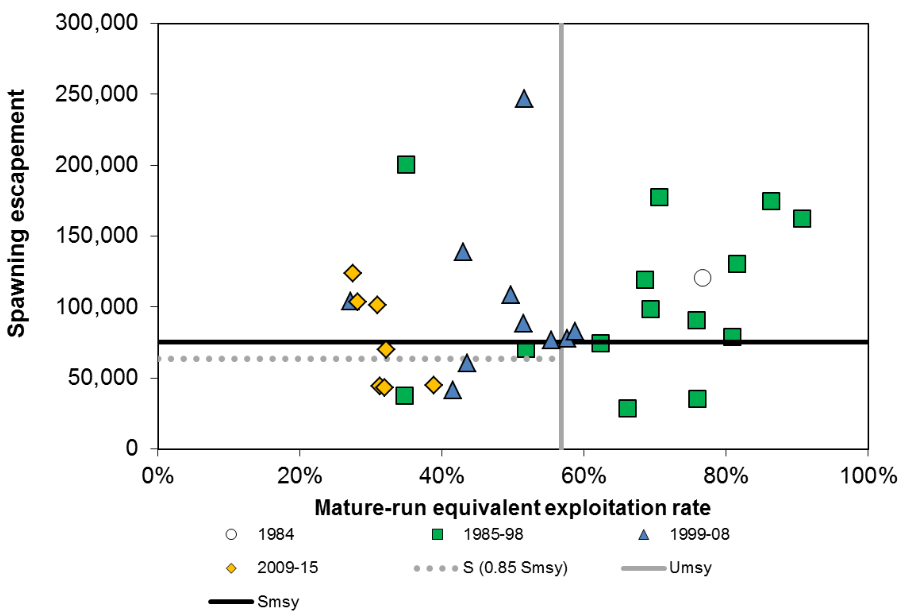
Escapement Trends: The escapement trajectory for Harrison is illustrated in Appendix A.6. Spawning escapements to the Harrison River have varied widely from a low of 28,616 adults in 1995 to a high of 247,121 adults in 2003. Escapements have been more than 15% below the lower bound of the escapement goal for three of the past four years.



Appendix A.6– Harrison River escapements of Chinook salmon, 1981–2015.

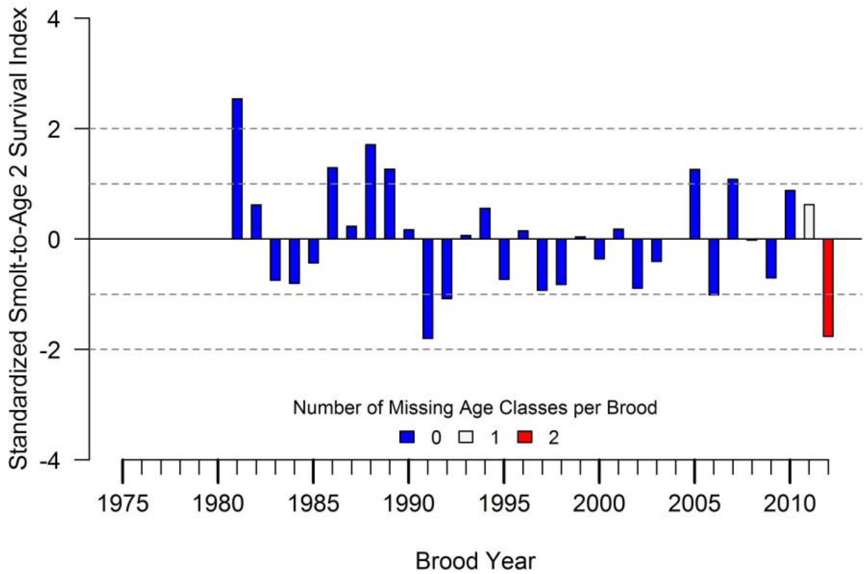
Fisheries Impacting Harrison River Chinook: Exploitation on the Harrison stock has declined over the period of monitoring. Overall, total exploitation averaged about 39% between 1999 and 2008 and 23% since 2009. The mortality distributions for the current Agreement and percent-differences from the 1999–2008 Agreement averages are presented in Figure 3. The largest sources of fishing mortality are the WCVI AABM troll (1999–2015 average: 9%) and the ISBM WA/OR Coast troll (1999–2015 average: 7%). The ISBM Strait of Georgia sport fishery used to be an important mortality component for Harrison during 1985–1998, with 11–16% of the total mortality, but its impact has diminished to levels of ~5% during 1999–2015. Harrison Chinook rarely occur in catches in Northern BC or SEAK. There is a limited terminal First Nations net fishery and a recreational fishery that occurs on the Harrison River.

The synoptic plot shows the stock with exploitation rates higher than the reference line in the majority of years from 1985 to 1998, with three years in the high risk zone and only one year in the safe zone (Appendix A.7). Cumulative exploitation rates were reduced under the 1999 Agreement, with the majority of years having exploitation rates less than U_{MSY}. Exploitation rates were further reduced under the 2009 Agreement, with only two years in the safe zone and the others in the buffer zone or the low escapement and low exploitation zone.



Appendix A.7– Mature-run equivalent exploitation rate, spawning escapement, and threshold reference lines for exploitation rate and spawning escapement by CY for the Harrison River stock of Chinook salmon, 1984–2015.

Environmental, non fishing factors: Marine survival fluctuated around average for brood years 1985 to 1992, was consistently below average from 1993 to 2009, and again, has fluctuated around average since 2010 (Appendix A.8).



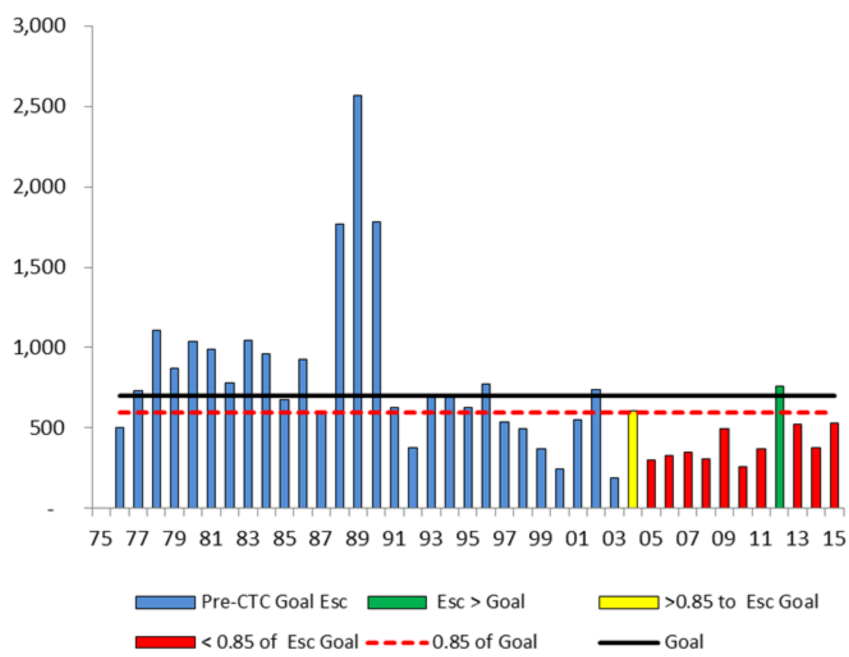
Appendix A.8– Marine survival index (standardized to a mean of zero) for the Harrison River stock of Chinook salmon, 1981–2012 brood years. No data are available for brood year 2004.

A.4 Queets River Spring/Summer

Annex Stock group	None
CTC Escapement Indicator	Yes
CTC Exploitation Rate Indicator	
ISBM CWT Index	No
Life History Type, Ocean Distn,	Stream type, far-north
Primary Age of Maturity	4 yrs
Escapement method	Redd count expansion
CTC escapement goal	700

The Queets River is a clear water system located on the west side of the Olympic peninsula near Queets, Washington. Queets River spring/summer stock has not been CWT'ed. Tagging of any Washington coast spring/summer stocks has been very limited. The sparse number of ocean recoveries has shown a far north migration, primarily in SEAK and Canadian troll fisheries with lesser number of recoveries in Washington troll and sport.

Escapement Trends: The total natural spawning escapement is calculated under the assumption of 2.5 fish per redd. Estimated spawning escapements have failed to attain the goal for all years except 2012, since the goal was accepted in 2004 (Appendix A.9).



Appendix A.9– Queets River escapements of spring/summer Chinook salmon, 1976–2015.

Fisheries Impacting Stock: There is no representative CWT indicator stock for Queets River spring/summer Chinook stock and therefore, information on fishing impacts on this stock are very limited beyond in-river areas. Due to the lack of a CWT indicator, it is not possible to determine AABM or ISBM fishery impacts, nor is it possible to construct a representative Garcia plot for the stock. Since 1990, terminal fisheries have had minimal impact on this stock, as returns to the river have rarely exceeded the escapement floor. Since 2000, sport anglers have been required to release all Chinook salmon during the summer, and tribal fisheries have been limited to one tribal netting day for ceremonial and subsistence purposes.

Environmental, Non-Fishing Factors and Additional Information: Relatively little information is available on environmental and non-fishing factors that may affect abundance of Queets River spring/summer Chinook. The watershed is relatively pristine because a large portion is located within Olympic National Park. Land disturbance from logging and road construction has occurred in some tributary watersheds, leading to increased sediment inputs, loss of some off-channel habitats and disturbance of riparian vegetation. There is also concern about elevated water temperatures in the lower mainstem Queets and some tributaries. Nonetheless, habitat alterations are relatively small compared to other watersheds.

The absence of a representative CWT program precludes investigation of marine survival for Queets River spring/summer stock.

APPENDIX B: OPERATIONAL APPROACH AND DATA INPUTS TO THE CHINOOK MODEL SIMULATIONS

Appendix **Page**

AABM fishery-specific catch assumptions were generated by Model projections using the PST1999 and PST2009 Table 1 gear allocations. Once AABM TACs were determined from each projected AI, fish were allocated to gears for modeling.

