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PST Southern Coho Reference Points and Exploitation Rate Caps

Engagement Process Discussion Paper

March 2018

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Acknowledgments

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1 Introduction

The Pacific Salmon Treaty (PST) has guided the collaborative management of Pacific salmon stocks originating in Canadian and US waters that are subject to harvest by the other Party since its inception in 1985. Fishing arrangements, captured under Annex IV of the PST, are subject to periodic renegotiation to address the evolving nature of fisheries management under the jurisdiction of both Parties. In this regard, negotiations have been underway since 2015 for most treaty chapters in preparation for the expiration of current arrangements at the end of the 2018 fishing season. This includes Chapter 5 which covers the management of coho salmon fisheries in both the southern and northern boundary areas.

The purpose of the current engagement process is to review and seek feedback on the approach for identifying PST **management reference points**[1] that demarcate the three PST status categories (i.e. low, moderate and abundant) and determining corresponding **exploitation rate**[2] (ER) **caps**[3] or ceilings for Canadian Coho Management Units (MUs) under the Southern Coho Management Plan. This is a requirement of the Southern Coho Management Plan under Annex IV, Chapter 5 of the PST that has been in effect since 2009. Key points with respect to what is being sought during the engagement are summarized in the highlighted box below. The input gathered through this process will help inform the Government of Canada on the perspectives of First Nations and stakeholders with respect to desired outcomes and risk tolerances, and thus contribute to the final approach for establishing reference points and ER caps for the bilateral management of Canadian Coho MUs under the PST. The core question is summarized in the second box below.

[1] Population levels based on biological, economic and policy considerations that trigger specified management actions under the Pacific Salmon Treaty. The use of the term is consistent with Holt and Irvine (2013).
[2] Mortality due to landed catch and incidental mortality, expressed as fishing mortality divided by fishing mortality plus escapement.
[3] Under the PST Southern Coho Management Plan (SCMP), the maximum ER that a MU can be subjected to, given its categorical abundance status. The US share of the ER cap is specified under the terms of the SCMP.

Key Points:

- This engagement process focuses on Canada's obligation to provide maximum bilateral (Canada and US) exploitation rates (ER caps) for each PST status category of Low, Moderate and Abundant, for Canadian Coho management units under the terms of Annex IV, Chapter 5 of the PST.
- Within each ER cap, explicit limits on the ERs for Canada and the US are established under the PST. Each country then manages within its ER cap through its own domestic fisheries management process and annual fishing plans.
- This means that within its portion of the PST ER cap, Canada will continue to implement its own annual domestic planning processes (i.e. through the salmon Integrated Fisheries Management Plan (IFMP) development process) and determine fishery-specific, domestic management actions to implement. Domestic annual ER targets may be set less than or equal to the maximum permitted under the maximum bilateral ER cap for domestic management purposes.
- Any new bilateral ER caps will only come into effect for a 10 year period beginning with the 2019 fishing season with discussions on specific fishing plans for Canadian fisheries to take place in developing the 2019 IFMP through existing consultation processes.

Core Question and Options

The key question being asked in this engagement is:

What are your views on the current ER caps for each status level? Do you think they should be maintained, reduced or increased? These ER caps will set the maximum allowable bilateral ER under the PST Southern Coho Management Plan.

As you review this document, consider your views with respect to maintaining or changing the current ER caps for each status level. Keep the general possibilities below in mind as you will be asked specific questions expanding upon the core question above.

Considerations for bilateral ER cap under Low Status	Considerations for bilateral ER cap under Moderate Status	Considerations for bilateral ER cap under Abundant Status
Reduce ER cap to X_1%	Reduce ER cap to Y_1%	Reduce ER cap to Z_1%
…	…	…
Maintain existing ER cap (20%)	Maintain existing ER cap (40%)	Maintain existing ER cap (65%)
…	…	…
Increase ER cap to X_2%	Increase ER cap to Y_2%	Increase ER cap to Z_2%

This discussion paper is intended to support the engagement process by providing the necessary background, including relevant science advice, in a format that will facilitate broad understanding of the issues and the feedback being requested. This document represents one component of the implementation of the Engagement Pan distributed in late January 2018. The present document is intended to be a companion, but not a replacement, to the more detailed Science Advisory Report (SAR). It highlights key components of the SAR and highlights

example results to focus discussion as part of the engagement process. Readers should refer to the SAR for more comprehensive explanation of the analyses and science advice. As a discussion paper intended to support an engagement process, this document poses a series of questions for participants to consider, which are integrated throughout the document and formatted as follows:

? *The blue boxes with question marks represent questions that DFO is explicitly seeking feedback on. These questions are numbered and match the questions in the "worksheet" in Appendix A for submitting feedback to DFO.* ?

 *The yellow boxes with "thought bubbles" provide additional questions for participants to think about while reviewing the content – they are intended to help participants build toward subsequent questions.* 

2 Background

2.1 PST Annex IV, Chapter 5 – Coho Salmon

From an initial focus on controlling interceptions in the initial 1985 PST, the PST coho chapter evolved in the 1999 agreement to one that recognized the need to conserve vulnerable coho stocks and to manage them to ensure sustainable harvests into the future. The coho chapter provides a framework for the bilateral management of a shared resource in both the northern and southern boundary areas. However, the focus of this paper and the engagement process it supports will be on the stock and fisheries in the southern boundary area as described in the Southern Coho Management Plan (SCMP).

The SCMP under Annex IV, Chapter 5 of the PST was finalized in 2002 as a requirement of the 1999 PST agreement. The SCMP establishes the international management regime for southern BC and southern US origin coho based on the status of defined MUs in each country. Nine US MUs and four Canadian MUs were identified in the original SCMP. In Canada, the following MUs were identified; Strait of Georgia - Vancouver Island , Strait of Georgia – Mainland, Lower Fraser River, Interior Fraser River. Each MU is to be managed using a series of decision rules which are based on the status category of the MU, or groups of MUs in the case of the US. The three status categories are Low, Moderate and Abundant. The SCMP also stipulates a maximum ER or ER Cap for the three status categories as well as an ER cap for the intercepting Party (U.S. or Canada) for each MU (Table 1). Within the PST low status category, each country is expected to implement additional, domestic fishery management measures as may be necessary to address conservation needs for MU's within its jurisdiction. For example, Canada has been managing the

IFR MU in recent years to an ER level of 3-5%, which is below the 10% that is permitted by the Treaty (Table 2).

Table 1. US ER caps on Canadian MUs, as per the current Pacific Salmon Treaty provisions. In the development of the current agreement, these values were identified as the default levels in the absence of explicit Canadian ER caps developed by Canada.

Condition of Canadian MUs	US ER caps	MU Applicability
Low	0.10	All MUs with Total ER ≤ 0.20
Moderate	0.12	All MUs with 0.20 < Total ER ≤ 0.40
Abundant	0.15	All MUs with 0.40 < Total ER

Table 2. Interior Fraser River (IFR) Management Unit (MU) Exploitation Rate (ER) caps under Annex IV, Chapter 5 of the Pacific Salmon Treaty, plus pre-season estimates of planned ERs resulting from domestic fishery planning processes and post-season ERs as estimated by the bilateral PSC Coho Technical Committee. The final column shows the smolt-to-adult survival rate associated with the return year. The pre- and post-season ER values are those estimated by the bilateral Coho Technical Committee using the FRAM model (the bilaterally agreed upon model under the PST management framework).

	US			Canada			Bilateral Total			Survival Rate
Return Year	PST ER cap	pre-season ER	post-season ER	PST ER cap	pre-season ER	post-season ER	PST ER cap	pre-season ER	post-season ER	
2004	10%	10.5%	10.7%	10%	2.3%	2.9%	20%	12.7%	13.6%	1.20%
2005	10%	9.8%	5.3%	10%	2.8%	2.9%	20%	12.6%	8.2%	0.80%
2006	10%	9.3%	7.3%	10%	3.9%	6.0%	20%	12.1%	9.9%	0.30%
2007	10%	10.0%	7.5%	10%	1.6%	2.3%	20%	11.6%	9.9%	1.20%
2008	10%	8.3%	7.4%	10%	3.1%	1.6%	20%	11.4%	9.0%	0.60%
2009	10%	10.1%	11.1%	10%	3.3%	3.0%	20%	13.4%	14.1%	1.10%
2010	10%	9.9%	6.8%	10%	1.1%	1.7%	20%	11.0%	8.5%	1.00%
2011	10%	9.6%	8.5%	10%	3.3%	3.7%	20%	12.9%	12.2%	1.40%
2012	10%	9.9%	9.9%	10%	2.1%	3.1%	20%	12.0%	13.0%	1.30%
2013	10%	10.0%	12.9%	10%	3.5%	5.5%	20%	13.5%	18.4%	0.90%
2014	12%	9.8%	8.0%	28%	8.0%	23.6%	40%†	17.8%	31.6%	2.10%
2015	10%	10.0%	9.4%	10%	7.7%	8.3%	20%	17.7%	17.7%	0.80%
2016	10%	3.6%	4.2%	10%	8.4%	3.0%	20%	12.0%	13.0%	n/a
Average		**9.3%**	**8.4%**		**3.9%**	**5.2%**		**13.1%**	**13.8%**	

† In 2014, Canada determined that IFR was in moderate status; however, the US fishing plans were already finalized based on low status before this decision was communicated.

2.2 Status of Current Negotiations

Five fishing chapters in Annex IV of the Treaty (including Chapter 5: Coho Salmon) expire on December 31, 2018. In February 2015, PSC Commissioners adopted a three-year planning horizon to conduct and complete negotiations on these chapters. The agreement in principle for Chapter 5 was reached in January 2018 and contains the following elements:

- Continued bilateral commitment to conservation-based management approach, acknowledging current environmental uncertainties.
- Structure of Canadian MUs will be simplified for bilateral management – two Strait of Georgia MUs have been combined into one Strait of Georgia MU. The Lower Fraser River and Interior Fraser Rivers MUs remain as before. Past information shows U.S. fisheries have similar impacts on the two existing Strait of Georgia MUs
- Continue the current approach to Chapter 5 implementation until Canada has finished work on a status-based management approach for Canadian MUs in the PST. The status-determination work will involve establishing reference points for moving amongst three status levels, and the maximum allowable sustainable ER at each status level (i.e., the topic of the present work and engagement process).
- Until Canada completes this work, bilateral (Canada-U.S.) management will be driven by the status of Interior Fraser Coho (IFR) at a "Low" status level. Canada has committed to completing the present work for Canadian MU(s) by the end of 2018. Feedback from this engagement process will be considered in developing Canada's recommended approach.

3 Canadian Management Approach for Fisheries on Strait of Georgia and Fraser River Coho Salmon Stocks

Since the late 1990's, the very poor status of Interior Fraser River coho has been the primary driver in the management of fisheries where these fish are encountered. Coho salmon originating in adjacent MUs, while not believed to be in as poor a condition as the IFR MU, are also experiencing the same low marine survival rates that have led to the persistent poor status of IFR coho (Figure 1). In responding to these conservation concerns in a manner consistent with its PST obligations and based on a realistic consideration of its available stock assessment and fishery monitoring capacity, Canada has adopted an effort-based ER approach focused on the IFR MU in managing its southern BC coho salmon fisheries.

For Canadian domestic fisheries, the objective is to manage fisheries in a manner that is consistent with DFO's policy framework for the management of Pacific salmon fisheries (Appendix B), which includes guidance on conservation of wild Pacific salmon, allocation of available harvests, selective fishing and implementing a precautionary approach to decision-making, while providing constitutional protection to existing aboriginal and treaty rights.

