Sacramento River Fall Chinook S_{MSY} Peer Review Panel Report

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Pacific Fishery Management Council

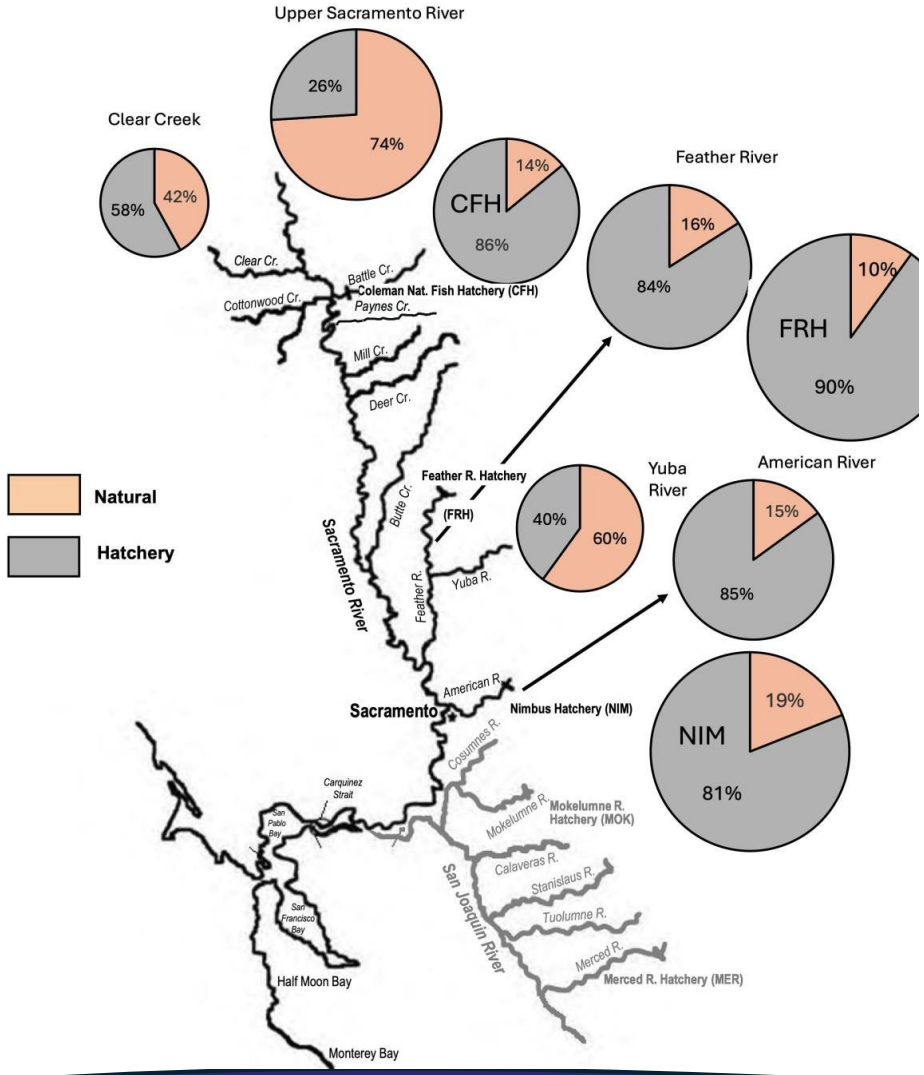
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PACIFIC FISHERY MANAGEMENT COUNCIL

Overview

- Sacramento River Fall Chinook (SRFC) Background
- Management strategy and recent status
- Peer Review Panel Terms of Reference (TOR)
- Summary of Peer Review Panel findings and recommendations

Sacramento River fall-run Chinook (SRFC)



- Sacramento R. basin ~ 26,000 square miles
  - Feather River
    - Yuba River
  - American River
- SRFC, late-fall run Chinook, winter run Chinook (E), and spring-run Chinook (T)
- Hatcheries are used to mitigate for the lost production due to habitat loss and degradation
- High hatchery fraction of natural-area escapement.
- SRFC compose large portions of ocean salmon fisheries.

