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FOR THE NORTHWEST POWER AND CONSERVATION COUNCIL, COLUMBIA
RIVER BASIN INDIAN TRIBES, AND NATIONAL MARINE FISHERIES SERVICE

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Review of the Comparative Survival Study (CSS) 2025 Draft Annual Report

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ISAB 2025-3
October 22, 2025

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I. Background

The Columbia River Basin Fish and Wildlife Program calls for a regular system of independent and timely science reviews of the [Fish Passage Center's](#) (FPC) analytical products. These reviews include evaluations of the draft annual reports for the Comparative Survival Study (CSS). The ISAB has reviewed these reports annually beginning fifteen years ago with the evaluation of the CSS's draft 2010 Annual Report, and most recently the draft 2024 Annual Report.¹ This ISAB review of the *[2025 Draft CSS Annual Report: Comparative Survival Study of PIT-tagged Spring/Summer/Fall Chinook, Summer Steelhead, and Sockeye](#)* is thus the ISAB's sixteenth review of CSS annual reports.

The Fish Passage Center has developed a valuable long-term database on the hydrological performance of the hydrosystem and its effects on salmon and steelhead survival during their seaward migration as juveniles, at sea, and during their upstream migration as returning adults based on detections of salmon tagged as smolts (e.g., smolt-to-adult return: SAR). The CSS reports since 1998 summarize the trends and provide analyses of the effects of the hydrosystem on salmon, steelhead, and other species in the Columbia River Basin. ISAB reviews from 2010 to the present have evaluated the analyses in the CSS reports, noted the usefulness and applicability of the CSS's analyses, and made suggestions for improved methods, interpretations, and presentation of results.

II. Summary

This ISAB review begins with an overview of the latest report's findings (this section), which is followed by suggested topics for further CSS review (Section III). The review then provides general comments and editorial comments on each chapter of the [draft 2025 CSS Annual Report](#) (Section IV).

¹ [ISAB 2010-5](#), [ISAB 2011-5](#), [ISAB 2012-7](#), [ISAB 2013-4](#), [ISAB 2014-5](#), [ISAB 2015-2](#), [ISAB 2016-2](#), [ISAB 2017-2](#), [ISAB 2018-4](#), [ISAB 2019-2](#), review of Chapter 2 of the 2019 Annual Report ([ISAB 2020-1](#)), [ISAB 2020-2](#), [ISAB 2021-5](#), [ISAB 2022-1](#), [ISAB 2023-2](#), and [ISAB 2024-3](#).

The annual CSS report is a mature product, including updates of analyses using the latest year of data and expansion of analyses when data are sufficient. Many of the methods have been reviewed in previous ISAB reports and now only receive a confirmatory examination. However, as more data are acquired, some new patterns may emerge. The passing years may also bring scientific advances and perspectives, leading to new conclusions, and these are now the primary focus of our reviews. The ISAB appreciates the CSS's detailed responses to suggestions provided in previous reviews (e.g., [CSS 2024 Annual Report](#), Appendix J), and we do not expect the CSS to necessarily respond immediately to new requests for further analyses.

In the following section of the Summary, the ISAB identifies major findings and issues on a chapter-by-chapter basis that warrant attention and potential decisions and actions by the Fish Passage Center and CSS research team. Chapters 1-6 are ongoing components of the CSS Report and specific comments are provided in our report. Chapter 6 was new in the 2024 CSS Annual Report, and Chapters 7-9 were added in 2025. Because they cover new analyses, we briefly summarize them, highlight important findings, and suggest areas for improvement.

CSS Chapter 6. Examining Heterogeneity and Factors that Influence Rates of Smolt-to-Adult-Return for Spatially Dispersed Stocks of Chinook Salmon and Steelhead in the Columbia River Basin

This chapter presents an analysis of the long-term time series of SARs as estimates of survival that are generated by the CSS. The CSS synthesizes data for groups of salmon and steelhead across the Columbia Basin. The analysis (termed basin-scale population model or meta-analytic approach) examines patterns of survival (SARs) and the variables that affect the SAR estimates of these groups. Chapter 6 also appeared in the 2024 report, and many of the ISAB's primary comments were addressed in this 2025 version. CSS authors addressed questions regarding inclusion of jacks and assessing the effects of the water transit time (WTT) and powerhouse passages (PITPH) covariates on the variance structure. The remaining substantive comments from the review of the chapter in the 2024 report that the ISAB still considers crucial to address, and new comments, are detailed below.

CSS Chapter 7. Steelhead Overshoot and Fallback Rates

Chapter 7 is a new CSS analysis that examines the migration routes of wild adult steelhead in the Columbia River Basin and movement of those that migrate past (overshoot) their natal tributary, those that eventually fall back to their natal stream, and upstream strays that were never detected in their natal basin. The chapter presents results for 13 major population groups in the Mid-Columbia, Upper Columbia, and Snake rivers. Overshooting is common for wild steelhead, often with values between 30-55% according to the CSS analysis. For those that

overshoot, the proportion that fall back to their natal basins generally are low, often lower than 70% and even lower than 50% for several populations. The combination of overshooting and failure to fallback represents a loss to the natal population. Straying of natural-origin and hatchery salmon and steelhead and not returning to their natal rivers have been ongoing concerns for Columbia River hydrosystem management, especially in the Snake River for the four lower Snake River dams (ISRP 2023-1, ISRP 2025-3). The ISAB commends the CSS for investigating this extremely important management issue and encourages them to refine and continue this analysis.

CSS Chapter 8. Have We Followed the PATH?

Chapter 8 is the second installment of “A Reader’s Guide to the Comparative Survival Studies.” Chapter 8 examines the context and milestones of the historical development of CSS analyses. In the early 1990s, the listing of anadromous salmonids under the Endangered Species Act changed management in the Columbia River Basin. A major step was the formation of the Plan to Analyze and Test Hypotheses (PATH) to resolve differences and reduce uncertainty regarding the effects of hydrosystem management on listed fish species. Chapter 8 describes the origin of the current scientific debates and how the CSS has followed the PATH process. PATH and its main products are briefly described, followed by how the CSS has built on PATH’s foundation, a comparison of PATH’s predictions to subsequent events, and some reflective observations about the efficacy of hydrosystem management to achieve management objectives for salmon and steelhead. The ISAB found this chapter to be well-written and informative to all readers, from those new to the Columbia Basin to those highly knowledgeable about it. It is a very useful addition to the Readers’ Guide series, and the ISAB strongly supports the CSS continuing these installments.

CSS Chapter 9. Quantifying the Effects of Water Transit Time, Powerhouse Passages, and Ocean Conditions to Achieve Regional SAR Goals for Columbia River Basin Spring/Summer Chinook and Steelhead

Chapter 9 quantifies the effects of water transit time (WTT), powerhouse passages (PITPH), and ocean conditions on salmon survival and identifies flow targets necessary to achieve regional SAR goals for spring/summer chinook and steelhead. Two modeling approaches are used: 1) Cohort models updated from the models developed by the Comparative Survival Study Oversight Committee (CSSOC) and the Fish Passage Center (FPC) as part of the Adaptive Management Framework for evaluating alternative hydrosystem operations, and 2) the basinwide populations model from Chapter 6. The ISAB comments on both modeling approaches. Based on the comments of previous reviews of the CSS annual reports and this review (Chapter 6), the ISAB has reservations with the present usage of the basin-scale

modeling presented in Chapter 9. The ISAB urges the CSS to consider two options in their revision of the 2025 report: (1) consider postponing the inclusion of the basin-scale modeling presented in Chapter 9 in the report until the major issues raised by the ISAB with the basin-scale modeling are addressed and resolved, or (2) add a section to chapters 6 and 9 that documents model assumptions and limitations related to the issues raised by the ISAB and others considered by the CSS during model development and application.

Importance of Information in CSS Reports

The ISAB strongly emphasizes the importance of the CSS reports for effectively monitoring and evaluating salmon co-management and hydrosystem operation. There may be a tendency to consider the annual CSS reports to be just “more of the same” each year. With more than 27 years of data, the conclusions reached are extremely valuable because the uncertainties in the results can be well estimated and outlier years identified. Moreover, annual data collection and analysis updating can play a sentinel role by permitting standardized detection of changes within a contemporary period. The physical (e.g., PIT tag detection arrays) and human capacity and expertise added over the 27 years are invaluable, and the CSS annual reports provide an effective and useful resource to many involved with the Columbia Basin.

Long-term records of fish abundance and environmental conditions are extremely difficult and expensive to develop. The survival of salmon and steelhead during parts of their life cycle is affected by the hydrosystem, and these data are essential for the Fish and Wildlife Program. Long-term data are particularly critical when assessing years with extreme conditions, such as low flows, warm temperatures, or other atypical seasonal patterns. Such cases, at the edges of the distributions, are expected to occur with greater frequency under climate change, and a long-time series is needed to capture enough of these uncommon conditions to make reliable assessments. However, collection of important long-term data from some sections of the Columbia River has been limited, interrupted, or eliminated in recent years. The ISAB continues to emphasize the need to extend PIT-tag trawl sampling in the lower river through August, increase the number of PIT-tagged fish, and enhance detection probabilities at the dams.

Editorial comments

In our review of the draft 2024 CSS Annual Report, we requested that the CSS include a glossary of terms in their report, as they had in many past reports. We appreciate that the CSS responded to our request and included one in the final 2024 Annual Report and the draft 2025 Annual Report.

In our reviews of the draft 2023 and draft 2024 CSS annual reports, we encouraged the CSS to include an “overview” chart showing a timeline when various chapters were added and others

no longer included over the years of reports. The CSS included such a table in the final 2024 Annual Report and the draft 2025 Annual Report (1.12, page 34), showing a time-series of routine and special topics covered in CSS Annual Reports from 2000 to 2025. This table was very useful in helping us organize our review, understand the history of chapters, and identify ongoing and new analyses and special topics. The size of this table makes formatting difficult in a print version of the report, but the CSS could maintain a publicly available spreadsheet and include a link to it in the final report.

To help future readers and reviewers understand the historical context, motivation, and activities of the CSS, the ISAB suggests that the CSS consider adding Chapter 7 of the [CSS Final 2022 Annual Report](#) “Hydrosystem Changes and Their Influence on CSS: Spill” and Chapter 8 in this draft report “Have We Followed the PATH?” as appendices to future annual reports. The ISAB found those chapters very useful for our review and provide important context, especially for new readers.

III. Suggested Topics for Further Review

Since 2011, the ISAB has suggested topics that warrant further CSS or regional review, and they are listed here in Section V as an appendix. The latest CSS report incorporates many of our past suggestions, and the ISAB greatly appreciates the CSS’s effort to respond to our past queries. As stated above, we do not expect the CSS to necessarily respond immediately to new requests for further analyses, and we understand that some of the requests might be beyond the existing mainstem passage focused scope and/or budget of the CSS and would require expanding the CSS scope or coordinating with other entities. Although other entities could potentially undertake some of these analyses, the CSS is well positioned to do many of the analyses, building on their current and substantial body of past work.

1. The ISAB continues to call for the CSS and/or others to develop a focused assessment of the influence of climate-related and density-dependent factors on the *marine survival of Columbia River salmon*. Climate and density-dependence will increasingly play a role in influencing population responses to hydrosystem operation and management actions and further assessment will improve understanding of causal factors of trends in SAR values. The CSS’s past and ongoing (e.g., Chapter 6) analyses of the effects of climate on specific aspects of the life histories, including the life stage survivals and recovery of salmon and steelhead, is already available and could provide valuable content for future syntheses. The CSS could also undertake new analyses to illustrate specific

important climate and density-dependent relationships identified in its previous studies and provide a context based on recent literature.

2. The current monitoring of the hydrosystem above Bonneville Dam is now well developed and mature. While studying fish in the estuary is somewhat beyond the current scope of the CSS, the ISAB recommends that the CSS conduct a brief review on the methods currently and previously used by others and potential new methods that could be used to better understand smolt and adult survival in the estuary below Bonneville Dam, in the North Pacific, and throughout the Basin.
3. The ISAB appreciates the CSS analysis of overshoot, fallback, and straying, which is an extremely important management concern in the Columbia River Basin. The extent to which these are observed and their relationships to hydrosystem operations (and other management actions) warrant examination. As data sets and associated analyses become more robust, the CSS and others in the basin should be able to test the influence of hydrosystem operations on straying rates. We encourage the CSS to refine and continue these analyses and include other stocks and species, such as hatchery steelhead and spring Chinook salmon. Future analysis by the CSS or others could also examine overshoot and straying at a finer resolution within basins or around specific dams or river confluences.
4. The CSS increasingly uses multiple models (e.g., Chapter 9) to bound the uncertainty in predicted responses. Two general cases of multiple models seem to occur with the CSS analyses: (1) alternative assumptions and explanatory variables within a hierarchy of similarly structured (often statistical) models, and (2) models based on fundamentally different assumptions and thus they can appear to have little direct relationship to each other. Using multiple models can be a very powerful approach but is also a complex endeavor and can easily lead to mis-interpretations of results. The CSS should develop a “multi-model guide” to help standardize the approach and documentation (for example, see [ISAB 2023-1](#) for a review of multiple models used for Willamette Valley System analyses). This will allow readers to better understand analyses that use multiple models and to properly interpret differences and similarities in predictions.

ISAB and CSS dialogue regarding the ISAB’s 2024 Suggestions for Topics for Further Review

In [ISAB 2024-3](#), we recommended the following seven topics (*italicized*) for consideration in future analysis. After each recommendation, we include the CSS’s responses (*blue font*) from

Appendix J in the final 2024 CSS Annual Report, and then we summarize the status of the work to address them:

1. *ISRP 2024 Report: Coho salmon is notably missing from the list of stocks and numbers of years of data. Although largely absent in the formative years of the CSS, hatchery and rewilded coho salmon are becoming an important part of the mix of stocks and species being studied. The CSS should consider including coho salmon (e.g., in the PIT tagging effort and reporting) to help understand the dynamics of success of the large reintroduction effort in the mid and upper Columbia River, and the potential for inter-specific effects on other salmonid populations as coho salmon become more abundant.*

CSS Response: We agree that additional lifecycle monitoring data on coho in the Columbia and Snake Rivers would be useful. The CSS has explored the possibility of increasing CSS mark groups for coho. However, BPA has denied funding additional marking on coho on the basis that Coho are extirpated and therefore BPA does not have any obligation to fund marking on Coho.

