Report to the Pacific Fishery Management Council on Klamath River Fall Chinook Interim Management Measures

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Pacific Fishery Management Council
Klamath River Fall Chinook Ad Hoc Work Group

Michael O'Farrell, National Marine Fisheries Service (Chair)

Brett Kormos, California Department of Fish and Wildlife (Vice Chair)

Barry McCovey, Jr. Yurok Tribe

Keith Parker, Yurok Tribe

Mike Orcutt, Hoopa Valley Tribe

Karl Seitz, Hoopa Valley Tribe

Morgan Knechtle, California Department of Fish and Wildlife

Cassandra Leeman, Oregon Department of Fish & Wildlife

Mark Hereford, Oregon Department of Fish & Wildlife

Stephen Gough, U.S. Fish and Wildlife Service

Rich Zabel, National Marine Fisheries Service

LIST OF ACRONYMS

CDFW	California Department of Fish and Wildlife
CWT	Coded Wire Tag
ER	Exploitation Rate
ESU	Evolutionarily Significant Unit
FCH	Fall Creek Hatchery
FMP	Fishery Management Plan
HCR	Harvest Control Rule
KRFC	Klamath River fall Chinook
KRWG	Klamath River work group
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
PFMC	Pacific Fishery Management Council
STT	(Council's) Salmon Technical Team
TOR	Terms of Reference
TRH	Trinity River Hatchery

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1 BACKGROUND

At their June 2023 meeting, the Pacific Fishery Management Council (Council or PFMC) formed the ad-hoc Klamath River Fall Chinook Workgroup (KRWG). One of the main purposes of the KRWG is to provide technical information for Council consideration that would assist the development of interim management measures, or a management framework, that would benefit Klamath River Fall Chinook (KRFC) as they respond to changing conditions due to the removal of Klamath River dams. The KRWG is guided by a set of Terms of Reference and General Timeline (TOR) adopted by the Council in June 2023.

In March 2024, the KRWG provided a report to the Council (Agenda Item C.4, Supplemental KRWG Report 2) which included a description of the removal of the four lower dams on the upper Klamath River and an overview of the Klamath River fall Chinook (KRFC) stock status and management framework. This information is incorporated herein by reference. The KRWG's report also outlined alternative management options for the Council to consider during the development of management measures for ocean salmon fisheries in 2024 and potentially beyond.

At the March meeting, the Council adopted a 20 percent buffer on the 2024 allowable exploitation rate (ER) for KRFC. The buffer reduced the maximum allowable ER of 25 percent specified in the 2024 NMFS Guidance Letter (March 2024, Agenda Item C.5.b Supplemental NMFS Report 1) down to a maximum allowable ER of 20 percent. The Council acknowledged the buffer would provide extra precautions in the face of uncertainty and rapidly changing conditions following dam removal. The Council opted to adopt the buffer for 2024 only, noting that the degree and magnitude of changing conditions will help inform the need for additional buffers or alternative harvest control rules in future years.

Since March 2024, all cofferdams have been breached and the river has returned to a free-flowing condition. Mobilization and removal of sediment is underway and volitional adult salmon passage began in early fall 2024. As of mid-October, salmon and redd were seen in Jenny Creek and Fall Creek in California and Spencer Creek in Oregon.

To address the continued need for more conservative management measures for KRFC until populations stabilize, the KRWG has continued to focus their work on providing the Council with additional alternative interim management options for consideration and developed a list of four potential candidates for future exploration. The KRWG has outlined the benefits, challenges, necessary next steps, and timeline for implementation of each potential management option. Some options may be appropriate for use in 2025 whereas others will require further development. The KRWG will continue to refine any options that the Council identifies as potential interim management measures.

2 POTENTIAL MANAGEMENT OPTIONS AND CONSIDERATIONS

The KRWG has discussed a range of potential interim management options for the Council to consider. As noted in Section 1, an overview of the current management structure is available in the KRWG's March 2024 report to the Council (Agenda Item C.4, Supplemental KRWG Report 2).

2.1 Current harvest control rule with a range of buffers

Background and intention of this approach

The KRWG recognized a need to provide more conservative alternatives to the current KRFC harvest control rule that could be used during the dynamic period following dam removal. The elaborations of the current KRFC control rule were presented at the March 2024 PFMC meeting. Conservation benefit (in terms of reduced exploitation rates) could be realized at low, moderate, and/or high abundances, depending on the alternative.