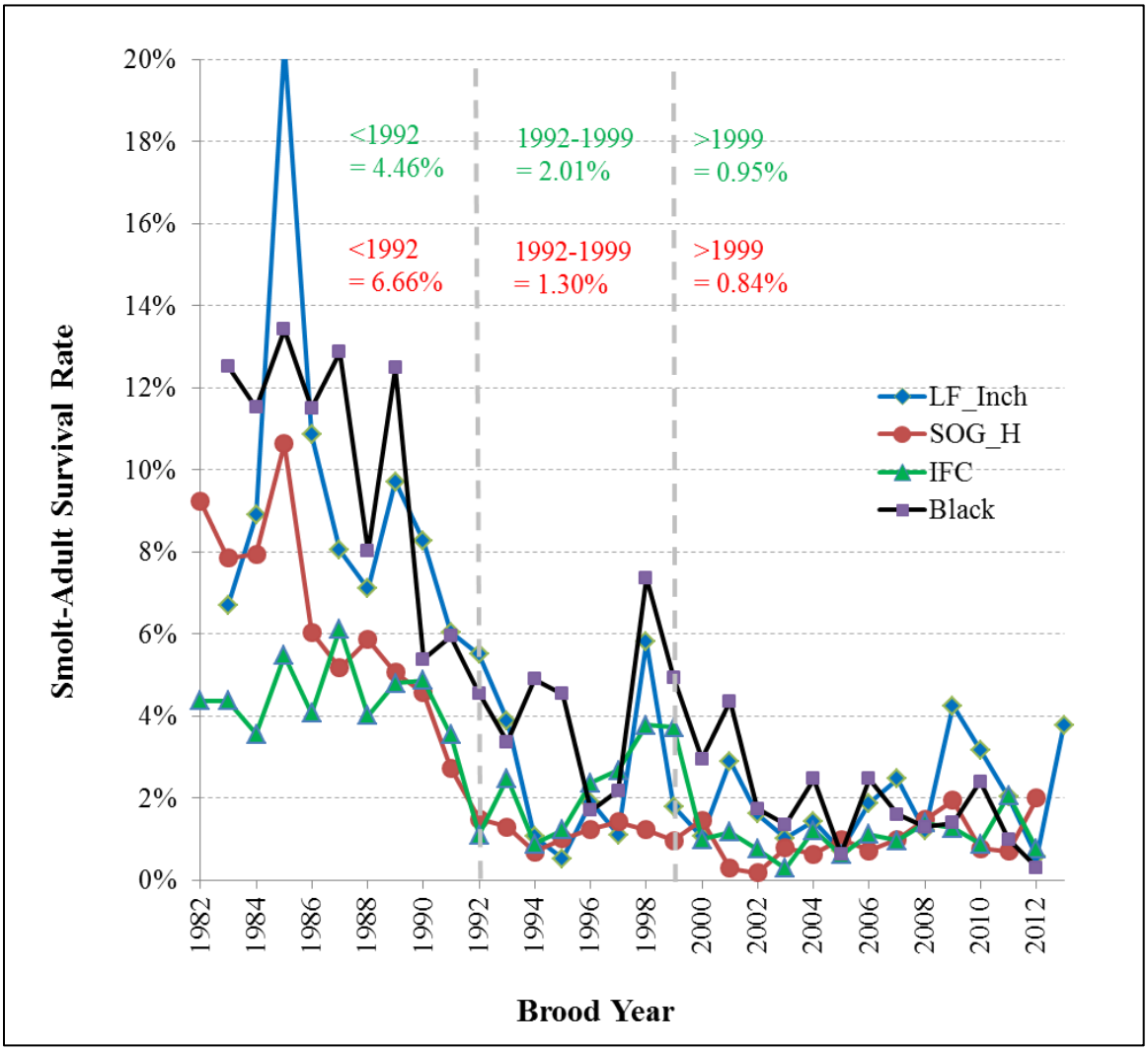


Figure 1. Trends in the smolt-to-adult survival rates for hatchery coho indicator stocks for Lower Fraser (LF, Inch Creek hatchery), Strait of Georgia (SOG_H as represented by Qualicum and Quinsum hatcheries), and Interior Fraser River (IFR) coho management units for **brood years** [4]1982 to 2013. Also shown is the trend for Black Creek, a wild population in the SOG. Vertical dashed grey lines denote 1992 and 1999, the boundaries of the periods referred to in the text. Green and red text shows the geometric average survival rates for the IFR and SOG_H time series for three periods, respectively. (From CSAS draft working paper, Korman and Sawada, 2017) .

4 Summary of Science Advice

As committed to by Canada, science advice was requested by DFO's Fisheries Management Branch through DFO's Canadian Science Advisory Secretariat (CSAS). The advice requested was on the development of PST reference points related to three status zones (low, moderate,

[4] The parental year for a group of returning salmon, i.e. the calendar year when the majority of parents of these fish spawned.

abundant) and associated fishery ERs aimed at achieving stated conservation objectives for the Canadian MUs for southern coho salmon. This request led to the development of a working paper by Josh Korman and Joel Sawada that was subsequently peer reviewed through CSAS with subject matter experts from DFO, First Nations, a variety of stakeholder groups and US members of the PSC Coho Technical Committee. This paper was accepted with revisions (in progress) and formed the basis for the CSAS Science Advisory Report (SAR) that will soon be publicly available. For further details on the CSAS process, please go to: http://www.dfo-mpo.gc.ca/csas-sccs/process-processus/index-eng.html. When the completed SAR on coho reference points and associated ERs is made available from CSAS, it will be located at: http://www.isdm-gdsi.gc.ca/csas-sccs/applications/Publications/result-eng.asp?params=0&series=7&year=2018. The following summary of the science advice draws on both the SAR and an updated draft of the working paper. Participants are strongly encouraged to refer to the SAR for further details and more comprehensive results from the CSAS process.

Current advice limited to Interior Fraser River (IFR) MU: Advice on developing PST reference points and associated ERs could only be provided for the Interior Fraser River (IFR) MU. The required **stock-recruit**[5] data as well as MU-based conservation objectives were not available for the Strait of Georgia and Lower Fraser River (LFR) MUs. The inter-annual variability of US ERs on Canadian MUs appear to be generally synchronous (Figure 2); overall exploitation rates tend to be highest on the LFR and IFR MUs. This, along with similar marine survival rate patterns, provides some reassurance that status-based ER caps for the IFR MU will also address the conservation requirements for the Strait of Georgia and Lower Fraser River MUs in most years. Nevertheless, due to its slightly later run timing, late season fisheries in both the US and Canada that avoid IFR coho can still impact the Lower Fraser MU to a greater degree in some years. As a result, in the absence of bilateral management provisions, care should be taken to avoid over-harvesting this MU in Canadian domestic fisheries.

This approach is consistent with the current management approach. Within the bilateral management framework in the PST, the Strait of Georgia and Lower Fraser management units will not have explicit ER caps and bilateral management restrictions will only be placed on IFR MU while the other two MUs will be managed passively. This approach does not mean that the ER for IFR will be applied to the SOG and LR MUs. Canada will still manage SOG and LF MUs within its domestic fisheries planning framework in accordance with domestic policies and priorities.

[5] Relationships that predict the expected number of individuals in one generation (the recruits) as a function of the number of spawning individuals in the previous generation (the stock). There are a variety of model forms, with the Ricker and Beverton-Holt models being some of the most common.

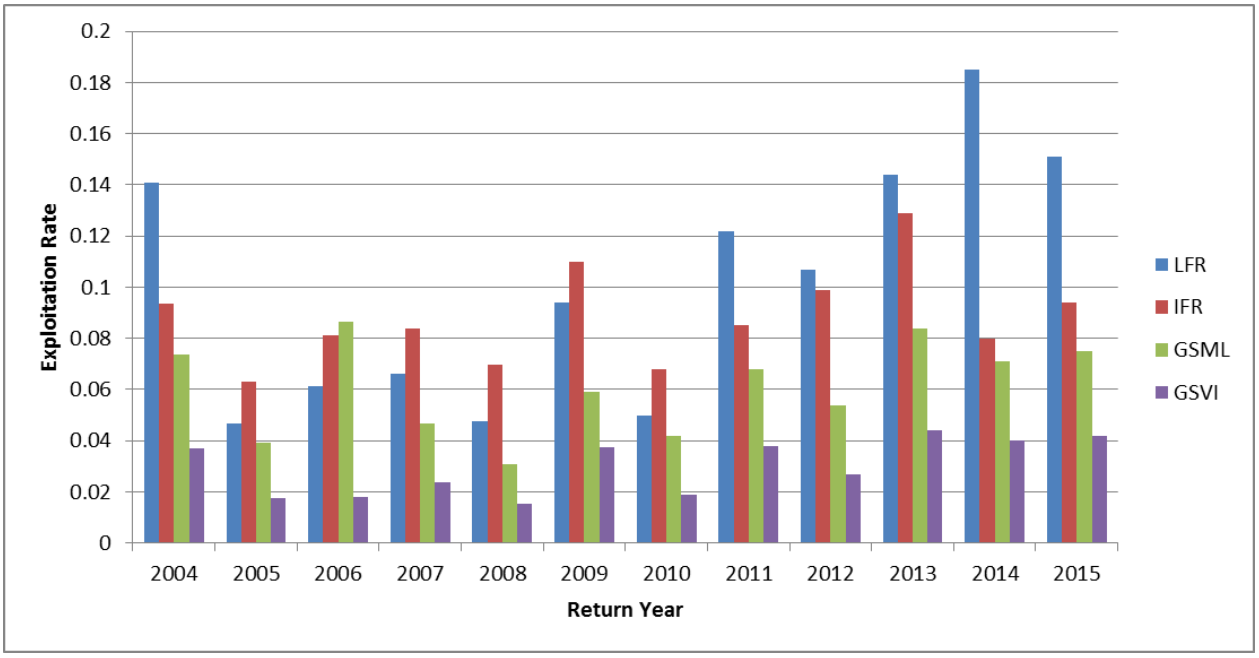


Figure 2. Estimated exploitation rates in US fisheries on Canadian PST MUs for southern coho salmon, 2004 to 2015. Return years 2004 to 2009 from PSC Coho Technical Committee report (2013). Return years 2010 to 2015 from annual reports to the PSC Coho Technical Committee.

Use of smolt-to-adult survival information to define status levels: Smolt-to-adult survival has been identified as a major factor influencing adult returns over the period of available data from the late 1970's to the present. Accurate estimates of escapements for many coho salmon populations and associated wild coho survival rates in BC are limited. The analysis in the current working paper therefore focused on informing the establishment of management reference points for PST status determination using hatchery smolt-to-adult survival rates rather than more traditional stock-recruit based reference points. Hatchery smolt-to-adult survival rates are herein referred to as "survival rates". Note that the establishment of management reference points is informed by science but not prescribed, as it requires consideration of a range of factors that are not direct outputs of scientific analysis, such as risk tolerance, First Nations obligations, socio-economic impacts, and implementation feasibility.

Although no analytically based method was used to demarcate low, moderate and abundant PST status categories, visual assessment of the data suggest that survival rates of 2% and 4% are **breakpoints**[6] in the data that would be suitable to use as reference points for defining the three PST status categories (Figure 3). In Table 3, a summary is provided of the number of past years

[6] **Breakpoints** are values that can be used to split a data set into classes or time periods of relatively similar values. In work described, the data on survival rates was reviewed to identify two potential breakpoints to divide the survival rate data into three classes. The current approach outlined here proposes to use these breakpoints in the data as the management reference points to define Low, Moderate and Abundant status categories under the PST bilateral management framework.

by period that fell into the proposed Low, Moderate or Abundant status levels based on reference points of 2% and 4% survival rates. The results show that these periods represent relatively distinct survival-based stanza, which aligns with the patterns that are visually evident in Figure 1.

? ***1.*** *Do you support the proposed approach of setting PST reference points for the IFR coho MU based on survival rates? If not, why not?*

2. *Do you agree with the selection of survival rates of 2% and 4% as the status reference points for PST management purposes? If not, why not?* ?

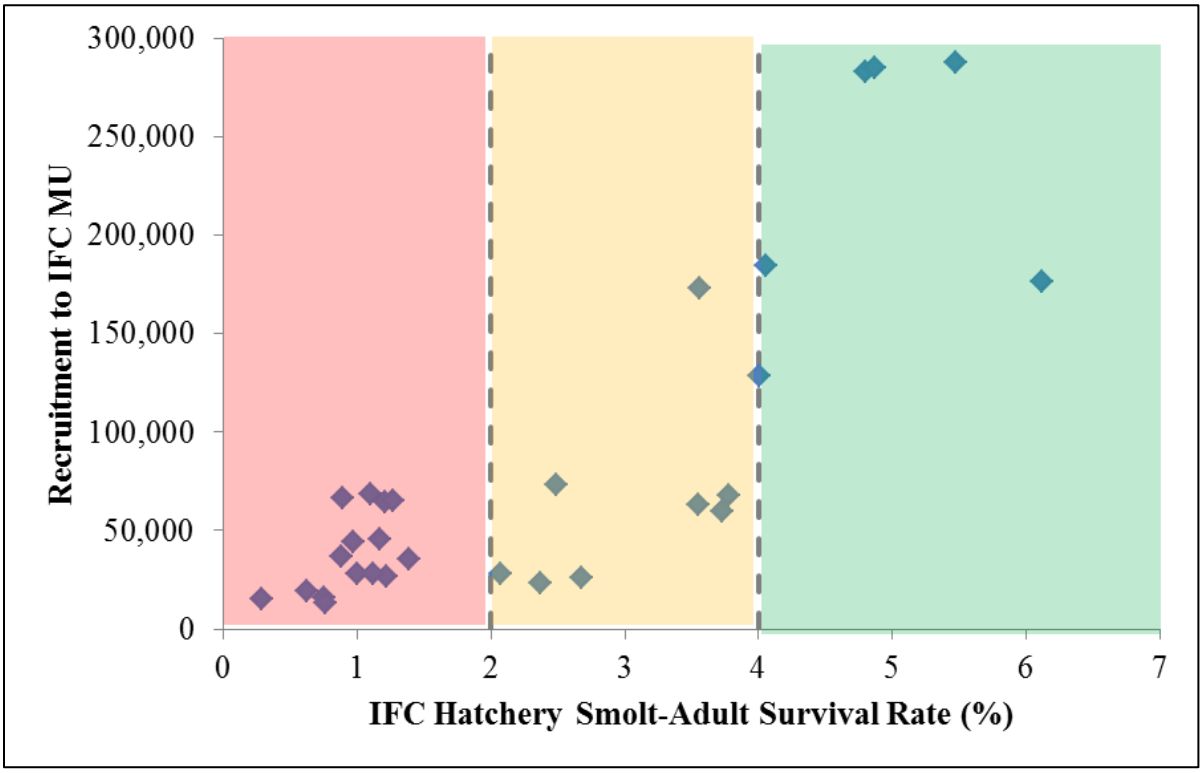


Figure 3. Relationship between the IFR (IFC in figure) hatchery smolt-to-adult survival rate and total recruitment to the IFR MU for brood years 1984-2012. Dashed vertical lines show potential 2% and 4% survival rate breakpoints in the data. The coloured zones show the low (red), moderate (yellow), and abundant (green) PST status categories that would result from adopting these breakpoints as the status reference points.