ISAB 2025 Response: Coho salmon is an important species to track mitigation-related progress toward achieving Fish and Wildlife Program goals. The ISAB continues to highlight the need for coho salmon monitoring using a CSS approach such as with other currently monitored species (e.g., in the PIT tagging effort and reporting). As noted in 2024, this monitoring and evaluation could improve knowledge about coho SARs and the potential for inter-specific effects on other salmonid populations as coho salmon become more abundant.

2. *ISRP 2024 Report: Last year [2023 review], the ISAB recommended that the CSS consider how to incorporate the influence of climate-related and density-dependent factors on the marine survival of Columbia River salmon in future reports. In 2023, we emphasized that:*

“In addition to concerns about SARs, from 2008 to 2022, an average of 74% of adult Snake River Chinook salmon migrating upstream past Bonneville Dam survived to Lower Granite Dam, but in the warm year of 2015, only 52% of the adults survived from Bonneville to Lower Granite. The frequency of warm years is likely to increase in the future under climate change, and the survival of adults may decrease more than recent averages illustrate. The collective ongoing poor survival of Columbia River salmon and steelhead warrants a comprehensive assessment of the long-term consequences of these trends and consideration of

likely scenarios of climate change and warming.”

The CSS did not respond to this recommendation, which the ISAB repeats, emphasizing that juvenile Fish Travel Time (FTT) and Ordinal Day are strongly related to temperature and flow and are likely to be affected by changing climate. With lower flow (or increased WTT), the time spent feeding in or migrating through warmer water may increase and affect growth rates, thermal stress, and forage community composition. Similarly, Ordinal Day may reflect seasonal temperature and hydrological profiles which can also affect growth, stress, and diet (among other effects). Such indirect effects on survival and productivity warrant greater consideration.

CSS Response: *These recommendations span a wide range of topics (adult upstream survival, juvenile fish travel time, water temperature, ordinal day, water transit time, density dependence, climate change), most of which are addressed in the current or previous CSS Annual Reports. Chapter 5 addresses adult upstream survival and the influence of water temperature, transportation history, and other factors on adult upstream survival. Chapters 2 and 3 address the influence of water temperature, ordinal day, water transit time, and powerhouse passage events on juvenile fish travel time. Chapter 2 examines these factors in the reach between Lower Granite and Bonneville dams for spring-summer Chinook salmon and steelhead, whereas Chapter 3 examines these factors at a finer temporal and spatial scale (Lower Granite to McNary and McNary to Bonneville) and includes more species (sockeye and fall Chinook). On the topic of density-dependence, we developed methods for estimating juvenile yearling Chinook abundance at Bonneville Dam in the 2018 and 2021 CSS Annual Reports and are exploring whether similar methods could be applied at other dams. If estimates of juvenile abundance can be developed, we would be interested in examining whether there are associations between abundance, instantaneous mortality, and survival, both in the freshwater and marine environments.*

Additional response provided by CSS in Appendix J regarding the ISAB’s 2023 Report’s suggested topic #3, which was repeated as topic #2 in the ISAB’s 2024 report: *The effects of climate-related factors are included in several of the chapters in the draft annual report. Chapter 2 examines the associations between freshwater and ocean indices on SARs and ocean survival. Chapter 3*

examines the associations between water temperature and water transit time on juvenile fish travel time, instantaneous mortality, and survival. Chapter 5 examines associations between water temperature and adult upstream migration success. Chapter 6 examines the associations between water transit time and SARs across eight populations of wild spring Chinook salmon and wild steelhead in the Columbia River Basin. Investigations into density-dependent effects will require estimates of abundance or density of juveniles, which have not been developed except at Bonneville Dam for yearling Chinook salmon (see 2018 and 2021 CSS Annual Reports). If additional abundance estimates or indices are developed, we are interested in examining the associations between juvenile abundance, instantaneous mortality, and survival.

ISAB 2025 Response: The CSS response to the ISAB’s recommendation to incorporate the influence of climate-related and density-dependent factors on the marine survival of Columbia River salmon in future reports pointed out a number of ways that climate-related factors and density-dependent factors are addressed in recurring chapters and recent chapters in CSS reports. We acknowledge that the CSS frequently assesses effects of climate on specific aspects of the life histories and recovery of salmon and steelhead. We should have stated our intent more clearly. We encourage the CSS to develop a focused assessment of the influence of climate-related and density-dependent factors on marine survival, synthesizing past CSS analyses in different chapters and reports and developing time series analyses to illustrate important relationships including those the CSS has previously highlighted. This would be a new chapter in addition to the recurring Chapters 1-5. In the CSS response to topic 4 below, the CSS indicated that they plan to examine a suite of ocean indices in future versions of Chapter 6, which might provide the content of a chapter focused on climate-related effects on ocean survival.

3. *ISRP 2024 Report: In 2023, the ISAB concluded that continued analysis of the benefits, uncertainties, and risks of breaching the lower Snake River dams is warranted and suggested that a more comprehensive effort to predict responses to simulate the complex ecological responses expected after breaching is needed. We suggested that the analyses could include scenarios for the geomorphic and environmental conditions after dam removal and evaluate additional sources of uncertainty (e.g., implementation uncertainty, realism of existing models for no-dam conditions) under present-day and plausible future (climate change) environmental conditions. We encourage the CSS to revisit our suggestion from*

the review of the 2023 CSS report on breaching by examining lessons learned from Klamath dam removals, which were removed this year, and other dam removals in the region. Information on the geomorphic, hydrologic, water quality, and ecological responses will soon be available for the CSS to expand their modeling analysis of breaching presented in Chapter 6 of the 2023 CSS Report.

***CSS Response:** The 2023 CSS Annual Report presented two independent decision analyses on the expected effects of five hydrosystem management strategies, including two strategies that involved breaching the four lower Snake River dams. Those models quantified the main environmental effects that would occur under a breaching strategy (faster water velocity through the breached portion of the river, elimination of powerhouse encounters at the breached dams).*

Major sources of uncertainty and variability were incorporated into those analyses, including variability in future flow levels, variability in future ocean conditions, variability due to residual process variation, and statistical uncertainty in the estimates of model parameters. In the discussion section of that chapter, we identified several future refinements that could be pursued, including re-estimating the models using additional years of data that have been collected since those models were originally estimated.

Chapter 2 presents an updated, comprehensive examination of ocean indices and their associations with SARs and ocean survival, incorporating an additional eight years of data that were available since the original models were developed. In addition, Chapter 6 of this year's report presents a multi-stock, multi-species analysis of the effects of water transit time and powerhouse passages on four wild spring Chinook and four wild steelhead populations within the Columbia River Basin. This analysis advances understanding of the effects of hydropower impacts, which differ by population and migration year, on SARs and how management strategies that reduce hydropower impacts (e.g., dam breaching, reduced reservoir elevations, higher flow levels, increased spill levels), would affect SARs for wild populations in the Basin. This chapter also is useful for assessing the realism of the projected effects of breaching, as the populations from the Yakima River would have similar hydrosystem impacts (i.e., migration through the remaining four lower Columbia River dams) as Snake River populations under a breach scenario.

Thus, the 2024 draft Annual Report includes several analyses that continue to assess and evaluate the expected effectiveness of dam breaching and hydropower management strategies. In the 2023 report we identified additional refinements to the decision analysis models that could be pursued, such as assuming different distributions for future flow and ocean conditions. The early effects of dam breaching on the Klamath and Elwha rivers have shown that water velocity is increased, water transit time is reduced, and powerhouse encounters are eliminated when dams are breached, as expected.

ISAB 2025 Response: The ISAB appreciates the CSS's contributions to assessing the potential responses of salmon and steelhead to removal of the four lower Snake River dams. Continued refinement of the influences of changes in WTT, FTT, and PITPH will be informative. Our recommendation for further analysis was focused on analysis of scenarios for the geomorphic and environmental conditions after dam removal and evaluation of additional sources of uncertainty (e.g., implementation uncertainty, realism of existing models for no-dam conditions) under present-day and plausible future (climate change) environmental conditions. We look forward to the CSS expanding its excellent models that primarily focus on WTT, FTT, and PITPH to develop a new set of models that include the geomorphic and environmental factors that would change with dam removal, as well as additional sources of uncertainty.

4. *ISRP 2024 Report: If analyses are performed that involve a priori selection of specific and limited explanatory variables, the description of the methods should clearly describe why those variables were selected and the implications of their use for the results and interpretation. For example, in Chapter 6 only WTT and PITPH were included in statistical models of SARs even though other variables are important and available for inclusion. The limited variable models did not predict SAR values well yet were extensively interpreted for the importance of WTT and PITPH. The rationale for such analyses needs to be clearly stated and, in some cases, additional models that include more explanatory variables should be considered.*

CSS Response: *CSS has examined other variables in past analyses and found that they were far less important at the population level and were not strongly associated with SARs. Chapter 6 included WTT and PITPH because those are the main factors influencing SARs based on decades of data and analysis. We have found that other possible factors, such as fish length, do not explain the*

variability in population-level SARs for stocks within or across the Columbia River Basin (Storch et al. 2020, McCann et al. 2019 Appendix G). We plan on examining a suite of ocean indices in future versions of this chapter.

ISAB 2025 Response: The ISAB looks forward to reviewing the CSS’s examination of a suite of ocean indices in future CSS reports. In addition, the ISAB encourages including the brief history and evidence of why some variables that would seem intuitively to be important are not included as candidate variables in analyses. In some cases, those earlier analyses may need to be confirmed (updated) because of the addition of new data. Including other “important” variables could help clarify the influence of the variables of interest. These can be included in an appendix so as not to interrupt the follow of the primary analyses.

5. *ISAB 2024 Report: Consider expanding certain analyses (e.g., SARs in Chapter 6 and benefits of flow augmentation in Chapter 7) to sockeye salmon. This is understandably a long-term objective. With the recent increases in sockeye salmon abundance, it would be wise to prepare for such analyses.*

CSS Response: We agree. The CSS has pursued increasing mark groups of Sockeye, particularly the Okanagan River Sockeye. The CSS proposed including increased sockeye marking in the 2023 CSS budget. Although the state, federal and tribal fishery management agencies, including the First Nations, agreed with the proposed sockeye marking BPA denied funding for the marking. The BPA explained that there was no BPA obligation to fund marking of Upper Columbia River sockeye because the Upper Columbia River sockeye are not listed under ESA.

ISAB 2025 Response: Sockeye salmon is an important mitigation species to track to gauge progress in achieving Fish and Wildlife Program goals. The ISAB greatly appreciates the CSS developing an analysis of sockeye adult migration success in Chapter 5. Chapter 6 addresses factors that influence SARs in the entire Columbia River Basin and Chapter 7 deals specifically with the Snake River Basin, where sockeye are listed as endangered. The ISAB continues to suggest the CSS expand analyses of sockeye salmon in the major chapters.

6. *ISAB 2024 Report: Some analyses would benefit from further resolution of the ocean phase (e.g., Chapter 6 on SARs), analyses of flows to include the lower estuary (Chapter 8 on WTTs), and decomposing results into year-types to more fully understand the robustness of general patterns (Chapter 7 on flow augmentation).*

***CSS Response:** We agree that the development and operation of upper basin large storage reservoirs had a profound impact on flow dynamics and timing in the Columbia River Estuary and the Columbia River Plume. The CSS has a limited scope as defined by the CSS Work Statement, which is approved by the Bonneville Power Administration. The scope of the project is defined as the Snake River and Columbia River mainstem fish passage corridor. Chapter 2 presents analyses on associations of ocean indices on SARs, which provides further resolution and understanding of the ocean phase.*

ISAB 2025 Response: The ISAB appreciates the CSS's efforts to provide comprehensive analyses of salmon and steelhead passage and survival (freshwater and marine) and to pursue discussions with the Council and BPA regarding potential changes in the project's scope to refine or expand the project's data collection and analyses to track F&W Program progress.

7. *ISAB 2024 Report: There is an agreement in principle between Canada and the United States for the Columbia River Treaty, but details are not yet available on the effects on the hydrosystem. The ISAB recommends that when information is available on the details of the Treaty the CSS should analyze the likely effects of the revised treaty on passage and survival metrics based on observed responses in the system to date.*

***CSS Response:** The Canadian Treaty operations have had a major impact on migration flows through the Columbia River. Chapter 8 of the 2024 includes discussion of the reduction in spring and summer flows as the result of the treaty operation. In addition, the additional volume of water needed from the Upper Columbia Treaty projects to meet minimum WTT in the Middle Columbia River reach is discussed in Chapter 8. We agree that the operation alternatives being considered in Columbia River Treaty discussions will be important for salmon and steelhead survival in the future. As the Treaty is revised and implemented, the CSS will monitor and report on the observed responses. If the fishery managers request it, and the Action Agencies provide a detailed projection of what future flows and operations will be under a revised Treaty, the CSS would present analyses on the expected effects of those flows and operations. To date, we have not seen data or descriptions of the operations being considered by the Canadian Treaty entities. on what those flows and operations will be.*

ISAB 2025 Response: As the United States and Canada revise the Columbia River Treaty, the ISAB looks forward to the opportunity for CSS to analyze the likely effects of the revised treaty on passage and survival metrics.

IV. Comments on New or Updated Analyses in the draft CSS 2024 Annual Report by Chapter

IV.A. Comments on the Executive Summary and Chapter 1. Introduction

In 2024, the ISAB recommended that the CSS should enhance the Executive Summary with more quantitative rather than qualitative information about the major results and conclusions rather than just summarizing what is in the report. The CSS chose to eliminate the Executive Summary rather than enhance it. Does the CSS intend to prepare an Executive Summary for the Final 2025 CSS Annual Report?

