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Review of the Comparative Survival Study (CSS) Draft 2024 Annual Report

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ISAB Review of the Comparative Survival Study (CSS) Draft 2024 Annual Report

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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 fourteen years ago with the evaluation of the CSS's draft 2010 Annual Report, and most recently with a review of the draft 2023 Annual Report.[1] This ISAB review of the *2024 Draft CSS Annual Report: Comparative Survival Study of PIT-tagged Spring/Summer/Fall Chinook, Summer Steelhead, and Sockeye* is thus the ISAB's fifteenth review of CSS annual reports.

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 2024 CSS Annual Report (Section IV).

The annual CSS report is a mature product, typically 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 2023 Annual Report, Appendix H), and we do not expect the CSS to necessarily respond immediately to all our requests for new analyses.

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

[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, and ISAB 2023-2.

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 critically evaluated the analyses in the CSS reports and made suggestions for improved methods, interpretations, and presentation of results.

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 1-5 are ongoing components of the CSS Report and specific comments are provided in our report. Three new chapters were added in 2024 (Chapters 6-8); we briefly summarize them, highlight important findings, and suggest areas for improvement.

Heterogeneity and Factors that Influence Smolt-to-Adult-Return Proportions

Chapter 6 is an omnibus analysis of the relationship between SARs and covariates. An empirical logistic regression analysis was conducted of SARs versus water transit time (WTT) and an index of powerhouse encounters (PITPH) for Chinook and steelhead was combined with random effects for group and year. Several models were fit and ranked using information criteria. However, all of the models assumed simple additivity between the factors (e.g., the incremental effect of water transit time was the same for both species). Additional models should be fit to investigate if the incremental effects of WTT and PITHP are the same for both species. Additionally, the effects of other possible explanatory variables (e.g., marine phase-related, freshwater habitat-related, migration dimensions), in addition to WTT and PITPH, are known and their effects should also be considered in the model building.

Influence of Flow Augmentation from the Snake River above Brownlee Reservoir on Salmon and Steelhead Survival

Chapter 7 examines the efficacy of flow augmentation. Only small effects on the hydrosystem were detected, so it is not surprising that there was little evidence of an overall effect on fish survival. However, flow augmentation may be beneficial under certain conditions (e.g., low flow years), so further analyses are needed to investigate its effects under different hydrological conditions and when salmon are scarce (i.e., if even relatively small benefits could benefit the population's status).

Estimating Powerhouse Passage Proportions at Hydropower Dams

Chapter 8 is a useful addition to the previous chapter of the 2022 CSS Report that describes the history of the hydrosystem, development of management of spill to benefit salmon and steelhead, and the formation and evolution of the CSS study to inform state, federal, and tribal fisheries managers. The ISAB noted some concerns about the use of some water gaging stations. This new chapter, and the chapter from the 2023 report on the history of the hydrosystem development, are valuable foundations for readers of the CSS reports, especially those without extensive prior knowledge of the system. Perhaps these types of chapters could be combined into a single document that is available as "background" on the CSS for future readers.

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 26 years of data, the conclusions reached are now extremely valuable because the uncertainties in the results can be well estimated and outlier years can be identified. Moreover, annual data collection and analysis updating can play a "sentinel" role by permitting a standardized detection of changes within a contemporary period. The physical (e.g., PIT tag detection arrays) and human capacity and expertise added over the 26 years are extremely valuable, 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. This is 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 likely to occur more often under climate change, and a long-time series is needed to capture enough of these uncommon conditions to make reliable assessments. Collection of important data from some sections of the Columbia River has been limited, interrupted, or eliminated in recent years. Critical needs include extending PIT-tag trawl sampling in the lower river through August, increasing the number of PIT-tagged fish, and enhancing detection probabilities at the dams.

Editorial Comment

The 2024 CSS Annual Report contains numerous acronyms and technical terms, many of which are not defined or explained. For example, several chapters use two acronyms for Bonneville Dam (BON and BOA) and McNary Dam (MCN and MCA). The 2010 CSS Report contained a useful glossary and defined BON as Bonneville Dam and BOA as Bonneville Dam adult fish ladder, with similar explanations for MCN and MCA. This glossary was continued in the CSS reports from 2010 through 2017 and included acronyms and definitions of technical terms. The CSS again included a glossary in the 2023 report, but none was provided in the 2024 report. We recommend that the previous Glossary of Terms be updated and included in the 2024 Report and all future reports. Each acronym needs to be defined when it is first used, and in general acronyms should be used only when needed, as they are inevitably less clear than the longer but complete name for the organization, dam, report, or process.

As we recommended in 2023, we continue to encourage the CSS to include in future reports an "overview" chart showing a timeline when various chapters were added and others no longer included over the years of reports. Such a chart would help the reader understand the history of chapters, know if a chapter is no longer being updated because the issues are settled, or if a chapter's number has changed because other chapters have been added or deleted. We suggest separating the report into sections on Ongoing Analyses and New Analyses to clearly distinguish the long-term analyses from new or revisited analyses.

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 CSS report being reviewed here incorporates many of our past suggestions, and the ISAB greatly appreciates the CSS's effort to respond to our past queries. The ISAB highlights the following topics for further consideration in a revised 2024 annual report or inclusion in future CSS annual reports:

1. 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.

2. Last year, 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.

3. 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.

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. 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.

5. 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 get prepared to do such analyses.

6. 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).

7. 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.

In ISAB 2023-2, we recommended the following four topics (*italicized*) for consideration in future analysis. After each recommendation, we summarize the status of the work to address them:

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 breaching scenario assessment reported in Chapter 6 pushes (and may exceed) the capabilities of the present models to simulate the complex ecological responses expected after breaching, and we suggest that a more comprehensive effort to predict these responses is warranted. There is much room for more detailed and inclusive evaluation of the 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. The framework started in Chapter 6 on uncertainty and risk has much room for further work, and its use within a decision-analysis framework should be rigorously pursued using established available approaches. 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*

The CSS did not respond to this recommendation.

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. First, what are the most important differences among dams that affect passage and survival? This approach*

would benefit from a model that looks at survival considering different configurations of the various dams during a fixed period of years when the dams were not changed substantially. Second, did the modification of dams increase survival? For example, the estimates of FGE are now 20 years old and they might be revisited in light of the new data and changes in the dam structures.

The CSS responded that *"The factors affecting FGE have not changed considerably in the past 20 year. While fish passage efficiency (the proportion of fish passing via the powerhouse) and spill efficiency are likely to have changed with increased spill proportions and the addition of surface spill weirs, we don't anticipate that great changes in the proportion of fish guided into the bypass systems upon entering the powerhouse have changed greatly."*

The ISAB thanks the CSS for their response.

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.*

The CSS did not respond to this recommendation.

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. The synthesis could draw from the results for hatchery and wild fish from throughout the report. It would be very information to assess the effects of body size and seasonal timing at initial tagging on in-river survival and return. There is good evidence that survival varies with smolt size and timing, which often co-vary, and often differ between fish of wild and hatchery origin. With the long-term data, the CSS could explore the interplay between origin, size, and timing on survival of salmon and steelhead.*

The CSS did not respond to this recommendation.

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

The Executive Summary is very brief and lacks adequate detail. It serves as a guide to what is in the report rather than summarizing the major results and conclusions. Considering that the Executive Summary might be the only thing read by those seeking important findings, it would be better to enhance it with more quantitative rather than qualitative information about the primary findings.

For example, as noted in comments on Chapter 6, the Executive Summary notes that "water transit time (flow) and [powerhouse interactions] PITPH (spill) are two important freshwater variables in predicting salmon and steelhead survival." However, there is no indication of the relative size of their effects or whether the effects are positive or negative. For example, does reducing PITPH by 1 dam give a larger or smaller effect compared to changing WTT, say by 10%? What are the potential changes for improvements from management actions in the system? Which is most cost effective?

Minor comments

p. 14. Add a sentence indicating why the CSS is moving to the Bayesian model to estimate survival.

p. 31. Add the same sentence indicating why the CSS is moving to the Bayesian model to estimate survival.

Editorial comments

p. 6, para. 1, line 1. The Comparative Survival Study (CSS)… Delete later spelling out of CSS (such as in line 2 of this paragraph).

p. 6, para. 1, line 7. "…hydro system" is hyphenated elsewhere in the document.

p. 6, para. 2, lines 2 and 6. Replace "confirm" with "consistent with." The models are correlative.

p. 6, para. 2, line 4. "…smolt-to-adult return rates (SAR)…" Delete later spelling out of SAR (such as in P. 7, para. 2, line 2). Note change in punctuation.

p. 7. Define first use of "PA" (Preferred Alternative)

p. 7, para. 1, line 6. "…wild fall Chinook SAR data…" (insert Chinook)

p. 7, para. 2, line 4. "when samples sizes were," not "sample size was."

p. 7, para. 2, line 6. "continue," not "continues."

p. 7, para. 3, lines 1, 3. Shift from present to past tense. Previous paragraphs used present tense.

p. 7, para. 4, lines 6–8. Reviewers were not clear with respect to what "These analyses" refer to, in part because the previous sentence notes that transit time did not improve.

p. 8. Define the first use of PITPH (a Powerhouse Encounter rate index).

p. 8 para. 1, line 2. Delete "survival" (and perhaps make SAR plural?). In line 4, move "survival" behind "ocean."

p. 8, para. 3, lines 2–3. Delete commas.

p. 8, para. 3, line 4. Delete hyphen.

p. 8, para. 4, line 3. After "Chinook," delete the comma and add "salmon."

p. 8, para. 4, line 4. Delete "stock."

p. 8, para. 4, line 7. Replace "negatively impacted" with "reduced."

p. 8, para. 5, line 2. "…patterns of survival and SAR for…"

p. 9, para. 1, line 6. "…reduced WTT for downstream migrants…"

p. 9, para. 1, line 7. Delete "specifically."

p. 9, para. 1, line 8. When using a date range, a leading "from" requires a subsequent "to,", not a hyphen.

p. 9, para. 1, line 24. Delete "to meet the WTT needed."

p. 10, para. 3 and 4. This has not been updated for this year's draft report. Please update.