Table 3. The number of years falling into each status level within the periods identified in Figure 1**,** based on the 2% and 4% survival rate reference points. These counts are based on the actual survival rate estimates for each brood year. Note: this does not address the issue of classifying each year in real time (i.e., how would the classification decision have been made – See Section 5.3.1).

		Time Period (brood years)		
		1982 to 1991	1992 to 1999	2000 to 2012
The number of years falling into each status level.	Abundant	8 years		
	Moderate	2 years	5 years	1 year
	Low		3 years	12 years

Conservation objectives used: Three conservation objectives were used in the analysis to inform the determination of appropriate total status-based ERs (Table 4). The example results shown in this discussion document focus primarily on an objective of MU escapement >20,000 spawners (i.e, the short-term recovery goal of the Interior Fraser Coho Recovery Team (IFCRT)). This has been done purely for illustrative purposes and is not meant to indicate a preference nor to reduce the importance of the other objectives, whose results are shown in SAR.

Table 4. Conservation objectives used in CSAS SAR.

Conservation Objective	Basis of Conservation Objective
MU escapement > 20,000 spawners (3-year geometric mean)	IFCRT short-term recovery goal (CU based) – the escapement to each CU that leads to a 95% probability that escapement to at least half of the sub-populations will meet or exceed 1,000 spawners. This translates to an MU escapement of approximately 20,000 spawners.
MU escapement > 40,000 spawners (3-year geometric mean)	IFCRT long-term recovery goal (CU based) – the escapement to each CU that leads to a 95% probability that escapement to all sub-populations will meet or exceed 1,000 spawners. This translates to an MU escapement of approximately 40,000 spawners.
ConObj1.5 (MU escapement > ~25,000 spawners) (3-year geometric mean)	From CSAS paper. ConObj1.5 (MU based) – the escapement to each CU that leads to a 95% probability that escapement to at least half of the sub-populations will meet or exceed 1,000 spawners in the same year. This translates to an MU escapement of approximately 25,000 spawners.

Bradford and Wood (2004) reviewed the basis for the IFR coho recovery targets from both a genetic and demographic perspective. They concluded that achieving 1,000 spawners per sub-population outlined in the draft Interior Fraser Coho Recovery Team (IFCRT) recovery plan met the accepted standards for the maintenance of genetic diversity and persistence of subpopulations over time, but that this value was at the lower end of the range and was considered minimally acceptable. Their paper also notes the risks of managing fisheries to this minimum value.

The IFCRT short –term recovery objective of 1000 spawners in half of the subpopulations or >20K over the aggregate IFR MU is based on minimizing long-term risks, and while achieving this objective in a consistent manner is highly desirable, it is unlikely that there will be dramatic changes in genetic or population persistence if the MU spawner abundance crosses below this objective on occasion by small amounts.

? ***3.*** *Are these conservation objectives appropriate for assessing conservation outcomes of different ERs under different survival levels? If not, what would you suggest as alternative objectives or as an alternative approach for assessing conservation outcomes of different ERs?* ?

Modelling options to represent population dynamics: Given the uncertainties in the stock-recruit (S-R) data for the IFR MU, there are several models that could represent the underlying coho population dynamics. Three Ricker S-R model variants that included a hatchery smolt-adult survival rate covariate based on data from the 1998 return year to the present were used in this analysis (Figure 4). It is unknown which of these models best represents the underlying population dynamics – each model has different justification for why they are appropriate, and they each have strengths and weaknesses in their ability to represent coho salmon dynamics. The CSAS process could not recommend relying on one of the models over the others and therefore the results of all three are presented together.

Base Ricker – This model, which does not include consideration of additional information on the nature of the stock-recruit relationship, has been used in previous analyses of IFR coho and provided the best fit to the data. The Base Ricker model is characterized by higher productivity at low stock sizes due to the beneficial effects of lower spawning ground and rearing habitat densities and declining productivity at high stock sizes (overcompensation). Overcompensation occurs when high densities of spawners results in lower **recruits**[7] per spawner due to effects like crowding on the spawning grounds and predator attraction.

Ricker-PriorCap – This model includes an adjustment for larger carrying capacity that eliminates overcompensation over the range of escapements observed since 1998. This model is consistent with the findings of Korman and Tompkins (2014) who found no evidence of overcompensation in the stock-recruit relationships for 16 coastal coho populations that they reviewed.

Ricker-Dep – This model includes adjustments for both larger carrying capacity as in the Ricker-PriorCap model and depensation, which reduces productivity by half when escapement to a CU

[7] Number of adult returns from spawners from a particular brood year.

falls below 1,000 fish. A variety of processes might result in depensation at low abundance; for example, inbreeding may occur, spawning fish may not find mates and higher mortality may result from predation or fishing. Depensation, where it exists, could accelerate declines or inhibit rebuilding at low abundances. There are limited empirical data to quantify the possible depensation in IFR coho – one study has shown that S-R data for the North Thompson coho population (one of five in the IFR MU) gave a good statistical fit to a variation of the Ricker model aimed at capturing depensation effects. (Chen et al, 2011).

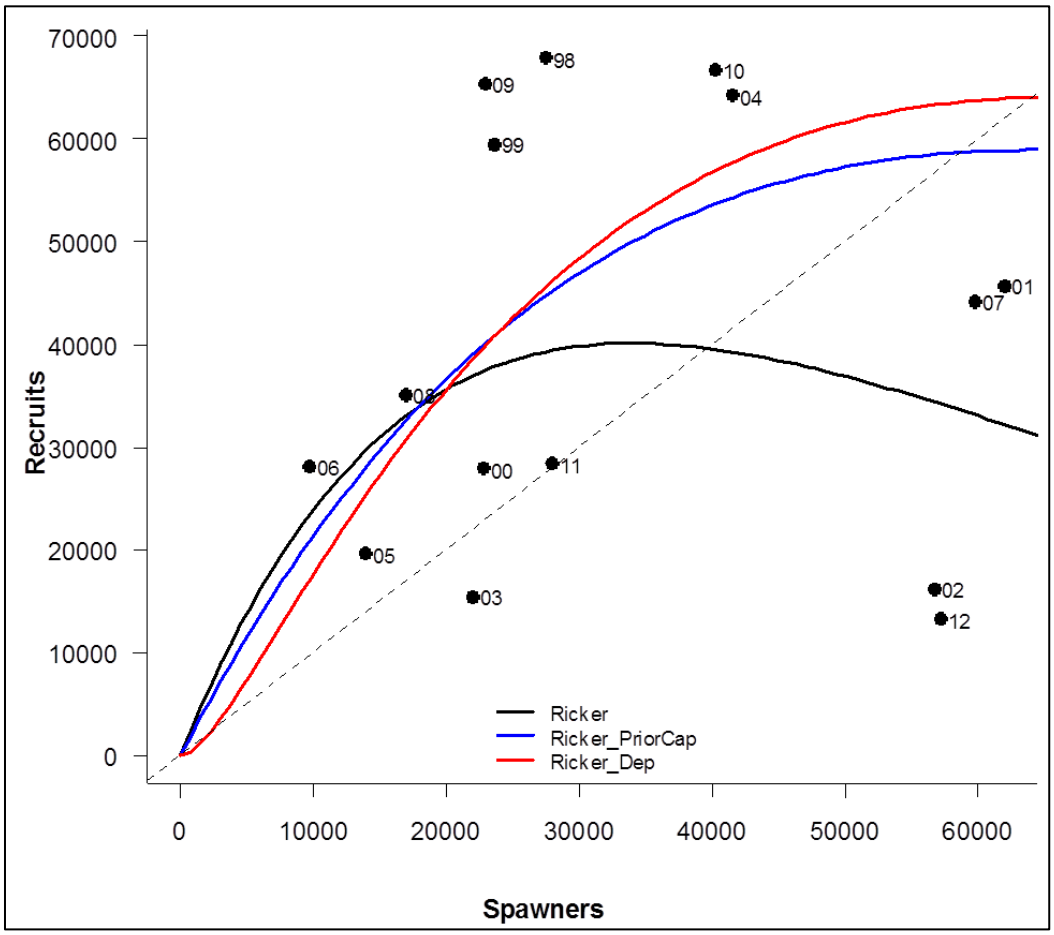


Figure 4. Comparison of three alternate Ricker stock-recruitment models for the IFR MU. All models were based on a hierarchical Bayesian structure with a hatchery smolt-adult survival index (HSASI). The solid lines are based on models with no informative priors (Base Ricker, black line), an informative prior on a larger carrying capacity (Ricker-PriorCap, blue line), and an informative prior on a larger carrying capacity and depensation (Ricker-Dep, red line), respectively. The MU stock-recruit curves were based on summing CU-specific recruitments at each spawning stock size. The numbers beside each point denotes the brood year.

Probability of achieving conservation objectives: The likelihood of achieving a particular conservation objective across a range of smolt-to-adult survival rates and fishery ERs for the IFR MU have been provided in a series of tables in the SAR that summarize the results of a 54-year forward simulation analysis based on the three stock-recruit models and the three conservation objectives described above. Mean probability levels as well as the 80% credible interval (measure of confidence in the mean) are provided for each combination of survival rate and ER. The generally broad credible intervals in the results indicate that there is significant uncertainty in the model results.

The results from the SAR represent the probability (or percent chance) of a particular conservation objective being achieved in a given year. These results can also be interpreted in terms of the average frequency of achieving the conservation objectives.

(a) 80% means that the objective should be achieved *on average* 8 out of every 10 years;
(b) 50% means that the objective should be achieved *on average* 5 out of every 10 years;
(c) 20% means that the objective should be achieved *on average* 2 out of every 10 years.

Indeed, the probability values shown in the SAR results were calculated from the percentage of years that a particular objective was achieved over the 54-year time frame of each simulation. Due to large uncertainties (e.g., natural variability, measurement errors) in coho population dynamics and environmental conditions, these forward simulations were performed many, many times. The mean probability results are the average of all those repeat simulations and the 80% credible interval characterizes the degree of variability in the results – i.e., 80% of the simulation results fell within this range, with only 10% of the simulations yielding higher probabilities and 10% yielding lower.

Ultimately, decision-makers must consider risk tolerances for achieving conservation objectives when developing PST management reference points and associated ER caps, and must therefore determine what level of risk is acceptable, based on science advice and the views of all interested parties.

Consider how the probabilities of achieving a conservation objective would influence your choice of ER caps. What level of probability for achieving conservation objectives should we be aiming for? What is an acceptable range of probabilities?

Uncertainty: The authors of the working paper raise cautions on the following potential sources of uncertainty and bias in their analysis that are in addition to the uncertainty outlined in their simulation results:

Exploitation rates (ER) – Current estimates are based on models that make extensive use of coded-wire tag (CWT) data from coho directed fisheries in the late 1980s and early 1990s. Current fisheries rely heavily on non-retention regulations where total mortality may not be fully accounted for. However, management measures to limit ER to a small proportion of total IFR MU abundance would also tend to make the impact of ER uncertainty relatively small.

Escapement data – Survey quality is highly variable with only relative measures available for many streams.

Hatchery smolt-to-adult survival – Small fishery sample sizes of CWT's, potential for hatchery strays and the representativeness of hatchery survival rates for wild stocks are potential sources of bias and uncertainty. Under-estimates of wild smolt-to-adult survival rates using hatchery indicators, as is thought to be the case, results in over-estimates of wild spawner-to-smolt productivity estimates that would translate into more productive S-R relationships than is actually the case.

Consider how uncertainties in the data and in the analyses (including the level of confidence around the estimates of mean probabilities) influence your choice of ER caps.

5 Evaluating Alternative Status-based ER Caps

This section addresses the core question identified at the beginning of this document through the following sequence of considerations:

- Section 5.1 presents an illustrative subset of results from within the comprehensive results in the SAR, demonstrating the potential conservation impacts of different ER levels. Based on these results (and the broader results in the SAR where desired), you will be prompted to consider your views on maintaining or changing the current bilateral ER caps for each status level with respect to conservation outcomes.
- Section 5.2 provides additional information on potential fishery management characteristics to consider.
- Section 0 outlines some implementation considerations related to pre-season forecasting, fisheries planning tools, and resources for fisheries monitoring and stock assessment.
- Section 5.4 then asks whether or not you agree with maintaining the current ER caps for each status level or have alternative suggestions.
- Section 5.5 asks two last questions about additional factors that have not been documented, as well as any overall comments you might have.