Landed catch estimates resulting from year-specific Model projections for the SEAK, NBC and WCVI AABM fisheries were based on PST1999 Table 1 gear allocations for the PST1999 scenario. Likewise, the Landed catch estimates resulting from year-specific Model projections for the SEAK, NBC and WCVI AABM fisheries were based on PST2009 Table 1 gear allocations for the PST2009 scenario. These estimates are given in Appendix B.1 and Appendix B.2, respectively. The fishery-specific catches were the same from 1999–2008 for both scenarios.

Appendix B.1– Landed catch estimates resulting from year-specific Model projections for the SEAK, NBC and WCVI AABM fisheries based on the PST1999 Table 1.

	SEAK AABM			NBC AABM			WCVI AABM	
Year	Troll	Net	Sport	Troll	Sport (QCI)	Sport[1] (Total NCBC)	Troll	Sport
1999	119,960	20,000	29,990	96,720	24,180	38,154	88,987	22,247
2000	99,840	20,000	24,960	94,640	23,660	34,181	87,276	21,819
2001	131,360	20,000	32,840	121,680	30,420	49,070	136,904	34,226
2002	249,061	20,000	62,265	182,074	45,518	55,048	155,728	38,932
2003	307,845	20,000	76,961	204,250	51,062	74,560	207,311	51,828
2004	270,718	20,000	67,679	180,906	45,227	76,064	160,862	40,216
2005	214,194	20,000	53,549	142,400	35,600	64,209	133,482	33,370
2006	208,482	20,000	52,121	121,680	30,420	55,040	112,946	28,236
2007	142,760	20,000	35,690	93,600	23,400	46,452	88,987	22,247
2008	96,720	20,000	24,180	83,200	20,800	40,049	92,410	23,103
2009	106,280	20,000	26,570	94,640	23,660	46,852	87,276	21,819
2010	119,960	20,000	29,990	110,240	27,560	49,449	126,636	31,659
2011	198,487	20,000	49,622	118,560	29,640	64,212	131,770	32,942
2012	113,120	20,000	28,280	104,000	26,000	47,272	109,523	27,381
2013	208,482	20,000	52,121	145,920	36,480	59,749	159,150	39,788
2014	331,050	20,000	82,762	199,581	49,895	79,591	213,179	53,295

[1] *The Model fishery representing North AABM (i.e., QCI) Sport is a composite fishery and also consists of the catch in North ISBM Sport and Central Sport. Consequently, the observed annual catches in these latter two fisheries were added to the Table 1 QCI sport catch and the total was used in the Model projections.*

Appendix B.2–Landed catch estimates resulting from year-specific Model projections for the SEAK, NBC and WCVI AABM fisheries based on the PST2009 Table 1.

	SEAK AABM			NBC AABM			WCVI AABM	
Year	Troll	Net	Sport	Troll	Sport (QCI)	Sport[1] (Total NCBC)	Troll	Sport
1999	119,960	20,000	29,990	96,720	24,180	38,154	88,987	22,247
2000	99,840	20,000	24,960	94,640	23,660	34,181	87,276	21,819
2001	131,360	20,000	32,840	121,680	30,420	49,070	136,904	34,226
2002	249,061	20,000	62,265	182,074	45,518	55,048	155,728	38,932
2003	307,845	20,000	76,961	204,250	51,062	74,560	207,311	51,828
2004	270,718	20,000	67,679	180,906	45,227	76,064	160,862	40,216
2005	214,194	20,000	53,549	142,400	35,600	64,209	133,482	33,370
2006	208,482	20,000	52,121	121,680	30,420	55,040	112,946	28,236
2007	142,760	20,000	35,690	93,600	23,400	46,452	88,987	22,247
2008	96,720	20,000	24,180	83,200	20,800	40,049	92,410	23,103
2009	90,338	17,000	22,585	94,640	23,660	46,852	61,094	15,273
2010	103,904	17,000	25,976	111,280	27,820	49,189	88,646	22,161
2011	171,142	17,000	42,785	119,600	29,900	63,952	93,437	23,359
2012	100,028	17,000	25,007	106,080	26,520	46,752	77,864	19,466
2013	178,424	17,000	44,606	147,094	36,773	59,456	112,604	28,151
2014	284,021	17,000	71,005	201,915	50,479	79,007	149,226	37,306

[1] The Model fishery representing North AABM (i.e., QCI) Sport is a composite fishery and also consists of the catch in North ISBM Sport and Central Sport. Consequently, the observed annual catches in these latter two fisheries were added to the Table 1 QCI sport catch and the total was used in the Model projections.

Description of how the PST1999 and PST2009 scenarios were modeled

For the years 1999–2008, annual Model projection runs were produced using the 1999 Agreement Table 1 values. For years 2009–2015, two sets of projections were generated. One projection run 'PST1999' assumed the 1999 PST Table 1 values remained in place whereas the 'PST2009' scenario assumed 2009 PST Table 1 values.

The simulation procedure involved making annual projection runs to estimate AIs for AABM troll sectors for each scenario. TACs for AABM fishery complexes derived from the AIs and the appropriate Table 1 were then allocated to gear sector. Projected catches for AABM gear sectors were then used as observed catches for the projected year. For both scenarios, ISBM fisheries were modeled as "FP-based" fisheries with catches determined using base period exploitation rates adjusted for the ISBM general obligation reduction called for in the Agreement. This procedure was repeated for each successive year until complete sets of projection runs were produced for the entire period through 2015.

The Environmental Variables (EV scalars to reflect estimated early marine survival rates for individual broods of each Model stock) produced from calibration 1601 using the current version of the Chinook Model (ChinookModel_26g_stage2fp.exe) were employed for all model runs. The same assumptions are used to generate survival rates and project estimates of productivity for all stocks in the model scenarios.

Analysis of results from this study required output only from the 2015 Model run for each scenario. The modelled spawning escapements, terminal runs, fishery catches, etc., from the two scenarios were compared and the differences were summarized.

Modifications required to CLB1601 input files:

Modifications to four of the CLB1601 input files were required for this study as follows:

FPA files: These contain the fishery policy (harvest rate) scale factors which adjust fishery impacts relative to the 1979–82 base period average. A modified version of each of these files was created. For FPA files representing ISBM fisheries, values for years 1999–2015 were set to the general obligation of 0.635 for Canadian fisheries and 0.600 for US fisheries. Appendix B.3provides an example of a modified FPA file for an ISBM fishery. The FP values for the AABM fisheries from 1999 onward were set to 1. Values for years prior to 1999 were unchanged from those used for the 2016 calibration.

1601FPA.PRN file: This file contains the list of FPA files the Model reads during a model run to locate input values contained in the individual files. This file was updated with the list of the modified FPA files each identified with '_c3pe' in the name. The name of the PRN file itself was left unchanged.

CEI file: This file contains the time series of observed fishery catches for those fisheries with a continuous series of reliable catch estimates. An 'initial' version of the CEI file for each projection run was created consisting of the same data present in CLB1601.CEI through 1998. Separate CEI files were generated for years 1999–2015 assuming that the 1999 Agreement had been implemented perfectly. A second set of CEI files were generated for years 2009–2015 assuming that the 2009 Agreement had been implemented perfectly. For AABM fisheries, from 1999–2015, AIs were estimated for the troll sectors for each AABM fishery complex with TACs determined through the use of the respective Table 1 values for each scenario, and TACs were allocated to gear sectors with values entered into the CEI file. Most ISBM fisheries were modeled as being under FP control for 1999 onward by setting catch levels to 500,000, the customary value used to instruct the Model to project catches using 'FP control' (see *FPA files* above). This approach was not adopted for four Canadian ISBM fisheries for which the fishery has not been prosecuted since around the start of the 1999 PST, or the small amount of reported catch had occurred as bycatch in a fishery targeting another salmon species (i.e., sockeye or chum salmon). The four fisheries were Central BC troll, Georgia Strait troll, Johnstone Strait net and Juan de Fuca net. Fully modified CEI files were assigned a name that included the calibration year and the letter 'm' to distinguish them from the initial version and also the actual version that had been used for the annual calibration. Appendix B.4 provides an example of the modified input for an ISBM fishery.

1601P.OP7 file: This file contains the list of commands, flag values, and specific input files to be used during a projection run by the Chinook Model. A new version of the 'P. OP7'file was created for each projection run with the name of the new version including the calibration year. The projection year was changed from 2016 to the projection year for the Model run in lines 3 and 13. The name of the modified version of the CEI file was entered on line 66. The same *P.OP7 file could be used for the dual sets of projection runs for years 2009–2015.

No changes were required to any other CLB1601 input files.

General operational procedure

Before Model projections were run, a complete set of folders was created, one for each required projection run. These were populated with all input files used in the CLB1601 projection run and a copy of the Chinook Model program. CLB1601 input files were replaced with the modified versions described above. Finally, two programs (written in the language AWK) and two DOS batch programs were also placed in each folder.

One DOS batch program, executed before each projection run from 2000–2015, called an AWK script which created a CEI file modified to contain the Model-generated AABM fishery catches. This script also appended the AABM cohort abundances, calculated AIs and corresponding TACs for the projection year to a file named 'AABMdata.out' for future reference. The second DOS batch program, executed after every projection run, called an AWK script which read in the Model output file containing the annual Chinook cohort abundance estimates for the AABM fisheries (i.e., the *PABD.CSV file). The script then calculated AIs for each of the AABM fisheries for the projection year and the TAC corresponding to each AI was read from a lookup table (a different one constructed from Table 1 for each scenario). Next, each TAC was decomposed into the individual fishery catches comprising each AABM fishery (troll, net and sport for the SEAK AABM, and troll and sport for the NBC and WCVI AABMs) using the gear allocations assumed in the Table 1 for each Agreement. Finally, the set of seven AABM fishery catches for the projection year were appended to a file named 'AABMcatches_Model.dat'.