Benefits

This alternative offers a variety of ways to reduce exploitation rates at different levels of abundance. The approach is familiar to the Council and the public because each alternative is a modification to the current harvest control rule. This method is readily implementable and similar to the buffering approach provided by Council guidance for KRFC, Sacramento River fall Chinook, and other salmon stocks in recent years.

Considerations and Challenges

During this dynamic and uncertain time in the Klamath Basin selecting a targeted action that will result in the desired outcome could be difficult.

Necessary next steps and timeline for use in management

The range of buffers to the current control rule already exists and does not require further work prior to the fishery planning process in March and April for the 2025 ocean salmon fisheries. The range of buffers was analyzed in Section 2.5 of the KRWG's March 2024 Report (Agenda Item C.4, Supplemental KRWG Report 2).

2.2 Sub-basin management approach

Background and intention of this approach

The objective of a sub-basin management approach would be to allow fishery access to more abundant salmon sub-stocks in the Trinity River while not impeding the rebuilding of KRFC that are dependent upon habitats in the dam removal reach. Focusing management actions at the sub-basin scale could protect the most vulnerable stocks contributing to the upper Klamath watershed. Greater resolution within Klamath Basin of estimated biological parameters such as productivity and capacity, maturation rates, and the proportion of annual run forecasts destined to either hatchery or natural spawning areas by sub-basin strata would be required for further exploration into this management approach.

Benefits

The primary benefit of a sub-basin management approach could be the potential to implement increased protections for spawners that are most likely to directly contribute to the repopulation of the Upper Klamath River above the former Iron Gate Dam site while not constraining fisheries focused on stocks which are unlikely to contribute to repopulation.

Considerations and Challenges

Challenges to this approach include evaluating data sufficiency, including the application of coded wire tag (CWT) data across time and area strata to inform new or modified harvest models for both sub-basins. California Department of Fish and Wildlife (CDFW) has historically estimated separate spawner abundances for the Trinity and Klamath rivers. Also, CDFW has estimated juvenile survival rates for the Trinity stock, which requires tracking hatchery releases until age two in the ocean. Other data requirements could be similar to those already being pursued for the single basin management scheme presently implemented for KRFC. However, cohorts would need to be partitioned into the two respective sub-basins to facilitate this more refined scale of management. The KRWG has been informed of a Trinity River specific fall Chinook cohort reconstruction specific to the Trinity River for the Trinity River Restoration Program (TRRP, US BOR) that could greatly assist in this effort and facilitate certain aspects of the technical workload. A cohort model for the balance of the Klamath Basin would need to be modified to accommodate the two sub-basins. Separate control rules for each sub-basin could follow.

While the entire KRWG has an initial interest in developing a stock recruitment analysis for the two strata (the Trinity River and the balance of the Klamath River basin excluding the Trinity River), agreement has not been reached over on whether this overall management approach would fulfill the core purpose of this workgroup. Part of the KRWG believes that added granularity to stock assessments would not address the management challenges associated with dam removal and the addition of new habitat. The other members of the group believe adding conservation benefit to one sub-basin (the Klamath) while not reducing harvest opportunities in another (the Trinity) uniquely achieves three important purposes of the KRWG's terms of reference: (1) promoting a sustainable abundance of KRFC as it responds to the freshwater environment post-dam removal, (2) enable a more direct assessment of the capacity of the modified habitat of upper Klamath watershed and (3) allow fishing on abundant salmon stocks while not impeding the rebuilding of KRFC from overfished status.

The KRWG also discussed that the KRWG membership does not include the necessary expertise or workload capacity to complete the list of five tasks that would be required to explore this potential and that are identified in the next section as '*Next Steps*'. Moreover, parsing management of the Klamath and Trinity Basin stocks could likely require development of separate HCR's and an associated plan amendment to the Pacific Salmon Fishery Management Plan (FMP). Hence, this approach does not represent an interim measure which could be accommodated within the extant FMP and rather speaks to a longer-term solution of balancing the interest of recolonizing restored upper Klamath River habitats while allowing fishing on more abundant salmon stocks.

Necessary next steps and timeline for use in management

Initial workload would require that the appropriate experts develop the elements listed below as '*Next Steps*.' Beyond the initial development phase, annual workload would also increase. Significant collaboration among co-managers is already in place for the Klamath Basin. Primarily facilitated by today's Klamath River Technical Team, this annual data gathering and analysis effort would be expected to continue and include additional management entities representative of the Klamath River from the dam removal area. As noted previously, this approach would require a broader expertise than currently available in the KRWG to address the technical workload up to and including an FMP amendment.