IV.B. Comments on Chapter 2. Adaptive Management Evaluation of Changes in Hydrosystem Operations on Salmon and Steelhead Survival and Travel Time

Summary of contents from 2024 Draft CSS Report: *Chapter 2 presents an Adaptive Management evaluation of changes in hydrosystem operations on spring-summer Chinook salmon and steelhead. This chapter provides updates to previous models characterizing variation in 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 all years of available data. The chapter also presents analyses comparing these response metrics across four spill management regime periods, 1998-2006, 2001, 2007-2019, and 2020-2023.*

Prospective analyses of expected responses under the Stay of Litigation Agreement operations are compared to the Proposed Action operations using the cohort models and the Grande Ronde life-cycle model.

ISAB Comments

Chapter 2 continues the analysis of the effects of the hydrosystem operations on Chinook and steelhead. The chapter is an update from past years to include an additional year of data and a comparison of predicted and observed effects. The analyses continue to show that juvenile fish travel time is reduced, juvenile survival is increased, and SAR survival is increased when water transit time and powerhouse passage encounters are reduced. From 1998-2023, the powerhouse passages have decreased, but the water transit times (WTT) have not changed. The Preferred Alternative from 2020 to 2023 resulted in increased WTT because of increased John Day Dam reservoir elevations and frequent increases above the minimum operating pool levels at the lower Snake River dams. These findings remain unchanged from the findings in the 2023 CSS Report.

The use of a Bayesian Hierarchical Model (Appendix H) to estimate juvenile survival from LGR to BON is a substantive change from previous annual reports. This new model is more robust to the impact of a very low number of detections on estimates of survival.

The narrative description of the predicted biological responses in the 2023 CSS Report (p. 38) was useful and could be used again in the 2024 CSS Report. The narrative descriptions could be combined with the additional quantitative information in this year's descriptions, which improve the reader's understanding of the basis for the spill strategy. In 2023, the predicted changes included 1) higher SARs of spring-summer Chinook and steelhead because of increasing spill proportions up to the biologically safe Total Dissolved Gas (TDG) levels and 2) reduced risk of extirpation due to lower probability of extremely low SARs with increased spill proportions. These are important metrics. Why are they not included in the 2024 CSS Report?

Tables 2.3 and 2.4 show that only a few variables are important for Chinook (model support concentrated in a few models), but many variables may be important for steelhead (model support spread over many models). The CSS should provide hypotheses or explanations for why this occurred.

The juvenile survival and travel rate models appropriately indicate the reference points used (Lower Granite Dam to Bonneville Dam), and the important factors are all plausible. It would be helpful if the section on Smolt-to-Adult Return (SAR) Models starting on p. 51 indicated what regions and periods the SAR data represent. They should be from Bonneville to Bonneville, so that the downstream (LGR – BON) and upstream sections (BON – MCN or LGR, etc.) are kept separate from the ocean phase. This is important and should be clear (and done this way). For example, Table 2.1 lists as performance metrics juvenile survival, ocean survival, and SAR, but the caption does not define them. Likewise, the presentation of results on SAR on p. 59 separates freshwater and marine variables but seems to imply that only one set of SAR values was used. Was this from LGR – BOA or BON – BOA (as would be correct)? Table 2.2 lists a series of marine variables but does not define the period encompassed in these "SAR survival models."

New additions to the chapter include a comparison of predicted survival, SARs, and spawning escapements under the Stay of Litigation Agreement (SLA) operations to the Preferred Alternative in the CRSO-EIS. The SLA provides flexibility in hydrosystem operations to reduce spill during the low flow season at several projects. The analysis uses two life cycle models to compare the effects of the SLA spill operations under a Best Case Scenario (spill is never reduced for adult delay or reserves and the reduction at Little Goose always occurs as late as possible) or Worst Case Scenario (spill is reduced for adult delay and reserves to the maximum extent possible and the reduction at Little Goose always occurs as early as possible). The SLA-Worst and SLA-Best scenarios bounded the Preferred Alternative operations in terms of the expected effects on the index for powerhouse passage experiences (PITPH). Biological metrics (spawning escapements, juvenile fish travel time, juvenile survival, ocean survival, SAR, TIR) did not differ substantially among the SLA-Best, Preferred Alternative, and SLA-Worst scenarios. The PITPH index for fall Chinook was predicted to increase under the SLA scenarios compared to the Preferred Alternative operations during the first half of August, due to the elimination of spill during this period under the SLA.

Results presented in Section 4 for the biological metrics showed increasing trends in the survival metrics across the spill management regimes and decreasing trends in juvenile fish transit time (FTT) and transport SAR divided by in-river SAR (TIR). The results for ocean survival of steelhead showed increasing trends across the spill management regimes, but the responses were not statistically significant. Why would this lack of statistical significance for steelhead be expected? Further examination of effect sizes would be helpful here.

Section 4 evaluates the effects of four major spill regimes. The "no spill regime" is represented by a single year (2001), thus the measures of FTT, juvenile survival, SAR, and ocean survival should come with caveats or some additional support for 2001 to be considered representative. The responses for the no-spill regime differ greatly from the other regimes, but is 2001 different for additional reasons as well? At the very least, the text could briefly describe the precipitation discharge, temperatures, and ocean conditions for 2001. Also, the expression "SAR survival" should not be used as it complicates the already considerable confusion around the terms return as in SAR and survival as in SAS. As used in the Columbia Basin, return and survival are not synonymous.

As noted in our summary at the beginning of our review, CSS reports contain many technical terms and acronyms, which may not be understood by many readers. In the ISAB reviews in recent years, we recommended developing a Glossary, which was included in the 2023 CSS Final Report. The draft 2024 CSS Report does not contain the Glossary. The ISAB strongly recommends including an updated Glossary in all CSS reports. The chapter reports several important metrics, but all are not clearly defined. For example, the Glossary defines SAR as:

> *"The survival rate of a population from a beginning point as smolts to an ending point as adults. SARs are typically calculated from the upper most dam with juvenile detection to Bonneville dam and or the upper most dam with adult detection. SARs for populations could be for wild only, hatchery-origin, or both combined. The populations can be defined as those being transported, being left in the river to migrate, or all smolts combined regardless of their route of passage."*

Where SAR is reported in the chapter and throughout the report, the authors should clearly describe the locations and populations included in the metric. The report should clearly explain that its use of SAR does not account for fish caught downstream of the initial sampling site including the ocean, which differs from smolt-to-adult survival (SAS), the proportion of smolts that survive to adulthood (i.e., catch plus escapement). The meaning of "first year ocean survival" is not clear. Is it survival from ocean entry to a particular month or number of months at sea? How it is calculated, and is fishery exploitation included or ignored? The chapter should describe these metrics clearly and explain which aspects of survival are included and which are not.

In our 2023 review, we encouraged the CSS to expand its efforts to highlight the most recent body of evidence related to spill issues, but they did not respond to the recommendation and the chapter still does not relate their findings to recent literature or body of evidence. The CSS reports tend to focus narrowly on the specific analyses and results performed and do not provide substantial review of other related literature in their reports. The ISAB recommends that CSS could provide more review of relevant literature without turning it into a major literature review.

The last paragraph of Chapter 2 summarizes the important operational actions to increase juvenile survival and SAR, but these key points are not included in the Conclusions. As a result, many readers who only look at the list of Conclusions will miss these important observations. We recommend that this summary either be added to the Conclusions or highlighted more prominently, perhaps as a separate paragraph on Major Management Implications at the end of the Conclusions.

Minor comments

In this chapter and other chapters, the authors report "change in percentage points." To provide context, the CSS should also describe the "percent change" for important biological responses. For example, the 0.06 change in percentage points for juvenile steelhead survival (0.55 to 0.61; Table 2.6) is a change of 11% in survival, which could have substantial biological consequences. Terminology for reporting change in percentage points and percent change should be consistent throughout the report.

The acronym PA is used for both "Proposed Action" (p. 42, 48, Table 2.1, 2.10, and Fig. 2.27, 2.28, 2.39, 2.30) and "Preferred Alternative" (p. 44, 78) under the CRSO-EIS. Explain the difference between Proposed Action and Preferred Alternative in the chapter's Introduction. Rather than using an acronym, the CSS could use the term Preferred Alternative in the text and only use the acronym PA for the term Preferred Action where space is limited, such as in a table or figure.

The section on Ocean Survival Models, starting on p. 63, does not indicate that this is from BON – BOA, as it should be calculated. Similarly, in Figure 2.20, Table 2.10, etc. the captions refer to "juvenile survival, ocean survival, SAR survival, and the TIR" but does not define them in the text. The expression "SAR survival" should not be used as it complicates the already considerable confusion around the terms return and survival.

The units of measure should be identified for all tables in this chapter with quantitative data. In Table 2.1, the "Proposed changes" or delta values have days as a unit of measure for FTT while the others are ratios. Table 1 should include columns for the source data as well as the ratio data so that a reader can compare the magnitude of the change.

The figures (2.4 to 2.9) for the biological responses to the Preferred Alternative and Flex Spill in the 2023 CSS Report highlighted the years of the Preferred Alternative and Flex Spill in red, which is useful in interpreting the graphs. We encourage the CSS to graphically highlight the Preferred Alternative and Flex Spill years in the 2024 CSS Report as they did in the 2023 CSS Report.

"Drafting" may be a well-understood term in hydrosystem operations (p. 45), but defining the term when first used would help readers.