Chapter 1 is an update from previous annual CSS reports that the ISAB has reviewed extensively over time. Most of the text is identical to recent CSS Reports. The CSS added an extremely useful table (Table 1.12) to identify the topics, chapters, and appendices that have been included in each CSS Report from 2000 to 2024. Information on the Stay of Litigation Agreement was updated. Overall, there are no major changes in Chapter 1, and the description of CSS studies is updated with 2024 data.

p. 3. In the ISAB’s review of Chapter 4 in 2024, we noted that the CSS reports tend to focus on the Snake River and Columbia River upstream of Bonneville Dam and devote little attention to performance of salmon and steelhead populations below Bonneville Dam. In their response to the ISAB, the CSS clarified that “The CSS is a regionally approved life-cycle monitoring program. The CSS project objective is upstream and downstream passage through the mainstem hydrosystem. Populations originating below Bonneville Dam are beyond the CSS Statements of Work.” The ISAB considers the salmon and steelhead use of the lower river to be relevant to their performance and the potential influence of the hydrosystem. Even if the CSS disagrees with this perspective, the section in Chapter 1 on the Development of the Comparative Survival Study should explain this fundamental focus on the Columbia River from Bonneville Dam upstream. The ISAB’s remaining questions about salmon and steelhead in the lower river below Bonneville Dam will be addressed in our comments on Chapters 2-4.

p. 3. Figure 1.1 is helpful, as is the summary of analyses and their geographic reference points (e.g., 1 to 3 or 1 to 4). An important and very simple analysis that is not described in

Chapter 1 is survival from reference point 2 to 4, which is the marine smolt to adult return phase. The analysis of ocean survival in Chapter 4 could be represented in Figure 1.1 as the estimation based on reference points 2 to 3.

Ocean survival is calculated in the CSS Annual Report using two different estimates that do not represent the same portions of salmon and steelhead life history. The BON-to-BOA SARs are referred to as ocean survival and are reported in Chapter 4 and Appendix B. In contrast, ocean survival is calculated in Chapter 2 as the ratio of SAR to juvenile survival (S_R). The CSS should highlight these different uses and clearly explain the portions of the life histories of salmon and steelhead represented by these two measures of performance. Also, see the ISAB's more detailed comments about the estimates of ocean survival for Chapter 2.

p. 5. At the end of the paragraph that begins *"All CSS study fish are uniquely identified with a PIT tag ..."*, the text should add a sentence that states that "Wherever possible the CSS makes use of mark groups from other research and coordinates with other marking programs to meet CSS requirements in order to reduce costs and handling of fish." This sentence is included on page 17 but would better inform the reader before presenting Figures 1.2 to 1.5, which show maps of *"CSS PIT-tag release locations ... in the Columbia River Basin."* This would also provide a better context for Table 1.3, which describes groups of fish to be marked in 2025 that do not include PIT tags provided by the CSS but are included in the study.

P. 17. "Wherever possible the CSS makes use of mark groups from other research and coordinates with other marking programs to meet CSS requirements in order to reduce costs and handling of fish." For more complete documentation, the CSS should provide the criteria and rationale they used to include PIT-tagged fish from other groups in the CSS analyses.

IV.B. Comments on Chapter 2. Adaptive Management Evaluations of Changes in Hydrosystem Operations on Chinook Salmon and Steelhead

Chapter 2 presents an Adaptive Management evaluation of changes in hydrosystem operations on spring-summer Chinook salmon and steelhead. Information on the Stay of Litigation Agreement was updated. The figures and tables are updated with 2024 data, and the models have been reviewed by the ISAB in previous years. This chapter is the fourth presentation of the analyses of five response metrics: juvenile fish travel time, juvenile survival, ocean survival, smolt-to-adult return (SAR) survival, and the transport:in-river ratio (TIR) using data from 1998-

2024. The chapter also presents analyses comparing these response metrics across four spill management regime periods, 1998-2006 (excluding 2001), 2001, 2007-2019, and 2020-2024. The analyses for the spill management regimes include one year of operation under the Stay of Litigation Agreement operations (2024), which provides a limited comparison of the expected responses with those of the Proposed Action operations (2020-2023). The results of these analyses will be particularly important for evaluating the effectiveness of the spill strategy, and continued modeling of expected outcomes and comparison with observed performance of salmon and steelhead are critical.

Chapter 2 concluded that the Flex Spill Agreement would result in greater survival than the CRSO-EIS Preferred Alternative and recommended that future analyses should evaluate the impact of daily load on juvenile fish survival and travel time. The ISAB agreed and encouraged the CSS to include this statement in their Conclusions in the 2024 CSS Annual Report. The CSS included the new recommendation in the 2024 Conclusions section. The ISAB also encouraged the CSS to continue these analyses of spill operations and conducting analyses as soon as the data become available to improve the “learning” part of Adaptive Management. The ISAB appreciates the CSS’s thorough responses to our suggestions in 2024, both those we agreed with and those we did not.

Primary comments

The fifth section of the 2024 CSS Annual Report was deleted because it assessed whether recent and future operations under the Stay of Litigation Agreement “*are expected to result in different biological responses than the Proposed Action operations that were in place from 2020 through 2023.*” The White House recently withdrew the United States from the Resilient Columbia Basin Agreement, which was the basis for the Stay of Litigation Agreement signed in 2023. For context, it would be useful for the CSS to clearly explain the change and refer to the 2024 CSS Annual Report’s results to identify the consequences of this operational action.

p. 40. One of the substantial differences in 2024 was the very low estimated proportions of yearling Chinook (0.04) and steelhead (0.07) transported, which likely reduces straying in returning adults. The CSS explained that the lower proportions of barged Chinook and steelhead was due to the combination of early timing of outmigrant juvenile salmon and relatively higher spill during passage in the lower Snake River. This is an important finding and should be added to the list of Conclusions at the start of the chapter.

p. 40. In the ISAB’s review of Chapter 2 in 2024, the ISAB recommended that the CSS should use the term SAR instead of “SAR survival” because it complicates the considerable confusion around the terms return as in SAR and survival as in smolt-to-adult survival (SAS). We further

pointed out that return and survival are not synonymous as used in the Columbia Basin. In their response to the ISAB, the CSS commented that *“We have retained the term “SAR survival” to emphasize that the SAR measures cumulative survival between defined monitoring points, in this case smolts detected at Lower Granite Dam and adults detected at Bonneville Dam. The CSS does not generally use the “SAS” acronym, but it is our understanding that if the monitoring points are the same (e.g., smolts at Lower Granite Dam and adults at Bonneville Dam), then the calculated values for SAR and SAS would be equal.”* The ISAB refers the CSS to our recent SAR and SAS Metrics Report ([ISAB 2025-1](#)) for a more detailed explanation of why SAR and SAS are not equal if the monitoring points are the same (e.g., smolts at Lower Granite Dam and adults at Bonneville Dam). *“Survival in SAS is the proportion of smolts (marked, detected, or counted at some location) that survive to be taken in fisheries plus those returning to spawning grounds or hatcheries”* ([ISAB 2025-1](#), underlines to emphasize distinction). Survival to “Return” in SAR values does not include fish taken in commercial or sport harvest. The ISAB continues to recommend use of “Smolt-to-Adult Return” or “SAR” instead of “Smolt-to-Adult Return survival” to avoid confusion with Smolt-to Adult-Survival (SAS), but we acknowledge their intent and decision to emphasize the implications of SAR for fish survival.

p. 45. The text described the Stay of Litigation Agreement:

“In the fall of 2023, state and tribal sovereigns signed a Stay of Litigation Agreement (SLA) that defined hydrosystem operations to be implemented starting in 2024. The SLA provides several opportunities for spill to be reduced in-season at several projects. Spill may be reduced if there is a need to increase powerhouse minimum requirements for reserves. Spill may be reduced if the Columbia Basin Research’s Data Access in Real Time (DART) PIT-tag Adult Reach Distribution and Delay tool indicates delay of adult spring Chinook passage. Spill at Little Goose Dam may be reduced for 8-hour per day once an adult abundance trigger is met or April 24th, whichever occurs first. There is no way of predicting in advance when or how often spill may be reduced under the SLA.”

At the time of release of the final 2025 CSS Annual Report, the text should explain the operational decisions that have been made or the operational plan moving forward into 2026.

p. 46. The analysis of the period from 1998 to 2024 indicated that the percent spill has increased and the powerhouse encounters (PITPH index) has decreased. The text for water transit time states that *“Like spill levels and the PITPH index, WTT from Lower Granite Dam to Bonneville Dam has varied over the 1998-2024 timeframe both among years and among cohorts (Figure 2.4). Seasonal WTT averaged 18.5 days 1998-2024, but there is little evidence of a consistent annual trend over time.”* Rather than simply stating that spill proportions, PITPH indices, and water transit times are similar in that they varied over the study period, the text

could emphasize the contrast between the lack of consistent change in water transit and the significant changes in spill proportion and PITPH indices.

The CSS could also briefly explain why hydrosystem operations have not substantially changed WTT, which is a largely a function of seasonal and annual hydrology because the dams are operated as run-of-the-river reservoirs with little or no storage of daily discharge.

p. 51/54. A beta distribution has two parameters, usually denoted as (a,b). We are not sure what a Beta distribution with a single parameter means? Are the parameters for the beta distribution the same for all cohort/years, or were the parameters selected to match the SE of the $S_{R,i,y}$? More details are needed here on the fitting process.

p. 53. The ISAB questions the use of the term “ocean survival” for the estimate used in Chapter 2. As mentioned previously, the CSS uses a different estimate of ocean survival based on BON-to-BOA SARs in Chapter 4.

In Chapter 2, the model calculates “ocean survival” as $SO_{i,y} = SAR_{i,y}/SR_{i,y}$ and the text indicates it follows the methods of Haeseker et al. (2012) and CSSOC (2017). These two sources use different methods to estimate ocean survival. Haeseker et al. (2012) bases the estimate on survival from BON to LGR, but CSSOC 2017 bases ocean survival on from BON to BOA.

Haeseker et al. (2012) explained that “*Survival estimates from this life stage encompass all survival processes during the period following passage at Bonneville Dam as a smolt through the time when adults migrate past Lower Granite Dam. As such, $\hat{SOA}$ includes survival down the remaining portion of the Columbia River from Bonneville Dam, survival through the estuary and nearshore ocean, survival during the 1–3 years spent in the ocean, and survival during the upriver migration from the ocean and through the FCRPS to Lower Granite Dam. For simplicity, we refer to this as ocean adult survival.*”

In contrast, CSSOC (2017) describes the estimate of ocean survival as “*the Smolt-to-Adult Return rate (SAR) divided by the juvenile survival rate from Lower Granite Dam to Bonneville Dam. The SAR was calculated as the number of adults detected at Bonneville Dam divided by the number of smolts detected at Lower Granite Dam. Therefore, the ocean survival rate measures survival from the time that smolts pass Bonneville Dam until the time that adults return to Bonneville Dam.*”

The ISAB recommends that the CSS use consistent methods to estimate ocean survival and clearly define all terms, including when alternate approaches represent different portions of the life history of salmon and steelhead.

The ISAB also encourages the CSS to include information on ocean fisheries exploitation. While we recognize that this analysis is based on PIT-tagged fish, any modelling of ocean survival should incorporate information on fisheries effects. Fisheries exploitations vary among years, have been estimated for various Chinook populations in the Columbia River, and provide a means to better understand temporal patterns in marine survival. See Tables 3 and 4 in our recent SAR/SAS report ([ISAB 2025-1](#)).

p. 54. The CSS uses the term Transport:In-river Ratio (TIR) and calculates it as the ratio of the SAR for fish that were transported divided by the SAR for fish that migrated in-river. While the CSS has used this term for many years and there are advantages in consistency, it may confuse readers. The most straight-forward interpretation of Transport:In-river Ratio would be that it is the ratio of the number of fish that were transported divided by the number of fish that migrated in-river. The CSS could consider using the term Transport:In-river Survival Ratio (TIR) to be clearer and more precise.

p. 59. Table 2.4. Given the very large number of possible predictors, how do you know that the selected predictors are not just artifacts of the data? Stepwise methods are very sensitive to small perturbations in the data.

Table 2.4. Is it reasonable that the selected variables for Chinook and Steelhead would differ? Is this an artifact of their life histories? Some details are needed in this regard.

Table 2.4 just BON-BOA? It would help if this was indicated, and also in the paragraphs on p. 58 that discuss "Smolt-to-Adult Return."

Was there a relationship between date when the smolts passed BON and FTT, or with ocean survival (BON-BOA)? Such an effect of timing on marine survival is often observed in salmonids.

p. 63. The CSS report indicates that the model for ocean survival found that Chinook survival in the ocean was reduced with increases in ordinal day, water transit time, and the number of powerhouse passage experiences and steelhead survival was reduced with increases in ordinal day and water transit time. The report refers to Petrosky and Schaller (2010) and Haeseker et al. (2012), which found associations between freshwater indices and ocean survival, but does not discuss why ocean survival would be related to in-river conditions and timing. Readers would benefit from a brief explanation of possible mechanisms for the relationship in this section or the Discussion.

Minor comments

p. 46. Figure 2.4. In most, the cohorts WTT tended to be below the yearly average WTT, but in some years the cohort WTT were substantially higher. What is special about these years, e.g., drier, wetter, warmer, or colder than normal?

p. 73. The Discussion of Section 4 states that *“Inclusion of fish travel time and juvenile survival from 2024 under the Stay of Litigation (SLA) in the PA (2020-2023) regime appeared to have minimal effect on fish travel time but may have resulted in slightly lower estimates of juvenile survival compared to the previous assessment (McCann et al. 2024).”* It would be clearer to say that inclusion of fish travel time and juvenile survival from 2024 under the Stay of Litigation (SLA) in the PA (2020-2023) regime appeared to have minimal effect on the average fish travel time but may have resulted in slightly lower estimates of average juvenile survival compared to the previous assessment.