The sub-basin management approach could result in discrete conservation and harvest objectives affecting Klamath Basin. Accordingly, the approach could lead to an intra-basin management group to address policy and harvest allocation issues. Conservatively, this approach would require three management cycles (2025-2027) to fully develop and be available by spring of 2028. The next steps for advancing this approach include:

1. Obtain Trinity cohort reconstruction from Trinity River Restoration Program (TRRP, US BOR-Denver Technical Services Center);
2. Develop separate cohort reconstruction for Klamath independent of Trinity;
3. Develop separate stock-recruit relationships for both sub-basins (similar to all approaches, the interim stock-recruit relationships for the Klamath Basin would not account for habitat capacity associated with removal of the Klamath dams);
4. Evaluate data sufficiency to inform management of the two independent stocks (e.g. CWT data, time and area strata, and contact rate estimation); and
5. If Step 4 demonstrates that sufficient data to inform management as two independent stocks is available, develop discrete Ocean Harvest Model outputs for both the Trinity and Klamath River stocks.

Request: The KRWG requests the Council provide guidance on whether this workgroup should continue to explore the sub-basin management approach as described above.

2.3 Habitat-based approaches

Background and intention of this approach

Key uncertainties for KRFC stocks after dam breaching are the capacity, both quantity and quality, of the newly available habitat before supporting salmon populations and how Chinook salmon will respond to the newly available habitat.

The STT (2005) has used accessible watershed area (5th order and higher streams) as a predictor of subsequent recruitment. Although this model was rejected, it only considered habitat quantity and not quality.

Benefits

Several recent analyses have attempted to assess habitat capacity above impoundments. Cooper et al. (2020) developed a model to estimate Chinook capacity above Scott Dam on the Eel River.

Bond et al. (2023) estimated capacity in the Similkameen River (tributary of the Columbia) above Enloe Dam. In both cases, dams were in place and the analyses were prepared in anticipation of dam removal. In the Klamath River, dams have already been removed, potentially making an assessment of available habitat easier.

An estimate of capacity in the newly available habitat could be used to gauge the repopulation potential in the new habitat. Assuming fish can be monitored as they enter the new habitat, success of the repopulation could be assessed (e.g., by estimating percent seeding). This information could then be used to guide management.

Fish surveys in the habitat above the former dam sites are underway. Carcass and redd surveys are being conducted above Iron Gate, and sonar along with tangle nets will monitor upstream progress of adults by stock.

Considerations and Challenges
The KRWG does not have the expertise to carry out such an analysis, and it doesn't appear that such an analysis currently exists for the Klamath River. However, the planned surveys will help collect the data to support such an analysis.

Necessary next steps and timeline for use in management
Given the lack of expertise on the KRWG and lack of analysis currently available for the Klamath River, a habitat-based estimate of capacity will not be available for several years. The KRWG encourages the initiation of a thorough analysis of habitat quantity and quality in the newly available habitat in the near future.

Request: The KRWG requests the Council provide guidance on whether this workgroup should continue to explore habitat-based approaches as described above.

2.4 Matrix-based approach

Background and intention of this approach
The KRWG considered a method to derive an interim conservation buffer to the allowable ER by using a matrix-based approach. This method provides an ER buffer based on a score derived from an array of area-specific and life-history specific metrics (Table 1) for one or more brood years subject to ocean and river fishery planning in any given year. The range of each component is assigned a numeric score where the poorest performance equates to the lowest possible score and optimum performance equates to the highest possible score.

For conceptual purposes, the KRWG has assembled five potential components for utilization in implementing added conservation:

- The first component could be the total natural-area adults returning above the former Iron Gate (IG) Dam as a measure of repopulation at the spawner stage. Current values included in the example table are derived from long term average historical trap totals at the

Klamathon Racks (Fortune et al., 1966), approximately 11 km downstream of IG. Large numbers of adults successfully utilizing the newly available habitat is a desirable outcome.