In Section 5, the text does not define the period that was modeled, which was the 80 years of the CRSO-EIS dataset of daily flows adjusted by the analyses in Appendix H to represent the

Best Case and Worst Case scenarios for the flows under the Stay of Litigation Agreement. This should be stated in the description of methods.

As noted below for Appendix H, the text of Chapter 2 includes a box-and-whiskers graphical representation of the predicted spawning abundances for the 80-yr hydrological reconstruction and not the 10-yr averages illustrated in Figure H.4. Unless there is good reason, it is best to report a consistent measure for either the 80-yr average or the 10-yr average for the 80-yr period.

Editorial comments

p. 51. Refers to Appendix G for the Bayesian Model, but this should refer to Appendix H.

p. 56. Figure 2.7. X-axis needs a label. Identify the year corresponding to the obvious “outlier” (2001?).

p. 58. Figure 2.10. Identify the year corresponding to the obvious “outliers” with low survival (also 2001?).

p. 59. Table 2.1.1? Is this the correct table number? It is related to FTT but the data are not a subset of Table 2.1. What are the values in parentheses? 95% confidence intervals?

p. 61. Figure 2.13. Identify the year corresponding to the obvious “outliers” for Chinook. However, too many outliers are present for Steelhead to identify them.

p. 65. Figure 2.16. Same recommendation as for Figure 2.13.

p. 71. Figure 2.22. “Least square means” is an older term for “Expected marginal means.” A reference to what is an expected marginal mean will be required in the text.

p. 77. Table 2.10. The PA/NAA ratio for ocean survival of Chinook should be 1.50 (not 1.54; see Table 2.8) and the PA/NAA for TIR of Chinook should be 0.75 (not 0.80; see Table 2.9)

p. 77. Table 2.10. The order of SAR and ocean survival is not consistent with the order in the text and supporting figures and tables. They should be in the same order of presentation.

p. 77. Table 2.10. Add SE to the estimates from the ANOCOVA analysis.

p. 78. In the discussion of SLA, the authors suggest “There is no way of knowing when or how often spill may be reduced under SLA.” We suggest substituting “predicting in advance” for “knowing.” Although after the fact, knowing will emerge from observation.

Appendix H. Methods for Characterizing the Stay of Litigation Agreement Operational Inputs for Models Presented in the CRSO-EIS

Summary of contents from 2024 Draft CSS Report: *Appendix H provides a summary of analyses on the operations that were outlined in the 2023 Stay Agreement and compared to results from the CRSO-EIS modeling of the PA. the CSS modeled spring and summer spill at each of the CRS projects under the 2023 Stay Agreement. We relied on the same Action Agency hydro-modeling dataset that was used for the CRSO-EIS analyses. However, it is worth noting that the Action Agencies' modeling of the PA often resulted in an overestimation of spill at lower flow levels and an underestimation of spill at higher flows (FPC 2020). To the degree possible, the CSS modeling of spill under the 2023 Stay Agreement operations corrected for these issues.*

ISAB comments

Appendix H describes the methods the CSS used to characterize the hydrological inputs in the two life cycle models used to evaluate the potential differences between the Stay of Litigation Agreement and the Preferred Alternative. Because the timing and frequency of spill are not known or fixed by policy, the CSS developed estimates of spring and summer spill for two scenarios: 1) a Best Case, in which spill is never reduced for adult delay or reserves and the reduction at Little Goose always occurs as late as possible and 2) a Worst Case, in which spill is reduced for adult delay and reserves to the maximum extent possible under the MOU and the reduction at Little Goose always occurs as early as possible. The Results and Discussion adequately describe the outcomes of the two models for spring Chinook (Grande Ronde/Imnaha Life Cycle Model) and Snake River yearling Chinook and steelhead (CSS Cohort-Specific Model). The Appendix also provides useful supplemental material on the specific spill operations, hydrological and operational capacities, and minimum requirements for each of the dams from LBR to BON. The ISAB considers that this appendix needs no major changes.

Minor comments

Figure H.4 graphically illustrates the 10-year average spawning abundances of spring Chinook for each of the six Grande Ronde / Imnaha populations predicted for the SLA-Best and SLA-Worst scenarios relative to the Preferred Alternative scenario. As we noted in the comments on Chapter 2 above, it would be useful to provide the actual quantitative values for the 10-yr average spawning abundances in a table, either in the text of Chapter 2 or in Appendix H. The text of Chapter 2 includes a box-and-whiskers graphical representation of the predicted spawning abundances for the 80-yr hydrological reconstruction and not the 10-yr averages illustrated in Figure H.4. Why not report a consistent measure for either the 80-yr average or the 10-yr average for the 80-yr period?

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

Summary of contents from 2024 Draft CSS Report: *Chapter 3 updates the time series of data on juvenile travel time, instantaneous mortality, and survival with data from 2021. Survival estimates have been recalculated for the time series, using a Bayesian hierarchical modeling framework, and estimating variability using credible intervals from simulations. The new methods are under development and methods will be published in Appendix I of the CSS 2024 Annual Report. Models are developed to evaluate the relationships between water transit time, spill proportions, spillway weirs, water temperature, and seasonality to juvenile travel time, instantaneous mortality rates, and survival. The species evaluated include juvenile yearling Chinook salmon, subyearling Chinook salmon, sockeye salmon, and steelhead as they migrate through the reaches from Lower Granite Dam to McNary Dam, Rocky Reach Dam to McNary Dam, and McNary Dam to Bonneville Dam.*

ISAB comments

Chapter 3 is an update of analyses of juvenile salmon and steelhead data collected from 1998 to 2023. Findings in these analyses were consistent with past findings of the chapter reported in earlier CSS annual reports. Fish travel time, instantaneous mortality rates, and survival vary considerably both within and across years. Results indicate that improvements to fish travel time, mortality rates, and survival may be possible through management actions that reduce water transit time (WTT), increase spill percentages, and reduce powerhouse passage rates (PITPH). The analyses also find no evidence of detrimental effects of TDG on instantaneous mortality rates across juvenile migration years 1998-2023. While the general approach was continued from earlier CSS reports, a new statistical model, further analyses of TDG effects, and new results were reported.

Previous reviews noted low survival estimates for some cohorts, and the CSS noted that these were artifacts of small sample sizes. To avoid such issues, the CSS this year implemented a Bayesian hierarchical model (Appendix I) to estimate survival probabilities. The hierarchical model "borrows" information from neighboring cohorts to help with the estimation in cases of small sample size. This is a good approach to deal with these issues. Even so, very small sample sizes still can lead to unreliable estimates of survival in some reaches, and so only cohorts with a minimum of 10 detections after the final dam in a reach were used. Furthermore, estimates with large standard errors were also excluded. These are all sensible decisions.

An integrated analysis of the impact of TDG levels on instantaneous mortality rates was also computed. To avoid a spurious artifact from years with low survival and low TDG levels (resulting from a reduction or elimination of spill), only those cohorts that experiences 115%+ TDG were used. This is a reasonable approach.

Several important findings emerged in this year's analyses. Yearling Chinook instantaneous mortality rates (Zi) in 2023 were some of the highest estimates of the entire time frame. Within the MCN–BON reach, ordinal day was consistently the least important explanatory factor. Water transit time had more importance for sockeye instantaneous mortality rates than yearling/subyearling Chinook and steelhead. Among species analyzed, steelhead instantaneous mortality rates were more variable than those of yearling Chinook salmon, possibly due to greater sensitivity to environmental and management factors. For several species-reach combinations, instantaneous mortality rates increased over the migration season and with rising water temperatures. Fish travel time is shortest when water transit time is reduced (i.e., higher water velocity) and powerhouse passage rates are low. The ISAB recognizes these results as the continued evolution of the analyses and supports such efforts.

The chapter would benefit from comparisons of survival among all species over the common reach from LGR to MCN and more detailed discussion for sockeye and coho salmon. The chapter explains that the number of PIT-tagged sockeye is low and the juvenile sockeye migration season is relatively narrow. As a result, FTT and instantaneous mortality rates for sockeye were estimated only for the annual migration season. Though the results are not as extensive spatially and temporally as for Chinook and steelhead, the chapter could provide more information and discussion about the recent and past performance of sockeye salmon and coho salmon from 1998 to 2023.

In the graphs of the relative variable importance values, the importance of the variables differed substantially between the reach from MCN to BON and the reach from LGR to MCN. In Figure 3.9, the Day variable has zero relative importance in the different models. The authors explain the meaning of the relative variable importance values on page 96 from a methodological perspective, but it could reduce potential confusion for readers if the interpretation of the values was also discussed in the Results section. The chapter should also explain the major differences between the two reaches (LGR-MCN, MCN-BON) for the relative variable importance values and identify the characteristics of the reaches and timing that could account for them. For example, why does temperature shift in importance between the two reaches for Chinook and steelhead FTT?

The ISAB has asked the CSS to examine the recent higher instantaneous mortality rates for yearling and subyearling Chinook salmon in the LGR–MCN reach. The chapter discusses this in more detail in this year's report, explaining that the increase may be attributed to fewer observations available for estimating fish travel time, which is used to calculate mortality rates, as well as possibly due to larger standard errors in these years. Cohorts were omitted for each species-reach combination to adjust for sample size. Despite these adjustments, the observed increase in mortality persists. The reduced observations may reflect lower detection probabilities at McNary Dam during years with higher spill proportions. Another possibility is that daily load-following operations with variable powerhouse flow could also contribute to higher mortality rates, warranting further investigation. As in previous years, the ISAB concurs with the CSS that improving precision in survival estimates (e.g., increasing the number of PIT-tagged fish, extending PIT-trawl sampling through August, enhancing detection probabilities at the dams) could enhance the evaluation of these factors affecting juvenile survival.