While reviewing the results in the following sections, it is critical to keep in mind that the question at hand is about setting the bilateral ER caps under which Canada and the US must operate. These caps set the maximum level for the total ER within the bilateral management framework. The actual domestic ER limits that Canada will set each year are determined through annual, domestic decision-making processes, and Canada retains the ability to manage harvest to lower ER limits than the maximum caps specified in the Treaty (e.g., Table 2).

Additionally, it is important to understand that the ERs used in this document are based on the FRAM model, which differ from ERs based on the domestic harvest planning model used in developing the South Coast Integrated Fisheries Management Plan (IFMP). For the purpose of implementing the PST Coho Chapter, Canada works with the United States within the Pacific Salmon Commission process to estimate fishery impacts on southern BC coho using a bilaterally agreed model (FRAM). FRAM estimated impacts on IFC may not match the estimates projected by Canadian domestic models as it is based on a shorter base period of CWT data (1986-92 vs 1986-97 in the domestic models) and includes other impacts associated with natural mortalities and dropouts.

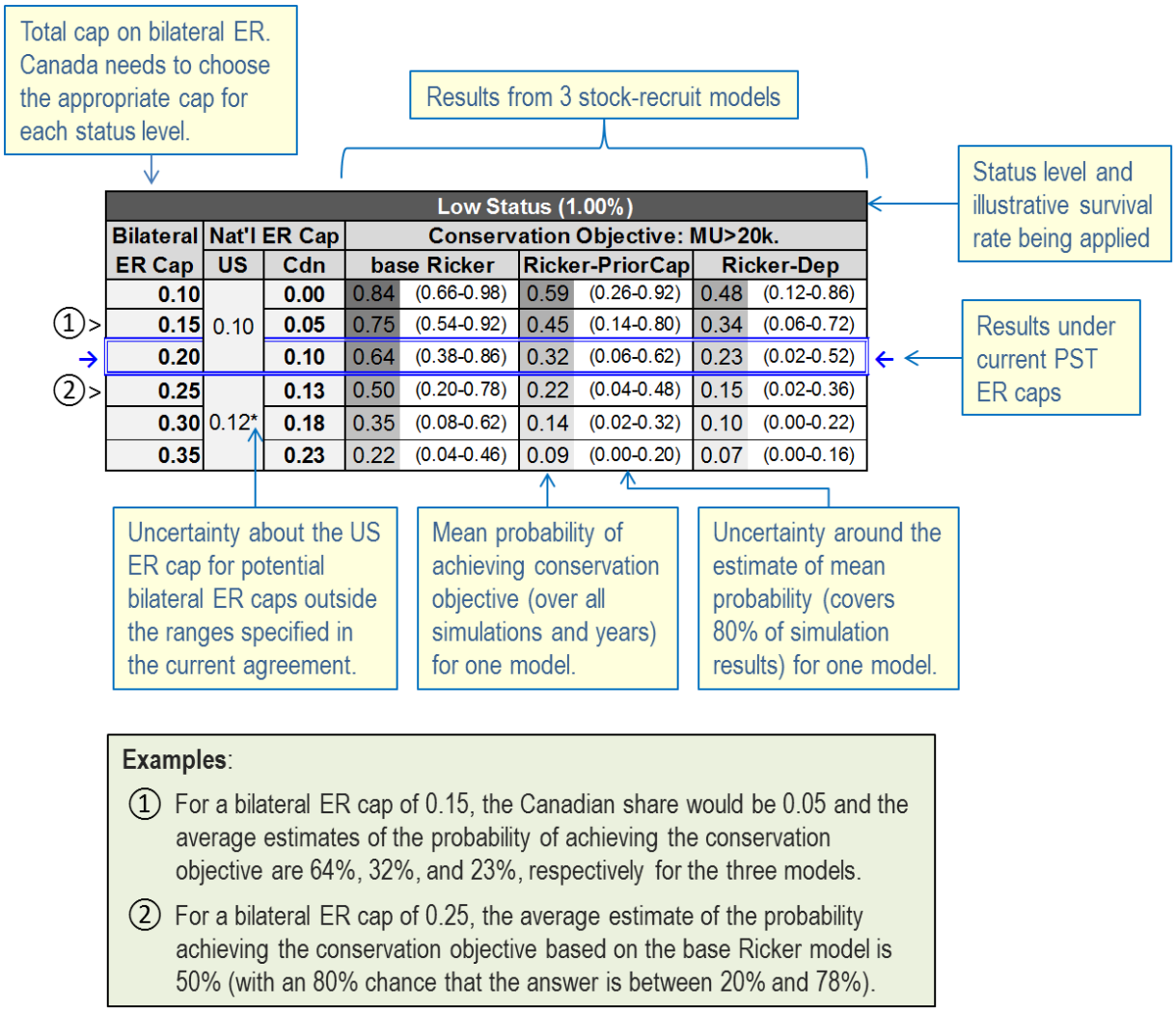
5.1 Conservation Considerations

The science advice in the SAR (summarized above) provides a useful framework for evaluating the probabilities and uncertainties of achieving a particular IFR MU conservation objective at specified total ERs for a range of possible smolt-to-adult survival rates .The information available in the SAR is comprehensive and it will not be possible to review all of the details within the engagement process.

To facilitate constructive review of such comprehensive analyses, we have highlighted a subset of the results for each status level for illustrative purposes in this engagement process. These results are all presented in tabular and graphical form in Appendix 3. For conservation objectives, we primarily focus on the Interior Fraser Coho Recovery Team short term recovery objective, which translates to an escapement objective of 20,000 spawners. Each status level is characterized with the results of one or two survival rates intended to be illustrative (for the purposes of this exercise) of that status level. The results from all three stock-recruit models are shown because they are an important source of uncertainty – i.e., they generate different results with respect to the degree to which they achieve conservation objectives across a range of survival rates and exploitation rates, but the CSAS work cannot say which one will best represent stock-recruit dynamics in the future. However, the models do show the same direction of change in the mean probability of achieving conservation objectives across ER choices. Additional results are presented under low status and abundant status to provide greater context. These results provide a focused subset of information from the SAR upon which to concentrate the engagement process. However, participants should refer to the SAR for more detailed explanation of the analyses and comprehensive results.

To help with the interpretation of the tables of results presented in Appendix C, Figure 5 provides a visual explanation of the content and structure of those tables. These details are also repeated in the captions of the tables.

The US ER caps under the current PST agreement (Table 1) are defined based on each status level and a range for the total bilateral ER cap. It is uncertain how the US ER caps would change in response to a bilateral ER cap outside of the current range (see Table 1) associated with each status level. For the purposes of the current work, the US caps shown in the tables in the following sections assume that the current caps from Table 1, as defined by "MU applicability", continue to apply.



Low Status (1.00%)

	Bilateral ER Cap	Nat'l ER Cap: US	Nat'l ER Cap: Cdn	Conservation Objective: MU>20k. base Ricker	Ricker-PriorCap	Ricker-Dep
	0.10	0.10	**0.00**	0.84 (0.66-0.98)	0.59 (0.26-0.92)	0.48 (0.12-0.86)
①>	**0.15**		**0.05**	0.75 (0.54-0.92)	0.45 (0.14-0.80)	0.34 (0.06-0.72)
→	**0.20**		**0.10**	0.64 (0.38-0.86)	0.32 (0.06-0.62)	0.23 (0.02-0.52)
②>	**0.25**	0.12*	**0.13**	0.50 (0.20-0.78)	0.22 (0.04-0.48)	0.15 (0.02-0.36)
	0.30		**0.18**	0.35 (0.08-0.62)	0.14 (0.02-0.32)	0.10 (0.00-0.22)
	0.35		**0.23**	0.22 (0.04-0.46)	0.09 (0.00-0.20)	0.07 (0.00-0.16)

Figure 5. A visual explanation of the content and structure of tables of results presented in Appendix C (Table 6, Table 7, Table 8, and Table 9).

Please review Appendix C for conservation outcomes under different ER caps.

*Consider how the information on the conservation outcomes influences your views on maintaining the current ER caps of 20% for **low**, 40% for **moderate**, and 65% for **abundant**. If you do not support the current PST ER caps for each status level, consider your reasons, and a suggested alternative(s) if you have one.*

REMINDER: Appendix C presents illustrative examples of the results of the SAR in order to provide a focal point for discussion. However, the SAR has more comprehensive results on potential conservation outcomes across a range of survival values and multiple conservation objectives.

NOTE: The formal questions on identifying preferred ER caps for each status level occur in Section 5.4, after having had a chance to think about how both conservation considerations and fishery considerations might impact these choices.

5.2 Fishery Considerations

Decisions by Canada on PST reference points for demarcating three status categories and associated ER caps will be made by the end of 2018 for inclusion in the new Chapter 5 provisions currently being negotiated by the Parties. As a result, implementation of these new provisions will begin in advance of the 2019 fishing season by the Parties and their respective domestic fisheries management planning processes.

Whereas the CSAS working paper and SAR focus on conservation objectives, Table 5 provides a qualitative description of general fishery management approaches that may be contemplated under Low, Moderate or Abundant status. This table is intended to be illustrative and not prescriptive and it does not preclude consideration of ER caps above or below the ranges associated with the existing agreement. Table 2 provides some additional historical context by showing how Canadian and US ERs have compared to the PST ER caps in recent years.

The specific management outcomes for a particular ER cap under each status level cannot be precisely specified in advance because they are the product of the annual domestic planning process. The development of specific fishing plans is the subject of annual domestic Canadian consultations to develop salmon Integrated Fisheries Management Plans (IFMPs) and considers a range of factors including total Canadian ERs permitted under each PST status zone, Departmental obligations to First Nations, policy and direction, and feedback from consultations. Bilateral ER caps set upper limits for harvest opportunities within the bilateral management framework, but each Party can choose to manage to more conservative levels.

Table 5. Qualitative descriptions of the fishery management approaches associated with the Department's current precautionary management approach for Interior Fraser (IFR) coho and potential management approaches under Low, Moderate and Abundant status zones for IFR coho under the Pacific Salmon Treaty. The management characteristic described under each status level are examples intended to provide an indication of potential differences in fishery opportunities between status levels but do not prescribe specific outcomes for future domestic management decisions.

	Current Management	Low Status	Moderate Status	Abundant Status
Survival Rates (as proposed)	0.5% to 1.5%	<2%	2% to <4%	≥ 4%
Bilateral ER cap (current PST)	20%	20%	40%	65%
US ER cap (current PST)	10%	10%	12%	15%
Cdn ER cap (current PST)	10%	10%	28%	50%
Implemented Cdn domestic ER	3% to 5%	*From annual domestic planning*	*From annual domestic planning*	*From annual domestic planning*
First Nations Food, Social and Ceremonial	Incidental catch or non-retention in fisheries directed on other species. Small tributary harvests where abundances are identified.	Incidental catch or non-retention in fisheries directed on other species. Small tributary harvests where abundances are identified.	Additional harvest opportunities considered including retention of wild coho bycatch in fisheries directed on other species, relaxation of the coho window closure dates and possible directed fisheries depending on allowable impacts.	Directed fisheries for wild coho.
Recreational	Non-retention of wild coho in fisheries directed on other species or marked coho. Retention of unmarked coho only in areas and times where impacts on Interior Fraser Coho are minimal.	Non-retention of wild coho in fisheries directed on other species or marked coho. Retention of unmarked coho only in areas and times where impacts on Interior Fraser coho are minimal.	Subject to allowable impacts, consideration of increased retention of wild coho in areas with low Interior Fraser coho impacts, additional retention of marked coho and/or relaxation of coho window closure dates.	Directed recreational fisheries for wild coho permitted, however, recreational limits for these fisheries will be determined by relative abundance. (Even in high abundance scenarios, recreational limits will not exceed 4 per day with a possession limit of 8.)
Commercial, including First Nations economic	Non-retention of wild coho in fisheries directed on other species or stocks.	Non-retention of wild coho in fisheries directed on other species or stocks.	Non-retention of wild coho in fisheries directed on other species or stocks. Additional fishing effort/times may be permitted (i.e. additional release mortality).	Subject to abundance, non-retention of wild coho in fisheries directed on other species or stocks, retention of wild coho by-catch[8], or, potential for directed fisheries if allowable impacts/abundance are high.

[8] Incidental or unintentional catch of non-target stocks or species.

The Department's current management approach is based on an objective for Interior Fraser River coho (including Thompson River coho) to manage Canadian fisheries in a highly **precautionary**[9] manner with fisheries management measures similar to those in place prior to 2014. This approach is expected to achieve an overall ER in Canadian waters within the 3-5% range.

How does the information available on fishery considerations change any of your initial views on maintaining the current ER caps under each status level?