- The second component could be the proportion of natural area adults returning above and below IG as a measure of how spawning distribution across the landscape, where a total shift of fish from the historical habitat below IG to the newly available habitat above IG would be an undesirable outcome. Initial values used to populate the table for proportions below IG were derived from totals in the Klamath mainstem below IG since 2005. Ideally fish will be spawn across all the quality spawning habitat available and this ratio should be an approximation of ideal distribution post repopulation and stabilization.
- The third component could be the natural origin juvenile emigration total below IG as a measure of successful spawning and rearing in the newly available habitat. This component requires a definition of spawning and rearing success defined as expected smolts per spawner with which to quantify a score for annual observations. Rates identified for nearby undisturbed habitat and healthy populations are utilized here as a proxy.
- The fourth component could be the total Fall Creek Hatchery (FCH) smolt releases to reflect achievement of capturing sufficient numbers of broodstock needed to achieve release targets and successful implementation of the hatchery program. When FCH is achieving or exceeding the target release totals for smolts then there will be more fish available for harvest in ocean and river fisheries.
- The final component could be a jack to smolt ratio specific to FCH that is intended to serve as a proxy for freshwater migration and early ocean survival. This component addresses the ocean entry portion of Chinook life history where substantial mortality can occur, regardless of the performance of freshwater life history measures.

The sum of the component scores is plugged into an ER buffer table (Table 2) where that sum equates to a specific ER buffer for preseason consideration. At this time the range of buffers have not been determined and data or methods to understand the appropriate level of ER reduction have not been identified. Ultimately, the range of ER buffers may be a policy decision that receives limited technical support. This would not be unlike a variety of breakpoints included in the current KRFC and SRFC HCRs, where there is little scientific basis for their form or function. The tables included in this section at this time are for illustrative purposes only and are subject to change pending further KRWG analyses and discussion and Council guidance.

Table 1. Draft of scoring matrix used to derive an interim conservation buffer to the allowable exploitation rate

Total NA Adults Above IG		Proportion of NA KM Run Above IG		0+ NO Juvenile Emigration Below IG		Fall Creek Hatchery Smolt Release		Fall Creek Hatchery Jack/Smolt Rate	
Adults	Score	Proportion	Score	Juveniles	Score	Smolts	Score	Rate	Score
>10,000K	10	1.0	6	>1,881,900	10	>1,750,000	10	>0.0490%	10
8,875	9	0.9	7	1,670,186	9	1,575,000	9	0.0430%	9
7,750	8	0.8	8	1,458,473	8	1,375,000	8	0.0370%	8
6,625	7	0.7	9	1,246,759	7	1,175,000	7	0.0310%	7
5,500	6	0.6	10	1,035,045	6	975,000	6	0.0250%	6
4,375	5	0.5	9	823,331	5	775,000	5	0.0190%	5
3,250	4	0.4	8	611,618	4	575,000	4	0.0130%	4
2,125	3	0.3	7	399,904	3	375,000	3	0.0070%	3
1,000	2	0.2	6	188,190	2	175,000	2	0.0010%	2
<1,000	1	<0.2	5	<188,190	1	< 175,000	1	< 0.0010%	1

*This table is for illustrative purposes only. Additionally, a duplicative table could be utilized for each, the age-3 and age-4 broods in any given management year.

*Values between steps equate to the corresponding scores until next threshold is reached. For example, 9,999 adults results in a score of 9 for that criteria.

Table 2. Exploitation rate buffer based on total matrix score

Total Score	ER Buffer
50	Lowest
45 to 49	
40 to 44	
35 to 39	
25 to 29	
20 to 24	
15 to 19	
10 to 14	
< 10	Highest

Benefits

A number of potential benefits for this approach have been identified by the KRWG as follows:

- Data needed to utilize the matrix such as presented here are readily available or expected to be available with the monitoring plans in place. Further, data availability timelines for the purposes of management post monitoring and assessment are well within the necessary timeframes the Council is accustomed to employing.
- The metrics used in this example matrix are directly tied to the adult brood years (age-3, age-4) being subjected to fisheries in any given management year. No time series lags, or indirect measures would be required.
- The example matrix and associated scoring is biologically driven and based on empirical data.
- If the Council directs the KRWG to refine the example matrix, the expertise within the KRWG is sufficient and does not require external support like other potential options included in this report (e.g. habitat-based model or two-basin approach)
- A matrix is multifaceted and does not depend on any one particular measure of stock performance. This buffers the impact of any one specific measure and also accounts for the potential for disparate metrics throughout the life history of KRFC.
- The performance of matrix components is specific to the life history stages of fish in or originating from the area of restoration and repopulation.