We previously asked if the CSS has assessed the trends in instantaneous mortality rates of hatchery-origin subyearling Chinook in the LGR-MCN reach. They responded that they plan on conducting additional analyses in the upcoming year to further examine the somewhat higher instantaneous mortality rates that have been observed in recent years for both wild yearling Chinook and hatchery subyearling Chinook in the LGR-MCN reach. Hatchery subyearling Chinook in the LGR-MCN reach are analyzed in this year's report, but wild yearling Chinook are not analyzed separately (included as wild plus hatchery yearling Chinook). Wild yearling Chinook were analyzed separately from hatchery yearling Chinook in the 2023 CSS Report. Why are wild yearling Chinook not included in the 2024 CSS Report? Does the CSS plan to include this analysis in future years?

The draft 2023 CSS Report reviewed by the ISAB stated that adequate funding of the operation of the PIT tag trawl below Bonneville through the spring and summer migration is critical for estimating juvenile subyearling Chinook survival. We encouraged the CSS to incorporate it as a conclusion, which was included in the final version of the 2023 report. We also asked if BPA and the Action Agencies had responded to their recommendation in the 2022 CSS Report that several actions were needed to estimate survival in the future of subyearling Chinook in the MCN-BON reach. The CSS responded that the Action Agencies have not responded to or implemented the recommendations.

Minor comments

p. 91. In 2023, the ISAB encouraged the CSS to explain the methods and past results for analyses such as the PITPH index. In the final 2023 CSS Report, they cited those sections of the report that provided additional information about the PITPH index. The draft 2024 CSS Report cites Chapter 8 of the 2023 CSS Report. Again, we suggest that it is more helpful to briefly describe the method in the present annual report and provide a citation to a more detailed description presented in past reports.

p. 115. "Overall, these findings demonstrate no considerable adverse effects of TDG on instantaneous mortality rates for steelhead and yearling Chinook salmon over the observed

TDG levels from 1998 to 2022 in the LGR–MCN reach or 1999 to 2023 in the MCN–BON reach." Some qualification is needed because not detecting an effect does not mean no effect, and because only TDG of 115+ were studied. Please add more context and key caveats – perhaps use the manner in which conclusions are stated on page 127 ("no evidence of detrimental impacts") as a guide.

Editorial comments

Figures 3.8, 3.9, 3.10, 3.11. The graphs use the term "Day" instead of "Ordinal Day" as in the other figures in the chapter. These figures should also use Ordinal Day.

p. 100. "… fluctuated by up to 32 percentage points for subyearling Chinook, 35 for yearling Chinook, and 35 for steelhead." Here and elsewhere require units in the remainder of the lists, i.e. "… fluctuated by up to 32 percentage points (p.p.) for subyearling Chinook, 35 p.p. for yearling Chinook, and 35 p.p. for steelhead." Similar changes are needed in the rest of the chapter.

p. 101. Figure 3.2 (and similar figures). The graph might be easier to read if the yellow open circles are plotted slightly to the right in each year? Perhaps only labeling every 2nd or 4th year might reduce clutter in the X-axis? Should the limits on the Y-axis in all panels be the same?

p. 109. Figure 3.10 (and similar figures). This is a graph for fish travel times, but this is only noted in the legend. Can "Fish Travel Times" be placed in the upper left of the square enclosing the plots?

p. 123. Figure 3.22. Earlier text indicated that some data were excluded (low TDG values). This should be noted in the plots (e.g., plot those points in lighter shades of the same color)? Perhaps only display every 4th year along the X-axis labels to reduce clutter?

p. 124. Remove line break after "Models incorporating random year effects for intercepts and slopes of ordinal day generally had lower AICc values compared to models with only fixed effects ("

p. 124. Replace "morality" with "mortality."

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

Summary of contents from 2024 Draft CSS Report: *Chapter 4 summarizes overall smolt-to-adult return rates (SARs) for wild and hatchery salmon and steelhead populations from the Snake River, Mid-Columbia, and Upper Columbia regions. Overall SARs of Snake River wild spring/summer Chinook and steelhead fell well short of the Northwest Power and Conservation* *council's (NPCC) objectives of SAR values of 2% to 6%, while those from the mid-Columbia region generally fell within this range. For Snake River populations, none of the passage routes (in-river or juvenile transportation) have provided SARs within the range of the NPCC objectives; the relative effectiveness of transportation decreases as in-river conditions improve and survivals increase. SARs of wild and hatchery populations were highly correlated within and among regions, suggesting that common environmental factors were influencing survival rates.*

ISAB comments

Chapter 4 confirms past findings reported in earlier CSS annual report that the Northwest Power and Conservation Council regional SAR objectives (i.e., 4% average for recovery and a 2% minimum) for Snake River and Upper Columbia salmon and steelhead populations are not being met. SARs for the Middle Columbia River wild-spring Chinook from the Yakima and John Day rivers continue to generally meet the regional SAR goal. SARs of hatchery spring Chinook from the Upper Columbia, Snake River, and the Middle Columbia River were correlated. These analyses are invaluable for the management of the fish populations, and the ISAB emphasizes their continued inclusion in CSS annual reports.

In the 2023 ISAB Review, we noted that previous reviews have suggested that more sophisticated analytical tools may be available and could strengthen the analyses. The CSS developed Chapter 6 in the 2024 CSS Report, which starts to address alternatives to improve the analyses.

In this chapter on overall SARs, it would be helpful to have, for each species, a table with the recent average (e.g., last decade) survival downstream from LGR to BON, in the ocean from BON to BON, and upriver from BON to LGR. Approximate values as reported seem to be about 0.6 for Chinook going downstream and 0.74 for Chinook going upstream. No specific set of values for ocean survival were reported per se, but if the overall LGR-LGR SAR is, for example 0.01, then the ocean survival would be about 0.023. Therefore, hypothetically, 1000 smolts at LGR would result in 600 smolts at BON, 14 adults at BON, and 10 adults back to LGR. Is this correct? Regardless of the details, such a table would be very helpful, and it should include sockeye salmon with approximated values for scale, though there are surely far fewer sockeye salmon smolts from the Snake River with PIT-tags compared to the other species. In this manner, the actual marine survival (BON-BON) can be specified for easier comparisons within and outside the basin.

In our review of the draft 2023 CSS Report, we raised several questions about how survival in the first year in the ocean (S.o1) was calculated. The CSS replied that Ricker (1976) was the source for the value of 80% survival and noted that several entities in the basin also use that value. This means that the value used for annual ocean survival after the first year acts as a scaler in the estimation of S.o1. As the assumed value for ocean survival increases, estimates of S.o1 decrease and the degree of this decrease is proportional to the magnitude of S.o1. We recommended that future CSS reports should explain the assumptions and provide tables of key input values, such as annual marine mortality rate and age structure, but the CSS responded that the methods in the chapter state that estimation of S.o1 accounts for year-to-year variability in age-composition of returning adults. The calculations do not assume a fixed age at maturity schedule for estimating S.o1, and the summaries of age composition of returning PIT-tagged adults are reported in Appendix F of the final report. The draft 2024 CSS Report explains some of the additional information that they provided in their 2023 response to the ISAB review, but it still does not clearly explain the nature and use of age composition data.

The previous ISAB review noted that with the exception of wild spring Chinook salmon and wild steelhead from the Mid-Columbia, SARs for all hatchery and wild stocks of spring Chinook, fall Chinook, steelhead, and sockeye in the upper Columbia and Snake rivers are below the NPCC's 2% minimum SAR objectives. We stated that the long-term consequences of this collective ongoing poor survival of Columbia River salmon and steelhead warrant a major conclusion and also warrant an immediate comprehensive assessment across the species and stocks of the Columbia River. The CSS did not make a conclusion related to our recommendation and responded that the primary purpose of the chapter is to provide updates to the time-series of SARs for salmon and steelhead populations from throughout the basin. They indicated that data are used in other CSS reports and analyses by other entities to examine patterns of survival throughout the Columbia Basin, and the data are available online to support analyses by any entity. The ISAB continues to suggest that the CSS could highlight this need more prominently in its report.

Minor comments

The age composition data were provided in Appendix F in the 2023 draft CSS report, but the draft 2024 CSS Report does not contain that Appendix. Only Appendices A, B, H, and I are included in the draft 2024 CSS report. Why is Appendix F with the age composition data not included in this year's CSS report? Does the CSS intend to include Appendix C Source of PIT-Tagged Fish, Appendix D Dam-Specific Transportation SARs, and Appendix F Returning Age Composition of Adults in the final 2024 CSS Report? We assume that Appendix E from the 2023 CSS Report will not be included because it supported the 2023 Chapter 7 on the Effects of the Juvenile Bypass Systems on SARs; this chapter is not included in the 2024 report.

CSS reports tend to focus on the Snake River and middle and upper Columbia River from Bonneville Dam upstream, and they devote little attention to performance metrics for salmon and steelhead populations below Bonneville Dam. In assessments that do not include the lower

Columbia River and its tributaries, the CSS should note the focus on the middle and upper river when discussing management implications for the Columbia River Basin.

Editorial comments

p. 139. Figure 4.1 (and similar figures). It is difficult to know which tick mark belongs, for example, to 2015 and 2020. Tick marks for labeled years should be longer, or tick marks for intervening years (2016, 17, 18, 19) should be excluded.

p. 142. Figure 4.4. The note that "Figure 4.4 also illustrates the pattern of highest SARs occurring in 2008, as the highest point in all the scatterplots is that from 2008." should be added to the legend of Figure 4.4 rather than in the text on page 140.

p. 156. Table 4.1. All AICc values should have 1 decimal place. Right justify the delta AICc column.

Appendix B: Supporting tables for Chapters 4 – Annual Overall SARs

There have been no major changes in Appendix B. Values for 2021 or 2022 have been added and overall averages or totals have been updated.

