Report to the Pacific Fishery Management Council on Klamath River Fall Chinook Interim Management Measures for Ocean Salmon Fisheries in 2024 and Potentially Beyond

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

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LIST OF ACRONYMS

CDFW	California Department of Fish and Wildlife
CRH	Cole Rivers Hatchery
ER	Exploitation Rate
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit
FMP	Fishery Management Plan
HCR	Harvest Control Rule
IGH	Iron Gate Hatchery
KRFC	Klamath River Fall Chinook
MSA	Magnuson-Stevens Act
MSSI	Minimum Stock Size Threshold
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NWFSC	(NMFS) Northwest Fisheries Science Center
PFMC	Pacific Fishery Management Council
SSC	(Council's) Scientific and Statistical Committee
STT	(Council's) Salmon Technical Team
SWFSC	(NMFS) Southwest Fisheries Science Center
TRH	Trinity River Hatchery
WCR	(NMFS) West Coast Region

TABLE OF CONTENTS

List of Tables and Figures

1 INTRODUCTION

The four lower dams of the upper Klamath River which had blocked anadromy are subject to the Klamath Dam Removal Project which entered the reservoir draw down and dam removal phase in January 2024, necessitating the planning for active management of Klamath River fall Chinook (KRFC) that may go beyond those prescribed in the Pacific Coast Salmon Fishery Management Plan (FMP) and the associated KRFC Harvest Control Rule (HCR). The current expectation for volitional passage of anadromous salmonids is during the fall of 2024. Post dam removal, over 400 miles of new habitat will be available to anadromous salmonids beyond dam locations, roughly twice the distance of what is currently available with dams in place. Further, the states of Oregon and California are currently developing freshwater fishing regulations to protect anadromous salmonids as they escape to and utilize this new habitat, such that repopulation and recovery is effectively and expeditiously achieved.

In 2018 Klamath River Fall Chinook were categorized as overfished and a rebuilding plan was adopted in 2019 (PFMC 2019). In the Rebuilding Plan, the Salmon Technical Team (STT) recommended a review of the conservation objective for KRFC. The 2023 KRFC stock assessment indicated that KRFC remain overfished. At the November 2022 Pacific Fishery Management Council (Council) meeting, the STT report and the Scientific and Statistical Committee (SSC) report indicated continued support for a review of the current conservation objective for KRFC. The SSC noted that developing new objectives should not require a lengthy process or period of time and that the necessary information to do so exists or can be developed. The STT added that the development of new interim measures should be tied to the dam removal timeline and the point when volitional passage is expected, meaning any interim measures should be adopted for implementation no later than the spring of 2024. The recommendation for a review of the management measures was also provided to the Council in the Pacific Fishery Management Council Salmon Fishery Management Plan Impacts to Southern Resident Killer Whales in 2020, and prior to that as a recommendation from the Habitat Committee

The current escapement objective (or $S_{MSY)}$ for KRFC of 40,700 natural-area adults has been in place since at least 2012 and was based upon a stock-recruitment analysis that was last performed in 2005 (STT 2005). With the expansion of habitat anticipated after dam removal, a new stock-recruitment analysis will be needed in the years to come. At least 8 to 12 years of data will likely be necessary before a new, long-term, escapement objective can be derived. A contemporary assessment of stock productivity is also warranted when considering the utility of the current management framework and any potential deviations in the near term. The timeline attached to this dam removal project is inflexible and a successful restoration project is of great importance to many. The success of a project of this importance and magnitude will require significant Council planning and adaptation.

2 OBJECTIVES

Dam removal is underway with volitional adult salmonid passage slated for September/October of 2024. There is an immediate need to begin considering new management objectives that go beyond the HCR-prescribed targets that could promote and enhance the repopulation and recovery of Chinook utilizing the new habitat. Coupled with a potential loss of productivity due to dam removal activities themselves in the near term, via turbidity and sedimentation of water and gravel downstream, a more conservative approach to managing fisheries that affect KRFC may be warranted. Adding that the stock has been in an overfished status since 2018 with modest rebuilding progress, action should be considered to buffer against the potential for a continued period of low abundance. While annual fluctuations in stock abundance and limiting factors related to weak stock management in ocean fisheries will clearly play a role in determining annual escapement projections, a critical look at KRFC escapement objectives and the HCR is warranted.