Editorial comments

p. 48. “reduced by 0.4 DAYS.”

p. 48. *“Ocean survival was predicted to be 29% higher and SAR survival was predicted to be 33% higher for Chinook salmon.”* Give the percentage point increase. We encourage the CSS to be clear and consistent in use of terms related to survival at sea. For example, is “ocean survival” different from “SAR survival”?

p. 49. Need a column for units for each row, e.g., days, percentage points, ratio, ratio, ratio. Then you can discard the last sentence in the legend.

p. 52. Provide reference or URL for the NOAAF Stoplight Chart.

p. 53. R^2 comes in a variety of flavors when you have random effects. Are you computing the marginal or conditional R^2 ? Based on Figure 2.5, it appears to be marginal values.

p. 55. Observed vs predicted plots usually have predicted values on the X-axis and observed values on the Y axis. Multiple places need to be fixed.

p. 57. The text states *“coefficients suggest negative relationships between juvenile in-river survival and both WTT and PITPH.”* But for Chinook, the trend in survival (Fig. 2.8 left panel) is flat or downward over the years, despite faster fish travel (Fig. 2.6, left panel). How is this explained? The expected relationship seems to hold for steelhead (faster travel and higher survival).

p. 65. Plot $\log(\text{TIR})$ on Y axis. To avoid squishing all data values to the X-axis.

p. 66. “... continuous PITPH variable with spill management regime as a factor variable.” What does this mean?

p. 67. “Least square means” is the old-fashioned terminology used when simple regression models were fit using least squares. “Expected marginal means” is the preferred terminology.

p. 67. Table 2.9 (and others). “Different letters identify statistical differences at the $\alpha=0.10$ level.” This needs rewording. Regimens that share the same letter indicate that there was no evidence of a difference in the marginal mean.

p. 68. Table 2.11. “SAR survival.” Just SAR.

IV.C. Comments on Chapter 3. Effects of the In-river Environment on Juvenile Travel Time, Instantaneous Mortality Rates and Survival

This chapter is an update from previous annual CSS reports that the ISAB has reviewed extensively since 2009. The chapter analyzes the movement of Chinook (subyearling and yearling), sockeye, and steelhead smolts in three reaches of the Columbia and Snake rivers: 1) the upper Columbia River migration corridor, from Rocky Reach Dam (RRE) to McNary Dam (MCN), 2) the Snake River migration corridor, from Lower Granite Dam (LGR) to McNary Dam, and 3) the common migration corridor from McNary Dam to Bonneville Dam (BON). The CSS has developed Bayesian models that allow estimates for multiple cohorts within a year, even when data are less available for some cohorts. Most of the text is identical to recent CSS Reports, and most of the figures are identical to previous graphs in this chapter, updated with 2024 data. The new summary illustration of survival probability of all species and stocks as a function of water transit time in Figure 3.24 is a useful illustration of an important relationship for hydrosystem management in the Columbia River.

Comments

p. 93. The graphs (Fig. 3.8) seem to indicate that water transit time is much less important in predicting fish travel time in sub-yearling Chinook compared to yearlings and steelhead. This seems counter-intuitive, as the sub-yearlings are smaller, and so water velocity might have more effect on travel rate, not less. Also, is the smaller effect of photoperiod (day of the year, really) weaker in the subyearlings because their migration bridges the summer solstice? Why not use day of the year? The daily rate of change of photoperiod is not fixed, so using photoperiod as a variable might not be right if the true variable is day of the year. Also, why is the effect of photoperiod on yearling Chinook very strong (~ 100%) from Lower Granite to

McNary but negligible from McNary to Bonneville? Does the CSS have an explanation for difference?

The CSS points out on p. 77 that photoperiod is not the same as ordinal day, though the two clearly are related. The text describes several examples where the biological responses to photoperiod are related to exposure to light and not just the sequential day of the year.

Day of the year (not Julian Day) progresses from 1-365, but photoperiod runs from the winter solstice to the summer solstice and back, with unequal rates of change each day. In Portland, for example, day length changes by about 1 minute per day around the solstice and about 3 minutes per day around the equinox. Animals may react to the rate of change of daylength rather than the daylength per se. A deep dive into smolt physiology as it relates to smolt migration and biology is not required, but some greater consideration is needed. Also, a given daylength or rate of change of daylength will occur before and after the summer solstice so just running analysis on daylength may not adequately represent factors affecting smolt migration. This is likely to be especially relevant to ocean-type Chinook salmon as their migration spans a longer part of the year compared to the older smolts of this and other species.

Additional explanation is needed, especially if it can provide evidence for the difference based on the CSS analyses that compare the outcomes of the analysis using photoperiod to that using ordinal day rather than just replacing ordinal day with photoperiod. The importance of photoperiod and ordinal day were similar in the 2024 CSS Report and the 2025 CSS Report.

p. 74. The Conclusion that elevated instantaneous mortality rates for yearling and subyearling Chinook in the LGR–MCN reach have increased in recent years was expanded to explain that dam operations (e.g., daily load-following and turbine loading, increased abundance of fish predators) may contribute to the higher mortality rates. The ISAB commends the CSS for providing a brief explanation rather than simply reporting the analytical outcome.

p. 111. The second paragraph of the Discussion makes an excellent point, that *“variables may not only influence survival directly but also affect the precision with which survival can be estimated.”* This is very insightful.

p. 113. In the Discussion, the CSS describes possible causes for the higher instantaneous mortality rates for yearling and subyearling Chinook salmon in the LGR–MCN reach in the period from 2014-2023 than in the period from 1999-2013. The ISAB appreciates the brief explanation of possible causes of the trend. The authors indicate that *“avian control efforts have been shown to produce unintended trophic cascade effects, including increased abundances of fish predators (e.g., pikeminnow), which could ultimately contribute to elevated*

smolt mortality (Wiese et al. 2008).” While avian control efforts might have increased pikeminnow populations, the avian predation that led to possible increases in pikeminnow abundance also caused mortality of Chinook juveniles in the LGR-MCN reach. The 2018 Annual Report of the Pikeminnow Sport Reward Program reported the electrofishing catch in the Bonneville Reservoir for several years from 1990 to 2017:

Table 18. Number of stock-length (n_s) Northern Pikeminnow and proportional size distribution (PSD, %) collected by boat electrofishing during biological evaluation in the Columbia River below Bonneville Dam and in Bonneville Reservoir, 1990–2017. Mean and SE were calculated across the time series.

Year	Below Bonneville Dam		Bonneville Reservoir	
	n_s	PSD	n_s	PSD
1990	366	49	541	48
1991	278	64	287	68
1992	1,353	38	—	—
1993	281	51	148	37
1994	401	33	378	40
1995	206	41	319	26
1996	245	33	199	24
1999	226	38	169	33
2004	357	35	136	18
2005	287	49	106	40
2008	344	65	40	45
2011	139	68	70	20
2014	29	66	18	<i>a</i>
2017	113	52	75	20
mean (SE)	330 (83)	49 (3)	191 (42)	35 (4)

Note: *a* = no PSD value calculated ($n_s \leq 19$), dashes (—) = no sampling conducted.

Electrofishing indices indicate that pikeminnow abundance in the reservoir was not higher for 2014 and 2017 than for the years between 1999–2011. The 2019 proposal of the Pikeminnow Sport Reward Program reported that smallmouth bass have increased in several Snake River

reservoirs and locations in the mainstem. The ISRP indicated that this suggests that compensatory responses by fish predators may be occurring in specific locations. Does the CSS have information or published sources on the total consumption or indices of consumption of juvenile salmonids by combined fish and avian predators from 1999-2023? If not, the CSS should acknowledge the high level of uncertainty about predation and trends in juvenile salmon consumption in the Columbia River in this reach and evidence for compensation by pikeminnow due to avian predator control efforts.

p. 112. The summary graphics of survival probability of all species and stocks as a function of water transit time for all cohorts in Figure 3.24 is a useful illustration of one of the major findings of this long-term research that has revealed an important relationship for hydrosystem management in the Columbia River.

IV.D. Comments on Chapter 4. Patterns in annual overall SARs

The analysis of overall SARs for wild and hatchery salmon and steelhead populations from the Snake River and Mid-Columbia and Upper Columbia River provides important long-term data for the Columbia River Basin and management of the hydrosystem. The chapter topic has been presented in CSS reports dating back to 2002 and reviewed by the ISAB in the previous 15 years. The SARs in the Snake River and Upper Columbia River remain lower than the 2% - 6% SAR objectives of the Fish and Wildlife Program and are a major concern for the region, but the species and stocks of the Middle Columbia generally meet or exceed the 2% - 6% SAR objectives. The CSS concluded that common environmental factors were influencing survival rates because SARs of wild and hatchery populations were highly correlated within and among regions. Much of the text and the Conclusions are identical to recent CSS Reports, updated with 2024 data. The format and content of several of the figures and tables have been improved.

Primary comments

p. 118. The CSS reports that it *“no longer compares SARs of hatchery stocks to the 2%-6% SAR objectives because they have different mitigation and management objectives than wild populations. Furthermore, the NPCC 2%-6% SAR objectives are for wild, ESA-listed Snake River and Upper Columbia River salmon and steelhead and do not apply to sockeye or fall Chinook.”* The ISAB agrees that this is reasonable as long as the SARs for natural-origin and hatchery stocks and sockeye and fall Chinook stocks are reported.

p. 125. The SARs for Chinook in the Tucannon for migration year 2022 are approximately 2.0, though the C.I. range was greater than previous years and overlapped the C.I. for previous years. This SAR is much better than past performance and has a greater increase in trend than other Snake River stocks. Wild steelhead in the Tucannon also have SARs of 1.54% in 2022. A

similar increase was observed in other wild steelhead stocks in the Snake River in 2022. Does the CSS have any explanations for the apparent improvement in survival, or is it just that the numbers have declined so much that the survival estimate is an artifact of the small populations in the Tucannon River?

p. 134. Sockeye production was phased out at Sawtooth Hatchery 2015 and shifted to the Springfield Hatchery. The CSS report discusses some of the disease and transportation problems that have occurred with the Springfield Hatchery and slight improvements in recent years. The juvenile in-river survival LGR to BON for sockeye from the Springfield Hatchery remain lower than those that occurred when the Sawtooth Hatchery was used to produce sockeye, with the in-river survival for 2009-2015 at the Sawtooth facility averaging 0.50% and in-river survival for 2015-2024 at the Springfield Hatchery averaging 0.27%. Could the CSS briefly provide information from IDFG about why the shift in hatchery facilities for sockeye production occurred and whether shifts back to the Sawtooth Hatchery are being explored or are possible?

p. 124. The last paragraph specifies that the SARs included jacks. Was this not the case for other estimates unless specified? The text in this paragraph indicates that the in/exclusion of jacks had a ca. 10% effect. This paragraph, also including the difference between returns to BOA vs GRA is very important.

p. 134. The sockeye SARs are very, very low for the species. What are the component values (i.e., smolts to BON, BON to BOA, and back upriver)? LGR – GRA values are not very informative in terms of where the losses occur.

p. 145. It is helpful to see the estimates for mid-Columbia fish (e.g., steelhead). It would be especially helpful to see comparable (BON – BOA) ocean survival estimates for a large number of stocks in a single table for this and other species, and also comparable in-river values.

p. 164. Are the survivals in the ocean (e.g., Figure 4.27) actually proportions (e.g., ca. 1-10% for Chinook) or are they percents (ca. 0.01%)? Elsewhere (e.g., Discussion on page 165), it is clear that percentages are being used. **Editorial comments**

The format and content of several of the figures and tables have been improved.

p. 125. Figure 4.2. “*Bootstrapped ...*” Do you mean that the shaded bands are 95% ci computed using bootstrapping methods?

Appendix B: Supporting tables for Chapters 4 – Annual Overall Smolt-to-Adult Returns

Appendix B contains tables of the overall SARs that are presented in Chapter 4 along with methods for estimating overall SARs. There have been no major changes in Appendix A and B. Values for 2023 or 2024 have been added and overall averages or totals have been updated.

IV.E. Comments on Chapter 5. Upstream Migration Success

Chapter 5 of this report continues analyses of upstream migration success and explanatory variables affecting upstream migration success for spring and fall Chinook salmon, sockeye salmon, and steelhead. This chapter is an update from previous annual CSS reports that the ISAB has reviewed extensively over time. The addition of an analysis of upstream migration of sockeye is a valuable addition. The largest and most consistent effects on upstream migration success of spring, summer, and fall Chinook, and summer steelhead are a history of juvenile transport and hatchery/wild stock origin. Adults of all species and stocks with a history of juvenile transportation consistently show lower upstream survival than those with a history of juvenile in-river migration. Hatchery fish are less likely to survive upstream migration than their wild counterparts. High temperatures negatively impact survival in all reaches for summer Chinook and sockeye salmon, only in the Snake River for spring Chinook, and in the Bonneville to McNary reach for fall Chinook. Most of the text is identical to recent CSS Reports. The Sockeye Supplement was added to evaluate threshold effects related to river temperature and juvenile transportation. The two new conclusions on transportation effects and temperature effects on sockeye are important additions to the chapter's conclusions. Otherwise, all of the figures are identical to previous graphs in this chapter, updated with 2024 data.

Primary comments

2024 CSS Final Report: In our review of the drafts for the 2023 and 2024 CSS Reports, we suggested that the CSS could report the total survival or mortality for each stock and species from Bonneville Dam to Lower Granite Dam to create a context for the reach-specific analyses. We also suggested that the mortality rate per distance of river could be reported to give a clearer understanding of the overall mortality rate as a function of distance and a spatially normalized comparison of the three modeled reaches. The CSS added an overall survival metric for the BON-LGR reach for all fish stocks in the draft 2025 CSS Report. The ISAB appreciates the CSS response and the context it provides for each stock and species. In their response to the ISAB's 2024 review in which we continued to recommend including mortality rate per distance to compare performance for the three reaches, the CSS did not agree. They emphasized that

the three reaches were specifically chosen due to their relevance to management decision making, even though they have differing lengths. They pointed out that the metric the ISAB suggested does not accurately reflect the underlying biological processes that govern upstream migration of salmon and steelhead, does not provide the fishery managers with useful metrics to consider migration success, and invites confusion and erroneous conclusions regarding migration success. The ISAB understands the CSS's concerns with our 2024 suggestion. While the ISAB continues to see value in the suggested "per km" migration metric as well as the way the CSS presents it, we see their point about possible misinterpretation or misuse of the data. The CSS has clearly explained their perspective, and we do not think it is a major flaw in their reporting. The healthy dialogue the CSS and ISAB have shared illustrates the benefit and give-and-take of the review process for CSS Annual Reports.