Minor comments

In Table B.103 (Overall MCN-to-WEA SARs for Upper Columbia Wild Summer Chinook—Okanogan River or Columbia Mainstem above Wells Dam) in the 2023 CSS Report, the number of smolts that arrived at MCN was reported to be 2,792 in 2020. For this table (renumbered as Table B1.5) in the draft 2024 CSS Report, the number of smolts that arrived at MCN in 2020 was reported to be 5,428. The same values for smolts at MCN were reported in Table B104 (MCN to BOA) in the 2023 CSS Report and Table B.106 in the draft 2024 Report. This is a substantial change in the smolt estimate for 2020. What was the cause of the disparity between values for 2020 reported last year and this year?

Editorial comments

Tables B.36, B.80, B.102, B106. Font size changed for part of the 2022[B] juvenile migration year.

Table B.107. Font type or size changed for lower half of the table.

Table B.113. Lower case c is used for superscript for 2022 instead of uppercase.

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

Summary of contents from 2024 Draft CSS Report: *Chapter 5 examines PIT-tag-based adult passage success from Bonneville Dam upstream. Date of passage, flow and spill conditions as well as juvenile passage experience (transport or in-river migrant) are used to predict passage success. The analysis estimates the relationship between temperature, juvenile transport, and salmon survival using models in generalized regression, mixed effects, and Cormack-Jolly-Seber (CJS) framework.*

ISAB comments

Chapter 5 of this report continues analyses of upstream migration success and explanatory variables affecting upstream migration success. 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 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, only in the Snake River for spring Chinook, and in the Bonneville to McNary reach for fall Chinook. These results, and especially the lower survival as adults of fish transported as smolts, seem to call for more interpretation. How is this finding explained?

In our review of the draft 2023 CSS Report, the ISAB 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 responded that they would consider adding an overall survival metric for the BON-LGR reach in subsequent updates to this chapter, but it is not provided in the draft 2024 CSS Report. The ISAB recommends that the CSS describe 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.

In response to the review of the 2023 report, the CSS did not agree that adding mortality rate per distance would be beneficial to compare performance for the three reaches. They emphasized that the chapter’s results show that there are fundamentally different processes governing survival and upstream migration success depending on where an individual is in the river. They stressed that one of their key findings is that in the upper reaches, mortality is strongly influenced by both previous travel time and cumulative temperature exposure during the previous migration experience. Equating mortality as a rate per mile in a particular reach removes the nuance of individual migration experience that this chapter is attempting to explore. They contend that a survival metric normalized for distance would not make survival rates easily comparable between reaches. Instead, it would mask the fundamental processes that are driving adult migration success in a way that could be easily misconstrued or misunderstood by managers or the public.

The ISAB still recommends that the LGR-BON and the per-mile mortality rates both provide useful contexts. The lengths of the three reaches in the analyses are 234.8 river km for BON-MCN, 51.0 river km for MCN-ICH, and 157.4 river km for ICH-LGR (data from the DART website). For spring Chinook as an example, the mortalities for 2023 are 22% from BOA-MCN, 2% from MCN-ICH, and 2% from ICH-LGR, an 11-fold difference between the BOA-MCN reach and the upper reaches in the Snake River. However, the mortality rates per km are 0.09%/km for BOA-MCN, 0.04%/km for MCNICH, and 0.01%/mi for ICH-LGR, resulting in mortality rates per km that were 2.5 to 9 times greater in the BOA-MCN in the upper two reaches. To avoid confusion, the CSS could note the distance adjusted mortality rates for a spatial context and emphasize that it does not accurately reflect travel time and cumulative temperature exposure that determine survival, though these factors themselves are influenced by distance as well as other river characteristics.

The text indicates that mini-jacks were excluded from analysis but implies that jacks were included. This is good to note, as analyses in Chapter 6 excluded jack Chinook. Does their inclusion here have any consequences for the results? Would those in Chapter 5 differ if jacks were excluded? Regardless, the Methods section in this chapter is quite clearly written.

For spring Chinook, the most important variables were the negative effect of transportation as juveniles and the lower recovery rate of hatchery compared to natural origin fish, and the losses were primarily between Bonneville and McNary dams. Similar results were obtained in terms of the key reach for summer Chinook, with hatchery fish again under-performing, and high temperature being the other key variable, with only a small effect of transportation. Fall Chinook too were mainly lost between Bonneville and McNary dams, and the key variables were negative effects of past transportation and temperature on arrival. Hatchery fish also underperformed, though the inferred effect was less pronounced. For summer steelhead, survival from Bonneville to McNary was similarly most affected by hatchery origin and almost all losses were between these two dams rather than farther upriver. The Discussion attributes the effects of transportation to straying, which is likely, but the Discussion should also cite some of the studies on this connection. Effects of temperature were plausibly linked to timing of arrival, but the lower performance of hatchery fish was not discussed. Given the rigors of several years at sea, it seems equally plausible that the failure of summer steelhead that arrived at Bonneville Dam to reach McNary Dam is related to some aspect of behavior leading to higher fishery exposure or straying. Some discussion of this prominent factor is warranted.

Minor comments

p. 208. Table 5.5 and similar tables for other fish groups. Compare the number of detections at ICH versus GRA. As expected, detections at ICH should be slightly larger than detections at GRA because of mortality between ICH and GRA. But Table 5.2 typically has fewer detections at ICH compared to GRA? Then the relationship switches for other release groups? Is there something peculiar about the detection system at ICH compared to the other dams?

In the ISAB's 2023 Review, we emphasized that distance is a variable in the models. It would be helpful if the Methods section reported the lengths of the three reaches in the analyses. We again encourage the CSS to provide these distances explicitly in this chapter.

Editorial comments

General – The chapter authors have largely changed "conversion" to upstream migration success and upstream survival. This makes the document much easier to understand. There still a number of places where "conversion" is still used. Perhaps "reach survival" is a better term?

p. 199. Table 5.3 and similar tables for other groups of fish. Adjust table so that "1" is displayed as 1.00 etc. so that the tables all align properly in column rather than being occasionally indented.

p. 199 Last paragraph – replace "conversion" with "upstream migration success" here and top of next page.

p. 202. Table 5.4 and similar tables for other groups of fish. Estimates are from model averaging, but an asterisk indicates a p-value < 0.05. Because model averaging uses multiple models, is the p-value from the top ranked model only? Indicate what NA means – variable not included because it fails to fit?

p. 203. Figure 5.4 and similar tables for other groups of fish. Table 5.4 gives survival estimates for BOA_MCA. But these plots give estimates from BON_MCN. Maximum spill variable is labeled as "Spill Max" in Table 5.4 but simply "Spill" in Figure 5.4. Similar inconsistencies in other variable names between table and graph. Be consistent. Ditto for Figures 5.5 and 5.6.

p. 203. Figure 5.4 and similar figures for other groups of fish. What does it mean that Age4, Age3, Age2 have a blue dot (estimate?) but only a tick mark for the right CI? If this a truncation problem with ggplot, use coord_cartesian to set the limits rather than simple xlim().

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

Summary of contents from 2024 Draft CSS Report: This is an analysis of the long time series of SARs generated by the CSS and is in response to earlier recommendations by the ISAB. The CSS synthesizes data for groups of salmon and steelhead across the Columbia Basin. The analysis examines patterns of survival (SARs) by group and the variables which affect the SARs.

ISAB comments

Both this chapter and Chapter 4 should document the differences between the methods used in the two chapters. For example, the graphs and discussion in Chapter 4 include jacks, but the analyses in Chapter 6 uses SAR values that do not include jacks. Depending on their prevalence in the population, jacks can be a large fraction of males, can differ in proportion between hatchery and wild fish and among treatment groups, and reflect other factors. Perhaps jacks are scarce enough in these populations that their exclusion in this chapter and inclusion in Chapter 4 does not significantly affect the results. Documenting the different treatment of jacks, as well as any other differences (e.g., PIT tags in Chapter 4 and associated limitations on marine survival), and the rationales for these differences, should be included in both chapters. In general, standardization regarding inclusion of life history forms is encouraged.

The focus of the analyses in this chapter is on Chinook and steelhead but there are also considerable data available on sockeye salmon that were not analyzed. Can these types of analyses be extended to sockeye salmon, especially with the exceptionally large 2024 return of sockeye salmon to the basin?

While the emphasis of the chapter on the numbers of dams encountered is understandable, additional discussion of how these interactions of fish with dams fit into the broader array of the other many factors that affect SARs would provide important context for the reader. Populations from the Yakima system encounter four dams, and those from the John Day encounter three, but are they otherwise assumed to be identical in analyses to those from the Snake River? Without discounting the importance of dams, the chapter should point out that other abiotic and biotic factors might also play a role in affecting SAR values. Many examples can be cited from the literature. Clear explanation that the analysis (i.e., model structure) was not designed to evaluate factors that may be responsible for interannual differences in SARs should be added. As part of this, a clear statement and explanation should be included that the purpose was to assess the influence of two pre-selected variables (WTT and PITPH). This can be done with new inserted text in the Introduction and Discussion, and the text could briefly discuss the potential effects of distances to Bonneville Dam, water temperatures, predator densities, migration start dates, body size, and smolt body condition on the results based on only two variables.

