CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE REPORT ON INFRASTRUCTURE NEEDED TO INCORPORATE COHORT RECONSTRUCTION INTO SACRAMENTO RIVER FALL CHINOOK ASSESSMENT AND MANAGEMENT

Benefits of a SRFC cohort reconstruction

The California Department of Fish and Wildlife (CDFW) would like to recognize the Sacramento River Fall Chinook (SRFC) cohort reconstruction completed by Dr. Chen and her colleagues (Chen et al. 2024) as a major accomplishment, and the culmination of years of intensive monitoring work in ocean fisheries, river fisheries, and in hatchery and natural area spawning escapement surveys by collaborating agencies. The National Marine Fisheries Service (NMFS), CDFW, US Fish and Wildlife Service (USFWS), Department of Water Resources (DWR), Yuba River Management Team (YRMT), and Pacific States Marine Fisheries Commission have upheld ongoing commitments for nearly two decades to collect, process, and analyze Coded Wire Tag (CWT) recovery data and scale-age data from ocean and inland monitoring programs integral to completion of this work, incorporating 10 successive brood years.

The current metric of abundance used to inform fishery planning and assessment of SRFC is the Sacramento Index (SI), which is an aggregate-age index of adult (3+) abundance equivalent to the sum of ocean harvest, inland harvest, and inland spawning escapement (O'Farrell et at. 2013). The abundance forecast of the SI serves both as the estimate of ocean abundance at the start of the fishing season, and as the forecast estimate of escapement a year later in the absence of fisheries. Under the current management approach for SRFC and as described in the Pacific Coast Salmon Fishery Management Plan, the SI forecast is instrumental to the preseason fishery planning process because the adult ocean abundance informs the x-axis of the SRFC Harvest Control Rule, which establishes the maximum allowable exploitation rate for the stock. The SI has been shown to underestimate ocean abundance and overestimate projected escapement in the absence of fisheries (Chen et al. 2024), due in part to its inability to account for natural mortality, non-landed fishing mortality, and maturation rates. The SI therefore assumes that all adults that were not harvested in the ocean will mature and return to the river each year to spawn.

Unlike the SI, the SRFC cohort reconstruction is a complete measure of abundance rather than an index, utilizing age-based estimates of freshwater returns and sequentially adding in sources of mortality to rebuild the size of a cohort back through time to an earlier point in time (i.e. age-2 ocean abundance). A SRFC cohort reconstruction requires age-specific harvest and escapement data, which are derived from Coded Wire Tag (CWT) recoveries of hatchery fish and from ageing scales collected from natural-origin fish recovered in inland surveys.

The SRFC cohort reconstruction completed by Chen et al. for run years 2010 – 2019 provided estimates of ocean abundance, projected escapement, ocean harvest, and exploitation rates, as well as providing additional data metrics that the SI does not provide, such as estimates of natural mortality, non-retention mortality, and maturation rates. Additionally, these data metrics are specific to age and origin, providing a significant improvement in understanding of harvest, exploitation, and abundance of natural-origin and hatchery-origin fish. Although the current SRFC

cohort reconstruction only covers 10 brood years, the informational value of a cohort reconstruction would be expected to increase with an increasing number of years analyzed.

CDFW recognizes that the SRFC cohort reconstruction is a significant improvement over the SI and has potential to improve management for California's ocean and inland salmon fisheries. When coupled with age-based abundance forecasting, a SRFC cohort reconstruction has significant potential to improve forecasts of preseason ocean abundance and projected escapement after accounting for fishing. These modeling and forecast improvements would offer more refined information for use in planning California's ocean and inland fisheries each year.

Preseason vs. postseason implementation of a SRFC cohort reconstruction

Incorporating the cohort reconstruction to into the Council's annual management cycle will require substantial changes to existing data flows, increased commitments from partner agencies, and assignment of new responsibilities within CDFW to develop and maintain new data systems and data streams needed to allow for annual updating of the cohort reconstruction. To achieve the full utility and benefits of the SRFC cohort reconstruction, it needs to be updated annually during the Council's preseason planning process and incorporated into an age-based abundance forecast, as is done each year for Klamath Fall Chinook.