5.3 Implementation Considerations

5.3.1 Forecasting smolt-to-adult survival rates

Implementing the PST management regime as described in the Southern Coho Management Plan will require a methodology for pre-season identification of PST status level. To support implementation, a pre-season method (e.g. smolt-to-adult survival rate forecast or a reasonable alternative) is required to determine the appropriate annual status category and ER cap for the IFR MU. Data required to estimate hatchery smolt to adult survival rates for the IFR MU are available but uncertainty in the data will impact the ability to develop pre-season forecasts of known accuracy and precision. Given the decline in survival in the late 1990's and the low but variable pattern in survival since then, forecasts based on multi-year average survival rates (e.g. 3-year or 6-year averages) or on indicators of change in the long-term low survival regime might be possible approaches to consider. Note that while the methodology to forecast survival for this new PST management regime has not yet been developed, inter-annual variation in survival and data quality issues will result in high uncertainty in forecasts that will need to be accounted for in determining the annual PST status category.

5.3.2 Fisheries planning tools – domestic and bilateral

A number of fisheries planning tools aimed at translating fisheries management measures into expected MU-specific ERs are used domestically and bilaterally in the implementation of the PST Southern Coho Management Plan. The US Fisheries Regulation Assessment Model (FRAM) is used by US management agencies for pre-season planning of US fisheries and by the bilateral PSC Coho Technical Committee for the post-season evaluation of each Party's performance with respect to complying with their ER limits on the other Party's coho MUs.

[9] The precautionary approach is, in general, about being cautious when scientific information is uncertain, unreliable or inadequate and not using the absence of adequate scientific information as a reason to postpone or fail to take action to avoid serious harm to the resource.

For Canadian domestic fishery planning purposes, IFR MU fishing mortality is estimated pre-season using planning models that integrate assumptions about anticipated coho encounters, fishing effort levels, an estimate of the proportion of Interior Fraser River coho stocks within the total encounters based on past data, and an average release mortality rate. A post-season estimate of ER is developed from the same models and the FRAM model but using any actual information on encounter rates and fishing effort collected during the fishing season. In order to validate the efficacy of these models, they are expected to undergo further rigorous peer review through CSAS.

5.3.3 Resources for stock assessment and fishery monitoring

On-going implementation of the PST Southern Coho Management Plan must include a realistic consideration of the stock and fishery monitoring and analytical capacity required for full implementation. Funding to date has focused on the stock status of the IFR MU as a priority with less resources available for assessing other Canadian MU's. New funding to address the monitoring needs of Canadian MUs has been requested as part of current efforts to re-negotiate expiring PST chapters. Further adjustments to the management approach may be required in the future depending on the available funding to support stock assessment.

? ***4.*** *Do you have comments, concerns or suggestions regarding the implementation considerations?* ?

5.4 Selecting Preferred ER Caps for each Status Level

Now that you have thought about your perspectives on the bilateral ER caps, based on the conservation considerations, fishery considerations and implementation considerations in the previous three sections, please answer the following questions. These questions provide a detailed approach to answering the core question described early in the discussion paper.

While considering these questions, it is critical to keep in mind that these questions are about setting the bilateral ER caps under which Canada and the US must operate. These caps set the maximum level for the total ER within the bilateral management framework. The actual domestic ER limits that Canada will set each year are determined through annual, domestic decision-making processes, and Canada retains the ability to manage harvest to lower ER limits than the maximum caps specified in the Treaty (e.g., Table 2).

5.4.1 Low Status

? ***5.*** *What are your views on maintaining the current ER cap of 20% for* ***low*** *status?*

a. *Do you (a)strongly agree, (b) agree, (c) feel neutral, (d) disagree, or (e) strongly disagree.*

b. *Which factors were most important in supporting your perspective? Consider factors discussed in Sections 5.1-5.3 and/or other factors that have influenced your perspective.* ?

? ***6.*** *If you do not support a PST ER cap of 20% for* ***low*** *status (i.e., "disagree" or "strongly disagree" above):*

a. *Do you think the PST ER cap should be (a) increased or (b) decreased?*

b. *If you have a suggested alternative(s), please identify a specific ER cap or a range of values you would find acceptable and/or unacceptable for* ***low*** *status.*

c. *Please explain your rationale. Which factors were most important in supporting your decision?* ?

5.4.2 Moderate Status

? ***7.*** *What are your views on maintaining the current ER cap of 40% for* ***moderate*** *status?*

a. *Do you (a)strongly agree, (b) agree, (c) feel neutral, (d) disagree, or (e) strongly disagree.*

b. *Which factors were most important in supporting your perspective? Consider factors discussed in Sections 5.1-5.3 and/or other factors that have influenced your perspective.* ?

? ***8.*** *If you do not support a PST ER cap of 40% for* ***moderate*** *status (i.e., "disagree" or "strongly disagree" above):*

a. *Do you think the PST ER cap should be (a) increased or (b) decreased?*

b. *If you have a suggested alternative(s), please identify a specific ER cap or a range of values you would find acceptable and/or unacceptable for* ***moderate*** *status.*

c. *Please explain your rationale. Which factors were most important in supporting your decision?* ?

5.4.3 Abundant Status

? ***9.*** *What are your views on maintaining the current ER cap of 65% for* ***abundant*** *status?*

a. *Do you (a)strongly agree, (b) agree, (c) feel neutral, (d) disagree, or (e) strongly disagree.*

b. *Which factors were most important in supporting your perspective? Consider factors discussed in Sections 5.1-5.3 and/or other factors that have influenced your perspective.* ?

? ***10.*** *If you do not support a PST ER cap of 65% for* ***abundant*** *status (i.e., "disagree" or "strongly disagree" above):*

a. *Do you think the PST ER cap should be (a) increased or (b) decreased?*

b. *If you have a suggested alternative(s), please identify a specific ER cap or a range of values you would find acceptable and/or unacceptable for* ***abundant*** *status.*

c. *Please explain your rationale. Which factors were most important in supporting your decision?* ?

5.5 Final Thoughts

? ***11.*** *Is there any critical information missing that would have helped inform your responses to the engagement questions? If so, please specify what information and how it would have helped.* ?

? ***12.*** *What additional information should DFO consider in its decision and approach? Please provide reasons.* ?

? ***13.*** *Do you have any other comments?* ?

6 References

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Appendix A: Engagement Questions Worksheet

This worksheet contains questions that target the feedback and input that DFO wishes to gather from participants in the engagement process. These questions have been interspersed throughout the discussion paper, along with additional "thought bubble" questions for readers to consider along the way. For reference purpose, each question indicates the page where the question occurs in the flow of the discussion document.

Please fill in as many of the questions as you can and email your worksheet to Cynthia.Johnston@dfo-mpo.gc.ca by May 11, 2018.

What is your affiliation (First Nation, organization, etc.)	
What is your role or position? (harvester, elected representative, delegate, etc…)	

Discussion Questions
1. Do you support the proposed approach of setting PST reference points for the IFR coho MU based on survival rates? If not, why not? **(p.11)**
2. Do you agree with the selection of survival rates of 2% and 4% as the status reference points for PST management purposes? If not, why not? **(p.11)**

3. Are these conservation objectives appropriate for assessing conservation outcomes of different ERs under different survival levels? If not, what would you suggest as alternative objectives or as an alternative approach for assessing conservation outcomes of different ERs? **(p.13)**
4. Do you have comments, concerns or suggestions regarding the implementation considerations? **(p.23)**
LOW STATUS
5. What are your views on maintaining the current ER cap of 20% for **low** status? **(p.23)**
a. Which statement best represents your perspective on maintaining the current ER cap of 20% for **low** status (choose one)?

STRONGLY AGREE	AGREE	NEUTRAL	DISAGREE	STRONGLY DISAGREE	*No opinion*
☐	☐	☐	☐	☐	☐

b. Which factors were most important in supporting your perspective?

For example:

- *conservation considerations such as probability of achieving a particular conservation objective, conservation risk, analysis uncertainty, etc. (see Section 5.1)*
- *management considerations such as constraints/flexibility for domestic management decisions, desire/concerns for changes in harvest opportunities, deviation from current agreement, etc. (see Section 5.2)*
- *implementation considerations (see Section 5.3)*
- *other considerations or factors*

6. If you do not support a PST ER cap of 20% for **low** status (i.e., "disagree" or "strongly disagree" above): **(p.23)**

a. Do you think the PST ER cap should be increased or decreased for **low** status (choose one)

☐ **INCREASE** the PST ER cap

☐ **DECREASE** the PST ER cap

☐ *No opinion*

b. If you have a suggested alternative(s), please identify a specific ER cap or a range of values you would find acceptable and/or unacceptable for **low** status?

	Choose values or a range
ACCEPTABLE PST ER caps for low status:	
UNACCEPTABLE PST ER caps for low status:	

☐ *No opinion (check box)*

c. Please explain your rationale. Which factors were most important in supporting your decision?

MODERATE STATUS

7. What are your views on maintaining the current ER cap of 40% for **moderate** status? **(p.23)**

   a. Which statement best represents your perspective on maintaining the current ER cap of 40% for **moderate** status (choose one)?

STRONGLY AGREE	AGREE	NEUTRAL	DISAGREE	STRONGLY DISAGREE	*No opinion*
☐	☐	☐	☐	☐	☐

   b. Which factors were most important in supporting your perspective?

   For example:
   - *conservation considerations such as probability of achieving a particular conservation objective, conservation risk, analysis uncertainty, etc. (see Section 5.1)*
   - *management considerations such as constraints/flexibility for domestic management decisions, desire/concerns for changes in harvest opportunities, deviation from current agreement, etc. (see Section 5.2)*
   - *implementation considerations (see Section 5.3)*
   - *other considerations or factors*

8. If you do not support a PST ER cap of 40% for **moderate** status (i.e., "disagree" or "strongly disagree" above): **(p.23)**

   a. Do you think the PST ER cap should be increased or decreased for **moderate** status (choose one)

   ☐ **INCREASE** the PST ER cap

   ☐ **DECREASE** the PST ER cap

   ☐ *No opinion*

b. If you have a suggested alternative(s), please identify a specific ER cap or a range of values you would find acceptable and/or unacceptable for **moderate** status?

	Choose values or a range
ACCEPTABLE PST ER caps for moderate status:	
UNACCEPTABLE PST ER caps for moderate status:	

☐ *No opinion (check box)*

c. Please explain your rationale. Which factors were most important in supporting your decision?

ABUNDANT STATUS

9. What are your views on maintaining the current ER cap of 65% for **abundant** status? **(p.24)**

a. Which statement best represents your perspective on maintaining the current ER cap of 65% for **abundant** status (choose one)?

STRONGLY AGREE	AGREE	NEUTRAL	DISAGREE	STRONGLY DISAGREE	*No opinion*
☐	☐	☐	☐	☐	☐

b. Which factors were most important in supporting your perspective?

For example:

- *conservation considerations such as probability of achieving a particular conservation objective, conservation risk, analysis uncertainty, etc. (see Section 5.1)*
- *management considerations such as constraints/flexibility for domestic management decisions, desire/concerns for changes in harvest opportunities, deviation from current agreement, etc. (see Section 5.2)*
- *implementation considerations (see Section 5.3)*
- *other considerations or factors*

10. If you do not support a PST ER cap of 65% for **abundant** status (i.e., "disagree" or "strongly disagree" above): **(p.24)**

a. Do you think the PST ER cap should be increased or decreased for **abundant** status (choose one)

☐ **INCREASE** the PST ER cap

☐ **DECREASE** the PST ER cap

☐ *No opinion*

b. If you have a suggested alternative(s), please identify a specific ER cap or a range of values you would find acceptable and/or unacceptable for **abundant** status?

	Choose values or a range
ACCEPTABLE PST ER caps for abundant status:	
UNACCEPTABLE PST ER caps for abundant status:	

☐ *No opinion (check box)*

c. Please explain your rationale. Which factors were most important in supporting your decision?

11. Is there any critical information missing that would have helped inform your responses to the engagement questions? If so, please specify what information and how it would have helped. **(p.24)**
12. What additional information should DFO consider in its decision and approach? Please provide reasons. **(p.24)**
13. Do you have any other comments? **(p.24)**

Appendix B: Pacific Salmon Management – Policy Framework

While the PST SCMP specifies the obligations of Canada and the US with respect to status-based ER caps and the total allowable ER of each country, it is the domestic policy framework that guides the management of Pacific salmon fisheries within territorial waters. Key components of Canada's policy framework as it relates to the conservation and sustainable use of Canadian Pacific salmon resources are described below briefly.

B.1. Canada's Policy for Conservation of Wild Pacific Salmon (2005)

The Wild Salmon Policy clarifies how Pacific salmon are to be conserved and managed by stating an over-arching goal "to restore and maintain healthy and diverse salmon populations and their habitats for the benefit and enjoyment of the people of Canada in perpetuity". It aims to achieve this goal through four guiding principles (related to conservation, obligations to First Nations, sustainable use, and open and transparent decision-making) and three objectives (safeguard genetic diversity, maintain habitat and ecosystem integrity, and manage fisheries for sustainable benefits).

B.2. An Allocation Policy for Pacific Salmon (1999)

The allocation Policy outlines the sharing arrangements for Pacific salmon based on the following order of priority: (1) conservation, (2) First Nation food, social and ceremonial (FSC) access and treaty rights, (3a) recreational access for chinook and coho has priority over commercial access in addition to more predictable opportunities for sockeye, pink and chum, and (3b) commercial access of at least 95 percent of the combined commercial and recreational allocation of sockeye, pink and chum.