2024 CSS Final Report: The CSS also responded to our questions about the possible effects of fishing and straying on the poorer metrics for migration in the MCN-BON reach. They indicated that they would be willing to include fishing exposure in their analysis if a more granular dataset assessing fisheries exposure becomes available.

p. 170. The CSS added two major conclusions about sockeye migration success.

- *Transported sockeye were 35% less likely to survive BON-ICH than in-river migrants, a persistent survival cost that was amplified at higher temperatures.*
- *Temperatures above 65°F predicted steep declines in sockeye survival, with average probability of survival between BON-MCA going from 68% to 20% at 70°F.*

The ISAB encourages the CSS to continue to include sockeye analysis in this chapter and to provide conclusions for regional decision makers.

p. 236. The ISAB appreciates the incorporation of the Sockeye Supplement to explore threshold effects related to river temperature and juvenile transportation and the addition of major findings about sockeye in the Conclusions. This is a valuable addition. Does the CSS intend to continue this analysis annually in future CSS reports?

p. 247. The Discussion ends with a major finding about the cumulative effects of temperature, even moderately high temperatures:

"Cumulative thermal exposure was a significant predictor of survival in nearly all reaches it was included. In every model run, this interaction term between travel time and temperature exposure explained the patterns of variability in probability of converting much better than did travel time or temperature alone. Individuals that are exposed to high temperatures for a long

period of time are much less likely to convert than individuals exposed to high temperatures for a short period of time. Because of this, it is unsurprising that the degree day variable performed so much better than the travel time or temperature variables alone, but helpful in our understanding of survival mechanisms, nonetheless. In all species, one of the best predictors of survival through the two upper reaches was the cumulative thermal exposure of an individual prior to entering the reach. This was true across species, but especially in the ones migrating during peak summer temperatures. This repeated finding illustrates a fairly important point for managers trying to affect upstream migration survival. That is, it's not solely environmental and operational conditions that dictate survival success through a particular reach, but also to a large degree, survival through a reach also depends on an individual fish's previous migration experience through the hydrosystem."

The Conclusions at the start of Chapter 5 does not make this point as clearly or thoroughly. Only the last bullet addresses it:

- *Degree Days consistently showed that one of the best predictors of probability of converting through a reach was the cumulative thermal exposure encountered prior to entering the reach.*

The CSS should consider revising the conclusion to highlight the implications for migration success and river management.

Minor comments

Several tables in this chapter report numbers of detected fish by species (e.g., Table 5.2 shows number of adult spring Chinook salmon detected at various dams and PIT tag detection arrays). The description of modeling methods indicates that detection probability is included in survival calculations. However, detection probabilities themselves are not reported. We suggest that the CSS should provide these detection probabilities in tabular form, which could be in an Appendix if cumbersome (e.g., if varies by time periods within a season). This information is needed to understand key limitations of the data and to understand where improvements are needed in detection.

p. 240. The figures for temperature effect on survival of sockeye (5.44, 5.45, 5.46) are very informative illustrations of an important relationship.

Editorial comments

p. 181. Table 5.4 (and similar other tables) “*Asterisks denote coefficient values that do not cross zero.*” Should read “Asterisks denote estimates whose confidence intervals do not include zero.”

p. 182. The CI for age effects are not shown, but there are tick marks on the right side of the plot.

p. 189. Figure 5.7 should be Figure 5.10. All subsequent figure numbers are off by three.

p. 192. Table 5.6 (and other similar tables). Report all figures to 2 decimal places, including 1.00, 0.80 etc. This will align the column and make it easier to read.

p. 195. The figure is numbered as 4.10 but should be 5.13.

p.239. Table 5.18 (and elsewhere). “*Survival probabilities*” should read simply survival.

IV.F. Comments on Chapter 6. Examining Heterogeneity and Factors that Influence Rates of Smolt-to-Adult-Return for Spatially Dispersed Stocks of Spring Chinook Salmon and Steelhead in the Columbia River Basin

This is an analysis of the long-term time series of SARs generated by the CSS. The CSS synthesizes data for groups of salmon and steelhead across the Columbia Basin. The analysis (termed basin-scale population model or meta-analytic approach) examines patterns of survival (SARs) and the variables that affect the SAR values of these groups (labeled stocks). Chapter 6 also appeared in the 2024 report and several of the ISAB’s primary comments (most all of the Minor and Editorial comments) were addressed in this 2025 version. The ISAB’s primary comments addressed include whether jacks are included and assessing the effects of the PITPH and WTT covariates on the variance structure.

The ISAB’s primary comments from the 2024 review of particular concern that were not fully addressed, or addressed but the changes made by the CSS triggered new comments, are repeated below. The models developed in Chapter 6 are then used in Chapter 9 in an analysis that systematically varies values of PITPH and WTT and determines their effects on SARs. The CSS indicated that Chapter 6 models are also planned for further applications. Thus, the primary comments discussed below become even more important to resolve to ensure Chapter 6 and Chapter 9 results (and futures applications) are scientifically sound and differences in predicted SAR values when PITPH and WTT are varied are interpreted with the appropriate level of

confidence. The ISAB considers some of the remaining issues to be sufficient to urge the CSS to either postpone their use in Chapter 9 until they are resolved or to add clear text on the assumptions, caveats, and limitations of the present model based on the comments below.

Primary comments

The CSS decided to not add text and/or conceptual models showing how fish interact with dams (WTT and PITPH) in a broader context and marine survival in a broader context of multiple, interacting factors. The ISAB reiterates that these conceptual models would serve as a communication tool and a framework to help many readers better understand the reasons for the analyses and why certain approaches were selected. The ISAB suggests that the CSS reconsider this suggestion again for the 2025 report.

A present limitation of the models used is that they assumed additivity of effects (i.e., the effect of WTT or PITPH is the same for both species and that the effect of WTT is the same for all levels of PITPH and vice-versa). Models where the effects of WTT and PITPH are allowed to differ across species and where the effect of WTT varies by values of PITPH should also be fit. Second, the R software used for fitting (i.e., `rma.mv()`) allows for more complex inter-year correlation structures, and these should be explored. Third, consideration of other covariates than PITPH and WTT should be explored to possibly explain more variance in the SARs and strengthen the ability to quantify the contributions of PITPH and WTT. These more complex models should also be fit, and model assessments should investigate the utility of including differences between species (beyond the random effect of year within species), the effects of across-year correlations, and the influence of other covariates. This can be done as an exploration that complements the present models that are based on simplifying assumptions and do not include these extensions. One outcome could be that the simplifying assumptions are supported. Another possible outcome is that a more complex model is partially supported. In the latter case, the simpler and more complex models can be used in parallel to compare the influence of PITPH and WTT on SARs under the alternative assumptions underlying the simpler and more complex models. The CSS response to this comment from the 2024 review was that more complex models will be explored in future updates to Chapter 6. The ISAB strongly urges the CSS to add these analyses to Chapter 6 as soon as possible before too many analyses are done going forward (e.g., Chapter 9 in 2025) that use the present (simpler) models without understanding the influence of these added complexities and their robustness.

In addition to the suggested model complexities (i.e., allowing for non-additivity, species differences, inter-year correlation structure), other aspects of the representation of the effects of PITPH and WTT rely on strong (un-confirmed) simplifying assumptions. First, WTT, PITPH, Origin effects (defined in Table 6.1), and distance from the mouth are highly confounded and

potentially show interaction effects. For example, how would using the distance from the reach with Bonneville as a covariate, in addition to WTT, affect the results? Second, is the impact of WTT the same for each reach? Further, related to the general additivity assumption, a parallel slope model for WTT is used in the models with the random reach effects being the intercept. An assessment of the validity of the parallel slope assumption is needed.

The ISAB explored, in a preliminary way, the parallel slope assumption to illustrate how and why investigating these types of assumptions is important. For example, Figure 1 is a plot of $\text{logit}(\text{SARs})$ versus WTT, with a separate line fit for each stock (the non-parallel slope model).

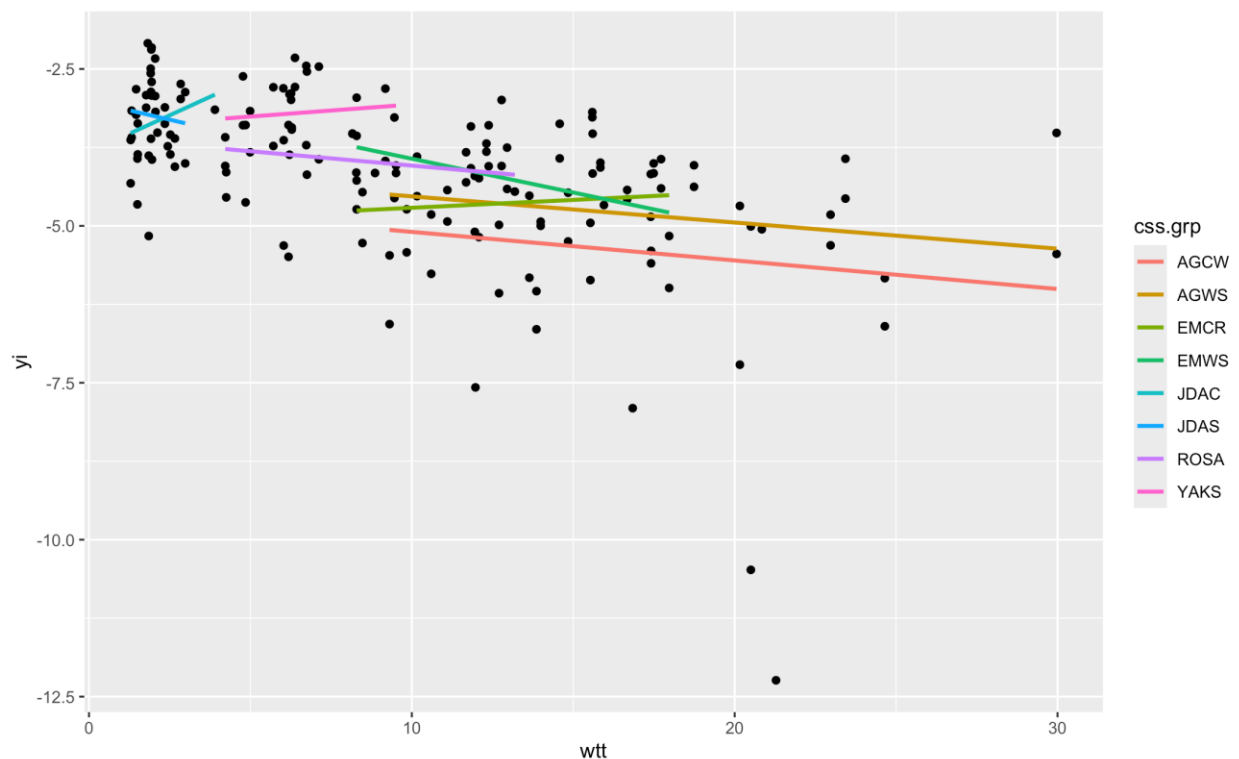


Figure 1. A simple plot to examine the assumption that the effect of WTT can be well-represented by a parallel slope assumption across stocks.

This assumption, like the other simplifying assumptions, needs to be directly addressed and evaluated. The lines (stocks) with positive slopes suggest the parallel slope assumption, while may still be usable, is also more uncertain than implied by the description of the model that does not acknowledge evidence like Figure 1. A more complex set of models can be fit, and their predictions compared to the parallel slope models. A similar exploration should be done with the other key simplifying assumptions, and more complex models added to the toolbox as appropriate.

Another simplifying assumption that needs to be evaluated is the assumption of independence within each random effect (p. 253). For example, consider the zeta_k random effect for the stock effects. There are two stocks from each Origin (Chinook or steelhead). Thus, for example, if one uses a random effect for Stock, one will have random effects for the two species within each Reach, Zone, and/or Origin; however, the independence assumption of these stock effects is questionable because they may be correlated. Similarly, year effects are likely to exhibit an AR(1) structure due to multi-year external factors such as PDOs and ENSO conditions. The validity of this independence assumption has not been documented. Is there a reason why the variable Origin was not included as a separate random effect and why the variable Species was not included as a separate fixed effect? A model with a random Origin effect would induce a compound-symmetric correlation structure on the two random-stock effects and would account for potential within-reach correlation among the two stocks in a reach. Models with AR(1) structure in the year random effects should also be fit.

In the methods, please provide a brief discussion of the ecological evidence as part of the rationale for including random effects for species-specific migration year. We learn later in the Discussion that this accounts for early marine experience that varies among years (and could affect species differently). But could the random effects be considered to reflect hydrosystem conditions (e.g., total discharge) that varies among years? Is there a reason species would differ in their response to annual conditions? Additional discussion is warranted. In addition, consider adding a figure to show these estimates by species. Such a plot would also reveal any temporal autocorrelation.

The presentation and description of the models evaluated as part of model building need to be revised to ensure consistency and clarity. There are notational issues that make it difficult for readers to follow the development and fitting of the models without looking at the actual R code. The model description (p. 253) needs a careful review and correction for clarity and consistency. For example, in Equation 6.2, the thetas have (i,j) subscripts, but the right-hand side of the equation has (j,k) subscripts. The group subscript k represents a combination of reach and species (Table 6.1) with 8 values. Then, the text introduces a subscript l (“el”) to represent species, but there is no such subscript shown in the thetas. To further complicate the description, R-syntax is used in the tables (e.g. Table 6.2) that use terms not clearly linked to description of the models in the text. The ISAB suggests that clear and consistent syntax be used, such as starting with (j,k,l) to represent (year, reach, species) or avoid subscripts and use a shorthand model notation such as:

$$\text{logit}(\text{SARs}) \sim 1 + \text{SampError}$$

$$\text{logit}(\text{SARs}) \sim 1 + \text{Reach:Species(R)} + \text{SampError}$$

$\text{logit}(\text{SARs}) \sim 1 + \text{Reach:Species}(\text{R}) + \text{Obs}(\text{R}) + \text{SampError}$

$\text{logit}(\text{SARs}) \sim 1 + \text{Reach:Species}(\text{R}) + \text{Obs}(\text{R}) + \text{Year}(\text{R}) + \text{SampError} \dots$

$\text{logit}(\text{SARs}) \sim 1 + \text{Reach:Species}(\text{R}) + \text{Obs}(\text{R}) + \text{Year}(\text{R}) + \text{Year:Species}(\text{R}) + \text{SampError}$

SampError is the uncertainty in each SAR's values (related to the binomial-type variance) with **known** variance and so is NOT estimated in the model fitting but is needed to allow estimates of SARs that are more precise to have higher weight than estimates with lower precision. Note that this new style notation shows that a residual error is never fit (as commonly done in regression models) unless the Obs(R) term is included.

