SCIENTIFIC AND STATISTICAL COMMITTEE REPORT ON
FINAL METHODOLOGY REVIEW

The Scientific and Statistical Committee (SSC) received a report summarizing reviews of salmon methodology topics conducted by the SSC's Salmon Subcommittee (SSCSS) via webinar October 11, 2023 and discussed supplemental materials received after the methodology review (Supplemental Attachments 2 and 3). Tanya Rogers (SWFSC) and Michael O'Farrell (SWFSC, STT) joined online to present material related to Supplemental Attachment 3. The SSC received summaries concerning three review topics and one informational update:

1. **Review Topic: Review and consider improvements to methods used to model South of Falcon fisheries in Chinook Fishery Regulation Assessment Model (FRAM)**
2. **Review Topic: Consider technical modifications to the Sacramento River winter Chinook abundance forecast by examining whether an egg-to-fry covariate can improve forecast performance**
3. **Review Topic: Explore alternative forecast approaches for the Oregon Production Index Hatchery coho forecast**
4. **Informational Update: FRAM documentation progress**

Methods used to model South of Falcon fisheries in Chinook FRAM

The SSCSS received a presentation from Jon Carey (NMFS WCRO, STT) on calculation of Chinook FRAM preseason fishery scalars for south of Cape Falcon fisheries, as described in pages 4-11 of Attachment 1. Fishery scalars are used to project catch for fisheries that are managed as seasons and have no external estimates of projected total catch, such as fisheries south of Cape Falcon (SOF). The new approach to deriving the scalar improves the agreement between projected catch and the observed historical catch in SOF Chinook fisheries.

The SSC endorses use of the new approach to calculate scalars for SOF fisheries in Chinook FRAM. The SSC further recommends that scalars used to project catch in other fisheries, including those in coho FRAM, be evaluated to see if they can be similarly improved.

Sacramento River winter Chinook forecast

The SSCSS received a presentation from Tanya Rogers (NMFS SWFSC) with support from Michael O'Farrell (SWFSC, STT) evaluating several preseason abundance forecast methods for Sacramento River winter Chinook (SRWC), including a model with an egg-to-fry (ETF) survival covariate, as described in pages 12-27 of Attachment 1, with additional analyses produced in response to SSCSS requests reported in Supplemental Attachment 3. The analysts used one-year-ahead cross validation to compare the performances of different models forecasting SRWC abundance (SRWC age-3 escapement absent fishing), including the currently-used Base model and an extension of the Base model that included the egg-to-fry covariate (empirically measured egg-to-fry survival rate; ETF model), as well as an array of Gaussian Process (GP) models using various predictor variables. The analysts highlighted two GP models based on their performance

in predicting abundance, GP-1 and GP-2. GP-1 used parent spawners and river temperature as predictors, while GP-2 used these two predictors along with hatchery releases.

The SSC recommends using GP-1 in harvest management starting in 2024. Overall, the highlighted GP models predicted abundance better than the Base or ETF models, and were similar in their performance. In general, GP-2 did best at predicting abundance in terms of the raw number of fish, while GP-1 generally did best according to metrics of percent or proportional error. There are statistical reasons to expect proportional errors in both forecasts and postseason abundance estimates.

There is no consequence of forecast errors in determining allowable impact rates when both the forecasted abundance and post-season estimate are above 3,000, even if these errors are very large when measured in numbers of fish. This is due to the form of the control rule for allowable SRWC impact rates, which is flat for abundances above 3,000 and very steep for abundances below 500. However, at low abundance, forecast errors that are small in numbers of fish can be very consequential in terms of mis-specifying allowable impact rates. GP-1 outperformed GP-2 in control rule outputs by all metrics examined.

Although it had lower performance in forecasting abundance than the GP models, the ETF model was the only model considered that captured all three years in the evaluated 2012-2022 period when the postseason abundance estimate was below 3,000, and application of the control rule to the postseason abundance estimate would have lowered the allowable impact rate. Therefore, continued consideration of the ETF, or other supplemental information on environmental conditions affecting SRWC, could be warranted.

The return year 2024 forecasts (Table 2 of Attachment 1) will be updated when 2023 data are available.

The SSC recommends that the forecast methods for SRWC be revisited periodically (3-5 years) to re-assess their performance and evaluate additional covariates (e.g. the Juvenile Production Index) as warranted. Although there was limited contrast among the GP model forecasts in recent years, the four forecasts methods differed in the abundance forecasted for 2023. A 2023 postseason estimate was not included in the analysis, but including 2023 for the performance evaluation would be informative. The SSC identified several additional factors that may warrant inclusion in future forecast models and communicated them to the analysts.

Oregon Production Index Hatchery coho forecast

The SSCSS received a presentation from Cassie Leeman (ODFW, STT) and Thomas Buehrens (WDFW) with support from Shannon Conley and Mark Sorel (both WDFW) on a new approach for forecasting Oregon Production Index-Hatchery (OPI-H) Coho abundance, as described in pages 28-51 of Attachment 1. Some typographical errors were noted as described in Supplemental Attachment 2, but these were errors in reporting only and did not affect the analyses or conclusions.

The Oregon Production Index Technical Team (OPITT) annually produces a forecast of natural-origin Coho salmon from the Columbia River Basin and hatchery Coho salmon production from Leadbetter Point, WA, to the California/Mexico border, and this aggregate is referred to as the

OPI-H. There are inconsistencies between this report, Preseason Report 1, and previous documentation of the OPI-H forecast in identifying the stocks that are included in the OPI-H. The SSC recommends making all documents consistent and correct.

Leeman and co-authors explored alternate forecast models and recommended a new approach, a MAPE (mean absolute percent error)-weighted ARIMA-based (autoregressive integrated moving average) ensemble forecast. Jack returns, delayed smolt releases, and nine environmental covariates were considered for use in a multi-model approach to forecasting.

The SSC finds that the MAPE-weighted ensemble forecast model is an improvement over the current methodology, and supports its use for 2024. The SSC recommends that the model structure and covariates of the top 10 models, and their assigned weights, be reported annually.

The SSC reviewed the performance of the forecast for the OPI-H, but this aggregate is divided into stocks for use in Coho FRAM and Preseason Report 1. Performance of the stock-specific abundance forecasts (or the stock-specific "forecasts" implied by disaggregating the OPI-H based on fixed proportions) is likely to be worse than performance for the aggregate. The SSC recommends exploring forecasts of the individual hatchery and natural origin Coho stocks used for management.

FRAM documentation progress

The SSCSS received a presentation from Derek Dapp (WDFW) on updates and additions to the FRAM documentation that have occurred since the 2022 Salmon Methodology review, as described in pages 1-3 of Attachment 1. The current FRAM online material documents parts of FRAM (with the eventual goal of complete documentation), including structural and design changes since 2007, and provides a more detailed description of its procedures and algorithms than previous iterations of the FRAM documentation. Updates and improvements to the documentation for this year focused on calibration methods: the process used to develop the Chinook FRAM base period.

The SSC appreciates the work done by the analysts to update and expand the online FRAM documentation and recommends that documentation of existing methodologies be completed as soon as possible.

Recommendation for future methodology review topic

Forecast evaluations have used a wide variety of performance metrics (e.g., metrics based on raw error, percent error, or proportional error; and whether the direction of errors are accounted for). The SSC recommends work on reducing redundant metrics and identifying which metrics should be emphasized for particular forecasts based on management goals and the broader context for that stock.

PFMC
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