B.3. A Policy for Selective Fishing in Canada's Pacific Fisheries (2001)

The Selective Fishing Policy defines selective fishing as "the ability to avoid non-target fish, invertebrates, seabirds and marine mammals or, if encountered, to release them alive and unharmed". This policy provided essential guidance in the development of fisheries management plans in the early 2000's when conservation concerns for Interior Fraser coho required minimizing the harvest mortality of these stocks.

B.4. Sustainable Fisheries Framework (2009)

The Sustainable Fisheries Framework (SFF) is a toolbox of existing and evolving policies for DFO to sustainably manage Canadian fisheries by conserving fish stocks while supporting the industries that rely on healthy fish populations. The SFF provides planning and operational tools that allow these goals to be achieved in a clear, predictable, transparent, inclusive manner, and provides the foundation for new conservation policies to implement the ecosystem and precautionary approaches to fisheries management.

B.5. A Fishery Decision-Making Framework Incorporating the Precautionary Approach (2009)

A key component of the Sustainable Fisheries Framework, this policy framework on the application of the precautionary approach in fishery decision-making provides guidance on the consideration of risk across a range of stock status levels and the degree of uncertainty in assessing stock status and fishery impacts. In general, the precautionary approach framework stipulates that lower risk fishery management measures are required when stock status is poor or declining and/or when uncertainty in assessments is high.

Appendix C: Conservation Considerations – Example Results from SAR

As described in Section 5.1, this appendix highlights a subset of the results from the SAR for each status level upon which to focus the engagement process. However, the SAR contains more comprehensive results on potential conservation outcomes across a range of survival values and multiple conservation objectives.

In the tables and graphs in the following sections, probability results are expressed as values from 0.0 to 1.0 (i.e., 0% to 100%).

C.1. Low Status

The probabilities of achieving the conservation objective of 20,000 spawners for the IFR MU under different bilateral ER caps under low status are shown in Table 6 for two different survival rates. Over the period of 2005 to 2013, the 3-year average survival rate has varied from 0.7% to 1.2%. A survival rate of 1.0% is therefore presented as a survival rate that is representative of recent years and offers a realistic indication of what is currently feasible. A survival rate of 1.75% is then presented because the goal is to select the ER cap (i.e., maximum level) for low status and this represents the upper end of the range. However, 1.75% is the "best-case" scenario under low status, which may present an overly optimistic picture with respect to what is possible under current survival rates. The same results are also shown graphically in Figure 6 (1.00% survival) and Figure 7 (1.75% survival).

*Consider how the information on the conservation outcomes influences your views on maintaining the current ER cap of 20% for **low** status. If you do not support a PST ER cap of 20%, consider your reasons, and an alternative if you have one.*

NOTE: The formal questions on identifying preferred ER caps for each status level occur in Section 5.4, after having had a chance to think about how both conservation considerations and fishery considerations might impact these choices.

Table 6. Probability of achieving the conservation objective of 20,000 spawners for the IFR MU under different bilateral ER caps while in low status. Results are shown for survival rates of 1.00% (top) and 1.75% (bottom). The mean probability of achieving the conservation objective is shown for each alternative stock-recruit model with the 80% credible interval in parentheses. The blue double-line outline with arrows indicates the ER caps under the existing agreement. The US portion of the bilateral ER cap, as specified in the PST, is shown across the range it applies (see Table 1). Figure 5 provides a visual guide. See text for discussion of uncertainty around US caps (*).

Low Status (1.00%)								
Bilateral	Nat'l ER Cap		Conservation Objective: MU>20k.					
ER Cap	US	Cdn	base Ricker		Ricker-PriorCap		Ricker-Dep	
0.00	0.10	**0.00**	0.93	(0.84-1.00)	0.81	(0.58-1.00)	0.72	(0.38-0.98)
0.05		**0.00**	0.89	(0.76-1.00)	0.71	(0.42-0.96)	0.61	(0.20-0.94)
0.10		**0.00**	0.84	(0.66-0.98)	0.59	(0.26-0.92)	0.48	(0.12-0.86)
0.15		**0.05**	0.75	(0.54-0.92)	0.45	(0.14-0.80)	0.34	(0.06-0.72)
→ **0.20** ←		**0.10**	0.64	(0.38-0.86)	0.32	(0.06-0.62)	0.23	(0.02-0.52)
0.25	0.12*	**0.13**	0.50	(0.20-0.78)	0.22	(0.04-0.48)	0.15	(0.02-0.36)
0.30		**0.18**	0.35	(0.08-0.62)	0.14	(0.02-0.32)	0.10	(0.00-0.22)
0.35		**0.23**	0.22	(0.04-0.46)	0.09	(0.00-0.20)	0.07	(0.00-0.16)
0.40		**0.28**	0.12	(0.02-0.28)	0.06	(0.00-0.12)	0.05	(0.00-0.12)
0.45	0.15*	**0.30**	0.06	(0.00-0.14)	0.04	(0.00-0.08)	0.03	(0.00-0.08)
0.50		**0.35**	0.04	(0.00-0.08)	0.03	(0.00-0.06)	0.03	(0.00-0.06)
0.55		**0.40**	0.02	(0.00-0.04)	0.02	(0.00-0.04)	0.02	(0.00-0.04)
0.60		**0.45**	0.02	(0.00-0.04)	0.02	(0.00-0.04)	0.01	(0.00-0.04)
0.65		**0.50**	0.01	(0.00-0.04)	0.01	(0.00-0.02)	0.01	(0.00-0.02)
0.70		**0.55**	0.01	(0.00-0.04)	0.01	(0.00-0.02)	0.01	(0.00-0.02)

Low Status (1.75%)								
Bilateral	Nat'l ER Cap		Conservation Objective: MU>20k.					
ER Cap	US	Cdn	base Ricker		Ricker-PriorCap		Ricker-Dep	
0.00	0.10	**0.00**	0.99	(0.98-1.00)	0.91	(0.72-1.00)	0.85	(0.58-1.00)
0.05		**0.00**	0.99	(0.98-1.00)	0.85	(0.62-1.00)	0.77	(0.42-1.00)
0.10		**0.00**	0.99	(0.96-1.00)	0.78	(0.48-1.00)	0.66	(0.22-0.98)
0.15		**0.05**	0.98	(0.92-1.00)	0.68	(0.32-0.98)	0.53	(0.14-0.90)
→ **0.20** ←		**0.10**	0.96	(0.88-1.00)	0.55	(0.20-0.92)	0.39	(0.06-0.80)
0.25	0.12*	**0.13**	0.93	(0.82-1.00)	0.40	(0.08-0.78)	0.25	(0.04-0.60)
0.30		**0.18**	0.87	(0.70-1.00)	0.26	(0.04-0.58)	0.16	(0.02-0.40)
0.35		**0.23**	0.77	(0.52-0.96)	0.15	(0.02-0.38)	0.10	(0.00-0.22)
0.40		**0.28**	0.62	(0.30-0.88)	0.09	(0.00-0.20)	0.07	(0.00-0.16)
0.45	0.15*	**0.30**	0.44	(0.12-0.74)	0.06	(0.00-0.12)	0.05	(0.00-0.10)
0.50		**0.35**	0.25	(0.04-0.50)	0.04	(0.00-0.08)	0.03	(0.00-0.08)
0.55		**0.40**	0.12	(0.02-0.28)	0.03	(0.00-0.06)	0.02	(0.00-0.06)
0.60		**0.45**	0.05	(0.00-0.10)	0.02	(0.00-0.04)	0.02	(0.00-0.04)
0.65		**0.50**	0.03	(0.00-0.06)	0.01	(0.00-0.04)	0.01	(0.00-0.04)
0.70		**0.55**	0.02	(0.00-0.06)	0.01	(0.00-0.04)	0.01	(0.00-0.02)

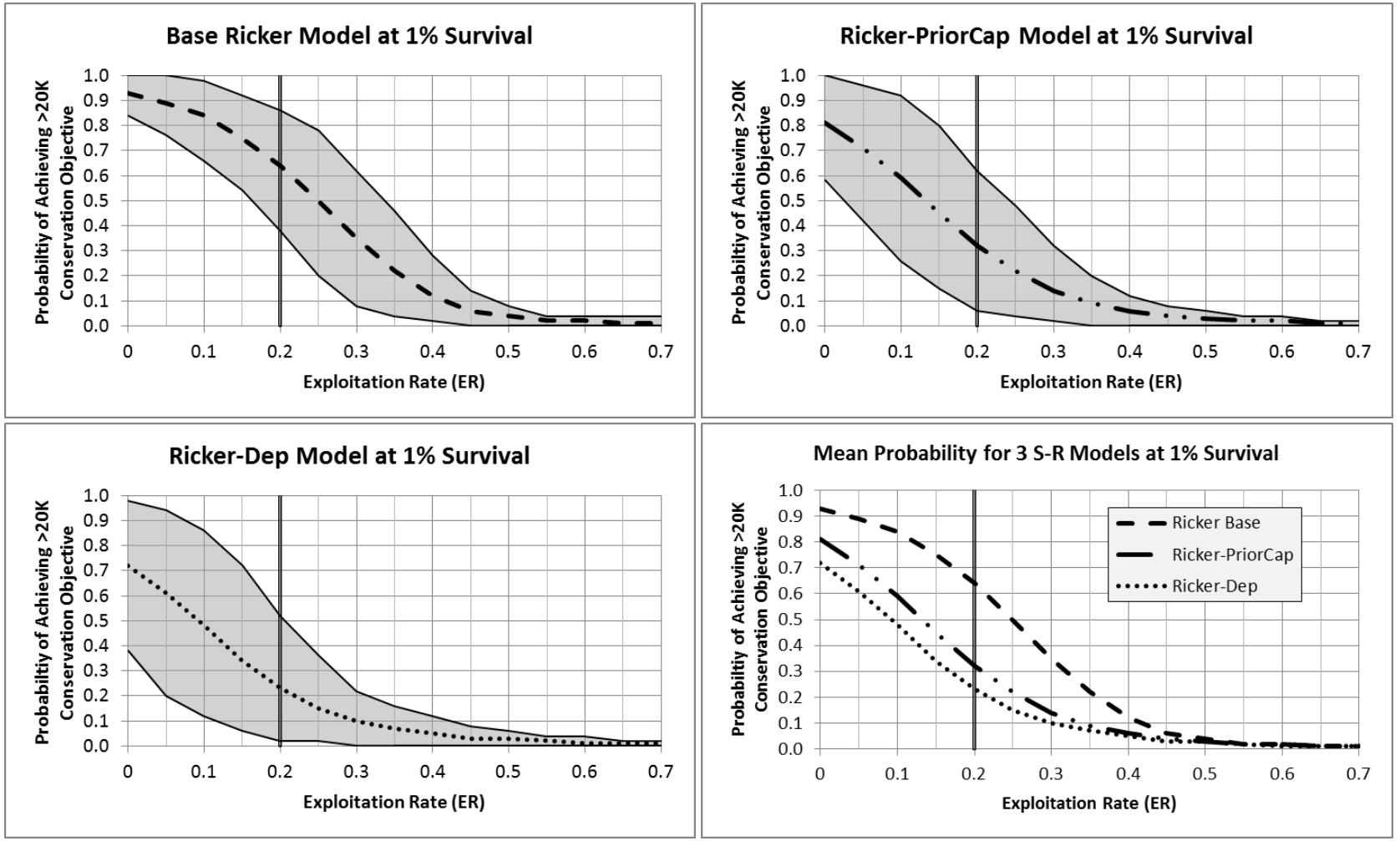

Figure 6. Probability of achieving the conservation objective of 20,000 spawners for the IFR MU under different bilateral ER caps while in low status based on the three stock-recruit models – for a survival rate of 1.0%. The bottom right panel shows the mean probability (y-axis) under different ERs (x-axis) for all three stock-recruit models. The other three panels show the results for each model individually, illustrating the 80% credible interval (shaded area) around the mean probability. The thick vertical line indicates the ER caps under the existing agreement for this status level.