The CSS added an analysis to address the ISAB's comment about further exploration of the variance components. The added analyses are a reasonable approach and provide useful information but would greatly benefit from additional analyses. First, how well do the data support the assumption that each of the stock random effects are independent of each other? Intuitively, this seems unlikely because there are two effects from each Origin corresponding to the species analyzed and thus a more reasonable assumption would be that year random effects have autocorrelation. The analysis of changes in the variance component for stocks (p. 261) suggests that WTT is more influential than PITPH. However, stocks located higher up the basin are farther away and hence have larger WTT values; impact of WTT is therefore confounded with the any Origin effects. A more refined analysis is needed to evaluate the importance of these assumptions in the new analyses about variance components.

The great fits between predicted and observed value on the right most column of Figure 6.3 is an artifact of the model structure. The model that generated those excellent fits allowed for individual observational effects that essentially assigns an individual SAR value to each combination of stock and year. This should be clearly explained and results properly caveated.

Minor comments

Further explanation of the correlation structure among the random effects (and fixed effects of WTT and PITPH), especially between the observation level (years nested with stock) and year (years nested with species), should be added.

p. 252. What happens with Equation 6.2 if x is 0 because then the value of y will be undefined. Because the logits are used directly in a standard regression as the response variable, bias adjusted empirical logits should be used by adding a small constant ($1/(2n)$) to x and to $n-x$. Last year, the CSS replied *"Because our dataset contained estimates of adult returns as fractions, x was never 0. We will explore the necessity of adding a constant to the response in future updates to the chapter."* The ISAB downloaded the data/code from the GitHub data, and the

Snake River Wild Spring/Summer Chinook in 1994 has a SAR of zero. Please indicate how this was handled [The R code appears to add .01 – this needs justification.].

p. 259. Table 6.5 shows 166 levels for the second variance component. But Table 6.1 shows a total of 167 observations. Why was one observation dropped? The ISAB ran the code provided in the GitHub site and yes, there is one observation that has a missing value. Why is this value missing?

p. 253. Add a sentence indicating that $Zeta_k$ has been replaced by $Zeta_{(ii)jk} + Zeta_{(iii)k}$ in the new model.

p. 253. Please specify the distribution of the random effects (i.e., a Normal with mean 0 and associated variance).

p. 255. Please include the deviance values for each model fit.

p. 257. Figure 6.3. The outlying points in the bottom right plot all seem to be Snake River. Any reason for this?

Editorial comments

p. 249. The references to Chapter 10 should likely be to Chapter 9. Here and elsewhere.

p. 252. Please be consistent in use of group k (p 252) and stock k (p. 253) throughout the chapter.

p. 253. μ is not a “pooled” $\logit(SARS)$, but rather an average. It is not clear if each year/reach/species combination is weighted by the sampling variance (which should also be defined in terms of how estimated) or is given equal weight. Suggest the CSS use similar language as the *rma()* documentation.

p. 253. *Stock* and *Study* are used interchangeably (definition of $Zeta_k$ and definition of $Zeta_{(iii)}$). Please be consistent.

p. 253. $\epsilon_{(j,k)}$ represents sampling error but this is not explicitly defined except for more vague statements about by ν_{jk} (p. 252) where it is defined as the sampling variance or epsilon.

p. 255. The report indicates that “... *the best-supported model structure consisted of four parameters for the random effects (stock, observation, migration year and species), and one for sampling/residual error.*” The sampling error is not a parameter because the basin-scale (meta-analytic) model assumes that the sampling errors are known exactly and therefore do not need estimation.

IV. G. Comments on Chapter 7. Steelhead Overshoot and Fallback Rates

The CSS added a new chapter on overshoot and fallback of adult wild steelhead in 2025. This chapter examines the migration routes of adult steelhead within the Columbia River Basin and movement of wild steelhead that overshoot the natal tributary, those that eventually fall back to their natal stream, and upstream strays that were never detected in their natal basin. The chapter presents results for 13 major population groups in the Mid-Columbia, Upper Columbia, and Snake rivers. Overshoot and straying have been ongoing concerns for Columbia River hydrosystem management, especially in the Snake River for the four lower Snake River dams. Overshooting is a common behavior for wild steelhead, often between 30-55% according to the CSS analysis, and fallback rates generally are low. This has been a major management challenge for the Lower Snake River Compensation Plan (ISRP 2023-1, ISRP 2025-3). The ISAB commends the CSS for undertaking this analysis of an extremely important management concern in the Columbia River Basin and encourages them to refine and continue this analysis of overshoot, fallback, and straying in the future and include other stocks and species, such as hatchery steelhead and spring Chinook salmon. Future analysis could also examine overshoot and straying at a finer resolution within basins.

Primary comments

p. 264. There are many nuances to fish migratory patterns, so it is important to be explicit and exact in defining terms, and to be clear about which and how data are used to quantify the rates of interest. There are several aspects of the rule set the CSS has developed for this analysis that may confuse readers and could be clarified to improve the interpretation and application of the results.

The category for overshoot includes wild steelhead that were detected upstream of their natal basins as well as fish from the Snake River basin that moved into the Upper Columbia River (above Priest Rapids) and Upper Columbia River fish that moved into the Snake River (above Ice Harbor Dam). Technically, these latter fish are downstream of their natal basins, but they are called “overshoot,” which may be confusing semantically. Is this interpretation of the rule set correct?

Similarly, the category for fallback includes fish that were detected upstream of their natal basin and were subsequently detected in their natal basin. However, it also includes Snake River fish that moved past Priest Rapids Dam but eventually returned to their upstream natal basin in the Snake River as well as Upper Columbia River fish that moved above Ice Harbor Dam but eventually returned to their upstream natal basin in the Upper Columbia. These latter fish

are referred to as fallback though they are migrating upriver. Again, this may be confusing if this interpretation of the rule set is correct.

The CSS *“identified any fish that strayed into a population upstream of their natal population by whether they were detected at a non-mainstem site outside their natal basin as an overshoot, and had no future detections in their natal basin, and we called these overshoot strays.”* We interpret this to mean that overshoot strays include fish categorized as overshoot that were detected downstream of their natal basin (e.g., Snake River fish that moved past Priest Rapids Dam or Upper Columbia River fish that moved past Ice Harbor Dam). If that is correct, it should be explained more clearly and *“upstream”* should be deleted in the definition above. If not, it should be explained more explicitly. The CSS calculated two measures of straying, one by dividing the number of overshoot strays by the number of total overshoot fish in each population. This is essentially the proportion of all overshoot fish that strayed. The second approach divided the number of overshoot strays by the total number of fish in that population detected crossing Bonneville. The CSS indicates that the second metric (total stray rate) does not include fish that strayed into a basin downstream of their natal basin. Apparently, the first metric (overshoot stray rate) does include fish that strayed into a basin downstream of their natal basin, which is consistent with our interpretation above. But if the tagged fish downstream of the natal basin are included in calculating overshoot and fallback but not in overshoot strays, this could lead to misinterpretation and application of the results. The ISAB interpretation may be incorrect, but in any case, we ask that these metrics and calculations be described in a manner that is as simple and easy to understand and replicate as possible.

In future analyses, the CSS could distinguish between migration upstream of the natal stream, and migration into basins downstream of the natal basin. Fallback to the natal basin could also distinguish fallback from upstream and return to the natal basin from downstream detections in tributaries to the mainstem Columbia River. This would allow the CSS to differentiate strays to recipient populations above the natal basin from strays to populations downstream. This distinguishes migration into downstream tributaries from migration past their natal streams and differentiates the geographic distribution of strays to recipient populations relative to the location of the natal stream. The additional detail might seem unnecessary, but different factors may contribute to overshoot, fallback, and straying upstream of natal basins (e.g., adjacent dam, passage, and reservoir characteristics, upstream temperature and other environmental conditions, upstream discharge and hydraulics [as Westley et al. 2025 investigated in spring Chinook salmon], ability of fish to pass downstream to return) than for upstream return to the natal basin after moving into tributaries downstream (e.g., temperature and other environmental conditions that may have caused movement into downstream non-natal tributaries, downstream dam, passage, and reservoir characteristics, impediments to

upstream migration after leaving downstream non-natal tributaries). Though the additional detail requires more complex reporting formats, it provides additional information for managers and researchers and is based on the same data set in the current analysis. We recognize that sample sizes of some of the subcategories might be inadequate in some cases and statistical power would need to be considered. The ISAB recommends that the CSS consider these migration types in future analyses of homing and straying. The CSS should at least provide clarification and help the reader understand potential areas of confusion or misinterpretation.

The Summary and Discussion section indicates that there are substantial rates of overshoot, and that in many cases fallback is insufficient to get all the "over-shooters" back home. Might it be possible to combine these numbers into an index of losses owing to both processes? For example, if 75% of the fish overshoot but 100% fallback and get home, the net effect is likely small to none. But if 50% of the fish overshoot and only 50% of those fall back and get home, then that would be a 25% net loss. The ISAB recommends that this is worth reporting the net loss to the natal basin, which is the most critical factor for population demographics. This should be included as both a figure and a table.

p. 268. Replace "adult" with "wild adult steelhead" in the first sentence of the first paragraph.

p. 269. The description of the analyses indicates that both overshoot stray rate and total stray rate were calculated. These two metrics are illustrated in Figure 7.2, but the values are not provided in a table. Please include a table to support the data illustrated in Figure 7.2.

p. 272. Boxes for the Deschutes and Klickitat rivers should be included in Figure 7.2.

p. 275. What is NA% in the first sentence under Fallback Rates? We assume that it is a placeholder for inserting analytical results.

p. 275. We suggest the following wording: *Fish from the Upper Columbia (Methow, Okanogan and possibly some fish from the Entiat, tagged at Rock Island) who ~~overshot~~ **migrated** into the Snake Basin demonstrated the smallest fallback rate (1.6%), while 9.4% of the fish from the Snake River (upstream of the Tucannon) ~~who that-overshot migrated~~ into the Upper Columbia **fell back with 9.4% success rate**.*

p. 269. The text describes the exclusion of data for some rivers based on small numbers of tags for analysis. *"Overall overshoot and fallback rates, by population group, are shown in Table 7.4. Some population groups have very few tags for the analysis, or have a sufficient number of tags but very small overshoot rates. To streamline the results, after Table 7.4 we have dropped any population group with fewer than a total of 25 tags with detected overshoot behavior across the entire time-series ..."*

The ISAB does not agree that “streamlining the results” is necessary or warranted, particularly when overshoot rates are low but sample sizes are high. The analysis for the White Salmon and Rock Creek (only 13 and 38 tags in total, respectively) might not be robust. However, the Klickitat River had 139 recovered tags and 8 that overshoot the river, and the Deschutes River had 804 recovered tags and 4 that overshoot the river. These two rivers would demonstrate low overshoot rates. Please depict all of the natal population groups in the figures or at least include the Klickitat and Deschutes rivers.

p. 281. In the Discussion, the CSS does not relate its findings on overshoot, fallback, or straying to the results of other published studies in the Columbia River Basin. The chapter cites several previous studies on this topic, such as Haeseker et al (2012) and CSSOC (2017). In addition, there are a number of relevant papers on this topic, such as Bond et al. (2017), Keefer and Caudill (2014), Pearsons and O’Connor (2020), Pearsons and O’Connor (2024), Quinn (1993), Tattam and Ruzycki (2020), and Westley et al. 2013. The CSS could provide a stronger context for the findings in this chapter by briefly summarizing the results of their previous study and other studies in the Columbia River Basin and relating them to the CSS results.

Discussion section: The ISAB encourages the CSS to refine and continue this analysis of overshoot, fallback, and straying in the future and include other stocks and species, such as hatchery steelhead and spring Chinook salmon. The CSS could expand the discussion of potential future directions for the analyses and recommend possible species or stocks to be added.

A paper by Min et al. (2025) has been published very recently that has considerable overlap with the CSS analysis of overshoot and fallback but also differs in some ways. The citation is below, and it would be helpful if it was included and some mention made of the similarities and differences between data, methods, and conclusions between the CSS report and this paper.

- Min, M.A., R.A. Buchanan, and M.D. Scheuerell. 2025. Modeling climate and hydropower influences on the movement decisions of an anadromous species. *Global Change Biology* 31: e70533.

Minor comments

p. 268. *“Repeat spawners were identified by subsequent detections at Bonneville **Dam** that had more than a year since the previous detection of that fish.”* What proportion of fish in this analysis were repeat spawners, and did their behavior differ over time?

p. 269. *“... as well as fish marked in the Upper Columbia that were detected overshooting into the Snake River (past Ice Harbor Dam).”* Please see the major comment for page 266. The ISAB

suggests that this is straying rather than overshooting because it is downstream of the natal stream. See suggested nomenclature above.

“Fallback rates were calculated by dividing the number of fish in a population detected in their natal basin after having an overshoot detection by the number of fish with an overshoot detection from that population in that spawn year.” Was it sufficient to have retreated downstream in the mainstem to the general area of the natal basin or did there have to be a non-mainstem detection in the natal basin?

p. 275. *“Fallback rates, or survival to the natal basin after overshooting, for population groups range from NA - NA% (Table 7.4).”* Please fill in this text.

“Fish from the Upper Columbia (Methow, Okanogan and possibly some fish from the Entiat, tagged at Rock Island) who overshoot into the Snake Basin demonstrated the smallest fallback rate (1.6%) ...” The text on p. 266 indicated that fish tagged at Rock Island Dam were excluded from the dataset. Please clarify or correct.

Editorial comments

p. 263. The format for the Summary, Take Home Messages, and Introduction is not consistent with other chapters.