Similarly, the same contextual information is also missing from the treatment of ocean conditions. The Introduction states that *"After passing Bonneville Dam, out-migrating fish experience comparable estuarine conditions and are subject to a common suite of physical and biological processes in the northeast Pacific Ocean."* Recent work (Bond et al. 2024) confirms earlier studies on the great importance of smolt timing on survival (Scheuerell et al. 2009), and this means that knowing the timing of arrival at Bonneville Dam would be very important for capturing important differences in ocean survival among populations. Moreover, the fish may not go to the same locations at sea and spring-summer stocks differ in return timing (Keefer et al. 2004), and this could have consequences on survival such as different levels of exposure to pinniped predators (Sorel et al. 2021). Notably, the lack of marine fisheries hinders our ability to discern possible differences in the distributions of Interior Basin spring Chinook. However, our inability to know their distributions does not mean that they are necessarily the same. The ISAB suggests that additional text be added that discusses how ocean survival is affected by multiple factors. In the future, additional analyses should be considered that further resolve the marine component, such as the inclusion of SAS (smolt to adult survival) data in addition to SAR data and consideration of different model structures than used to date.

In addition to further resolving ocean survival in the statistical models, several aspects of the model structure used to date should be explored for their effects on the results. The treatment of year as a random effect raises several questions. What is the interpretation of a random-effects year? The SARs values for Chinook are computed across multiple ages. Ocean conditions are therefore somewhat shared across years (i.e., ocean conditions for age 3 from releases in year x are the same as for age 2 from releases in year x+1). Does the "year" effect essentially measure the first year of ocean effects? Further, there are likely to be long-term oscillations in the SAR due to external factors such as PDO. But all of the fitted models assumed independence among years.

The analyses did not present information on the role of the random effects (e.g., a table of variance components and proportions of variation). The meta-analysis evaluates the overall effects of WTT and PITPH on SARs across different stocks. However, for proper inference, these fixed effects need to be interpreted with greater attention to their effects on the variance structure. The inclusion of WTT and PITPH could reduce different components of the random effect variances. For example, WTT and PITPH may primarily act as stock level covariates, thereby reducing the stock-level random effect variance. This seems possible since the stocks differ in the number of dams along the migration route. Alternatively, WTT and PITPH may act as year level covariates – and this may be the more interesting case. Exploration of variance partitioning will likely provide complementary information to evaluate WTT and PITPH effects on SARs.

A present limitation of the models used is that the fitted models all assumed additivity of effects (i.e., the effect of WTT or PITPH is the same for both species). Models where the effects of WTT and PITPH are allowed to vary across species should also be fit. The rma.mv() function used for fitting these models allows for more complex inter-year correlation structures. These types of models should also be fit, and model assessments should investigate across-year correlation effects. Flexible models that allow for species differences would also add to the robustness of the analysis.

The models also used different reaches for the SARs among the rivers of origin (e.g., Snake versus Yakima). Table 6.1 lists the stocks considered in the meta-analysis and the reaches over which the SARs are estimated. For each Chinook-steelhead pair (i.e., matched by origin), the same dams (that define the reaches) are used (Lower Granite to Lower Granite, McNary to McNary, John Day to John Day, and RRE to RRE). However, different reaches are used across the pairings. For example, Snake River uses Lower Granite, while Yakima River uses McNary. What is the reason for these differences? If the focus is on conditions during passage down the river, then Bonneville Dam is the endpoint, and the starting point is determined by upper-most detection location, or (ideally and also) by some common reach for all such as McNary to Bonneville or John Day to Bonneville. Then the marine portion would be Bonneville to Bonneville, so that one can objectively assess the effects of history down the river by different stocks with how well they fare at sea. The rationale for using different reaches for SARs should be added, and the potential effects of this on the results and interpretation discussed in the text.

Finally, the wide scatter of points in the predicted SAR versus estimated SAR ("observed") plot (Figure 6.4) strongly suggests that the statistical models did not capture the major factors affecting SAR values. The ISAB questions whether such models can then be used to infer the strengths of the PITPH and WTT explanatory variables. The text discusses how well the models did or did not perform but relatively little about the actual fit of the predictions to estimated SAR values. The last sentence of the section states *"... decreased water transit time and reduced powerhouse encounters lead to greater smolt-to-adult returns; where WTT appear particularly influential (Figure 6.5)."* The series of three 3-D plots in Figure 6.5 that show alternative views of the estimated effects of WTT and PITPH on SARs and certainly seems to confirm the statement that the primary driver of SAR is water transit time. The relative importance of WTT versus PITPH seems like an exceptionally important result, and it would be very helpful to have a more quantitative statement of the relative importance of these two factors. Further, these derived relationships need to be reconciled with the generally poor fit of the model shown in

Figure 6.4. Perhaps reporting standardized effects (with careful explanation of the x-axis scale and the meaning of a 1 standard deviation change) and additional information related to the percent of variance in estimated SARs attributable to each explanatory variable would help.

Minor comments

General – What is the source of the reported SARs by stock and year in the data file on the GitHub site? For example, the values of SARs from the data files in the GitHub site did not match the values shown in Appendix B. If the values used are a transformation/subset of those reported in Appendix B, then they should be explicitly listed (there are only 159 of them).

p. 242 – Please indicate where WTT and PITPH values can be found in this report; please report the temporal period for the calculation of WTT values.

p. 243, Table 6.1 – Please define abbreviations or refer to a table of abbreviations elsewhere in this report.

p. 244 – Please elaborate on this choice of sampling variance, and by proxy, the weights. Is this the only or best way to define sampling variance for logit(SAR)? Please show the x and n values in a table or refer to a table elsewhere in this report.

p. 244, Equation 6.1 – The value of *x* should be an integer because it is the number of returning adults. The computed value of *x* may not be an integer, because the reported SAR value has been rounded. The actual data used (available at the GitHub site cited on page 247) was examined, and fractional values of *x* were used rather than integer values. This should be noted.

p.244, Equation 6.2 – What happens 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.*

p.244, Equation 6.3 – The second term in the variance computation is not correct. See https://stats.stackexchange.com/questions/118403/logit-standard-error and consider doing the calculations after adjusting *n* and *x* by adding the constant. Because *n* is so large relative to *x* in these cases, this correction is likely to have small effects on the results.

p. 245, Equation 6.4 – Theta is never defined. Do you mean *y* as defined earlier?

p. 245, Equation 6.6 – The delta_i and epsilon_i will be confounded, and this model should not be able to be fit? This model does not appear in Table 6.2. This model was also not fit in the R code available on the GitHub site. Please clarify the text and tables with equation 6.6.

p. 245 – The terms "study," "stock," and "CSS group" are used interchangeably as noted in the middle of page 242 and this is confusing. Please standardize the terminology. Similarly, SAR and logit(SAR) are both used as part of "effect size."

p. 245 – Please specify the distribution of the random effects (i.e., a Normal with mean 0 and associated variance).

p. 245 – The difference between the "residual error" in equation 6.4 and the "observation-level random effect" is not clear. Please correct this or provide an explanation.

p. 245 – In model 6.6, how many random effects are produced relative to the number of observations in the entire data set? Is there an issue with the model being over specified?

p. 246 – Because a standard regression approach is used, the standard VIF can be computed (i.e., not necessary to use a simulation approach). The ISAB notes that the VIF for the three variables are very similar (virtually identical), which should be confirmed because such occurrence would be unusual.

p. 246 – Equation 6.7 is not a VIF. Because these models are standard regression methods, the standard VIF can be computed as specified in https://online.stat.psu.edu/stat462/node/180/.

p. 246 – Because the analysis was done on the empirical logits, the index of agreement should be computed both on the empirical logistic values and the back-transformed (0 to 1) values.

p. 247, Table 6.2 – The random effects are not listed exactly as described. Please correct.

p. 247, Results – Consider showing a forest plot of the results, estimates of variance partitioning for all random effects, and comparisons of WTT and PITPH among stocks.

p. 248, Figure 6.2 – These are the estimates from the best fitting model. If you are using AIC, then you should model average. In this case, the top model has 90% of the weight, so there will not be much change in the reported results, but the analysis should be consistent with the use of the IC paradigm.

p. 249. Figure 6.3 – Perhaps showing a separate panel for each variable to help the reader. It is surprising that the curves for the three variables are essentially the same. See previous comments about computing VIFs.

p. 250 – Consider presenting a plot of agreement on the empirical logit scale as well. This will spread out many of the values close to 0.

p. 251, "WTT appears particularly influential." It is not clear that this follows from the results, especially since variance partitioning was not evaluated and WTT and PITPH are not in common units.

p. 252, Figure 6.5 – The models all assume additive effects (i.e., marginal effect of WTT and PITPH is the same for both species) which leads to the nice separation shown in the bottom panel. This result should be noted as a consequence of the assumption.

p. 253, "latent factors (e.g., ocean conditions)." It is not clear how the analyses accounted for these. Please explain how the latent factors were included (or not).

Editorial comments

p. 137 – The text indicates that Chapter 6 evaluated long-term trends. Please correct, as this chapter evaluated stock estimates and sources of heterogeneity, not trends.

p.243, Table 1 – Please include the start and end years used for each stock and explain why, for example, there are fewer estimates for Snake River steelhead than for Chinook salmon.

p. 244-245 – The explanation of the basic model structure fitting process is a bit muddled. The methodology will likely be unfamiliar to most readers. Thus, it would be useful to provide additional details about the methods and results. A useful source, among others, to refer readers to is Donnelly and Verkuilen (2017). In addition, the methods should include details about the computational model used (i.e., R packages). It might be clearer to simply refer to Table 6.2 and use text to explain the full model and its components and then the approach of sequentially dropping random effects.

p. 245, "Next, given the binomial nature of our analysis, we modified the basic structure above and fitted a model that included a fixed intercept, and an observation-level random effect. The model took the same form as above, but where ϵij _now accounts for extra-binomial noise." But the epsilon term is already included in Equation 6.4, so this is not a "next." Please clarify.

p. 245 – The model descriptions of "first," "second," etc., are not always consistent with the models listed in Table 6.2.

p. 247, Table 6.2 – Please include a column for number of parameters similar to what is shown in Table 6.3. The terms listed in the Random Effects are never defined – a legend should explain them. The column labeled "Deviance" is also never defined. There are too many decimal places in AIC_c column (at most 1) and in the AIC weight column (at most 2).

p. 247, Table 6.2 – Species variable only has two levels, so the effect size can be reported rather than simply a +. The column labeled DF appears to be number of parameters. Decimal places in some columns should be adjusted as noted above.

p. 253 – The conclusions about VIF do not follow from definition of VIFs. Even if WTT and PITHP were collinear, they both could play a role in modifying SARS. Collinear factors just mean that you cannot separate the individual effects using standard regression. Please adjust the associated text.