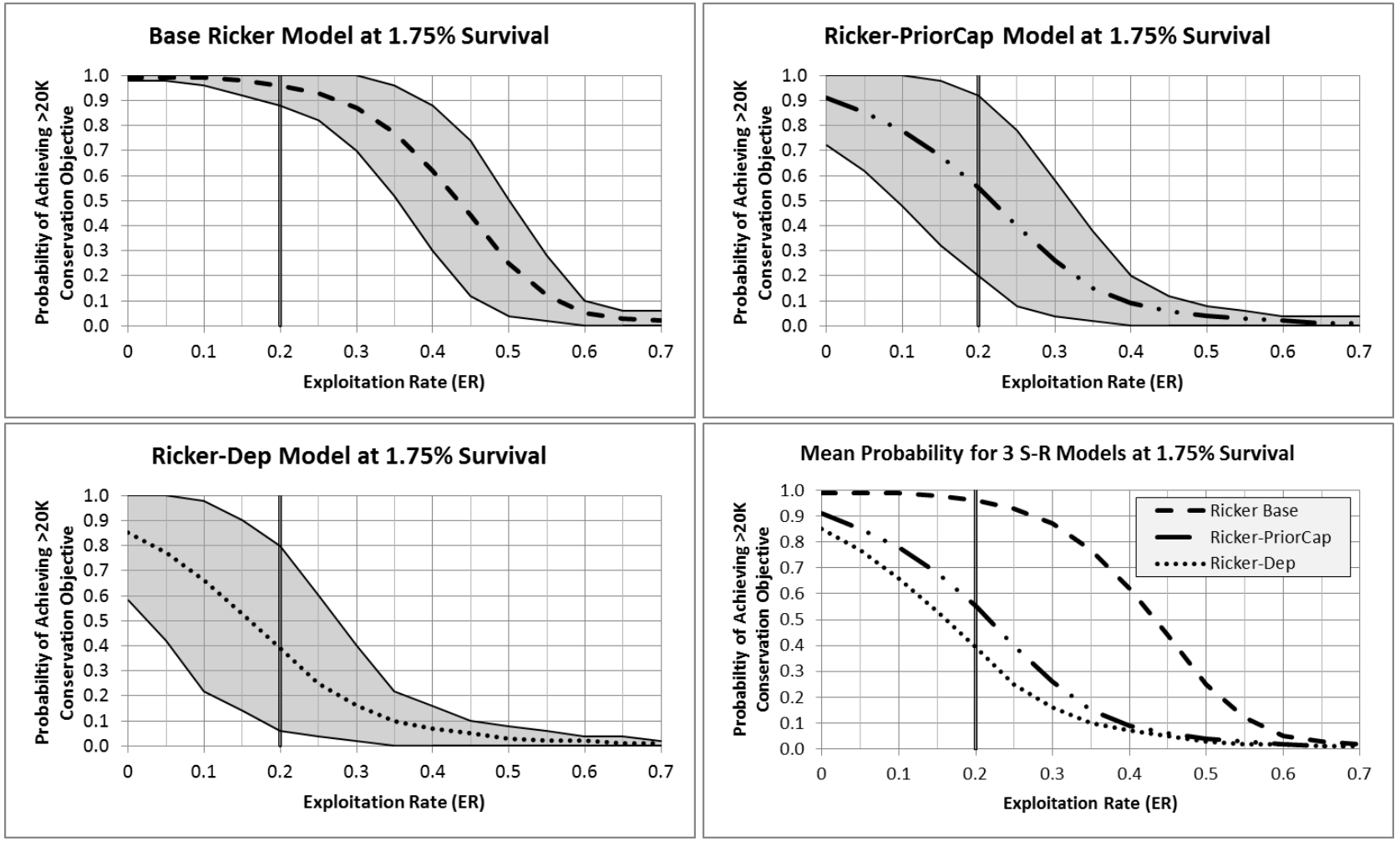

Figure 7. Probability of achieving the conservation objective of 20,000 spawners for the IFR MU under different bilateral ER caps while in low status based on the three stock-recruit models. The bottom right panel shows the mean probability (y-axis) under different ERs (x-axis) for all three stock-recruit models. The other three panels show the results for each model individually, illustrating the 80% credible interval (shaded area) around the mean probability. These results are based on survival rates of 1.75%. The thick vertical line indicates the ER caps under the existing agreement for this status level.

C.2. Moderate Status

The probabilities of achieving the conservation objective of 20,000 spawners for the IFR MU under different bilateral ER caps under moderate status are shown in Table 7. The results for a survival rate of 3.75% are presented because the goal is to select the ER cap (i.e., maximum level) for moderate status and this represents best-case scenario under moderate status. The same results are also shown graphically in Figure 8.

*Consider how the information on the conservation outcomes influences your views on maintaining the current ER cap of 40% for **moderate** status. If you do not support a PST ER cap of 40%, consider your reasons, and an alternative if you have one.*

Table 7. Probability of achieving the conservation objective of 20,000 spawners for the IFR MU under different bilateral ER caps while in moderate status. Results are based on a survival rates of 3.75%. The mean probability of achieving the conservation objective is shown for each alternative stock-recruit model with the 80% credible interval in parentheses. The blue double-line outline with arrows indicates the ER caps under the existing agreement. The US portion of the bilateral ER cap, as specified in the PST, is shown across the range it applies (see Table 1). Figure 5 provides a visual guide. See text for discussion of uncertainty around US caps (*).

Moderate Status								
Bilateral	Nat'l ER Cap		Conservation Objective: MU>20k.					
ER Cap	US	Cdn	base Ricker		Ricker-PriorCap		Ricker-Dep	
0.00	0.10*	**0.00**	1.00	(1.00-1.00)	0.92	(0.72-1.00)	0.91	(0.70-1.00)
0.05		**0.00**	1.00	(1.00-1.00)	0.89	(0.60-1.00)	0.87	(0.60-1.00)
0.10		**0.00**	1.00	(1.00-1.00)	0.85	(0.46-1.00)	0.80	(0.40-1.00)
0.15		**0.05**	1.00	(1.00-1.00)	0.79	(0.32-1.00)	0.71	(0.22-1.00)
0.20		**0.10**	1.00	(1.00-1.00)	0.72	(0.20-1.00)	0.60	(0.14-1.00)
0.25	0.12	**0.13**	1.00	(0.98-1.00)	0.64	(0.10-1.00)	0.48	(0.06-0.96)
0.30		**0.18**	0.99	(0.98-1.00)	0.54	(0.06-0.98)	0.35	(0.04-0.86)
0.35		**0.23**	0.98	(0.94-1.00)	0.42	(0.04-0.94)	0.24	(0.02-0.64)
→ **0.40** ←		**0.28**	0.97	(0.90-1.00)	0.30	(0.02-0.80)	0.15	(0.00-0.40)
0.45	0.15*	**0.30**	0.94	(0.82-1.00)	0.18	(0.00-0.50)	0.09	(0.00-0.20)
0.50		**0.35**	0.86	(0.64-1.00)	0.10	(0.00-0.24)	0.06	(0.00-0.12)
0.55		**0.40**	0.73	(0.36-0.98)	0.05	(0.00-0.12)	0.04	(0.00-0.08)
0.60		**0.45**	0.52	(0.12-0.90)	0.03	(0.00-0.06)	0.02	(0.00-0.04)
0.65		**0.50**	0.27	(0.04-0.64)	0.02	(0.00-0.04)	0.02	(0.00-0.04)
0.70		**0.55**	0.12	(0.00-0.30)	0.01	(0.00-0.04)	0.01	(0.00-0.04)

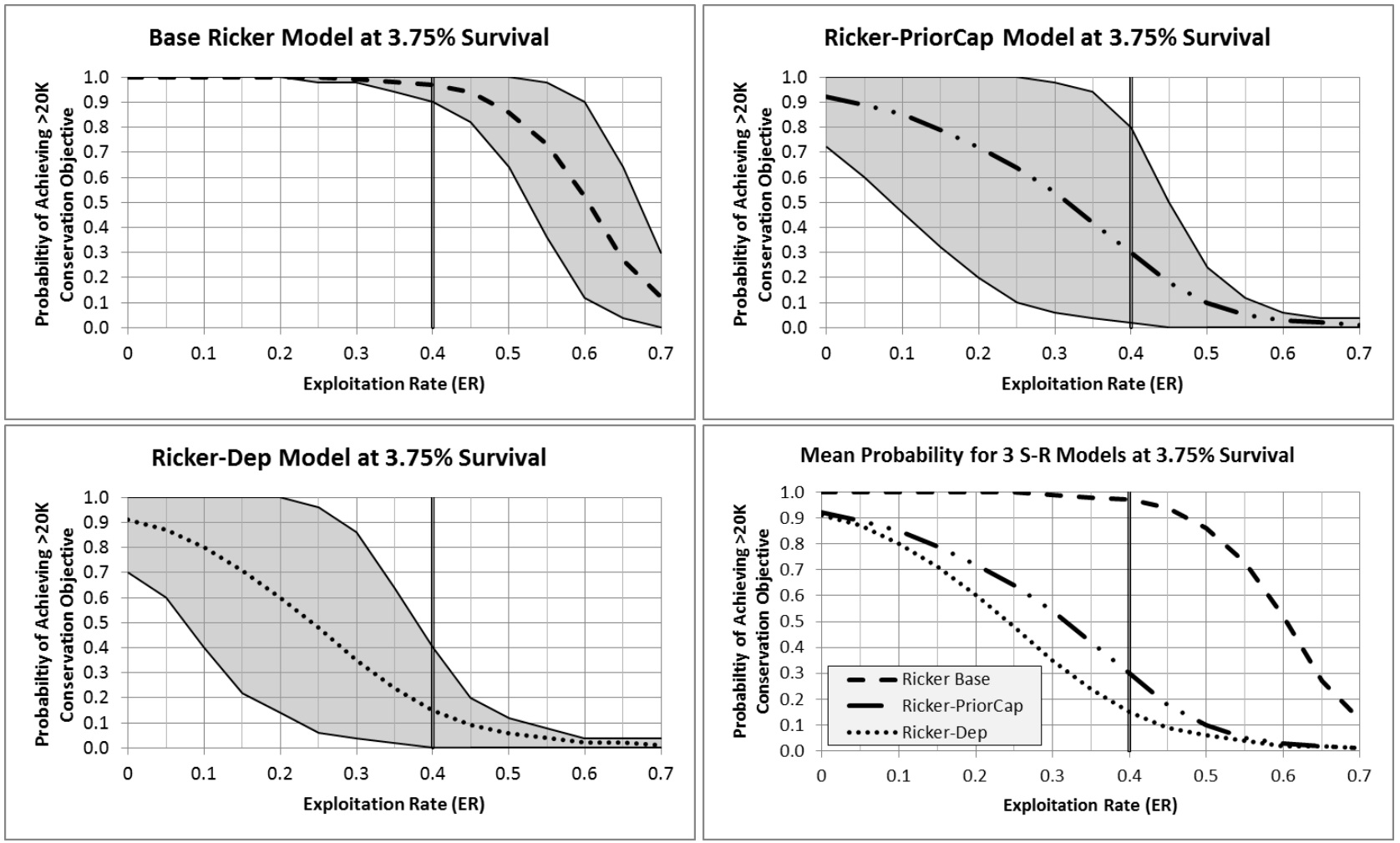

Figure 8. Probability of achieving the conservation objective of 20,000 spawners for the IFR MU under different bilateral ER caps while in moderate status based on the three stock-recruit models. The bottom right panel shows the mean probability (y-axis) under different ERs (x-axis) for all three stock-recruit models. The other three panels show the results for each model individually, illustrating the 80% credible interval (shaded area) around the mean probability. These results are based on survival rates of 3.75%. The thick vertical line indicates the ER caps under the existing agreement for this status level.

C.3. Abundant Status

The probabilities of achieving the conservation objective of 20,000 spawners for the IFR MU under different bilateral ER caps under abundant status are shown in Table 8. The survival rate of 5.0% was chosen as a level that represents a high but not unrealistic survival rate with respect to the historic record since 1985. During the decade from 1985 to 1994, IFR MU would have been classified as abundant status (by the presently proposed definition) in 8 out of 10 years and survival rates of 4.4-5.5% were observed in 5 years. By comparison, survival rates only exceeded 5.5% once in the past 30 years (Figure 3). Therefore 5.0% represents a strong scenario but not the absolutely best-case, which is appropriate for selecting the maximum bilateral ER under abundant status. The same results are also shown graphically in Figure 9.

*Consider how the information on the conservation outcomes influences your views on maintaining the current ER cap of 65% for **abundant** status. If you do not support a PST ER cap of 65%, consider your reasons, and an alternative if you have one.*

Table 8. Probability of achieving the conservation objective of 20,000 spawners for the IFR MU under different bilateral ER caps while in abundant status. Results are based on a survival rates of 5.0%. The mean probability of achieving the conservation objective is shown for each alternative stock-recruit model with the 80% credible interval in parentheses. The blue double-line outline with arrows indicates the ER caps under the existing agreement. The US portion of the bilateral ER cap, as specified in the PST, is shown across the range it applies (see Table 1). Figure 5 provides a visual guide. See text for discussion of uncertainty around US caps (*).