Throughout the chapter, replace “fallback success” or “successful fallback” with “fallback.” “Success” or “successful” does not add to the meaning or quantification of “fallback.”

Also, capitalize “dam” when it follows the name of a single structure (e.g., Rock Island Dam) and use lower case dam when it follows a series of names of dams (e.g., Bonneville, John Day, and McNary dams).

p. 263. We suggest the following revisions of the Summary and Take Home Messages:

First sentence of Summary: *“This chapter examines the migration routes of **wild** adult summer steelhead within...”*

Second sentence of Summary: *“In particular, we focus on behavior known as overshooting, **in which where** an adult fish moves past a mainstem dam **that which** is upstream of its natal watershed.”*

Third bullet in Take Home Messages: *“Overshooting path **affects fallback rates** ~~impacts success:~~ (i.e., the ~~success~~ rate at which overshooting fish ~~to~~ return to their natal streams), ~~known as~~ “fallback,” **which** is frequently less than 70%.”*

Fifth bullet in Take Home Messages: *“Fallback ~~success has~~ generally decreased over the time-period ~~series~~ of the study (2011-2024), especially for fish that overshoot into the Mid-Columbia or Snake River.”*

p. 263. The CSS Report uses the heading “Take Home Messages” in Chapter 7 instead of Conclusions. Why does it use a different format?

p. 264. Third bullet: ...pathways...

p. 265. Table 7.1, caption. Please explain fallback site abbreviations and provide some way for the reader to know where they are. These abbreviations are not the same as those in Figure 1. Should some of these abbreviations be the same as the abbreviations in the glossary?

p. 266. *“We started with a PTAGIS query of any wild steelhead tagged...also detected at Bonneville Dam.”* Please specify whether the latter was during outmigration as a juvenile or during re-entry as adults from March to October.

Second sentence: *Wenatchee* is misspelled.

p. 266. Replace *“worked to separate out”* with *“separately analyzed.”*

p. 266. Replace *“filtered out”* with *“excluded.”* We recommend this replacement throughout the chapter.

p. 267. Figure 7.1. Is there a need to indicate all potential PTAGIS locations? More relevant would be only those locations that provided initial marking locations for this study (and those are not that important) and re-detection locations used to identify overshoot and fallback (these are very important), and the symbols for two groups should be different.

The colors for the Tucannon and Umatilla, as well as several other subbasins, cannot be distinguished, especially with the additional complexity of labels for dams and black dots for PTAGIS detection sites. Also, the legend is cropped slightly, deleting text within the legend.

p. 268. *“First, **we excluded the initial** adult detections at Bonneville dam **that were less than one year from the initial** ~~was identified, based on it being at least a year since the~~ date of tagging.”*

p. 268. Replace *“i.e.”* with *“i.e.,”*

p. 271. Table 7.4. Please add tables or stacked tables overshoot strays, downstream transient strays, and total strays.

p. 275. Figure 7.3. Please use the same MPG colors as in Figure 7.2.

p. 334. The volume and page numbers for Murdoch et al. 2022 are 42:1066-1080.

IV.H. Comments on Chapter 8. Have We Followed the PATH?

The ISAB generally found this chapter to be well-written and informative to all readers, from those new to the Columbia Basin to those highly knowledgeable about the Columbia Basin. It is a nice next-addition to the “Readers’ Guide” series, and the ISAB strongly supports the CSS continuing these installments. The ISAB offers the following suggestions (mostly editorial for take-away messages) for further improving this well-done chapter.

The ISAB suggests modifying the text so that the main messages are highlighted. The messages are very important and presented within the text but can be easily overlooked or lost. Adding explicit statements of the main conclusions, either to the start of the chapter or the final section, would ensure readers who read the chapter at different levels of scrutiny will understand the main conclusions. For example, it is not until the end of the chapter (p. 295) that a major important message is clearly stated:

“In summary, thirty years after the initiation of PATH, it is clear that incremental hydrosystem management changes (in addition to changes in habitat, harvest, and hatcheries) have been insufficient to recover Snake River salmon.... CSS analysis identifies breaching the four Snake Dams as the management option with the highest likelihood of recovery and attainment of salmon management goals.”

This is an important statement and should be highlighted but also needs clarification and placed into a proper context. What is missing is an accompanying statement that explains the quote does not use another critical comparison about what would have happened without the restoration. If possible, also adding some discussion of some of the hypotheses on why incremental hydropower management changes does not seem to result in the anticipated recovery would add important context. This would lead to a nice broad view of why the connection between habitat and fish physiology and health is sometimes fuzzy. This can then lead to a discussion of how the relevance and usefulness of CSS analyses can be further advanced by integration with incorporation of additional external factors, such as avian predation, seal and sea lion predation, introduced species (e.g., walleye), extreme weather years, and climate change.

Other important conclusions are clearly stated and would be more completely described with the addition of a few concluding sentences to complete the thoughts. Some examples (p. 291) are:

Quotes: “However, disagreements about assumptions and techniques continue still (see Storch et al. 2021 and Faulkner et al 2021 for arguments concerning hypotheses about latent mortality and hydrosystem effects).” and

“CSS analyses continue to support the PATH hypothesis that deleterious hydrosystem conditions (slow water travel time and multiple powerhouse passages) result in significant latent mortality in the marine environment.”

Suggestion(s): Perhaps add some quantitative evidence of the magnitude and importance of latent mortality. Also, please consider summarizing the mechanisms by which delayed effects occur and the disagreements or uncertainties regarding this concept. For example, if the mortality occurs in the early marine period, which is not observed or quantified directly, what are the fish dying of and what in their past predisposes them to die? Did they arrive in marine waters too early or too late in the season? Were they infected with some disease that they later succumbed to or some acute stress? Importantly, how might these influences be related, directly or indirectly, to passage?

Quote: “The relative survival benefits of transportation versus in-river emigration have been quantitatively described (see the TIR analysis in Chapter 4).”

Suggestion: Rather than referring to an analysis in Chapter 4, state here the actual conclusion about the survival benefits of transportation.

Quotes: “In summary, thirty years after the initiation of PATH, it is clear that incremental hydrosystem management changes (in addition to changes in habitat, harvest, and hatcheries) have been insufficient to recover Snake River salmon ... CSS analysis identifies breaching the four Snake Dams as the management option with the highest likelihood of recovery and attainment of salmon management goals.” and

“Results showed that expected Chinook salmon and steelhead SARs under the breach alternative were 2-3 times higher than SARs under alternatives that maintained the lower Snake River dams in place.”

Suggestion: These are major statements and deserve to be re-stated in other places in the report (e.g., Summary, Chapter 8).

IV.I. Comments on Chapter 9. Quantifying the Effects of Water Transit Time, Powerhouse Passages, and Ocean Conditions to Achieve Regional SAR Goals for Columbia River Basin Spring/Summer Chinook and Steelhead

Chapter 9 quantifies the effects of water transit time (WTT), powerhouse passages (PITPH), and ocean conditions on salmon survival and identifies flow targets necessary to achieve regional SAR goals for spring/summer chinook and steelhead. Two modeling approaches are used: 1) cohort models updated from the models developed by the Comparative Survival Study Oversight Committee (CSSOC) and the Fish Passage Center (FPC) as part of the Adaptive Management Framework for evaluating alternative hydrosystem operations, and 2) the basinwide population models from Chapter 6.

Primary comments

In the first part of this chapter, cohort models are developed for the Snake River to predict the impact of WTT and PITPH (and other covariates) on SARs. Many ocean covariates were examined, and no single one was a good predictor for all three stocks. This may indicate that the selected ocean variables are artifacts of the selection process (e.g., false positives) or that survival is the result of multiple (partially correlated) ocean variables making identification of a single driver difficult. Further work is needed to assess this. The final cohort models are then used in a simulation study to examine the combinations of WTT and PITPH that lead to years with higher SARs. Because these cohort models are “homogeneous” with respect to distance from the mouth and number of dams encountered, this approach may be reasonable.

Two other issues with the cohort model analysis that merit further evaluation are the additivity assumption and the independence between year effects and ocean variables. The results (p. 302 and Tables S2, S3, and S4) are all based on assuming additivity of effects of PITPH and WTT (i.e., that changes in WTT have the same effect at all levels of PITPH and vice versa). However, non-additive effects seem likely given that on page 300, the text says *“Increases in PITPH have been shown to be associated with increases in fish travel times...”* This issue also arises with the basin-scale model (see comments below and expanded upon in Chapter 6). The ISAB suggests adding bivariate plots to show the relationship between WTT and PITPH, and text that offers explanations of why one would expect WTT to be correlated with PITPH. This has management implications because if they are related, then management actions to improve one would also affect the other. The other issue of the relationship between the independence of year effects and ocean variables involves Steps 2 and 3 of the simulation methodology (p. 306). The sequence of steps shown assume that year effects are not associated with the ocean variables.

What is the basis for this assumption? An evaluation of these assumptions, as well as additivity, is warranted.

In the second part of the chapter, the basinwide populations models (wild Chinook and steelhead) identified in Chapter 6 of this report are used in a similar fashion as the cohort model analysis. The ISAB has primary comments (and some concerns) about the use of this model for the analyses presented in Chapter 9. First, our comments about Chapter 6 imply that further development of the basinwide models (mostly checking a suite of simplifying assumptions) is warranted before their application is expanded in applied analyses (as is done in this chapter). A series of primary comments related to confirming the validity of several simplifying assumptions (e.g., additivity of WTT and PITPH effects, parallel slopes across stocks, treatment of random effects, accounting for distances from the mouth, other covariates) or if found specific assumptions are sufficiently unsupported, the addition of more complex models with the existing Chapter 6 models may be warranted. The ISAB urges consideration of these assumptions. In the future, perhaps the CSS could also include an alternative approach to complement the basin-scale approach, which would help reduce uncertainty. For example, if changes in WTT or PITPH were examined at the reach level (e.g., Lower Granite to Bonneville, see Table 6.1), it would be possible to evaluate the impact in each reach of reducing WTT by 1 day or by 10% or some other reasonable value.

This chapter demonstrates the increasing use of multiple models to better quantify uncertainty in predictions. Using multiple models is a powerful approach for understanding uncertainty and the role played by different assumptions. But the approach is also highly nuanced, and results can be easily mis-interpreted. The CSS does not appear to have a standardized way to implement and report on the results of multiple models. The CSS should develop a “multi-model guide” to help standardize the approach and documentation. Documentation should compare and contrast: (a) the data used to develop the separate models; (b) the assumptions made for each model; (c) the results of model fitting including assessments of fit; (d) the relationship among the outputs from each model, and (e) how the results from the multiple models (when they agree and disagree) can be used in decision-making. This will allow readers to better understand analyses that use multiple models and to properly interpret differences and similarities in predictions. Without such guidance, it is not clear the degree of independence among the multiple models.

For example, a short section with a table that compares the major features and assumptions of the cohort and basin-scale modeling is needed. Most reviewers could not easily determine how these two modeling approaches are similar and how they differ and thus were unsure of the rationale for including both of them in the analysis. The cohort modeling refers to other

documents and the basin-scale modeling refers to Chapter 6 for more details. This makes it very challenging for the reader to appreciate the benefits of using both models to answer the same (or very similar) questions. Features and assumptions would compare what covariates are included, applicability to river systems, years used for estimation, how WTT and PITPH effects are represented, strengths and weaknesses, etc., presented side-by-side in a table (columns for Feature/assumption, Cohort models, Basin-scale model) with accompanying text. The text would also explain the reasons for including both models in terms of how they offer complementary strengths and weaknesses. The presumption is that the CSS thinks that predictions with both models provide more robust and higher confidence results than the predictions from either individual model alone. This needs to be fully explained.

Both models are used to explore a range of PITPH and WTT values on a basinwide scale. This is puzzling – how does a single WTT value of 9 days apply to fish released low in the basin compared to fish released high in the basin? A similar concern exists with single values for PITPH. Why was this approach used rather than looking at “incremental” changes that could be more readily applied basinwide such as a 10% reduction in WTT from each release point or a 10% reduction in the PITPH at each release point?

For both the cohort and basin-scale modeling, more explanation and graphical documentation of how the WTT and PITPH values explored in simulations fall within and outside of the range of the observed data used to develop the model would provide important information within which to view the predictions. For example, with the cohort modeling results presented in Figures 9.5, 9.6, and 9.7 (p. 310), one could overlay dots showing the combinations of WTT and PITPH seen in the data to enable a visual assessment of where the simulated conditions fit within the observed data. This also applies to the results presented with the basin-scale model (Figures 9.10 and 9.11). In addition to graphical assessment of the how the WTT and PITPH values used in the simulations fit within the observed data, perhaps generating “delta WTT” values for each reach would offer a more robust predictor?

The ISAB also has reservations about the simulation methodology outlined with both the cohort and basin-scale models. First, with the cohort models (p. 302), the ISAB notes that data dredging can cause an unacceptable number of occurrences of “random” false positives showing in Figure 9.1. Table S1 shows a large number of ocean variables were screened and each variable was tested in 3 models. Even at $\alpha=.05$, some or many of the positive results may, in actuality, be false positives. Forward selection methods for identifying significant covariates, like all stepwise selection methods, are known to be sensitive to small changes in the data. The ISAB suggests that this be evaluated, such as via bootstrapping, as part of the analyses.

The simulation methodology with the basinwide model from Chapter 6 also needs some clarification. First, why are the BLUPs being used to estimate the variances (p. 313, Steps 2 and 3)? The estimates of the variance of the random effects are directly available from the model fits. Step (5) refers to Step (2) but maybe Step (3) is meant? In any case, it is not necessary to generate the BLUPs. Second, Steps (7) and (8) indicate that the models are refit multiple times. This seems unnecessary, as the data has not changed, so the fits do not change over the simulations. Perhaps the approach being used (or could be used) is to generate the fits from each of the models in the model set; estimate the variance components; estimate the marginal predictions; and only then vary (Step 5) over the random effects multiple times in much the same way as done with the cohort models.