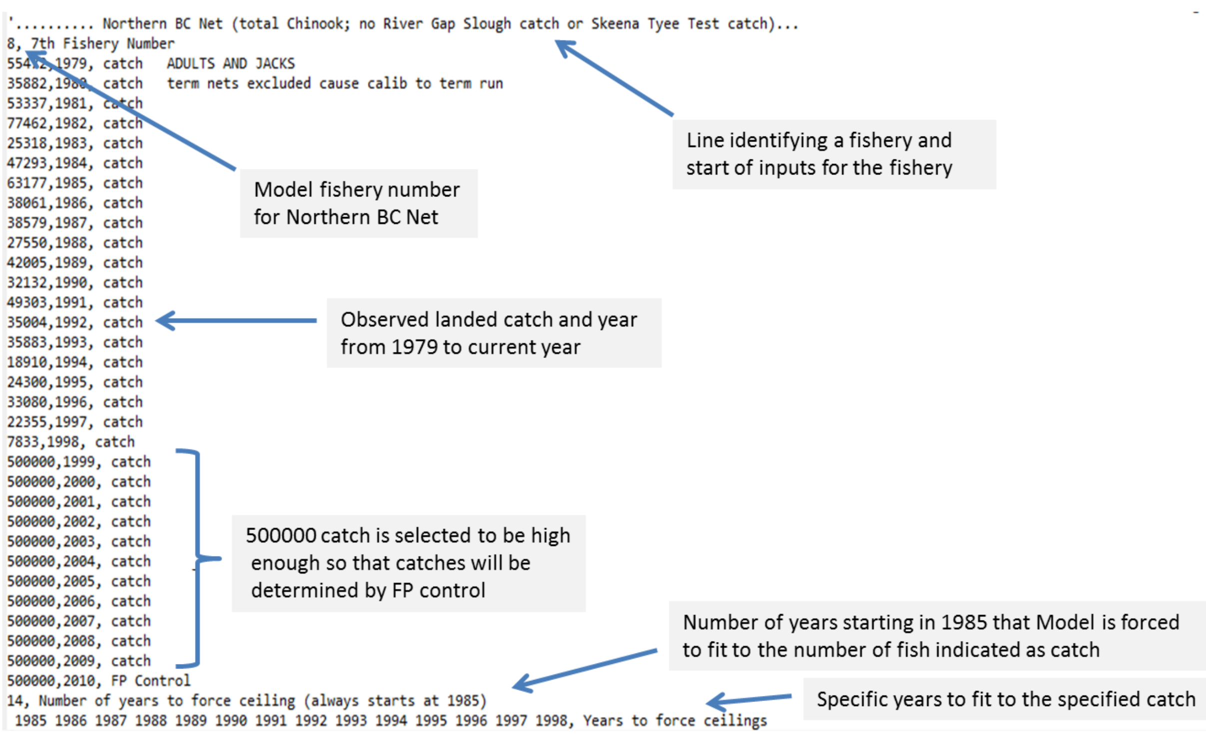
An adjustment was required to the Model catch for the NBC AABM sport fishery before entry into the modified CEI file. The NBC AABM sport fishery does not exist as a separate Model fishery. Instead, it is part of the 'NCBC Sport' Model fishery which also includes NBC ISBM sport and Central sport. The total observed catch for NBC ISBM sport and Central sport was added to the Model-based estimate for NBC AABM sport generated through the decomposition of the TAC for a given projection run. This new total for the NCBC sport fishery was used as the 'Table 1' catch.

Each projection run was completed by copying the two output files created by the AWK scripts into the folder for the next projection year in the sequence.

The completion of all projection runs involved a specific sequence of steps (Appendix B.5 and Appendix B.6). A total of 24 runs were required which conceptually occurred in two phases. The first involved constructing the series of AABM fishery catches from 1999–2008 as would've been expected under the 1999 PST version of Table 1. The second involved initializing a paired sequence of projections with the 1999–2008 PST 1999 Table 1 AABM catches. One sequence continued using the PST1999 Table 1 assumptions. The other used the PST2009 Table 1 assumptions. The fishery-specific AABM catches used as the actual catch in all Model projections are provided in Appendix B.1 and Appendix B.2.

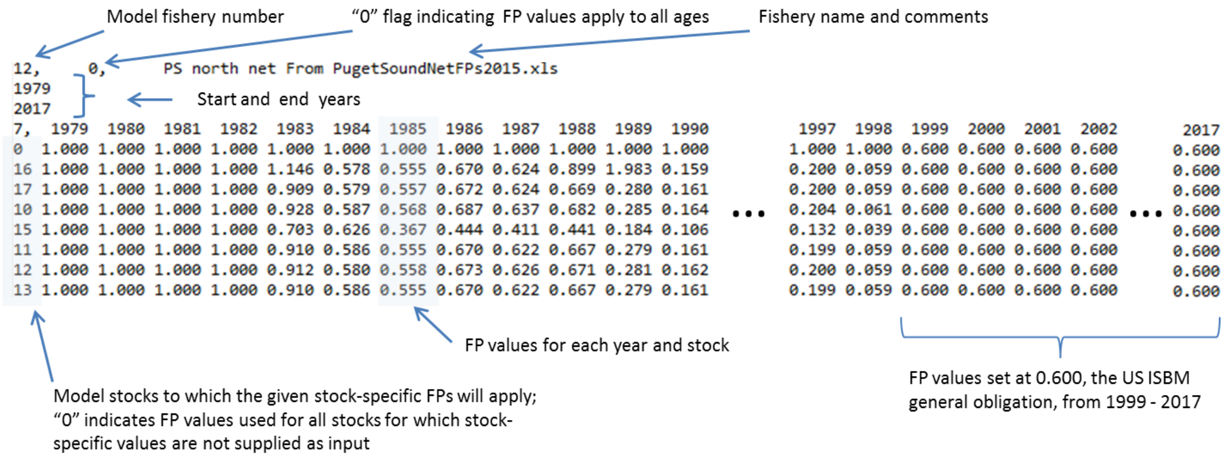
The approach used in this study required no modifications to the algorithms in the PSC Chinook Model and enabled a retrospective "what if" investigation into the effects of each fishery regime by generating 'expected' fishery catches, escapements, etc.

ISBM fishery modifications to the CEI file for Model projections (example is for year 2010)



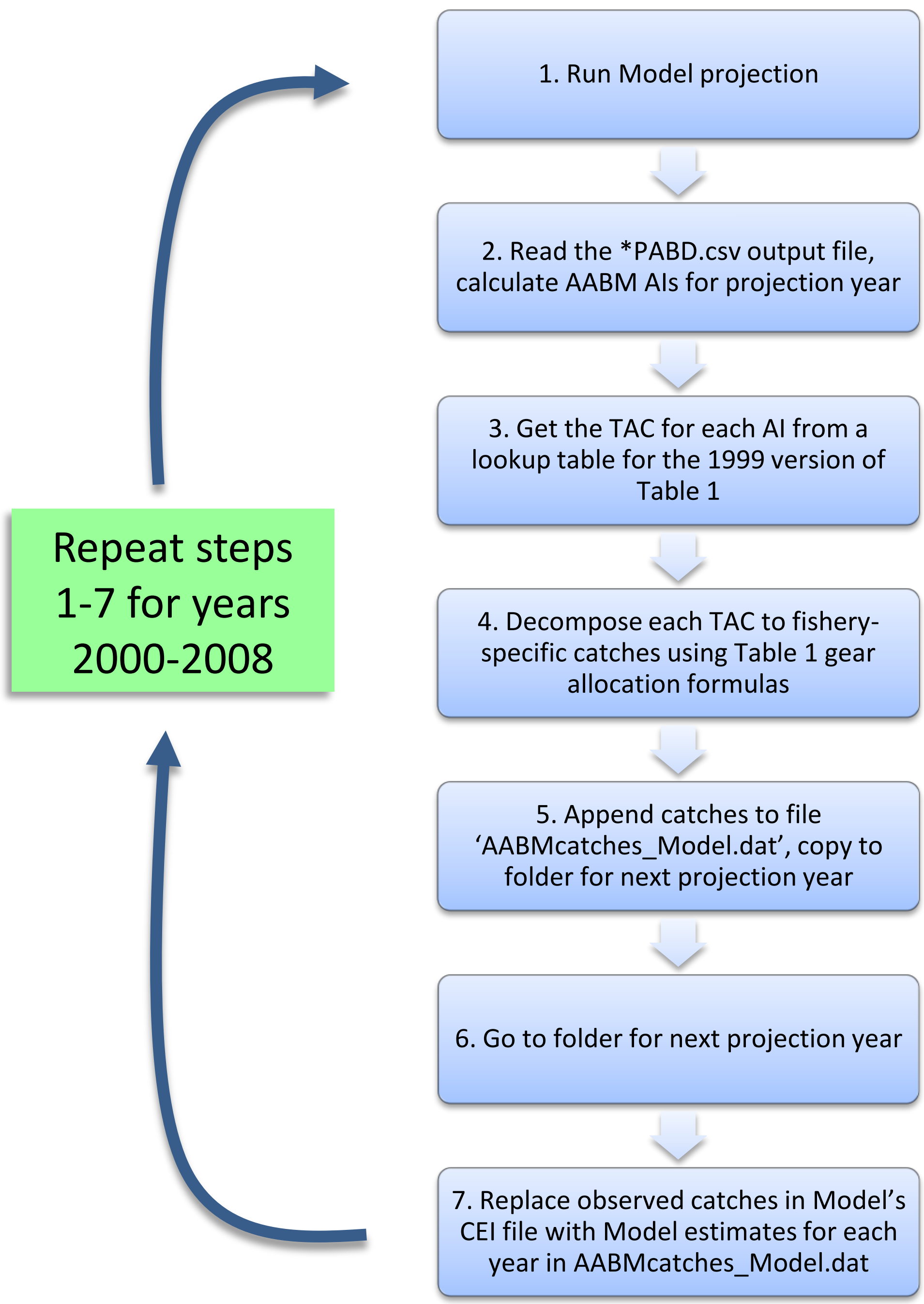
Appendix B.3–A portion of a CEI file illustrating modifications for an ISBM fishery. The example is for the northern BC net fishery and calibration year 2010.