In June 2023 the Council adopted the Draft Terms of Reference and formed this Ad-Hoc Workgroup (Workgroup) to address the following needs, to the extent practicable:

- Assist the Council with developing interim management measures, or a management framework, intended to address the response of KRFC to the dynamic nature of the Klamath River environment and the available habitat immediately following dam removal, and post dam removal until the natural environment is stabilized and the salmon population is more predictable.
- Allow fishing on abundant salmon stocks while not impeding the rebuilding of KRFC from overfished status.
- Promote as best as possible a sustainable abundance of KRFC as it responds to the freshwater environment post-dam removal.
- Advise the Council on the implications to fisheries and fishery management tools from changes to production and coded-wire-tagging programs associated with dam removal.
- Advise the Council on data needs following dam removal.
- Design new, or update existing abundance forecast methods and harvest models to account for the capacity of the modified habitat and availability of new or lost data inputs, as appropriate.

To address the objectives set for this Workgroup for the immediate future (2024 and potentially 2025) the Workgroup has initially focused their work on providing the Council with an overview of KRFC and associated fishery management, an updated evaluation of stock productivity and capacity, a range of alternative management options and consideration of their relative utility, and a brief overview of monitoring needs for current and new habitat in the Klamath River Basin.

Because of the short timeline the Workgroup had to address fishery management of KRFC in 2024, it was not possible to consider the design of new, or updates to, existing abundance forecast methods and harvest models to account for the capacity of the modified habitat and availability of new or lost data inputs. While the Workgroup has not been able to consider or develop more sophisticated management framework alternatives (adaptive or otherwise) or forecasting methods given the time constraints, the potential exists that the Workgroup may be able to provide additional tools for Council consideration in the future, should the Council so desire.

3 STOCK OVERVIEW

3.1 Stock Overview

3.1.1 Location and geography

The Klamath Basin lies in Northern California and Southern Oregon and encompasses 40,632 km^2 (Figure 3.1). More than half of the watershed (20,875 km^2) lies in the upper Klamath Basin, defined here as upstream from Iron Gate Dam (IGD). Anadromy in the upper basin was cut off by the construction of Copco 1 Dam in 1917 and was further limited by construction of IGD in 1962, built to re-regulate the discharge from Copco Dam.

The Trinity River is the largest tributary to the Klamath River and the mouth of the Trinity River is about 44 miles upstream from the ocean. Access to the upper Trinity Basin was cut off by the construction of Trinity Dam in 1962 and its re-regulation dam (Lewiston) in 1963, which together blocked access to the upper 459,264 acres (1,859 km^2) of the Trinity Basin, leaving an accessible watershed area of 17,898 km^2. Various other smaller dams and water diversions have also been constructed in the basin. All remaining habitat accessible to anadromous fish lies in California, though portions of the lower Klamath Basin Watershed extend into Oregon. Major tributaries to the Klamath River within the lower basin include the Trinity, Salmon, Scott, and Shasta rivers, and Bogus Creek, all of which support naturally spawning populations of KRFC (PFMC 2008).