Appendix I. Evaluation and Application of a Bayesian Hierarchical CJS Model for Survival Estimation

Summary of contents from 2024 Draft CSS Report: *Appendix I provides a summary of methods and results of new Bayesian survival estimation procedures being developed for reach survival estimation. In addition, simulations are shown that identified possible bias in previous reach estimates. Tables of new reach survival estimates are also provided at the end of the Appendix.*

ISAB comments

The Bayesian methods are straightforward and appear to be properly done. The estimates in Tables I.6 onward are used in earlier chapters of this report. This Bayesian hierarchical model was developed to deal with issues raised in past years where some estimates of inter-dam survival appeared to be very "odd" and/or have poor precision. The Bayesian hierarchical model "borrows" information from other cohorts in the same species/year/release group so that inter-dam survivals based on very small number of recaptures will be "shrunk" back to the mean for the species/year/release group. This is a standard way to deal with problems of small sample sizes.

It appears that separate analyzes were performed for the different reaches for a species (Table I.2). For example, for wild and hatchery yearling Chinook (CHI HW) the Lower Granite to McNary Dam was analyzed, and then from McNary Dam to Bonneville, and then the combined Lower Granite to Bonneville, each having different release lengths (weekly vs biweekly). So, does this mean the same data can be used in multiple analyses? This should be clarified.

No discussion of model assessment (e.g., convergence) is provided. The ISAB notes that the models are fairly simple and straightforward so the assessment metrics should be reasonable.

Minor comments (Appendix I was not paginated, so the page numbers below refer to the page numbers in the pdf document)

p. 574 – It was not clear why the m-arrays need to be generated? Even with thousands of individual histories, the Bayesian models should be quick to fit, assuming that the likelihood is explicitly computed rather than relying on latent (underlying) variables indicating the survival status of the animal. Please explain the reason for the m-array generation.

p. 576 – The authors ultimately decided on the hierarchical model rather than the random walk model. Additional explanation for the decision is needed, and they should consider removing the text about the random walk model or explaining it as an alternative that was not used.

p. 576 – Why was WinBugs used rather than JAGS? The ISAB is assuming that R was used to drive the fitting rather than running WinBugs code individually by hand for each year/species/release group?

p. 576 – It appears only a single chain was fit in the MCMC process. Usually at least 3 chains are fit so that standard methods of convergence assessment can be computed such as Gelman's R; mixing through trace plots, etc. Please document the details of the MCMC process.

p. 576 – The ISAB agrees with the data truncation that was used to avoid issues with very small sample sizes.

p. 577, "… as part of a single stratum." Not sure what "stratum" refers to? Presumably a year/species combination in which the hierarchical model was fit as noted in the rest of the paragraph?

Editorial comments

p. 574 (and elsewhere) – Replace "phi" by its corresponding Greek letter.

p. 576, Equation (1) and following – This is a mixture of semi-mathematical and BUGS notation. We suggest using formal mathematical notation with a "sub-appendix" with the BUGS model code.

p. 576 – Vague U(0,1) or Beta(1,1) priors were used. However, sub-reach survival is fairly high, so why not use something a bit more informative such as a Beta(2,1) or Beta(3,1) prior?

p. 580 – Figure I.2 is difficult to read. Please adjust the figure so it is clear.

p. 581, Table I.4 – Are these "estimates" or "true" values used in the simulation? The title of Table I.4 should be different than the title of Table I.5.

IV. G. Comments on Chapter 7. Influence of Flow Augmentation from the Snake River above Brownlee Reservoir on Salmon and Steelhead Survival

Summary of contents from 2024 Draft CSS Report: *Chapter 7 examines the efficacy of flow augmentation from the Snake River above Brownlee Reservoir on survival and travel time of juvenile salmon and steelhead through the lower Snake River. The chapter discusses the history of Snake River flow augmentation and the complexity of the implementation. The chapter uses water accounting data for 2006-2023 to identify flow augmentation water in the lower Snake River and compare survival rates and travel times predicted with and without flow augmentation.*

ISAB comments

The chapter provides a good history of flow augmentation efforts involving the Snake River and its watershed projects. Modeling was used to predict differences in survival for four cohort groupings of fish (yearling Chinook salmon, subyearling Chinook salmon, juvenile steelhead, and juvenile sockeye salmon) as a response to flow augmentation (the observed condition) compared to a modeled condition of no flow augmentation. Predicted Water Transit Time (WTT) was used to derive Fish Travel Time (FTT), and this was combined with estimates of Powerhouse Encounter Index (PITPH) to derive an instantaneous mortality rate (Z), and ultimately an annual fish survival metric for each cohort group of fish. The ISAB support these types of analyses and considers this particular analysis to be a reasonable use of available data and to be informative.

The analyses completely rely on the generation of the flow augmentation schedule and the changes in flows at the dams. The subsequent steps in the analysis use existing models on survival and travel times. Thus, careful evaluation of the generated time series used as inputs to the models is necessary to have confidence in the final results. The conclusion of small benefits of flow augmentation predicted to occur would likely remain robust to alternative assumptions about constructing the flow time series. However, it is still important to confirm the realism of the reconstruction of the flows so the analyses are complete and the analysis is well-positioned for possible further applications of the modeling.

The interpretation of the modeling results is centered on the small differences in survival between augmented flows and non-augmented flows. While this appears to be the case, some further analyses would provide important confirmation. Two key next steps would be 1) including uncertainty in the flow input time series, and 2) understanding the predicted survival among years. Various categorizations of years can be explored. Are there specific year-types (e.g., low and high flow years with warm and cold years) where the relatively small effects of augmentation are large compared to other years and could be biologically meaningful? If feasible, uncertainty in the input flow time series data can be combined with partitioning of predictions into year types to ensure the robustness of the general conclusion of universally small benefits.

The analyses focused on survival through Lower Granite and McNary dams. It may be more appropriate, if feasible, to extend the analysis through John Day Dam given the length, predator population, and sometimes sluggish flow through its reservoir. The modeling also offers opportunities for further application. For example, can the modeling be used to identify the best timing to provide augmented flows? What are the (albeit small) benefits relative to costs in providing augmented flows? What magnitude of augmented flows would result in a biologically significant increase in survival? This expansion of the modeling effort should understandably consider the assumptions and practical constraints, but model runs could be done to explore these questions and compare results to simulations under constraint-free conditions to understand the full potential benefit of flow augmentation.

Minor and editorial comments

p. 262 and 269 – No results were presented for juvenile sockeye salmon as promised. Please correct the text or (ideally) add results for sockeye salmon.

p. 269 – The authors use the term "absolute percent survival improvement" to differentiate between a relative improvement and the numerical change. For example, "The absolute percent survival improvement predicted with flow augmentation across years and cohorts ranged from 0.05% to 0.21% with the least benefit." A better way is to use the term "percentage points" to represent the "absolute" change (e.g., a change from 4% to 5% is a 1 percentage point change).

p.272, "The low predicted benefit of flow augmentation as implemented is unsurprising and would be undetectable without a predictive model." – It can be detected with large amounts of data. Perhaps replace "undetectable" by "difficult to detect in nature or with field data."

There are references to a Table 7.3 in the text (e.g., p. 268, 269), and yet no such table exists in the section. Supposedly, this Table 7.3 would depict survival data for four cohorts of fish, including sockeye salmon. Sockeye salmon are not represented in any of the figures.

IV.H. Chapter 8. Estimating Powerhouse Passage Proportions at Hydropower Dams

Summary of contents from 2024 Draft CSS Report: Chapter 8 examines the effects of hydrosystem development on water transit time needed for successful downstream migration of salmon and steelhead. The region's historical efforts to understand the impact of hydro-electric development on downstream migration conditions are nicely summarized. The measures implemented, since 1982, to mitigate the impacts of development on water transit time through the migration corridor are described. The success of these measures in terms of resulting water transit times through the spring and summer downstream migration season are discussed, and recent analyses of the importance of water transit time on salmon and steelhead survival are noted.

ISAB comments

The description of the flow management policies and influence of the hydrosystem on river discharge and WTT is a valuable addition. The historical summary will be valuable to many readers.

The chapter explains why particular gaging stations were used to match the periods of record, which indicated that the lowest site in the Columbia River included in the analysis and discussion is the Columbia River at The Dalles. A result of this analytical constraint is that it ignores the changes in the hydrology and WTT in the lower Columbia River and estuary, which are major components of the habitat of juvenile and adult anadromous salmonids and other native species. The ISAB and ISRP have frequently noted the critical questions related to the hydrosystem's effects on the lower Columbia River and estuary, particularly in the ISAB's recent review of the Fish and Wildlife Program (ISAB 2024-2).

There is a USGS gaging station below Bonneville Dam in Vancouver and gaging stations on the major rivers below that. The chapter would be strengthened by, at minimum, a discussion of the implications of excluding the lower river below Bonneville Dam and estuary and by possibly also adding a graph similar to those in Figure 8.2 for the discharge and moving averages for the river below Bonneville Dam, either at Vancouver or for a composite discharge estimate for the mouth of the Columbia River. These could be compared to the historical reconstructions of Naik and Jay (2005) and Gedalof et al. (2004). Further analyses that explicitly include below Bonneville and the estuary by creatively estimating long-term flows from existing records should be considered.