Example of an FPA file for an ISBM fishery modified for the Model projections

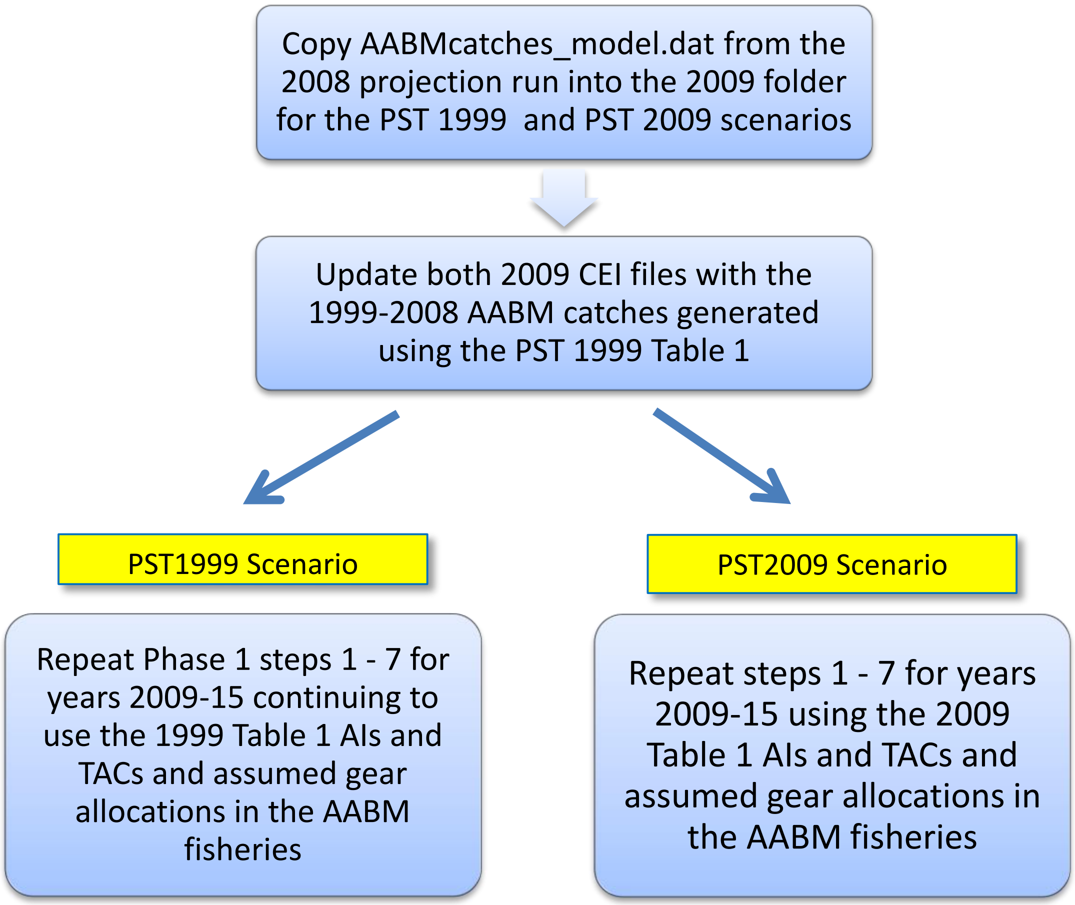



```
12,    0,      PS north net From PugetSoundNetFPs2015.xls
1979
2017
7,  1979  1980  1981  1982  1983  1984  1985  1986  1987  1988  1989  1990  ...  1997  1998  1999  2000  2001  2002  ...  2017
0  1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000      1.000 1.000 0.600 0.600 0.600 0.600      0.600
16 1.000 1.000 1.000 1.000 1.146 0.578 0.555 0.670 0.624 0.899 1.983 0.159      0.200 0.059 0.600 0.600 0.600 0.600      0.600
17 1.000 1.000 1.000 1.000 0.909 0.579 0.557 0.672 0.624 0.669 0.280 0.161      0.200 0.059 0.600 0.600 0.600 0.600      0.600
10 1.000 1.000 1.000 1.000 0.928 0.587 0.568 0.687 0.637 0.682 0.285 0.164      0.204 0.061 0.600 0.600 0.600 0.600      0.600
15 1.000 1.000 1.000 1.000 0.703 0.626 0.367 0.444 0.411 0.441 0.184 0.106      0.132 0.039 0.600 0.600 0.600 0.600      0.600
11 1.000 1.000 1.000 1.000 0.910 0.586 0.555 0.670 0.622 0.667 0.279 0.161      0.199 0.059 0.600 0.600 0.600 0.600      0.600
12 1.000 1.000 1.000 1.000 0.912 0.580 0.558 0.673 0.626 0.671 0.281 0.162      0.200 0.059 0.600 0.600 0.600 0.600      0.600
13 1.000 1.000 1.000 1.000 0.910 0.586 0.555 0.670 0.622 0.667 0.279 0.161      0.199 0.059 0.600 0.600 0.600 0.600      0.600
```

Appendix B.4– Illustration of the FPA file for an ISBM Model fishery and replacement of calculated year- and stock-specific FP values with the ISBM general obligation for each country (i.e., US = 0.600 and CA = 0.635). The example given is for the US ISBM fishery Puget Sound north net.



Appendix B.5–Flow chart of the Phase 1 sequence of steps involved in the Model projections for years 1999–2008.



Appendix B.6–Flow chart of the Phase 2 sequence of steps involved Model projections for the PST1999 and PST2009 scenarios and years 2009–2015.

APPENDIX C: CWT IMPROVEMENTS

Assessment of Chinook CWT Program

Improvements for the assessment of stocks and fisheries that were identified in Technical Report (TR) 25 (PSC 2008) have occurred since the start of the CWTIP funding. TR 25 identified and summarized gaps and deficiencies for individual stocks and fisheries in the PST area, as well as those that met or exceeded statistical criteria of the PSC Chinook Work Group for analysis that PSC technical committees use to evaluate the management regimes. Note that this section does not include CWTIP funding that addresses issues related to Data Coordination and Reporting, nor does it cover new CWT indicator stocks that have been incorporated by the CTC since publication of TR 25.

Appendix C.1 and Appendix C.2 provide a visual basis to compare the change in status of specific stocks and fisheries that received CWTIP funding. Appendix C.1is an extraction of Figure 4-2 in TR 25 and portrays the status of tagging and sampling levels, and associated CWT data in fisheries and escapements from 2000–2004 using statistical criteria set by the PSC Chinook Workgroup. Green cells indicate that a stock or fishery met or exceeded all criteria, e.g., tagging of indicator stocks, enumeration and associated precision of fisheries and escapement and sampling levels of fisheries and escapements. Yellow cells indicate that a stock or fishery failed to meet 1 of 3 criteria. Red cells mean that 2 or more criteria were not met and are the most problematic for data analysis. Blank cells are not applicable to the specific stock or fishery. Appendix C.2 represents the CWTIT's qualitative evaluation of the color (status) of each cell after 5 years of CWTIP funding. An empirical assessment utilizing statistical criteria similar to that employed in the formation of the TR 25 Red/Yellow/Green figure would be an appropriate analysis in preparation for upcoming PST Chapter renegotiations.

The CWT system for Chinook salmon has been substantially improved for stock and fishery analysis over the 5-year CWTIP. Of the 244 colored cells in Appendix C.1 (prior to the CWTIP), 27% were red, while in Appendix C.2 as a result of the CWTIP funding, the proportion of red cells have decreased to 1% (Appendix C.3). Also, 65 stock or fishery cells (32% of the former red and yellow cells, including 94% of the red cells) have improved status for estimating statistics for management (either from red to yellow or from yellow to green).

It should be noted that during the period of the CWTIP support for baseline monitoring and sampling programs continued to deteriorate and these programs were only maintained through the use of CWTIP funds. **Without continuation of annual funding, the status of the CWT system for Chinook salmon would quickly deteriorate to worse than that described in TR25.**

STOCK INFORMATION								REGIONAL MIXED-STOCK FISHERIES																		
		Stock Specific Key Issues						Fishery Specific Key Issues																		
Region	Stock	Release	Escapement (Hatchery)	Escapement (Sp Grounds)	Term Com	Term Native	Term Spt	SEAK Troll	SEAK SPT	SEAK Net	NCBC Troll	NCBC Sport	NCBC Net	WCVI Troll	WCVI Sport	Geo Strait Troll	Geo Strait Spt	SBC Net	WAOcn Troll	WA Ocn Sport	PS Sport	WA Net	Col Riv Sport	Col Riv Net	OR Coast Troll	OR Coastal Sport
Alaska	Alaska Central Inside	1	1	1				1	2																	
	Little Port Walter	1	1	1				1																		
	Alaska Southern Inside	1	1	1	1			1	2																	
Canada	Big Qualicum	1	1		3	3	3	2				3					3									
	Chilliwack (Harrison Fall Stock)	2		2		3								1	3		2		1							
	Cowichan	1	1			3	3							2	3							2				
	Kitsumkalum	1				3	3	1				3														
	Puntledge	2	1		3	3	3	2				3					3									
	Quinsam	1	1	1	3	3	3	1				3														
	Robertson Creek	2	1	1	1	2	3	1				3			3											
	Atnarko / Snootli	3			3	3	3	2			2	3	2													
Washington	George Adams Fall Fingerling	1	1	3	2		3							1	3				1		1	2				
	Green River Fall Fingerling	1	1	2	1									1	3		3		2		1	1				
	Grovers Creek Fall Fingerling	1	1											1	3				1		1	1				
	Hoko Fall Fingerling	3	1	2				1			2															
	Nisqually Fall Fingerling	1	1		1		3							1							1					
	Nooksack Spring Fingerling	2	1	2				2						1	3		3									
	Queets Fall Fingerling	2		3	1			1			1	3														
	Samish Fall Fingerling	1	1				3							1	3		3		2		2	1				
	Skagit Spring Fingerling	1	1											1	3						2					
	Skagit Spring Yearling	2	1											1	3						1					
	Sooes Fall Fingerling	2	1		2			2			2	3														
	South Puget Sound Fall Yearling	1	2		2										3						2	2				
	Skagit Summer Fingerling	3						1				3		2	3		3									
	Stillaguamish Fall Fingerling	3	1	2										2	3		3				2					
	White River Spring Yearling	3	1																		2					
Oregon	Salmon River	2		1			2	1			1															
Columbia River	Cowlitz Tule	1	1	3				2						2	3				2	2				2	2	
	Hanford Wild	1		2				1			2													1		
	Columbia Lower River Hatchery	1	1											1	3				1	2				1	1	
	Lewis River Wild	3						2			2			2	3				2					2	2	
	Lyons Ferry	3												2					1	1				1	2	
	Spring Creek Tule	1	1											1	3				1	1				1	1	
	Columbia Summers	1	1					1			1	3		1	3				1						1	
	Upriver Bright	1	1					1			2													1		
	Willamette Spring	1	1				2	1																1		

1 indicates that all criteria were met; 2 indicates that one criteria is not met; 3 indicates that two or more criteria are not met. Rows and columns highlighted in blue indicate stocks and fisheries for which CWT improvement programs were implemented.