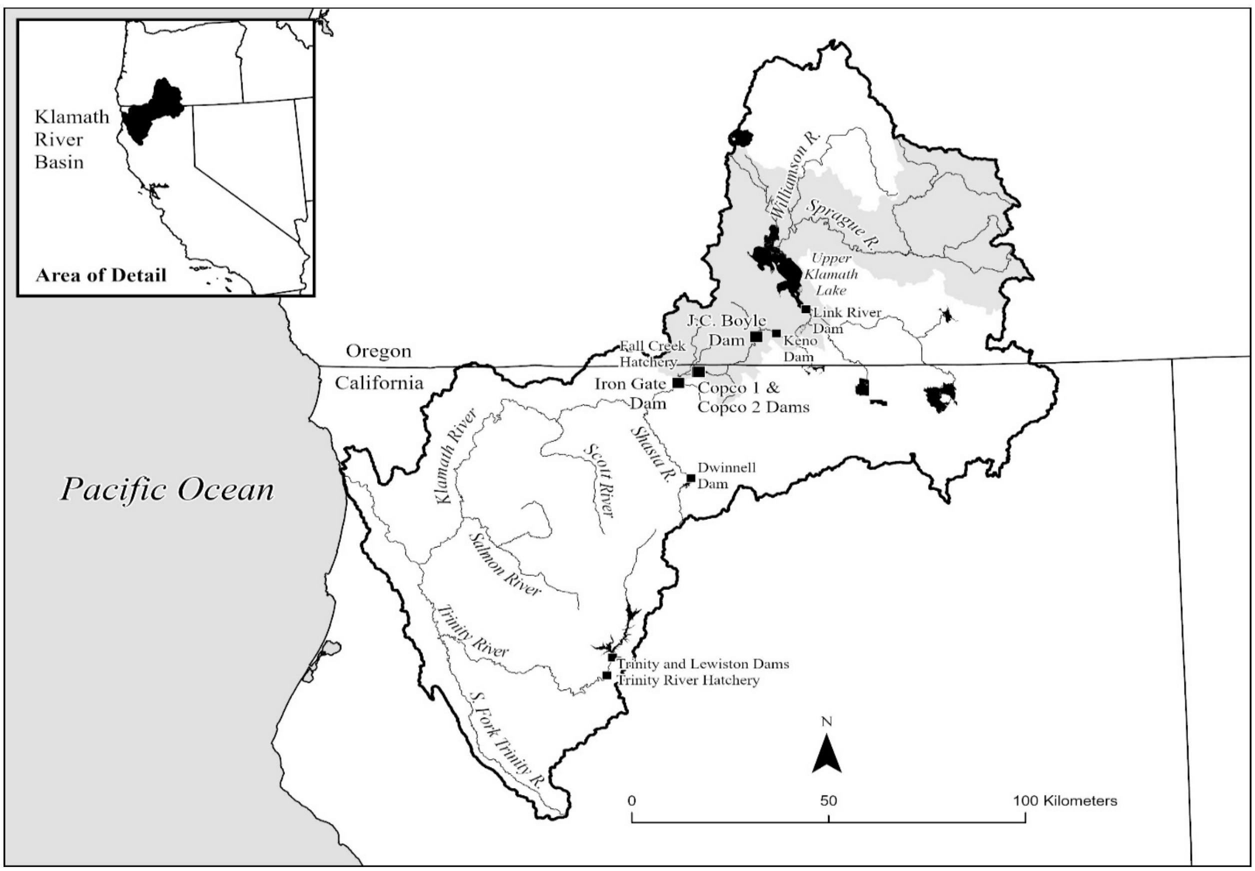

Figure 3.1. Klamath River Basin map.

3.1.2 Stock composition

Fall Chinook are the predominant salmon run type in the Klamath Basin. Naturally spawning KRFC enter freshwater to spawn during August-September and deposit their eggs during October-December. The eggs incubate in the gravel during October-January and young fish emerge in February-March. Downstream migration begins soon after emergence. When ready to enter the ocean, juveniles reach the estuary during June-August and ocean entrance is generally complete by the end of September. In August-September following the year of ocean entry, a small proportion of each cohort, mostly males (jacks), returns to the river to spawn as age-2 fish. The first major contribution to adult spawning escapement takes place during August-September after the second year of ocean entry, as age-3 fish. The majority of the adult fish in each cohort are destined to spawn by age-4. The very few remaining fish of each cohort mature at age-5 or very rarely at age-6.

Hatchery KRFC production occurs at Iron Gate Hatchery (IGH) located at the base of IGD at the upper limit of anadromous migration in the Klamath River and at Trinity River Hatchery (TRH) located at the base of Lewiston Dam at the upper limit of anadromous migration in the Trinity River. Both facilities were constructed to mitigate habitat loss resulting from construction of the major dams on the mainstem of the Klamath and Trinity Rivers, respectively. At both hatcheries, most juvenile fish are released directly into the river as fingerlings at or near the respective facilities. This generally occurs during June of the year following spawning, although release timing can be advanced if river water temperatures are projected to be suboptimal during the downstream migration period, or if the fish sooner reach an average minimum release size. A proportion of each hatchery's production goal is released as yearlings in October and November (PFMC 2008).

3.1.3 Current stock status

KRFC natural-area adult escapement has been below the FMP-defined maximum sustainable yield level of 40,700 in five of the last 10 years and four of the past five years (2019-2023). The stock remains overfished and there has been little progress toward achieving rebuilt status following implementation of the rebuilding plan. Table 3-1 displays trends in run size and escapement to hatcheries and natural areas.

Table 3.1. Klamath River fall Chinook adult inriver runsize and escapement.