SRFC Management

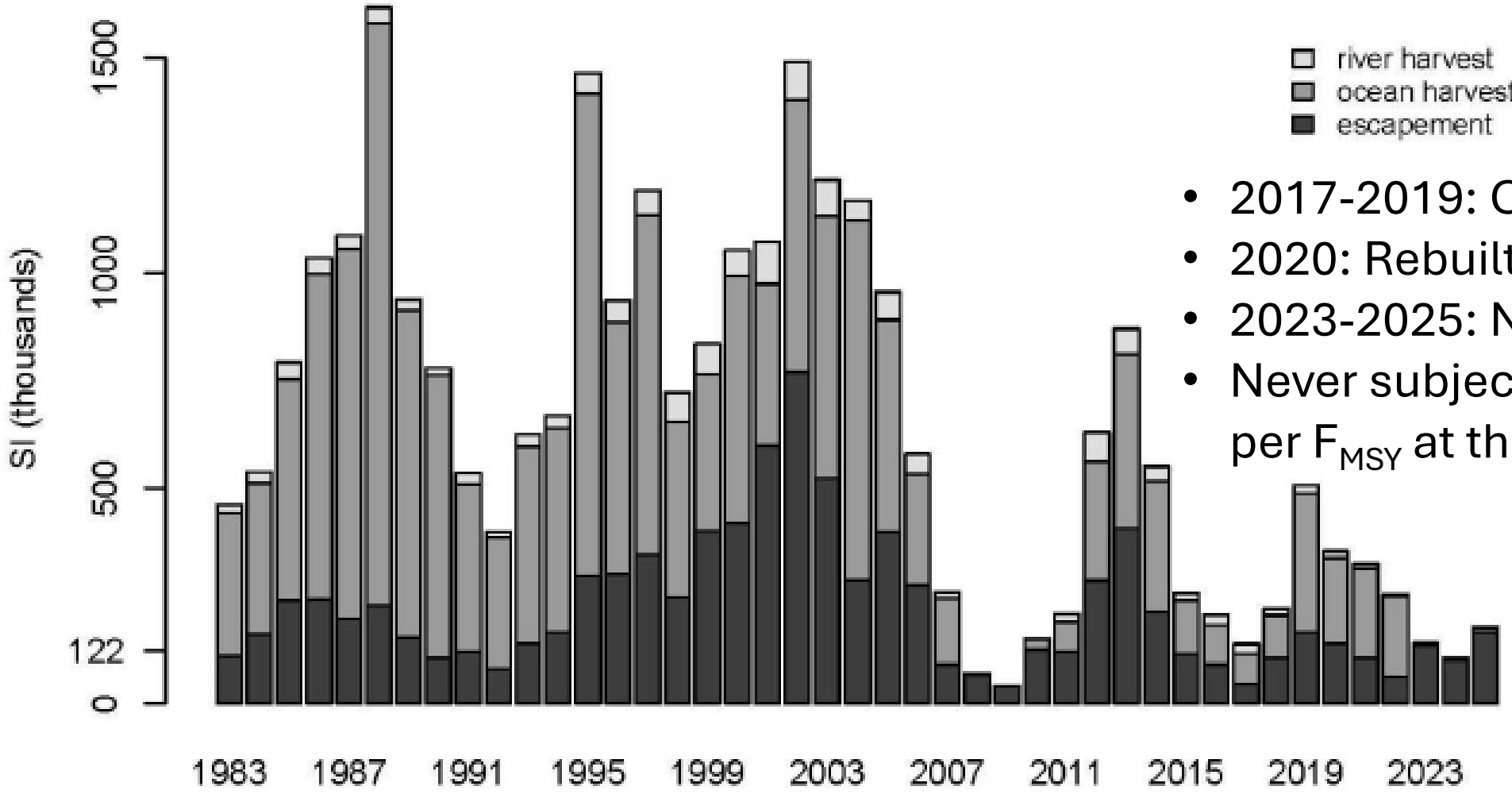
- **1984** – PFMC SRFC escapement goal range 122-180k to hatchery + natural areas.
  - 122k "interim goal" for combined natural + hatchery
- **2009** – PMFC develops reference points under reauthorized MSA (S_{MSY})
- **2011** – 122k adopted as S_{MSY} proxy for SRFC
- **2022** – Methodology review of report that found S_{MSY} = 122k difficult to reproduce
  - SSC found S_{MSY} proxy not compelling without additional scientific justification
  - STT concurred the current S_{MSY} value is difficult to reproduce
- **2023** - SRWG formed. Terms of Reference include providing the Council with new or updated management measures
- **June 2024** – 1st SRWG report – highlights challenges in applying MSY theory to composite natural-hatchery stock
- **Nov. 2024** – SRFC F_{MSY} proxy proposed; SRWG instructed to develop S_{MSY} for natural-area spawners using ratio method: $S_{MSY} = F_{MSY} \times S_{MP}$