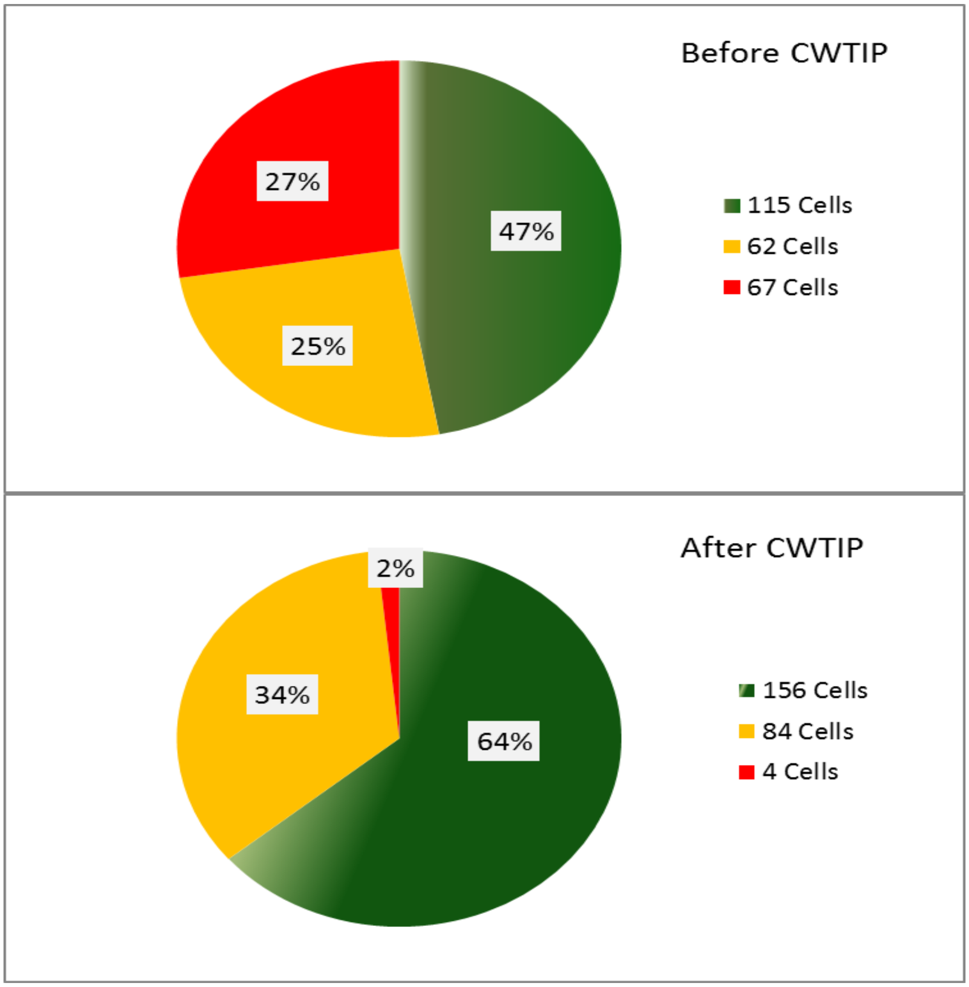
Appendix C.1– Coded-wire tag stock and fishery-specific issues. (Figure 4-2 extracted from TR 25)

Results of evaluating tagging, fishery, and escapement sampling levels using criteria set by workgroup for Chinook salmon. A blank cell indicates a fishery did not represent over 2.5% of the total exploitation for a stock. Green (1), yellow (2), or red (3) cells represent different situations with respect to the criteria as noted below; corresponding numbers are useful for black and white reproduction.]

STOCK INFORMATION								REGIONAL MIXED-STOCK FISHERIES																		
		Stock Specific Key Issues						Fishery Specific Key Issues																		
Region	Stock	Release	Escapement (Hatchery)	Escapement (Sp Grounds)	Term Com	Term Native	Term Spt	SEAK Troll	SEAK SPT	SEAK Net	NCBC Troll	NCBC Sport	NCBC Net	WCVI Troll	WCVI Sport	Geo Strait Troll	Geo Strait Spt	SBC Net	WAOcn Troll	WA Ocn Sport	PS Sport	WA Net	Col Riv Sport	Col Riv Net	OR Coast Troll	OR Coastal Sport
Alaska	Alaska Central Inside	1	1	1				1	1																	
	Little Port Walter	1	1	1				1																		
	Alaska Southern Inside	1	1	1	1			1	1																	
Canada	Big Qualicum	1	1		2	2	2	1				2					2									
	Chilliwack (Harrison Fall Stock)	1		1		2								1	2		1		1							
	Cowichan	1	1			2	2							2	2							2				
	Kitsumkalum	1				2	3	1				2	2													
	Puntledge	1	1		2	2	2	1				2					2									
	Quinsam	1	1	1	2	2	2	1				2														
	Robertson Creek	1	1	1	1	1	2	1				2			2											
	Atnarko / Snootli	1			1	1	1	1			2	2	2													
Washington	George Adams Fall Fingerling	1	1	2	2		3							1	2				1		1	2				
	Green River Fall Fingerling	1	1	2	1									1	2		2		1		1	1				
	Grovers Creek Fall Fingerling	1	1											1	2				1		1	1				
	Hoko Fall Fingerling	1	1	2				1			2															
	Nisqually Fall Fingerling	1	1		1		3							1							1					
	Nooksack Spring Fingerling	1	1	1				2						1	2		2									
	Queets Fall Fingerling	1		2	1			1			1	2														
	Samish Fall Fingerling	1	1				3							1	2		2		1		2	1				
	Skagit Spring Fingerling	1	1											1	2						2					
	Skagit Spring Yearling	1	1											1	2						1					
	Sooes Fall Fingerling	1	1		2			2			2	2														
	South Puget Sound Fall Yearling	1	2		2										2						2	2				
	Skagit Summer Fingerling	1						1				2		2	2		2									
	Stillaguamish Fall Fingerling	1	1	2										2	2		2				2					
	White River Spring Yearling	1	1																		2					
Oregon	Salmon River	1		1			1	1			1															
Columbia River	Cowlitz Tule	1	1	1				2						2	2				1	1				1	1	
	Hanford Wild	1		1				1			2													1		
	Columbia Lower River Hatchery	1	1											1	2				1	1				1	1	
	Lewis River Wild	1						2			2			2	2				1					1	1	
	Lyons Ferry	1												2					1	1				1	1	
	Spring Creek Tule	1	1											1	2				1	1				1	1	
	Columbia Summers	1	1					1			1	2		1	2				1						1	
	Upriver Bright	1	1					1			2													1		
	Willamette Spring	1	1				2	1																1		

1 indicates that all criteria were met; 2 indicates that one criteria is not met; 3 indicates that two or more criteria are not met. Rows and columns highlighted in blue indicate stocks and fisheries for which CWT improvement programs were implemented.

Appendix C.2– A qualitative assessment by the CWTIT of the color (status) of stock- or fishery-specific cells where CWT improvements were realized over the 5-year CWT Improvement Program, to provide a comparison to Appendix B.1. Cells to the left of the vertical black line are stock issues and those to the right are mixed stock fishery issues.



Appendix C.3– The estimated percentage and number of the 244 total colored cells representing stock- and fishery-specific status (green, yellow or red) before CWTIP funding in Appendix B.1 (upper chart) and after CWTIP funding in Appendix B.2 (lower chart).

APPENDIX D: ERRATA

Soon after the June 1, 2016 publication, errors were identified in the TCChinook (16)-02 document. Corrections to tables, figures, and text with currently accepted metrics of the Chinook Technical Committee are provided in Appendix D.

Page 2, Executive Summary

For ISBM fisheries, average mortality distribution percentages decreased on average for 7 indicator stocks, increased for 14 indicator stocks, and did not change for 6 from the 1999 Agreement.

Page 9–10, Table 1

Table 1– Status of PST Escapement Indicator stocks in the 1999 and 2009 Agreements.

All escapement percentages are calculated as a percent of either the point goal or the lower end of the escapement goal range. The geometric mean (Recent GM) is given for the most recent number of years (# Yrs) that represent the stock's predominant age of maturation.

Legend	
Esc Goal Ranges	Esc Point Goals
Above Range	>200%
Within Range	100-200%
85-100% Lower End	85-100%
< 85% Lower End	< 85%

Stock	CTC Goal	Other Goal	Average Escapements							
			1999-2008		2009-2015		Change	Recent GM		# Yrs
U. Georgia St. Index[5]				10,907		15,165	39%		20,241	4
UGS - Nimpkish				540		1,656	207%		2,310	4
UGS - Klinaklini				9,925		13,146	32%		17,366	4
UGS - Kakweiken				104		190	82%		263	4
UGS - Kingcome				251		95	-62%		31	4
UGS - Wakeman				86		79	-9%		43	4
Nooksack Spring[3,4]		4,000	56%	2,256	47%	1,881	-17%	42%	1,688	4
Hoko[3]		850	82%	699	110%	939	34%	115%	980	4

[3]State–tribal management goal (upper management threshold for Puget Sound and Washington Coastal stocks).