Third, what does it mean in Step 4 of the simulation methodology that values are chosen for PITPH and WTT for stocks when the reaches have different distances from the mouth of the Columbia? How can a single WTT value represent the experience of all stocks in the basin at several reaches? What does a WTT of 6 to 9 days mean on a basinwide scale? Similarly, what does a single value of PITPH mean on a basinwide scale? This is needed to properly interpret conclusions like:

“Means of simulated SAR distributions for wild Chinook salmon indicated that the lower bound of NPCC goals (2%) would be met at WTT between approximately 6 and 9 days”

These aspects of the simulation methodology with the basin-scale modeling requires clarification in its description, justification, and how it affects the interpretation of results.

Finally, the statement in the report pertaining to the basin-scale modeling results that *“Predictions generated are therefore generic, and not specific to any one stock (p. 316).”* needs clarification and expansion. This seems like very important information and a major caveat that guides readers in how to appropriately interpret the predictions. What does this statement mean in a practical sense when readers look at the model results? Does this also apply to the predictions from the cohort modeling or is it specific to the basin-scale modeling?

Based on the cumulative comments of previous reviews of the CSS annual reports and this review (Chapter 6), the ISAB has reservations (i.e., a revision is needed) in the present usage of the basin-scale modeling presented in Chapter 9. The ISAB urges the CSS to consider two options in their revising of the 2025 report: (1) consider postponing the inclusion of the basin-scale modeling presented in Chapter 9 in the report until the major issues raised by the ISAB with the basin-scale modeling are addressed and resolved, or (2) add a section on caveats or model assumptions and limitations to Chapter 6 and Chapter 9 to document the issues raised by the ISAB, as well as others considered by the CSS during model development and

application. The second option is less preferred, as addressing the issues now rather than later (first option) is more straightforward. However, if it is deemed necessary to include basin-scale results in Chapter 9 in the 2025 report, then these new sections (expanded version in Chapter 6 and summarized in Chapter 9) would provide the reader with the proper context with which to view the predictions.

Minor comments

Please present plots of SARS versus WTT and SARS versus PITPH to give the reader a sense of the data.

p. 303. The Ocean variables are indexed using month. How is a value assigned for cohorts 2 and 4 that spans 2 months?

p. 306. These plots make it difficult to see any lack of fit. Perhaps the plots in the supplemental material should also be referenced here.

p. 310-312. The predictions of the cohort models (Figures 9.5 to 9.9) are presented as mean values of SARs and as number of years with SAR below 1%. This is useful information, and readers should be cautioned to use both sets of predictions and not just the number of years. Counts of years viewed alone can mask situations when values are very close to the 1% versus when values are much lower and higher than 1%. The corresponding figures showing the mean values are also needed.

p. 310. Figure 9.5 (and similar) could be changed to a contour plot with a layer of observed values. In addition, consider adding contour plots to represent the uncertainty around the estimates of mean SAR values across the simulations.

Figure S7 has axes switched compared to Figure 6.3. Is there a reason, or should model fit be represented the same way across the entire report?

Table S1. Variables should be described. Elsewhere in the report, describe how to interpret the ocean indices (especially NPGO and PDO).

Table S4. Please discuss the relative importance of freshwater versus marine covariates. Can we conclude that ocean covariates explain up to the same proportion of the variance in SAR as the freshwater covariates?

Editorial comments

p. 298. Please change *“first agencies and tribes flow proposal”* to *“first agencies and tribes’ flow proposal”*

- p. 298. Please fix the use of a comma in “new dams, (Lower Granite, Little Goose, Lower Monumental and John Day).”
- p. 299. Please clarify the statement “*At the same time the development and operation of the Columbia River Treaty (CRT) dam and reservoir system in Canada was completed.*” At the same time as what?
- p. 302. Please clarify the statement “*As juvenile survival is a component of SAR survival, our base models consisted of the same variables and form as the juvenile survival model for each species (see Chapter 2 of McCann et al. 2024)*” In particular, indicate what these *same variables* were.
- p. 303. Specify that the statement “*There were 96 Chinook salmon cohorts available for analysis during 1998-2021*” is for Spring/yearling Chinook.
- p. 313. Please define what an HDI interval is.
- p. 315. Please modify the color scale to avoid using “pink” in the upper left corner that is a desirable area and not to be confused with the similar-looking red in the lower right.
- p. 322. Figure S7 (and other similar figures). Each individual panel should have the predicted SARs on the X-axis and the observed SARs on the Y-axis. Can the extreme values (outliers) be identified, especially if they belong to a single year, and flagged?

IV.J. Comments on Appendix A: Survivals (S_R), SAR by Study Category, TIR, and D for Snake River hatchery and wild spring/summer Chinook, steelhead, sockeye, and fall Chinook

Appendix A updates the CSS time series of juvenile in-river survival from LGR to BON (termed SR), SARs by study category, and TIRs and D for Snake River hatchery and wild spring/summer Chinook, hatchery and wild steelhead, and hatchery sockeye. Patterns of TIR and in-river survival probability are also updated for Snake River wild spring/summer Chinook, steelhead, and fall Chinook.

The ISAB has no specific comments on Appendix A. The presentation of the information supports the concepts of open data and increases transparency.

V. ISAB Appendix: Suggested Topics for Further Review 2011-2024

[ISAB 2024-3](#), pages 4-7

1. The CSS should consider including coho salmon (e.g., in the PIT tagging effort and reporting) to help understand the dynamics of success of the large reintroduction effort in the mid and upper Columbia River, and the potential for inter-specific effects on other salmonid populations as coho salmon become more abundant.
2. The ISAB repeated its recommendation from its 2023 review that the CSS should consider how to incorporate the influence of climate-related and density-dependent factors on the marine survival of Columbia River salmon in future reports.
3. The ISAB encouraged the CSS to revisit our suggestion from the review of the 2023 CSS report on breaching by examining lessons learned from Klamath dam removals, which were removed this year, and other dam removals in the region.
4. If analyses are preformed that involve *a priori* selection of specific and limited explanatory variables, the description of the methods should clearly describe why those variables were selected and the implications of their use for the results and interpretation.
5. The CSS should consider expanding certain analyses (e.g., SARs and benefits of flow augmentation) to sockeye salmon.
6. Some analyses would benefit from further resolution of the ocean phase (SARs), analyses of flows to include the lower estuary (WTTs), and decomposing results into year-types to more fully understand the robustness of general patterns.
7. When information is available on the details of the Columbia River Treaty, the CSS should analyze the likely effects of the revised treaty on passage and survival metrics based on observed responses in the system to date.

[ISAB 2023-2](#), pages 7-9

1. Building upon the 2019 model comparison, Basin Partnership 2022, and Chapters 2 and 6 in the 2023 Report, continued analysis of the benefits, uncertainties, and risks of breaching the lower Snake River dams is warranted. The ISAB views this as a critical effort going forward, as the issues to be addressed likely involve changes to models, adding sources of uncertainty not previously considered, and using modified models to perform new simulations.
2. With the long-term data available and changes in some of the dams, additional dam-specific information is available to include in the analyses.

3. The CSS could consider how to incorporate the influence of climate-related and density dependent factors on the marine survival of Columbia River salmon in future reports.
4. Given the value of the time series for comparative analyses, a useful addition would be a recurring chapter that synthesizes similarities and differences between hatchery and wild fish in SARs, FTTs, PITPH, and other response variables.

[ISAB 2022-1](#), pages 5-7

1. Given that the Council's SAR targets are generally not being met, are the populations more or less destined for functional extirpation sometime in the future? Explain factors related to attaining the recommended SARs with respect to the suite of actions implemented under the Fish and Wildlife Program.
2. Although the CSS is an empirical modeling effort, can the FPC and CSS Oversight Committee expand upon previous analyses to identify further evaluation and data needed to address the "breaching" proposals for the four lower Snake River dams more fully? Is breaching an all or nothing proposition, or can significant gains be expected with fewer dams being breached?

[ISAB 2021-5](#), pages 4-7

1. Provide a more robust introduction section that includes a summary of major findings, highlights new analyses, and describes recommendations for potential management applications of findings. Describe changes in annual report structure from year to year, including why chapters and analyses were dropped or added.
2. Describe major applications of the CSS data that have been published or reported over the last few years and briefly highlight the important findings that are based on CSS data.
3. Consider recent analyses conducted outside of the CSS to identify possible new analyses that would inform issues raised by these external analyses. Step back, decide on the core results that need to be presented, identify the major uncertainties in the results and how these could be addressed.
4. Explore analytical methods to adjust for biases for smolts captured and tagged at Rock Island to maintain a longer period of information.
5. Address the unusually high mortality rates of subyearling Chinook in the MCN-BON reach and include major recommendations in their Conclusions.
6. Form a working group to explore how newer computer technology could reduce the human cost of updating and reporting the CSS report.

[ISAB 2020-2](#), pages 3-7

1. Expand the annual report's introductory section to highlight 1) an overall summary for the survival of Chinook salmon, steelhead, and Sockeye salmon in the Columbia River Basin and how the SARs for the year compare to the long-term means, 2) new analyses included in the report, 3) major changes that may signal emerging management concerns, and 4) major recommendations for management of the hydrosystem that substantially alter or reinforce previous decisions or concerns.
2. Consider ways to address the spatial and temporal aspects of the effects of total dissolved gas (TDG) on acute and long-term survival, as we also recommended in 2019.

[ISAB 2020-1](#), Review of the 2019 Annual Report's [Chapter 2](#), *Life Cycle Evaluations of Fish Passage Operations Alternatives from the Columbia River System Operations Environmental Impact Statement (CRSO-EIS)*, pages 5-6:

1. Perform a sensitivity analysis to investigate the impact of climate change for potential future flow regimes.
2. Compare results between different types of flow years and include demographic and other stochasticity in the models so that year-to-year variation in the output measures is more reflective of the response from different operations.
3. Incorporate the relationship of individual fish characteristics—such as body size, body mass, condition factor, and date of ocean entry—to survival. The current literature is confusing (e.g., Faulkner et al. 2019 vs Appendix G of the 2019 CSS Annual Report). Collaborate on joint analyses and use a common data set to resolve this issue.

[ISAB 2019-2](#), pages 3-4:

1. Include information about the effects of mini-jacks on estimates of SARs and other relevant parameters.
2. Investigate implications of very low smolt-to-adult survivals (SARs) to hydrosystem operation alternatives and explore whether there is enough information to estimate how much improvements in habitat and other “controllable” aspects of the hydrosystem are needed to improve SARs.
3. Continue the work on the integrated life-cycle model looking at smolt-to-adult survival.
4. Continue to model adult salmon and steelhead upstream migration and consider adding information on individual covariates.
5. Consider ways to address the spatial and temporal aspects of the effect of TDG on survival.
6. Continue work on methods to estimate numbers of outgoing smolts at Bonneville.

[ISAB 2018-4](#), pages 3-6:

1. Develop models for multiple populations that include combined and interactive effects.
2. Use the life-cycle models to investigate potential benefits to survival of management actions such as spill modification.
3. Expansion of ocean survival estimates to additional populations.
4. Include an analysis of mini-jacking and impact on SARs.
5. Include a more in-depth analysis of the PIT/CWT tagging experiment.
6. Improve the model for estimating abundance of juveniles at Bonneville.

[ISAB 2017-2](#), pages 2-5:

1. Modeling flow, spill, and dam breach scenarios is very useful for policy makers. Consequently, it is important that all assumptions be clearly stated and that the results are robust to these assumptions. Work on testing assumptions was suggested.
2. Include other important processes in the life-cycle models such as compensatory responses and predator control programs.
3. Elucidate reasons for shifts in the age distribution of returning spring/summer Chinook Salmon.
4. The graphical analysis of the impact of TDG could be improved using direct modeling to deal with potential confounding effects of spill, flow, TDG, and temperature.
5. The (new) modeling of adult survival upstream of Bonneville should be continued and improved to identify the limiting factors to adult returns.
6. The CSS report is a mature product, and the authors are very familiar with the key assumptions made and the impact of violating the assumptions. These should be collected together in a table for each chapter to make it clearer to the readers of the report.

[ISAB 2016-2](#), pages 5-6:

1. Use variable flow conditions to study the impact of flow/spill modifications under future climate change, and examine correlations between Pacific Decadal Oscillations (PDOs) and flows.
2. Examine impact of restricted sizes of fish tagged and describe limitations to studies related to types/sizes of fish tagged.
3. Modify life-cycle model to evaluate compensatory response to predation.
4. Comparison of CSS and NOAA in-river survival estimates.

5. Examine factors leading to spring/summer Chinook Salmon declines of four and five-year olds and increases in three-year olds.

[ISAB 2015-2](#), pages 4-5:

1. Use SAR data to examine both intra- and interspecific density dependence during the smolt out migration and early marine periods.
2. Propose actions to improve SARs to pre-1970s levels.
3. Explore additional potential relations between SARs and climate and ocean conditions.
4. Consider ways to explore the variability of inter-cohort response.

[ISAB 2014-5](#), pages 2-3:

1. Hypotheses on mechanisms regulating smolt-to-adult return rates (SARs) [update from 2013 review]
2. Life-cycle modeling questions and Fish and Wildlife Program SAR objectives [update from 2014 review]
3. New PIT/CWT study

[ISAB 2013-4](#), page 1:

1. Hypotheses on mechanisms regulating smolt-to-adult survivals (SARs)
2. Life-cycle modeling questions and Fish and Wildlife Program SAR objectives
3. Data gaps
4. Rationalization of CSS's Passive Integrated Transponder (PIT)-tagging
5. Publication of a synthesis and critical review of CSS results

[ISAB 2012-7](#), pages 2-3:

1. Evaluate if the NPCC's 2-6% SAR goals and objectives are sufficient to meet salmonid species conservation, restoration, and harvest goals.
2. Development of technology to improve PIT-tag recovery in the estuary.
3. Review estimation methods for smolt survival below Bonneville Dam through the Columbia River estuary using PIT-tags, acoustic tags, and other methods.
4. Examine measurement error in SAR estimates associated with PIT-tags.

[ISAB 2011-5](#), page 2:

1. Influence of mini-jacks on SARs.

2. Effects that differential harvest could have on the interpretation of hydropower, hatchery, and habitat evaluations.
3. Extent to which PIT-tag shedding and tag-induced mortality varies with species, size of fish at tagging, tagging personnel, and time after tagging.

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