- A matrix can be used with the current KRFC stock complex approach or with a Trinity and Klamath specific (sub-basin) approach.
- Additionally, this approach is conceptually similar to other matrices used for other stocks in PFMC management.
- Part of this effort could include the development of a new Harvest Control Rule based on reference points from the recent stock-recruit analysis.

Considerations and Challenges

The KRWG also discussed several additional considerations and challenges related to further development or refinement of matrix components, as well as finalization and employment of such a management tool. These considerations and challenges include the following:

- The range of adult escapement above IG is based on historical Klamathon Rack data from a period with different overall productivity and hatchery/natural-origin fractions that may not be directly comparable to the contemporary population dynamics of the Klamath Mainstem below IG today. The KRWG will continue to consider this and any potential approaches to bring them into better alignment.
- The KRWG has yet to identify data or methods for determining the appropriate range of buffers for the HCR derived maximum allowable ER. This may ultimately become a policy decision that receives limited technical support.
- Several additional component metrics could be considered for inclusion in the final matrix such as a jack escapement to natural areas above IG, FCH yearling release totals, and indicator covariates from the latest stock-recruit analysis that were particularly influential. This analysis found statistically significant relationships with several environmental indicators, and the strength of these relationships, along with currently measured conditions, could be used as a matrix entry.
- Several considerations related to other component metrics included in the draft example table could use further technical consideration and possible refinement.

Necessary next steps and timeline for use in management

The KRWG supports additional refinement of this approach and believes it could be a potentially useful tool for the interim period of restoration and repopulation of the upper reaches of the Klamath basin. Ultimately, a new stock recruitment analysis, conservation objective, and HCR will be required in 10 to 15 years when the sufficient data become available.

Request: If the Council supports the continuation of this work, the KRWG requests guidance from the Council regarding potential refinements to the example matrix, including potential components for inclusion or elimination and any maximum ER buffer the Council may consider employing in management for the next 10 to 15 years. Given the capacity of the KRWG and the relative simplicity of this approach, and barring any delays associated with FMP amendment, the KRWG anticipates this method could be available for Council consideration and adoption by the fall of 2025, with implementation in 2026 fishery planning.

3 MONITORING NEEDS AND RECOMMENDATIONS

The KRWG reiterates their statement made in March 2024 (Agenda Item C.4, Supplemental KRWG Report 2) regarding the need to maintain and increase monitoring of the KRFC stock and information specific to habitat and water quality.

The KRWG discussed the merits of using the Rogue River fall Chinook population as an interim reference for the KRFC population. The KRWG explored the concept to compare historical abundances of the populations to identify potential similarities between the two populations in terms of abundance or recruits per spawner. The potential relationship between the two stocks could then be used if the KRFC population deviates from past patterns (presumably by having greater abundances). These increases may then be attributed to dam breaching. Upon further discussion, the KRWG decided that this relationship between the two populations could be used as a general guideline for assessing the KRFC population but not for any rigorous analysis due to the noisiness of the data.

4 MANAGEMENT OPTIONS CONSIDERED BUT NOT RECOMMENDED FOR FURTHER DEVELOPMENT

4.1 Range to inform future analysis

This concept could allow for setting year-specific exploitation rates or escapement goals, potentially based on environmental indicators, that could allow for a wide range of escapement outcomes. Such an approach could allow for improved estimates of productivity and capacity if the data informing those estimates span a wide range of potential abundances. The concept has merit but is currently a low priority during the early stages following dam removal. Furthermore, escapement to the Klamath has typically spanned a wide range of abundances and exploitation rates without a concerted effort to achieve this result.

5 SUMMARY

The four interim management measures proposed by the KRWG each have unique benefits and challenges, along with varying requirements for additional resources and time before they could be implemented. The existing harvest control rule with a buffer could be utilized in the pre-season planning for the 2025 ocean salmon fisheries. A matrix-based approach might be ready for implementation by 2026. Although both a habitat-based approach and a sub-basin management approach have potential advantages, they would require expertise beyond what the current KRWG composition can provide to be effectively developed for management use at this time.

The KRWG will continue to work on any of the management alternatives the Council determines to have merit for potential use. The KRWG is scheduled to meet in January 2025 and then not again until after the completion of the 2025 ocean salmon fisheries pre-season planning process is complete.

6 LITERATURE CITED

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