At present, portions of the Sacramento inland escapement and scale-age data are available on a two-year lag. Increased commitments would be required from CDFW and partner agencies to expedite the process for processing and transmitting data on a timeline that could inform the preseason management process. Robust inland surveys conducted by CDFW, USFWS, DWR, and YRMT are currently in place throughout the Sacramento Basin to gather the requisite CWT and scale data necessary to generate age-specific escapement data for hatchery- and natural-origin fish. Hatchery escapement data for SRFC are provided by Coleman National Fish Hatchery, Feather River Hatchery, and Nimbus Fish Hatchery. The Central Valley Angler Survey monitors sport fisheries occurring on the Sacramento mainstem and in the Feather and American Rivers. There are also 10+ individual surveys monitoring natural area escapement using a variety of survey methods such as carcass surveys, video counts, and/or redd surveys in the areas of the mainstem Sacramento, on the American, Feather, and Yuba Rivers, and in a multitude of upper Sacramento tributaries. In order to perform an annual preseason cohort reconstruction, all participating agencies and surveys would have from the start of the spawning season until late January to conduct field sampling, age scale samples, process CWTs, enter and QAQC data, estimate sampling expansions, and produce the age-specific run size estimates needed to inform the cohort reconstruction.

Alternatively, annual postseason updates of the cohort reconstruction could still inform postseason stock assessments and provide better data inputs to re-parameterize the Sacramento Harvest Model. Although this option foregoes management improvements associated with age-based abundance forecasting, it may be a reasonable starting point for incorporating the cohort reconstruction into annual management because the timeline required for preparing data and running models would be extended to roughly a year as opposed to a few months.

Additional workload considerations

In either scenario, significant work would be required to expedite status quo data processing timelines, and success is contingent upon garnering increased commitments from partner agencies to adhere to these timelines. Additionally, new tools, R programming functions, and databases need to be constructed in order to take on the task of annually developing age-specific run size estimates and maintaining the SRFC cohort reconstruction. Data systems need to be built to consolidate Sacramento Basin survey data, CWT recovery data, and scale-age data in order to generate sample expansions, estimate hatchery and natural proportions, and apportion age structure. New R coding functions need to be developed to generate the outputs and inputs that link data between the age-specific run size estimates, the cohort reconstruction, and the Sacramento Harvest Model. This additional workload and responsibility need to be assigned within CDFW. The individuals taking on these responsibilities need to be tenured staff well versed in escapement monitoring in the Sacramento Basin and familiar with using CWT and scale-age data to generate estimates of hatchery vs natural contributions to harvest and escapement. The assigned stewards need to also be well connected to the Council's preseason process to ensure smooth delivery and integration into the forecast modeling work of the Salmon Technical Team.

Importantly, there is already an exemplar for this process of developing annual age-specific run size estimates, cohort reconstruction, and age-based abundance forecasting in the Klamath-Trinity system for Klamath River Fall Chinook. For this basin, a Klamath River Technical Team (KRTT) meets annually at the end of January where survey leads convene and discuss survey methodologies and provide CWT and scale data that they have collected and processed themselves. In the weeklong meeting, the group makes decisions to apportion the age-structures to the hatchery- and natural-origin components to develop age-specific escapement estimates for the entire basin. State, federal and tribal agency personnel contribute to the work of the KRTT and have successfully maintained an ongoing commitment to meeting attendance, as well as the monitoring, data collection and data processing that occurs each year, which culminates annually into the Klamath River fall Chinook abundance forecast.

A multi-agency workgroup analogous to the KRTT could be useful to develop age-specific run size estimates to inform a SRFC cohort reconstruction and subsequent age-based abundance forecast for SRFC. While perhaps a KRTT-like group wouldn't be necessary indefinitely, it would be beneficial at least for the initial development phase to coordinate and combine survey data and create the tools needed for generating age-specific escapement data required for cohort reconstruction.

Conclusion

For SRFC, annual updates of the cohort reconstruction for use in management will not be ready for the 2025 management cycle. Although the data required to inform a SRFC cohort reconstruction largely exists, further refinements in data processing timelines, development of new tools, models, and databases, and defining new roles and responsibilities are required for annual cohort reconstructions to inform management and assessment of SRFC. CDFW recognizes the importance of this work for improving management of California's ocean salmon fisheries and

intends to explore next steps in the planning and coordination process to achieve the shared goal of improving management of the Central Valley stock complex.

Citations

Chen, E.K, W.H. Satterthwaite, M.R. O'Farrell, S.M. Carlson. 2024 Cohort Reconstruction for Sacramento River Fall Chinook salmon and Comparison with the Sacramento Index. Report prepared for PFMC Salmon Methodology Review. https://www.pcouncil.org/documents/2024/09/cohort-reconstruction-for-sacramento-fall-chinook-salmon-and-comparison-with-the-sacramento-index.pdf/

O'Farrell, M. R., M. S. Mohr, M. L. Palmer-Zwahlen, and A. M. Grover. 2013. The Sacramento Index (SI). NOAA-TM-NMFS-SWFSC-512:1–41. https://swfsc-publications.fisheries.noaa.gov/publications/TM/SWFSC/NOAA-TM-NMFS-SWFSC-512.pdf