Abundant Status								
Bilateral	Nat'l ER Cap		Conservation Objective: MU>20k.					
ER Cap	US	Cdn	base Ricker		Ricker-PriorCap		Ricker-Dep	
0.00	0.10*	**0.00**	1.00	(1.00-1.00)	0.92	(0.70-1.00)	0.92	(0.74-1.00)
0.05		**0.00**	1.00	(1.00-1.00)	0.89	(0.58-1.00)	0.89	(0.62-1.00)
0.10		**0.00**	1.00	(1.00-1.00)	0.85	(0.44-1.00)	0.83	(0.48-1.00)
0.15		**0.05**	1.00	(1.00-1.00)	0.81	(0.30-1.00)	0.75	(0.26-1.00)
0.20		**0.10**	1.00	(1.00-1.00)	0.75	(0.18-1.00)	0.66	(0.16-1.00)
0.25	0.12*	**0.13**	1.00	(1.00-1.00)	0.68	(0.10-1.00)	0.55	(0.06-1.00)
0.30		**0.18**	1.00	(1.00-1.00)	0.60	(0.06-1.00)	0.43	(0.04-0.96)
0.35		**0.23**	0.99	(0.98-1.00)	0.51	(0.04-1.00)	0.31	(0.02-0.82)
0.40		**0.28**	0.99	(0.96-1.00)	0.40	(0.02-0.94)	0.20	(0.02-0.60)
0.45	0.15	**0.30**	0.97	(0.92-1.00)	0.27	(0.02-0.78)	0.13	(0.00-0.32)
0.50		**0.35**	0.94	(0.82-1.00)	0.16	(0.00-0.46)	0.07	(0.00-0.16)
0.55		**0.40**	0.87	(0.64-1.00)	0.08	(0.00-0.20)	0.04	(0.00-0.10)
0.60		**0.45**	0.73	(0.32-1.00)	0.04	(0.00-0.10)	0.03	(0.00-0.06)
→ **0.65** ←		**0.50**	0.50	(0.10-0.92)	0.03	(0.00-0.06)	0.02	(0.00-0.04)
0.70		**0.55**	0.26	(0.02-0.64)	0.02	(0.00-0.04)	0.01	(0.00-0.04)

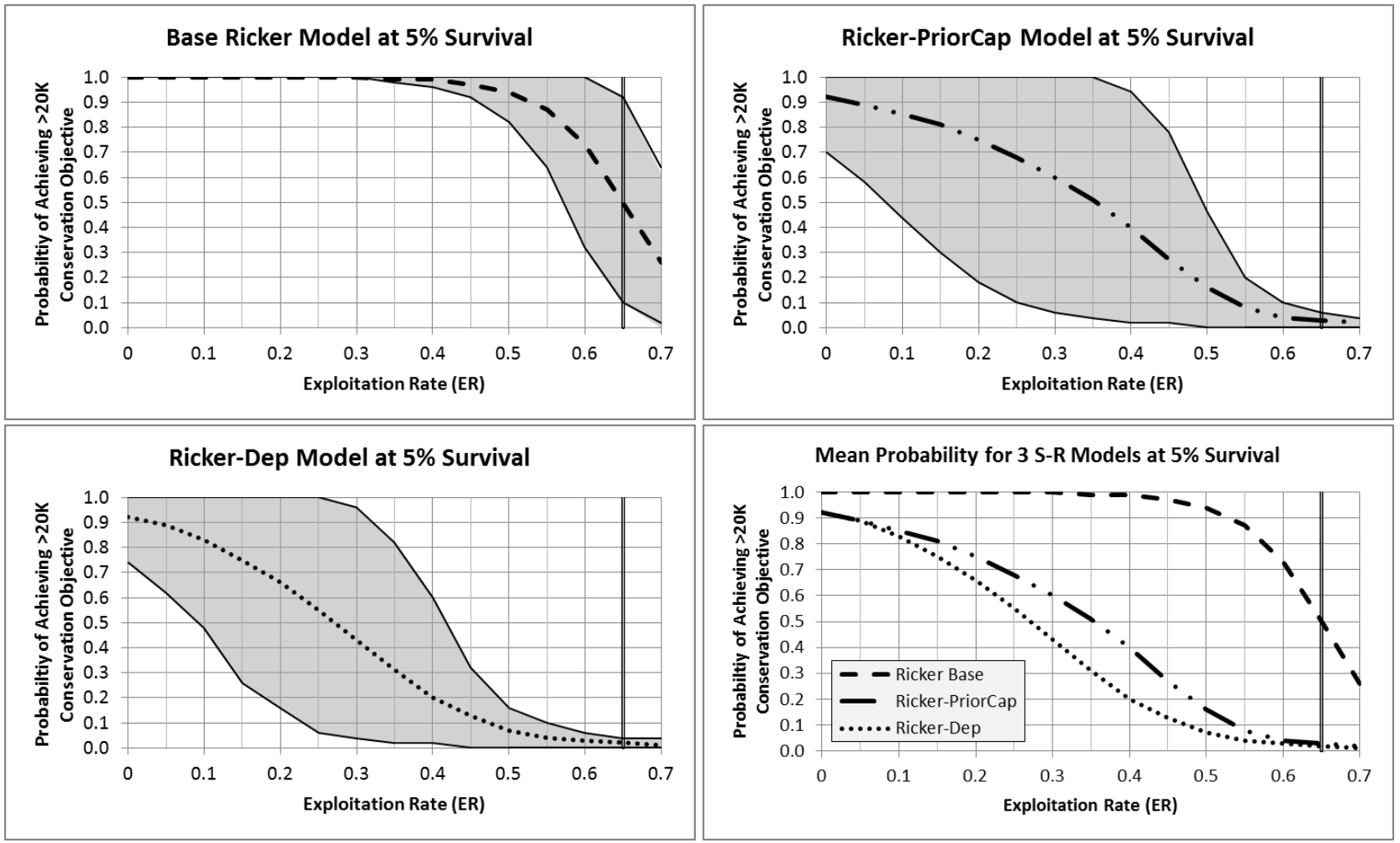

Figure 9. Probability of achieving the conservation objective of 20,000 spawners for the IFR MU under different bilateral ER caps while in abundant status based on the three stock-recruit models. The bottom right panel shows the mean probability (y-axis) under different ERs (x-axis) for all three stock-recruit models. The other three panels show the results for each model individually, illustrating the 80% credible interval (shaded area) around the mean probability. These results are based on survival rates of 5.0%. The thick vertical line indicates the ER caps under the existing agreement for this status level.

For the abundant status only, the results are also shown for the more aggressive conservation objective of 40,000 spawners (Table 9). Abundant status represents the scenario with the best chance of achieving this objective. The same results are also shown graphically in Figure 10.

Table 9. Probability of achieving the conservation objective of 40,000 spawners for the IFR MU under different bilateral ER caps while in abundant status. Results are based on a survival rates of 5.0%. The mean probability of achieving the conservation objective is shown for each alternative stock-recruit model with the 80% credible interval in parentheses. The blue double-line outline with arrows indicates the ER caps under the existing agreement. The US portion of the bilateral ER cap, as specified in the PST, is shown across the range it applies (see Table 1). Figure 5 provides a visual guide. See text for discussion of uncertainty around US caps (*).

Abundant Status								
Bilateral	Nat'l ER Cap		Conservation Objective: MU>40k.					
ER Cap	US	Cdn	base Ricker		Ricker-PriorCap		Ricker-Dep	
0.00	0.10*	**0.00**	0.90	(0.80-0.98)	0.61	(0.08-0.96)	0.54	(0.14-0.92)
0.05		**0.00**	0.88	(0.76-0.98)	0.55	(0.04-0.94)	0.47	(0.06-0.88)
0.10		**0.00**	0.86	(0.70-0.98)	0.49	(0.02-0.92)	0.39	(0.02-0.84)
0.15		**0.05**	0.84	(0.66-0.98)	0.43	(0.00-0.88)	0.31	(0.00-0.76)
0.20		**0.10**	0.81	(0.62-0.96)	0.36	(0.00-0.84)	0.23	(0.00-0.66)
0.25	0.12*	**0.13**	0.77	(0.56-0.96)	0.29	(0.00-0.78)	0.16	(0.00-0.52)
0.30		**0.18**	0.72	(0.44-0.94)	0.21	(0.00-0.70)	0.10	(0.00-0.36)
0.35		**0.23**	0.65	(0.36-0.92)	0.14	(0.00-0.46)	0.06	(0.00-0.18)
0.40		**0.28**	0.57	(0.24-0.88)	0.08	(0.00-0.24)	0.03	(0.00-0.06)
0.45	0.15	**0.30**	0.47	(0.14-0.80)	0.04	(0.00-0.10)	0.01	(0.00-0.02)
0.50		**0.35**	0.35	(0.06-0.68)	0.02	(0.00-0.02)	0.01	(0.00-0.00)
0.55		**0.40**	0.22	(0.00-0.52)	0.01	(0.00-0.00)	0.00	(0.00-0.00)
0.60		**0.45**	0.12	(0.00-0.34)	0.01	(0.00-0.00)	0.00	(0.00-0.00)
0.65		**0.50**	0.05	(0.00-0.14)	0.01	(0.00-0.00)	0.00	(0.00-0.00)
0.70		**0.55**	0.02	(0.00-0.06)	0.00	(0.00-0.00)	0.00	(0.00-0.00)

Given the need to be cautious in the face of uncertainty, does the science advice provide you with enough information to assess the conservation risk of alternative ERs? Why or why not? Do you have thoughts on how this work could be improved in the future?

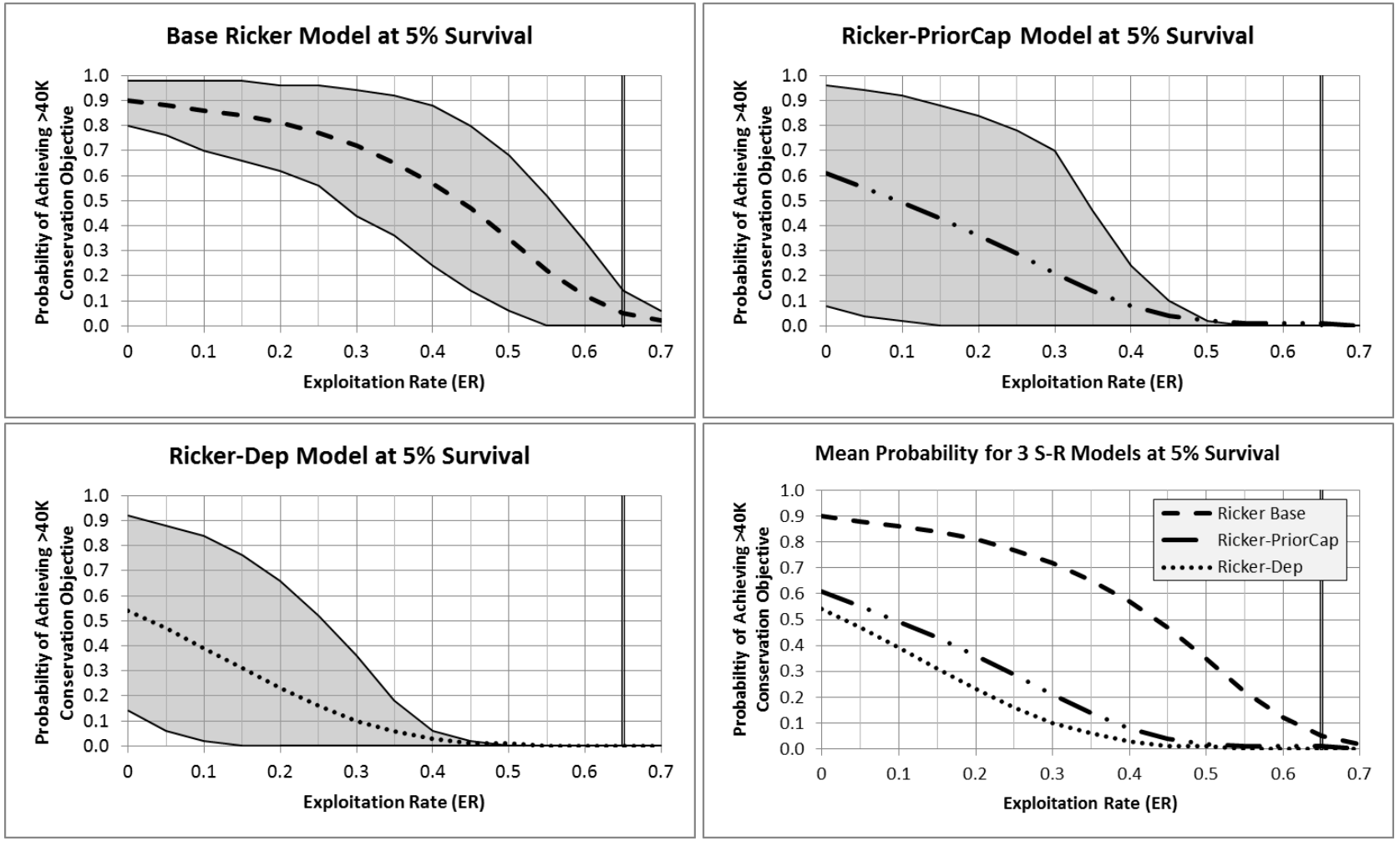

Figure 10. Probability of achieving the conservation objective of 40,000 spawners for the IFR MU under different bilateral ER caps while in abundant status based on the three stock-recruit models. The bottom right panel shows the mean probability (y-axis) under different ERs (x-axis) for all three stock-recruit models. The other three panels show the results for each model individually, illustrating the 80% credible interval (shaded area) around the mean probability. These results are based on survival rates of 5.0%. The thick vertical line indicates the ER caps under the existing agreement for this status level.