SRFC Management

- 180k upper end of ‘escapement goal range” was the sum of 160k natural areas + 20k hatchery production:
    - 99k Upper Sacramento natural areas
    - 27k Feather River natural areas
    - 10k Yuba River natural areas
    - 24k American River natural areas
    - 9k Coleman hatchery (Upper Sac), 5k Feather R., 6k Nimbus (American R.)
- Status Quo S_{MSY} = 122k “until such times as problems caused by Red Bluff Diversion Dam are rectified”:
    - 50k Upper Sacramento natural areas + Coleman Hatchery combined
    - 61k lower Sacramento natural areas
    - 11k lower Sacramento natural areas

PFMC (1984), p. 3-18 to 3-19

SRFC Status



- 2017-2019: Overfished
- 2020: Rebuilt
- 2023-2025: Not overfished
- Never subject to overfishing per F_{MSY} at the time

SRFC S_{MSY} Peer Review Panel

Peer Review Panel Members:

Dr. Scott Rumsey (Chair), Pacific States Marine Fisheries Commission

Dr. Thomas Buehrens, Washington Department of Fish and Wildlife

Dr. Tim Copeland, Idaho Department of Fish and Game

Mr. Tommy Garrison, Tribal Panelist

Dr. Hamachan Hamazaki, Alaska Department of Fish and Game

Dr. Martin Liermann, National Marine Fisheries Service, Northwest Fisheries Science Center

Dr. Steve Lindley, Independent expert

Pacific Fishery Management Council Staff:

Ms. Angela Forristall, Staff Officer, Salmon and Pacific Halibut

SRFC S_{MSY} Peer Review Panel – Terms of Reference

Scope of Peer Review:

- Comparison to Status Quo S_{MSY} Method
- Merits of Ricker Relationship and Ratio Approach
- Review of Candidate Datasets
    - Natural-origin fry passing Lower Sacramento River
    - Potential Natural-origin adults in absence of fishing from cohort reconstruction
    - Sacramento Index *x* Proportion Natural-origin Spawners
    - Natural-origin Juvenile Migrants at RBDD
- Recommended Range of Years
- Future Recommendations

SRFC S_{MSY} Peer Review Panel – Findings and Recommendations

- **Comparison to Status Quo S_{MSY} Method**

  - scientific basis for the status quo S_{MSY} value of 122,000 adults is insufficiently documented and cannot be reproduced from the available historical record.
  - not demonstrably derived from a biological relationship intended to estimate maximum sustainable yield
  - not compatible with the Council's current direction to estimate S_{MSY} for natural-area spawners.
  - each of the four approaches evaluated by the SRWG is more fully documented, reproducible, and rooted in defensible scientific theory than the status quo method.
  - ***the Panel does not recommend selecting any of the four candidate datasets as the stand-alone preferred dataset for adoption at this time given their current limitations and potential biases***

SRFC S_{MSY} Peer Review Panel – Findings and Recommendations

- **Merits of Ricker Relationship and Ratio Approach**

  - Applying a **Ricker stock-recruitment relationship** to SRFC is "scientifically appropriate"
    - not uniquely supported over other plausible stock-recruitment models
    - reliability requires observations across an adequate range of spawning, recruitment, and environmental conditions
    - can incorporate important environmental covariates (e.g., flow)

  - The **Ratio method** is mathematically valid given a Ricker formulation, and provides a transparent means of using the Council's adopted F_{MSY} proxy.
  - The strength of the application depends on whether:
    - the Ricker function captures the true spawner-recruit dynamics
    - the available data reliably estimate S_{MP}
    - the adopted F_{MSY} proxy is sufficiently representative of SRFC

  - Does not resolve interactions between hatchery-origin and natural-origin components

SRFC S_{MSY} Peer Review Panel – Findings and Recommendations

- Review of Candidate Datasets*
    - Natural-origin fry passing Lower Sacramento River
    - Potential Natural-origin adults in absence of fishing from cohort reconstruction
    - Sacramento Index x Proportion Natural-origin Spawners
    - Natural-origin Juvenile Migrants at RBDD

* All four datasets are compromised by unmarked fry releases from brood years prior to 1999, and for brood years 2021-2024*. The necessary genetic sampling to identify unmarked hatchery-origin fish later in the life cycle was not in place.

- All four candidate datasets provide scientifically useful information, but each has substantial limitations and uncertainty.

SRFC S_{MSY} Peer Review Panel – Findings and Recommendations

- Review of Candidate Datasets
  - **Natural-origin fry passing Lower Sacramento River**

Principal strengths	Principal limitations and uncertainties	Panel interpretation
• Longest and broadest coverage of escapement, flow, and environmental conditions • Strong statistical support for spawner and flow effects	• Application of Ratio method with this dataset assumes that the spawner abundance that produces maximum outmigrating juveniles produces maximum recruits (S_{MP}) • May not capture delayed density dependence, density dependence in outmigration strategy, size-dependent survival, downstream mortality • Affected by variation in juvenile migration pathways	• Provides strong temporal contrast for juvenile-production analysis • May overestimate S_{MP} if important density-dependent effects occur after fry enumeration.