[4]Nooksack spring data average under the current PST Agreement is for 2009–2013; 2014 and 2015 data are not yet available.

[5]Missing annual estimates for some years under both Agreement periods were derived using a gap filling procedure.

Page 15, Section 2.3 Stock-Specific Fishery Impacts

For ISBM fisheries, average mortality distribution percentages decreased on average for 7 indicator stocks, increased for 14 indicator stocks, and did not change for 6 from the 1999 Agreement.

Page 16–18, Table 3

Table 3– Average CWT total mortality distributions during 2009–2015 and % change from 1999–2008 average, based on CWT indicator stocks.[1] Percentages were adjusted for age-specific adult equivalency and include both landed and incidental mortalities.

Escapement Indicator Stock	Expl. Rate Ind.	AABM						ISBM				ESC	
		SEAK		NBC		WCVI		US		CAN			
		% Mort	% Chg	% Mort	% Chg	% Mort	% Chg	% Mort	% Chg	% Mort	% Chg	% Esc	% Chg
Alsek[2]		11%	↑ 1%	0%	→ 0%	0%	→ 0%	0%	→ 0%	2%	→ 0%	87%	↓ -1%
Taku[7]	TAK	14%	↓ -7%	0%	→ 0%	0%	→ 0%	0%	→ 0%	10%	↓ -1%	77%	↑ 9%
Stikine[7]	STI	7%	↓ -22%	0%	↓ -2%	0%	→ 0%	0%	→ 0%	16%	↓ -10%	77%	↑ 32%
Situk[2]		22%	↓ -21%	0%	→ 0%	0%	→ 0%	0%	→ 0%	0%	→ 0%	78%	↑ 21%
Nass Skeena (Kitsumkalum)	KLM	15%	↓ -3%	12%	↑ 1%	0%	→ 0%	0%	→ 0%	5%	↓ -3%	67%	↑ 5%
Dean Wannock Chuckwalla/Kilbella Atnarko	ATN	9%	→ 0%	5%	→ -1%	0%	→ 0%	0%	→ 0%	30%	↑ 3%	55%	↓ -2%
Nooksack Spring	NSF	5%	→ 1%	0%	→ 0%	20%	↓ -6%	11%	↑ 6%	16%	↑ 7%	47%	↓ -8%
Hoko	HOK	11%	↓ -6%	7%	↓ -3%	2%	↑ 2%	4%	↑ 3%	3%	→ 0%	73%	↑ 4%

[1]Results for Alaskan and Canadian stocks are based on data from 2009–2015. For southern U.S. stocks, results from 2015 were not yet available.

[2]Harvests are inriver and terminal and data are based on landed catch run reconstruction. Results for Canadian AABM and Southern U.S. ISBM fisheries are assumed to be 0%.

[7]Harvests are inriver and in mixed stock marine fisheries and are based on a combination of landed catch, genetic stock identification and coded wire tag run reconstruction. Results for Canadian AABM and Southern U.S. ISBM fisheries are assumed to be 0%. Note that impacts in Canadian freshwater fisheries for the Alsek, Stikine and Taku rivers have been included for convenience under the Canadian ISBM fishery category, however, the collective impacts in these fisheries are managed under river-specific provisions given in Chapter 1 (Transboundary Rivers) of the PST. Terminal fishery impacts occurring in Alaskan fisheries under Chapter 1 management provisions have been grouped under the SEAK AABM fishery category for convenience.

Page 25, Section 2.4 Exploitation trends

The methodology to estimate rates of change in Annual MRE-based Total Exploitation Rates (MRE Total ERs) was the same used in analysis of escapement trends. While MREs represent the probability that a fish of a given age would have survived to spawn in a given year in the absence of fishing, MRE Total ERs represent the proportion of potential spawners in a given year that can be attributed to fishing. Therefore, MRE Total ERs is an annual statistic that includes data from the several broods contributing to escapement in a given year. Forty-one CWT indicator stocks were included in the evaluation of trends in annual MRE Total ERs, although the most recent year with CWT recovery data included in the analysis was 2014 for southern US stocks and 2015 for BC and AK stocks. Thirteen CWT indicator stocks were not included in this analysis because of missing data in the time series (Figure 2).

Those stocks presented in Figure 2 were chosen to represent trends in coastwide exploitation. Figure 2 includes both stocks present in Table 4 used by the CTC-AWG to represent exploitation rates of natural stocks and ERA stocks used to monitor coastwide trends. Twenty-nine of the 41 indicator stocks exhibited positive mean percent change in MRE Total ERs ranging from +0.2% to +12.1%, with 10 of the remaining stocks exhibiting negative percent changes ranging from -9.0% to -1.4%, and two stocks, QUI and SAM exhibiting no change on average during the time period. Inter-annual variability in annual rates of change was broad for many stocks leaving only few cases of clearly positive or clearly negative trends. Eight stocks exhibited clearly positive trends in MRE Total ERs – URB (mean percent change = +1.6%), GAD (+2.5%), WSH (+2.8%), LRH (+5.0%), NSF (+6.2%), QUE (+5.3%), SKF (+7.1%), and PPS (+7.6%).Only ~~2~~ one stock exhibited a clearly negative trend NIS (-1.8%). Stocks showing the largest inter-annual variability in rates of change, judging by the width of their rate of change confidence intervals, were HOK, SOO, TAK, and RBT.

Page 26, Figure 2

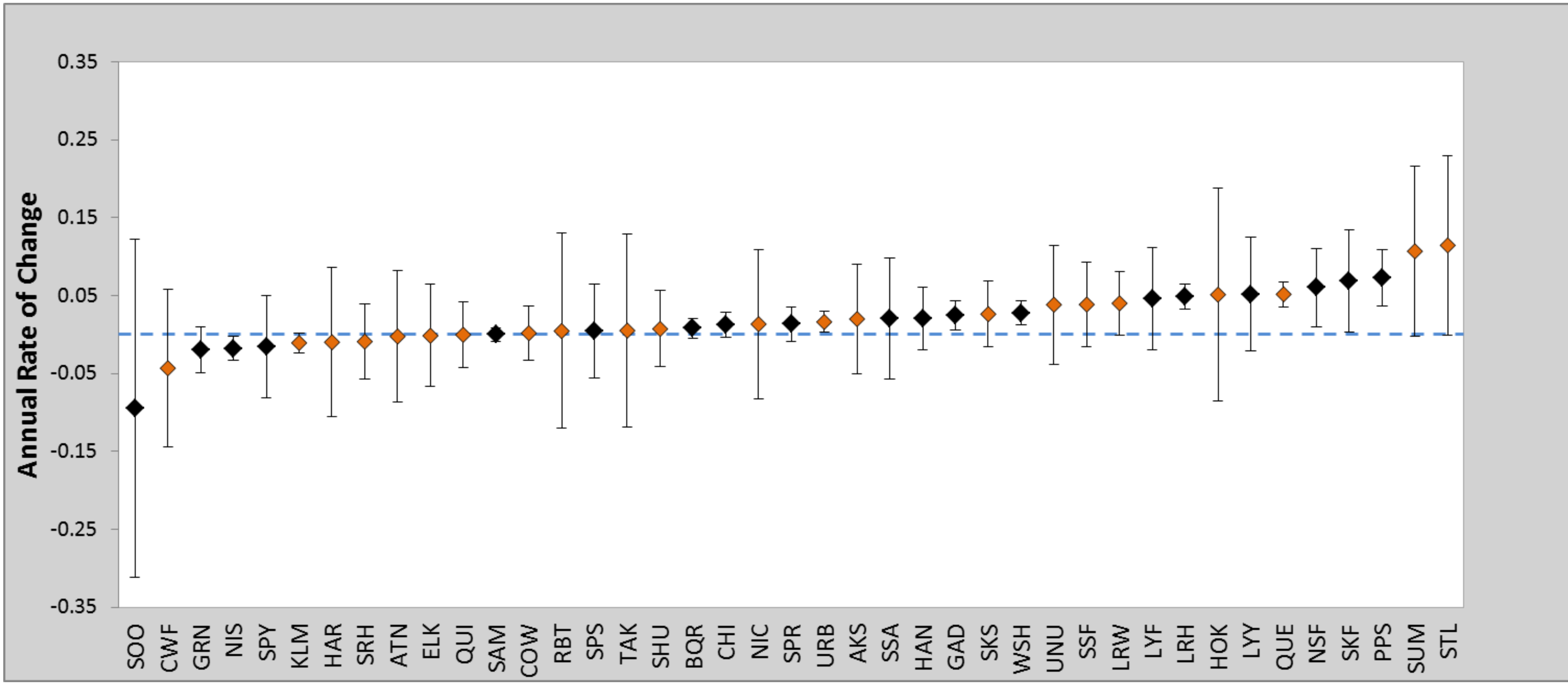


Figure 2— Annual rate of change for mature run equivalent (MRE) total exploitation rates, 1999—2015.

Diamonds represent mean rates of change (μ); orange diamonds correspond to escapement indicator stocks and black diamonds represent hatchery indicator stocks. Bars represent 80% confidence intervals. Stocks are ordered from the smallest to the largest μ value. The red line at zero represents equilibrium (i.e. no change).

Refer to page ii for a list of acronyms for current exploitation rate indicator stocks.

Page 29–31, Table 4

Table 4– Summary of escapement, survival and fishery information for CTC escapement indicator stocks.