Additional rationale about how the Grand Coulee Dam is represented is needed. Grand Coulee is one of the largest hydropower production facilities in the world, yet it is treated as headwater storage. Before it was built, one could convincingly argue that this was a "mainstem" reach. Consequently, it might be clearer to the reader to be less geographically specific in this paragraph (p. 275, paragraph 2) and focus more on the primary local effect of dams that have limited storage capacity (i.e., alteration of channel shape).

Why is a qualitative analysis used to document the effects of upstream storage developments on river discharge (p. 275, paragraph 3)? There are a number of ways of quantitatively assessing the effects of water storage on seasonal discharge. Also, please explain why median May–June discharge is the metric of interest (i.e., why it matters to anadromous fish). This is mentioned briefly in paragraph 2, page 276.

Minor comments

p. 275. para. 1, line 2 – Does 5.185 maf refer to the storage capacity of Grand Coulee Dam or the upper Columbia River Basin above this point? Also, it would help the reader to see a table (accompanying Figure 8.1) of all storage facilities (grouped by subbasin, ordered by river km), noting their date of installation and their storage capacities. Also, highlighting the mainstem reaches to be analyzed should be included in this table. All of this information serves as the foundation for later analyses and interpretations.

p. 275, para. 3, line 6 – The method of selecting sites is confusing. Reviewers could not tell whether the authors chose a few sites from among many that met certain criteria, or they selected all sites that met those criteria. As part of the clarification, an explanation of why these sites constituted "areas of interest" should be added.

p. 276, para. 1 – Please explain why discharge estimates from three locations for the lower Snake River, instead of a single site, were used.

p. 276, para. 2 and 4 – Visual interpretation of Figure 8.2 suggests a long-term decline in flow in the Columbia River, and therefore better justification and more explicit guidance for where the reader should look is needed to support the authors' argument of no trend in the early part of the period and other stated interpretations. Likewise, the post-1976 emergence of synchronous multi-year oscillations among portions of the Snake River basin was not obvious. Figure 8.2 is quite complicated. Guidance on interpreting the figure and, even better, a more quantitative treatment to summarize these data would help clarify and strengthen the stated interpretations of trends.

p. 277, para. 3 – The authors have the opportunity to provide a much stronger argument by showing a table with 1) actual changes in cross-sectional area with time, and 2) a figure showing actual changes in WTT (based on observed discharge and changes in cross-sectional area over time). The latter can be done because the authors show as much in Figure 8.5.

p. 278, para. 1 – The CBFWA white paper is not readily available, so a brief summary of the approach for estimating the cross-sectional area-discharge-WTT relationship should be added. In particular, please explain the relative contributions of discharge and channel shape to WTT, and the linearity (or lack thereof) of that relationship. More importantly, text in later pages (284–301) seems to equate WTT solely with discharge, although only discharge is directly addressed from a regulatory perspective. It would be more powerful to translate those results into WTT, then use the CSS report to show quantitative analyses that demonstrate the likely consequences for salmonid survival. That would be more in keeping with the title and main point of this chapter.

p. 278, para. 3 – The authors noting that the position of a particular quantile differs among periods of time should be strengthened by providing additional evidence. Also, given that the authors note that they cannot assign the observed patterns to a particular phenomenon, the three concluding sentences in this paragraph should be deleted or appropriately caveated.

p. 279, para. 3 – It is not clear to the ISAB that the data support the conclusion that water development has not altered discharge in the lower Snake River. One would need an independent estimate of potential discharge (basinwide annual precipitation) to determine this. Please provide additional evidence or re-word to be more speculative.

p. 280, Figure 8.1 – This figure could be improved by adding a timeline of Project completions for UCR, LCR, and LSR either above or below the time series graph to permit the reader to see which project is responsible for the increases in water storage.

p. 285–288 – The preceding chapter made a point of noting that the arguments about the relation between WTT and salmonid survival need not be re-examined. The authors may consider adding similar wording to this chapter.

p. 286 – Please summarize key components of the Water Budget concept.

p. 290, para. 2 – Given that earlier analyses focused only on spring flows, the extension to summer flows needs additional explanation.

p. 292 – Please cite supporting evidence for "there are some indications that low run-off volume is likely to occur more often than it has in the past."

p. 299. The interpretation of a p-value is incorrect. The report states: "The data and analyses presented in Chapter 2 of this report show that there is effectively no chance that WTT does not influence juvenile fish travel time, juvenile survival, and SAR survival of Chinook salmon and steelhead (Table 8.2)." A small p-value only indicates that the probability of observing the data if there was no effect of WTT is unusual. This could happen because the assumptions of the model used to estimate effect size are not satisfied, outliers, etc. Please correct the wording.

p. 299, Table 8.2 – What is the source of these p-values? A table of effect sizes (and standard errors) would be preferable.

Editorial comments

p. 274, para. 3, lines 3-4 – Please provide a citation for these data on maximum discharge and preferably a date (or date range) for each.

p. 274, para. 2, line 3 – Replace “encapsulates” with “is influenced by”

p. 274, para. 2, line 8 – To be consistent in this clause, please insert “River” after “Upper Columbia.”

p. 274, para. 2, lines 10 and 11 – To emphasize the three types, insert an em dash after “water resource development” and before “have influenced WTT.”

p. 274, para. 3, line 8 – To be consistent in this clause, please insert “basin” after “Columbia River.”

p. 274, para. 3, line 12 – “Basin” is variously capitalized, lower-case, or assumed (and omitted). Please choose one version and use throughout when referring to the Snake or Columbia River basins.

p. 275, para. 1, lines 2 and 11 – Please standardize capitalization of the abbreviation for million acre-feet.

p. 275, para. 1, line 3 – Replace “Each” with “Most” and modify from singular to plural.

p. 275, para. 1, line 5 – Please insert a space after “1961.”

p. 275, para. 1, line 10 – Remove “current;” it is implied by the verb tense.

p. 275, para. 2, Heading – Simply use “Discharge.”

p. 275, para. 2, lines 2 and 3 – The second sentence of this paragraph is not required.

p. 275, para. 2, lines 9 and 10 – This is confusing, because the preceding paragraph suggests that active storage behind Grand Coulee Dam is 5.185 maf, ten-fold greater than storage above John Day Dam. Please clarify.

pp. 275–6, para. 3 on page 275 and para. 1 on page 276 – To have the text logically follow the structure of the basin, the ISAB suggest moving all but the last sentence of first paragraph on page 276 to immediately after page 275, paragraph 3, the sentence ending “… areas of interest

(Figure 2).” Then follow with the remaining lines in the original paragraph on 275, and conclude with the last sentence from the original first paragraph on page 276.

p. 275, para. 3, line 1 – Please associate “discharge” with a specific metric with a temporal component (i.e., such as May-June median daily instantaneous discharge).

p. 276, para. 2, lines 8 to 10 – The concluding sentence seemed redundant with the preceding sentence and could be deleted.

p. 276, para. 3, line 1 – Consider re-wording this sentence along the lines of “Trends in discharge in the Snake River basin were not evident…”

p. 277, para. 2 – This paragraph did not seem necessary.

p. 277, para. 3 and 4 – The authors need to note that there is a pre-dam period.

p. 278, para. 2 – This paragraph appears to be a re-statement of the results from the analysis on lines 276 and 277. Are both necessary?

p. 279, under Historical Summary is a statement, “The simple relationships between WTT … upstream storage development.” – Seems to be a major point that could be included under Conclusions.

p. 281 – Please explain the arrows in the caption.

p. 282 – If the lower panel of this figure is retained (in lieu of a figure depicting actual estimated WTT), then truncate the depicted values to the actual ranges of values observed over the period of record for the upper and lower Columbia River basin (ditto for the bottom panel of Figure 8.4). In the top panel, reverse the order of the reaches in the legend.

p. 284, para. 1, line 5 – Did the authors intend to delete one of the first two sentences here? Figure 8.5. Why emphasize the latter box as constituting low-flow years? It seems a portion of the 1930s had even lower flows.

p. 299, Table 8.2 – Such small p-values are usually reported as simply <0.0001 because the statistical assumptions needed to determine the p-value at such a low level are not usually satisfied.

p. 300, under the first Conclusion. It states that “the need for fast WTT… are undisputable.” It might be better to frame as “having overwhelming evidentiary support.” (or other less-than-absolute terminology).

p. 300, Figure 8.15 – Please provide additional explanatory text so the reader can easily understand the derivation of "relative variable importance." Also, this appears to be cited as Figure 8.14.

P.301, under the Conclusion stating "The rapid development of flood control capacity…" – This is supported by the evidence, but it would be insightful to get a sense by how much (in a relative sense). That is, is it nearly as much as the hydrosystem, 10% of the effect? Some sense of magnitude would be helpful to the reader.

p. 301, Table 8.2 – Please provide additional explanation about the what is in the table so the ready can easily understand the models associated with the p-values.

p. 302 – Many of the references do not appear to have been cited in this chapter.

Citation for Gedalof et al. 2004 has Nate Mantua's last name misspelled in the list of authors.

In the text, the authors refer to Figure 1, 2, … 15. The captions of those figures are identified as Figure 8.1, 8.2, … 8.15. These could be easily changed to be consistent.

In text, the abbreviations for water storage volume and flow are variably listed in all-caps, all lower case or a mix of caps and lower case. These could be easily changed to be consistent throughout the chapter (and whole report, as well).

IV.I. 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

There have been no major changes in Appendix A. Values for 2023 have been added, and overall averages or totals have been updated.

Editorial comments

Table A.4. The font size for the year 2023 is incorrect.

Table A.14. The year 2021 is listed twice. The second time it is listed should be 2022.

V. ISAB Appendix: Suggested Topics for Further Review 2011-2023

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, this could imply that the populations are 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 on 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.

VI. References

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