The Panel does not recommend the Lower Sacramento River fry index as a stand-alone dataset.

SRFC S_{MSY} Peer Review Panel – Findings and Recommendations

- Review of Candidate Datasets
  - **Potential Natural-origin adults from cohort reconstruction**

Principal strengths	Principal limitations and uncertainties	Panel interpretation
• Best available year-specific estimate of natural-origin adult recruitment • Incorporates age, origin, escapement, and fishery information	• Short time series; Substantial reporting lag • Limited contrast in escapement and flow • Strong confounding by density-independent variation in marine survival, etc • Downstream density dependence may reflect total fish density, which natural-area escapement may explain only weakly. • Requires multiple mortality, maturation, age, and sampling assumptions	• Biologically the most relevant recruitment metric • Current series is too short and environmentally confounded

The Panel recommends continued development of adult cohort reconstruction as the preferred long-term approach, but does not recommend adopting the *present* series as the stand-alone preferred dataset.

SRFC S_{MSY} Peer Review Panel – Findings and Recommendations

- Review of Candidate Datasets
  - **Sacramento Index x Proportion Natural-origin Spawners**

Principal strengths	Principal limitations and uncertainties	Panel interpretation
• Adult-based metric • Slightly more years than cohort reconstruction • Less data intensive • Broadly correlated with cohort reconstruction.	• Aggregate-age rather than cohort based • Potential misassignment among brood years • Inferior year-specific estimates; • Uncertainty from hatchery/natural-origin and coded-wire-tag expansions.	• Useful as a corroborating adult-based analysis but offers no clear scientific advantage over cohort reconstruction despite numerous disadvantages

The Panel does not recommend the Sacramento Index as a stand-alone preferred dataset.

SRFC S_{MSY} Peer Review Panel – Findings and Recommendations

- Review of Candidate Datasets
  - **Natural-origin Juvenile Migrants at RBDD**

Principal strengths	Principal limitations and uncertainties	Panel interpretation
• Relatively long time series • Includes multiple juvenile sizes • Comparatively direct interpretation • Provides an independent comparison with the lower-river fry index	• Represents only the upper Sacramento River • Mismatched spatial scales of spawners and recruits • Confounded by earlier hatchery releases • Measures recruitment before most downstream and ocean mortality.	• Valuable corroborating evidence • Spatial mismatch and early life-stage measurement limit its utility as the sole basis for a basin-wide S_{MP}.

The Panel does not recommend the RBDD natural-origin juvenile index as a stand-alone preferred dataset.

Comparison of SRFC S_{MP} and S_{MSY} Values among Datasets

Candidate Dataset	**S_{MP}**	**S_{MP} 95% CI lower**	**S_{MP} 95% CI upper**	**S_{MSY}**
Fry Index	496,980	280,194	2,196,108	288,248
Red Bluff Diversion Dam (RBDD) Passage	393,544	236,380	1,174,336	228,256
Cohort Reconstruction	114,767	66,219	430,067	66,565
Natural-Adjusted Sacramento Index (SI)	92,187	58,787	213,471	53,468

- All values **are adult Sacramento River fall Chinook spawning in natural areas.**
- S_{MP} estimates and 95% CI include the flow covariate. S_{MSY} values use the Council-adopted F_{MSY} of 0.58.

SRFC S_{MSY} Peer Review Panel – Findings and Recommendations

- Alternative Datasets
    - **Chipps Island Juvenile Index**

Principal strengths	Principal limitations and uncertainties	Panel interpretation
• Enumerated near downstream end of the delta • Could help determine whether upstream juvenile indices are biased by density dependent processes and mortality occurring downstream of sampling.	• Otolith information for determining hatchery and geographic origin is limited to brood year 2013-2020. • Record is thus substantially shorter than cohort reconstruction • Available data series has low contrast in recruitment and flow conditions	• Continued development of the dataset is warranted.

The Panel does not recommend the Chipps Island monitoring dataset as a stand-alone preferred dataset.

SRFC S_{MSY} Peer Review Panel – Findings and Recommendations

- Recommended Range of Years

The Panel recommends using the longest scientifically defensible time series available for each dataset. Do not truncate the data to emphasize recent conditions or restrict an integrated analysis to the shortest common period.