					Escapement						Standardized Survival			Exploitation Rate[6]	
Escapement Indicator	Expl. Rate Ind. Stk	Attachments	CTC Goal	Agency Goal	Esc. Data meet CTC data standard	1999 Agreement Mean	2009 Agreement Mean	Recent Brood Geo Mean	Years missing goal in current agreement	Change over previous agreement	Average since 1996 BY	Recent Brood average	3 poor broods in a row (<-1 stnd survival)	Avg. % MRE 1999-08	Avg. % MRE 2009-15
Alsek[1]			3,500-5,300		Y	5,920	5,670	4,564	1R, 1Y	-4%				10%	10%
Taku[2]	TAK		19,000-36,000		Y	38,723	25,129	23,070	1Y	-35%	0.017	-0.351		22%	24%
Stikine[2]			14,000-28,000		Y	35,475	18,166	19,491	1Y	-49%				30%	19%
Situk[1]			500-1,000		Y	1,017	456	395	4R, 1Y	-55%				43%	22%
Chilkat[3]	CHK		1,750-3,500		Y	3,255	2,329	1,971	3Y	-28%	0.000	-0.621		19%	16%
Unuk[3]	UNU		1,800-3,800		Y	5,598	2,370	1,727	2R, 1Y	-58%	-0.306	-0.718	2006-09	22%	38%
Chickamin[4]	AKS		2,150-4,300		Y	4,527	3,138	2,638	1Y	-31%	-0.163	-0.633		22%	25%
U. Georgia St.					N	10,907	15,165	20,241		+39%					
UGS - Nimpkish		1,2,4			N	540	1,656	2,310		+207%					
UGS - Klinaklini	QUI	1,2,4			N	9,925	13,146	17,366		+32%	-0.549	-1.090	2009-11	30%	29%
UGS - Kakweiken		1,2,4			N	104	190	263		+82%					
UGS - Kingcome		1,2,4			N	251	95	31		-62%					
UGS - Wakeman		1,2,4			N	86	79	43		-8%					
Nooksack Sp[5]	NSF	4,5		4,000	N	2,256	1,881	1,688		-17%	0.142	-0.138		32%	38%
Snohomish		3, 4,5		4,600	N	6,735	3,518	3,978		-48%					
Lake Washington		3,4,5		1,680	N	1,274	1,212	1,381		-5%					
Green	SPS	3,4,5		5,800	N	5,804	2,246	2,897		-61%	-0.006	-0.334		42%	32%
Hoko	HOK	1,2,5		850	N	699	939	980		+34%	-0.181	0.235		24%	19%
Deschutes	LYF	1,2,3,5	4,532		Y	10,950	14,797	17,685		+35%	0.216	0.412		28%	53%

Cells are colored in green if the mean escapement is 100% or more of the point value or range of the CTC-accepted escapement objective, yellow if the mean is within 85-100% of the CTC-accepted escapement objective, or red if the mean is less than 85% of the CTC-accepted escapement objective. Years missing goal in the 2009 agreement are coded as yellow (Y) for the number of years within 85-100% of the CTC-accepted escapement objective and red (R) for the number of years less than 85% of the CTC-accepted escapement objective. Standardized survival is the smolt to age-2 cohort survival of a stock standardized to a mean of zero.

[1]Harvests are inriver and terminal and data are based on landed catch run reconstruction.

[2]Harvests are inriver and in mixed stock marine fisheries and are based on a combination of landed catch, genetic stock identification and coded wire tag run reconstruction.

[3]There are CWT programs in place to estimate harvest.

[4]There are no CWT programs in place to estimate harvest for the Chickamin; MRE exploitation rates from the nearby Neets Bay and Whitman Lake hatcheries are used as surrogate values after discounting any terminal hatchery harvests.

[5]Nooksack spring escapement average under the current PST Agreement is for 2009–2013; 2014 and 2015 data are not yet available.

[6]Results for Alaskan and Canadian stocks are based on data from 2009–2015. For southern U.S. stocks, results are based on data from 2009–2014 as data from 2015 were not yet available.

Page 36, Table 5. *Note: no changes were made to ISBM indices.*

Table 5– Summary of ISBM Indices for Canadian fisheries based upon CWT-based exploitation rate analysis, 1999–2014.

Stock Group	Stock (CTC agreed goal year)	Base Per. Data[1]	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
North/ Central B.C.	Yakoun, Nass, Skeena, Atnarko, Dean (no goal)	-	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
WCVI Falls	Artlish, Burman, Kauok, Tahsis, Tashish, Marble, Gold (no goal)	100%	0.431	0.083	0.060	0.248	0.496	0.488	0.267	0.267	0.906	0.652	0.464	0.178	0.650	1.017	0.351	0.324
L. Georgia Strait	Cowichan (2005)	0%	0.517	0.196	0.260	0.247	0.363	0.284	0.132	0.191	0.043	0.242	0.400	0.261	0.147	0.262	0.289	0.429
	Nanaimo (no goal)	0%	0.163	0.154	0.260	0.247	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
U. Georgia Strait	Klinaklini, Kakweikan, Wakeman, Kingcome, Nimpkish (no goal)	100%	0.021	0.123	0.040	0.063	0.006	0.018	0.028	0.079	0.268	0.073	0.247	0.182	0.032	0.175	0.109	0.170
Fraser Late	Harrison (2001)	0%	0.112	0.073	0.090	0.105	0.055	0.032	0.058	0.032	0.035	0.031	0.058	0.314	0.092	0.141	0.167	0.208
Fraser Early (spring & summers)	Upper Fraser, Mid-Fraser, Thompson	-	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Puget Sound Spring	Nooksack (no goal)[1]	0%	0.183	1.176	0.040	0.023	0.046	N.A.	N.A.	N.A.	N.A.	N.A.	0.106	0.014	0.144	0.137	0.105	N.A.
	Skagit (no goal)	-	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Puget Sound Falls	Skagit (no goal)	-	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
	Stillaguamish (no goal)[2]	6%	0.194	0.111	0.145	N.A.	N.A.	0.027	0.057	0.074	0.192	N.A.	0.252	0.083	0.246	0.158	0.273	N.A.
	Snohomish (no goal)	-	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
	Lake Wash. (no goal)	-	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
	Green River (no goal)[2]	56%	0.171	0.154	0.350	0.323	0.328	0.162	0.085	0.109	0.076	0.106	0.208	0.151	0.300	0.346	0.322	N.A.

Cases wherein the fishery met the obligation are colored in green whereas cases where the obligation was exceeded are colored in red. Cells are not colored in cases where a stock-year ISBM statistic cannot be calculated. The ISBM performance metrics reflect the combination of presence of an escapement goal and if so, whether or not it was met, and the CWT-based evaluation of exploitation rate as compared to the base years.

[1] This column contains the percentage of the maximum possible age-year combinations available for calculating the 1979–1982 base period average total mortality (landed catch and incidental mortality) which is the denominator of the postseason ISBM index. The base period average total mortality is based on data contributed from four possible age classes in each year of 4 possible base period years for a total of 16 possible age-year combinations. In practice, the postseason ISBM index is calculated for a CWT indicator stock when fewer than the maximum number of age-year combinations with data are available (<100%). When actual CWT data are not available for the majority of ages in all of the base period years (0%–6%), the base period average is calculated from values found in the PSC Chinook Model's STK input file for the Model stock corresponding to the CWT indicator stock; in these cases, the ISBM index should be interpreted judiciously (see TCChinook (11)-04 for details).

Page 37, Table 6. *Note: no changes were made to ISBM indices.*

Table 6– Summary of the first postseason ISBM Indices for U.S. fisheries based upon CWT-based exploitation rate analysis, 1999–2013.

Stock Group	Stock (CTC agreed goal in year)	Base Per. Data[1]	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Fraser Late	Harrison (2001)	0%	0.470	0.130	0.310	0.410	0.640	0.320	N.A.	N.A.	N.A.	0.260	0.150	0.470	N.A.	0.405	0.410
Puget Sound Spring	Nooksack (no goal)	0%	0.440	0.000	0.040	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	0.210	0.520	0.700	0.795	2.758	1.137
	Skagit (no goal)	-	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Puget Sound Fall	Skagit (no goal)	-	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
	Stillaguamish (no goal)	6%	0.120	0.040	0.890	N.A.	N.A.	0.010	0.220	0.080	0.120	N.A.	0.200	0.380	0.195	0.213	N.A.
	Snohomish (no goal)	-	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
	Lake Wash. (no goal)	-	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
	Green (no goal)	56%	0.500	0.700	1.180	1.070	1.030	1.010	0.170	0.370	0.380	0.280	0.290	0.340	0.439	0.544	0.320
WA Coast Falls	Hoko (no goal)	-	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
	Grays (2014)	63%	0.430	1.630	0.860	0.540	0.150	0.530	0.560	0.520	0.790	0.390	0.700	0.690	0.923	0.591	0.670
	Queets (2004)	63%	1.000	0.850	1.440	0.840	0.850	0.840	2.050	0.600	*1.050*	0.610	0.450	0.670	N.A.	0.951	0.745
	Hoh (2004)	63%	1.540	2.750	1.660	0.950	1.340	1.220	1.030	1.290	2.230	0.950	1.220	1.000	2.003	1.593	2.263
	Quillayute (2004)	63%	1.300	2.470	1.480	1.420	0.990	1.150	1.030	1.180	1.470	1.160	1.970	0.670	N.A.	2.140	0.776
Columbia Fall	Brights (2002)	94%	1.370	2.530	1.350	1.320	1.430	1.740	1.780	3.080	3.100	1.830	2.790	1.750	2.862	3.133	2.298
	Deschutes (2010)	0%	0.510	0.710	0.520	0.590	0.049	0.510	0.670	0.580	0.510	1.860	2.360	0.790	0.798	1.045	0.830
	Lewis (1999)	56%	0.000	0.360	0.580	0.560	1.030	0.170	0.980	1.330	0.790	0.630	0.140	0.430	0.432	0.895	0.656
Columbia Summers	Summers (1999)	56%	1.640	4.820	5.320	7.250	10.040	2.690	6.080	0.480	1.840	6.800	1.310	9.810	5.376	5.192	7.166
N. Oregon Coast	Nehalem (1999)	81%	1.960	1.970	1.940	2.170	3.110	1.800	2.000	3.480	2.010	0.920	0.590	1.210	1.210	2.267	2.291
	Siletz (1999)	81%	0.820	1.160	1.190	1.310	1.590	2.290	1.190	2.340	1.600	0.670	0.730	0.500	1.068	0.997	1.054
	Siuslaw (1999)	81%	1.220	2.450	2.180	2.560	3.820	1.030	1.630	2.230	1.000	0.640	1.070	0.770	1.108	1.603	2.145

Cases wherein the fishery met the obligation are colored in green whereas cases where the obligation was exceeded are colored in red. Cells are not colored in cases where a stock-year ISBM statistic cannot be calculated. The ISBM performance metrics reflect the combination of presence of an escapement goal and if so, whether or not it was met, and the CWT-based evaluation of exploitation rate as compared to the base years.