SRFC S_{MSY} Peer Review Panel – Findings and Recommendations

- **Future Recommendations**

Near Term

- Evaluate interim proxies and approaches

Longer Term

- Maintain and extend adult cohort reconstruction
- Conduct structured review of data sufficiency approximately every two to three years
- Evaluate long-term biological and conservation implications of managing a natural area spawning component with substantial hatchery influence.
- Evaluate whether S_{MSY} is the most appropriate management target for a heavily hatchery-influenced stock such as SRFC

SRFC S_{MSY} Peer Review Panel – Findings and Recommendations

- **Future Recommendations**

Near Term

- Evaluate interim proxies and approaches

  - Incorporate habitat-based estimates of capacity, historical abundance, formalized expert knowledge
  - Integrated analyses (e.g., incorporating Chipps Island juvenile information)
  - Model averaging, unweighted averaging
  - Utilizing current conservation objective range
  - Interim escapement goal intended to support sustainability, with assumptions/limitations distinguished from an empirical S_{MSY} estimate
  - Escapement-based percentile approach (e.g., ADFG)

Questions? Discussion?

“Back-Pocket” Slides

Summary of Public Comment

Stock definition and hatchery influence. Questioned applicability of Ricker and ratio analyses a heavily hatchery-supplemented composite stock

Scientific criteria and reference points. Sought clarity in Panel's definitions of the terms scientifically "Appropriate" and "Sound" included in the Terms of Reference.

Fry-index and Chipps Island data. Questioned the fry index's utility given uncertainty in the estimates and the potential for mortality and density dependence after fry enumeration. Cautioned that variable Chipps Island sampling complicates comparisons across years.

Productivity assumptions and data quality. Requested tests of alternative stock–recruit models and time periods, and closer examination of environmental covariates, water-management effects, and uncertainty in geographic and hatchery/natural-origin assignments.

Higher escapement and fishery impacts. Urged evaluation of recently adopted harvest measures before revising the escapement objective. Raised concerns about a higher SMSY estimate constraining ocean and inland fisheries.

Transparency and participation. Advocated for a transparent process with meaningful stakeholder participation; requested additional opportunities for public comment during Panel meetings.

Summary of Advisor Contributions

Scientific and Statistical Committee Advisor – Dr. Jason Schaffler

- emphasized the difficulty of interpreting reference points derived from natural-area spawners and natural-origin recruitment within a composite system that is substantially influenced by hatchery production.
- encouraged the Panel to distinguish clearly between what the available analyses can estimate and the broader management interpretation of those estimates.
- encouraged the Panel to identify what additional data and analyses would improve the approach in the future, including the conditions under which cohort reconstruction might become sufficiently informative for use in estimating S_{MP}.
- suggested that the Panel address an appropriate schedule for periodically reviewing the reference points rather than allowing another extended period to pass without reassessment.

Summary of Advisor Contributions

Salmon Technical Team Advisor – Ms. Kandice Morgenstern

- noted that meaningful natural-area spawning occurs in the Sacramento River mainstem
- described the distribution of escapement above and below RBDD
- Noted that the SRFC system is influenced not only by hatchery production but also by water-storage and delivery decisions that strongly affect juvenile production and survival.
- helped distinguish the scientific estimation of a reference point from subsequent Council decisions concerning a conservation objective and control rule.
- discussed possibility of developing a natural-area spawning objective and separately accounting for hatchery broodstock needs in the conservation objective.
- described recent differences between preseason harvest projections and realized harvest, as well as new inseason management measures that are anticipated to better align preseason allowable exploitation rates with realized exploitation and improve the likelihood of achieving escapement objectives
- suggested the Panel consider whether the current conservation objective range could inform an interim option in light of changes at RBDD.

Summary of Advisor Contributions

Salmon Advisory Subpanel Advisor – Mr. Kevin Godes

- highlighted the challenges of a composite natural-hatchery system, the uncertainty introduced by coded-wire-tag expansions, fractional marking rates, mark recognition, and potential differences in survival.
- sought clarification concerning the assumptions required to interpret a Ricker relationship between natural-area spawners and recruitment when hatchery-origin fish comprise a substantial portion of natural-area spawning.
- asked if there were comparable applications of the Ratio method in systems as large and complex as the Sacramento River system
- encouraged consideration of whether Bureau of Reclamation water-management actions could be represented in the analysis and whether changes following the 2008–2009 collapse reflected a persistent regime shift or increased interannual variability.
- helped focus Panel discussion on the treatment of prevailing conditions, the appropriate range of years, and the distinction between a long-term reference point and annual adjustments more appropriately addressed through a control rule or other management process
- noted limitations of length-at-date classification and the treatment of fast-growing fall-run fish in the Chipps Island Juvenile monitoring dataset.