[1] This column contains the percentage of the maximum possible age-year combinations available for calculating the 1979–1982 base period average total mortality (landed catch and incidental mortality) which is the denominator of the postseason ISBM index. The base period average total mortality is based on data contributed from 4 possible age classes in each year of 4 possible base period years for a total of 16 possible age-year combinations. In practice, the postseason ISBM index is calculated for a CWT indicator stock when fewer than the maximum number of age-year combinations with data are available (<100%). When actual CWT data are not available for the majority of ages in all of the base period years (0%–6%), the base period average is calculated from values found in the PSC Chinook Model's STK input file for the Model stock corresponding to the CWT indicator stock; in these cases, the ISBM index should be interpreted judiciously (see TCChinook (11)-04 for details).

Page 38, Figure 6. *Note: no changes were made to ISBM indices.*

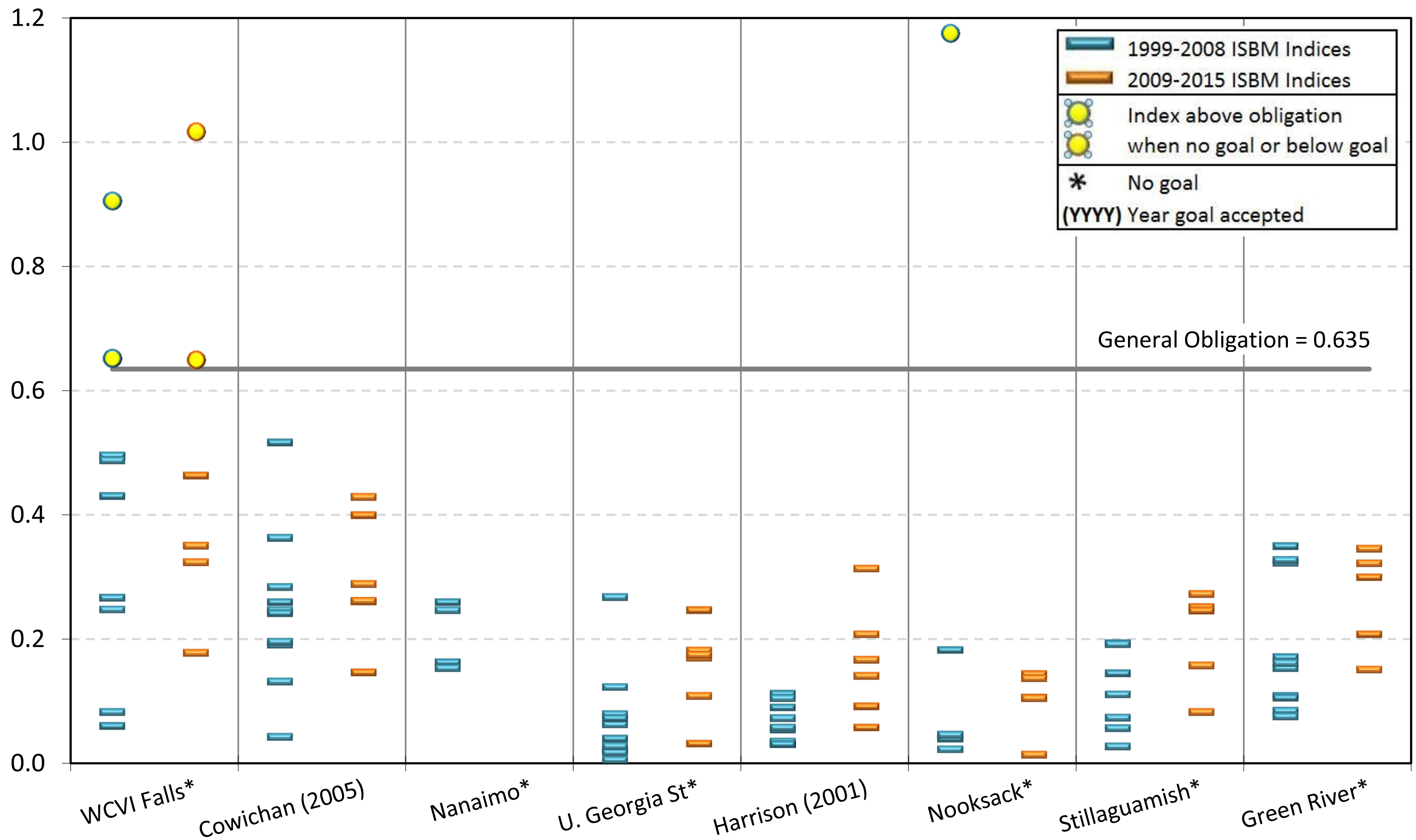


Figure 6—Performance of Canada ISBM fishery, 1999–2014 for Canadian stocks and 1999–2013 for U.S. stocks.

Note: The percentage of base period data (1979–1982) available to calculate ISBM indices is as follows: WCVI Falls (100%), Cowichan (0%), Nanaimo (0%), Upper Georgia Strait (100%), Harrison (0%), Nooksack (0%), Stillaguamish (6%), and Green (56%).

Page 39, Figure 7. *Note: no changes were made to ISBM indices.*

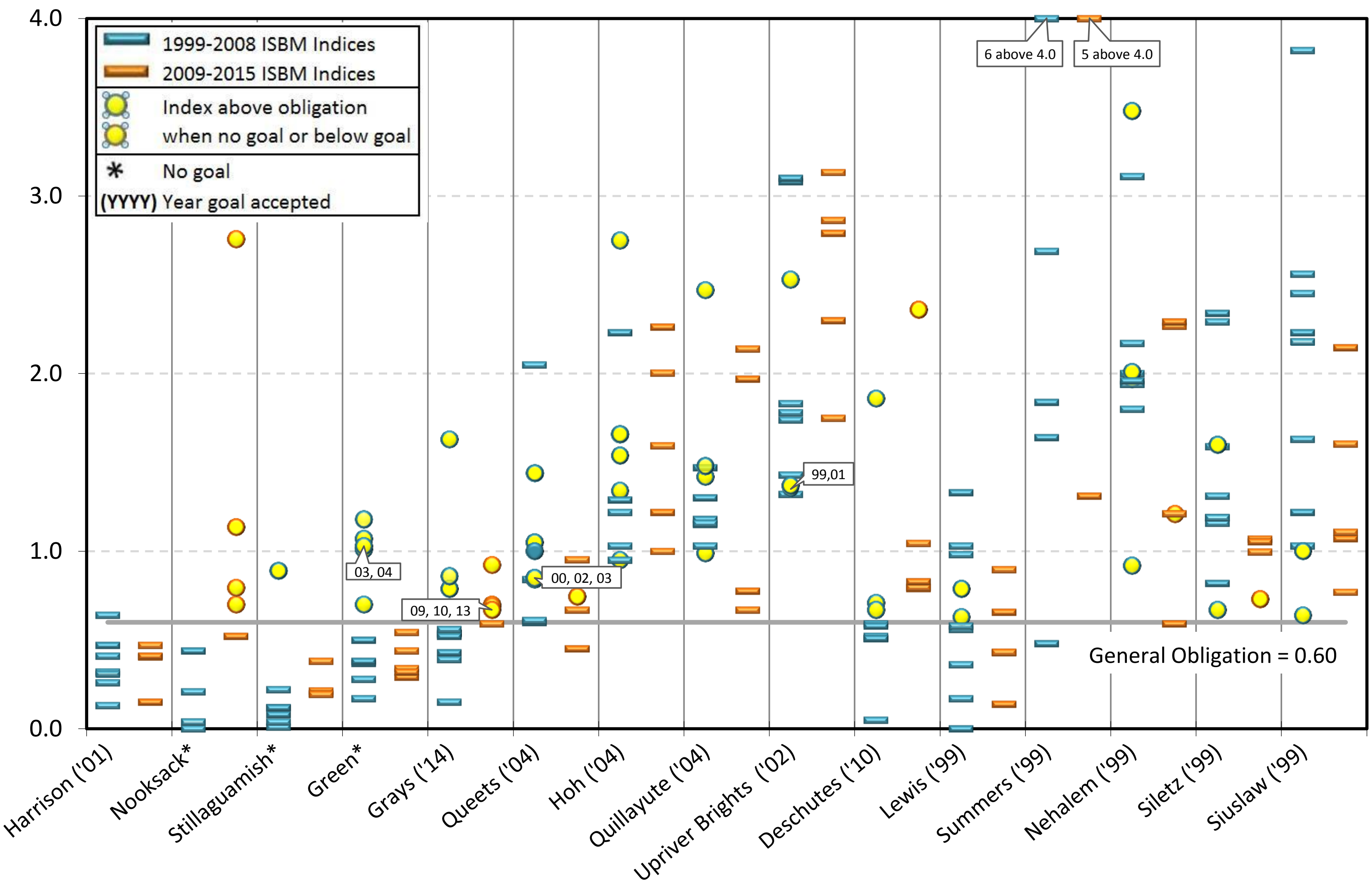


Figure 7— Performance of U.S. ISBM fishery, 1999–2013.

Note: The percentage of base period data (1979–1982) available to calculate ISBM indices is as follows: Harrison (0%), Nooksack (0%), Stillaguamish (6%), Green (56%), Grays (63%), Queets (63%), Hoh (63%), Quillayute (63%), Upriver Brights (94%), Deschutes (0%) , Lewis (56%), Summers (56%), Nehalem (81%), Siletz (81%), and Siuslaw (81%).

Page 42, Table 7 caption

Table 7– Preseason allowable, postseason allowable, and observed catches for AABM fisheries, 1999–2015. Postseason values each year are from the first postseason calibration following the fishing year[1].

Page 81, Key Findings and Recommendations

For ISBM fisheries, average mortality distribution percentages decreased on average for 7 indicator stocks, increased for 14 indicator stocks, and did not change for 6 from the 1999 Agreement.