Year(s)	Inriver Run Size Numbers	Spawning Escapement Hatchery	Natural	Total	Percent
1981-85 average	63,230	11,746	27,667	39,413	63%
1986-90 average	151,203	25,106	70,785	95,891	63%
1991-95 average	80,666	18,084	47,932	66,016	74%
1996-00 average	123,856	35,970	54,229	90,199	72%
2001-05 average	136,848	38,952	56,346	95,298	70%
2006	61,374	19,522	30,163	49,685	81%
2007	132,131	35,050	60,670	95,720	72%
2008	70,554	13,552	30,850	44,402	63%
2009	100,644	19,614	44,409	64,023	64%
2010	90,860	18,052	37,225	55,277	61%
2011	101,977	22,337	46,763	69,100	68%
2012	295,322	55,939	121,543	177,482	60%
2013	165,025	17,148	59,156	76,304	46%
2014	160,396	31,276	95,104	126,380	79%
2015	77,821	11,085	28,112	39,197	50%
2016	24,582	3,578	13,937	17,515	71%
2017	33,232	11,213	19,904	31,117	94%
2018	91,060	18,567	52,352	70,919	78%
2019	37,084	5,178	20,022	25,200	68%
2020	45,409	8,331	26,185	34,516	76%
2021	53,954	12,850	29,942	42,792	79%
2022	46,544	13,234	21,956	35,190	76%
2023	66,017	21,964	41,623	63,587	96%
Goal			≥40,700		

4 MANAGEMENT OVERVIEW

4.1 Management framework

4.1.1 Conservation objectives

Table 3-1 in the FMP (PFMC 2022) defines the current conservation objective for KRFC:

At least 32 percent of potential adult natural spawners, but no fewer than 40,700 naturally-spawning adults in any one year. Brood escapement rate must average at least 32 percent over the long-term, but an individual brood may vary from this range to achieve the required tribal/nontribal annual allocation. Natural area spawners to maximize catch estimated at 40,700 adults (STT 2005).

Prior to adoption of Amendment 16 to the salmon FMP in 2012, the KRFC conservation objective was defined as:

33-34 percent of potential adult natural spawners, but no fewer than 35,000 naturally spawning adults in any one year. Brood escapement rate must average 33-34 percent over the long-term, but an individual brood may vary from this range to achieve the required tribal/nontribal annual allocation.

Further information on and justification for this conservation objective can be found in Table 3-1 of the most recent FMP.

Prior to 2012, the conservation objective defined in the FMP guided fishery management for KRFC. Fisheries were planned such that the projected natural-area adult escapement was at least 35,000 adults in most years. Upon adoption of Amendment 16 to the FMP in 2012, annual fishery management of the KRFC stock has been guided by a HCR that incorporates some aspects of the current conservation objective (PFMC 2016).

4.1.2 Management strategy

Current management of KRFC is guided by a control rule that specifies the maximum allowable exploitation rate (ER) on the basis of a forecast of the natural-area adult escapement in the absence of fisheries (E0) (Figure 4.1). The ER cap specified by the HCR includes harvest and incidental impacts in both ocean and river fisheries.

For KRFC, potential spawner abundance in the absence of fisheries is forecast each year based on age-specific ocean abundance estimates, ocean natural mortality rates, age-specific maturation rates, stray rates, and the proportion of escapement expected to spawn in natural areas (PFMC 2022). The result is the number of natural-area adult spawners expected given no ocean fisheries between Cape Falcon, OR, and Point Sur, CA, and no river fisheries.

The HCR describes maximum allowable ERs at any given level of abundance. At high levels of potential spawner abundance, the HCR specifies a maximum allowable ER of 0.68, the fishing mortality rate (F) associated with the Acceptable Biological Catch ($\mathrm{F_{ABC}}$). At moderate abundance levels, the HCR specifies an allowable ER that varies with abundance to result in an expected spawner escapement of $\mathrm{S_{MSY}} = 40{,}700$ natural-area adults (the curved portion of the control rule). At low levels of abundance, the HCR specifies *de minimis* ERs that allow for some fishing opportunity but result in the expected escapement falling below 40,700 natural-area adult spawners.

Consistent with the FMP in section 3.3.6, the Council may recommend lower ERs as needed to address uncertainties or other year-specific circumstances, including closure of a fishery. When recommending an allowable *de minimis* ER in a given year, the Council shall also consider the following circumstances:

- The potential for critically low natural spawner abundance, including considerations for substocks that may fall below crucial genetic thresholds;
- Spawner abundance levels in recent years;
- The status of co-mingled stocks;

- Indicators of marine and freshwater environmental conditions;
- Minimal needs for tribal fisheries;
- Whether the stock is currently in an approaching overfished condition;
- Whether the stock is currently overfished;
- Other considerations as appropriate.

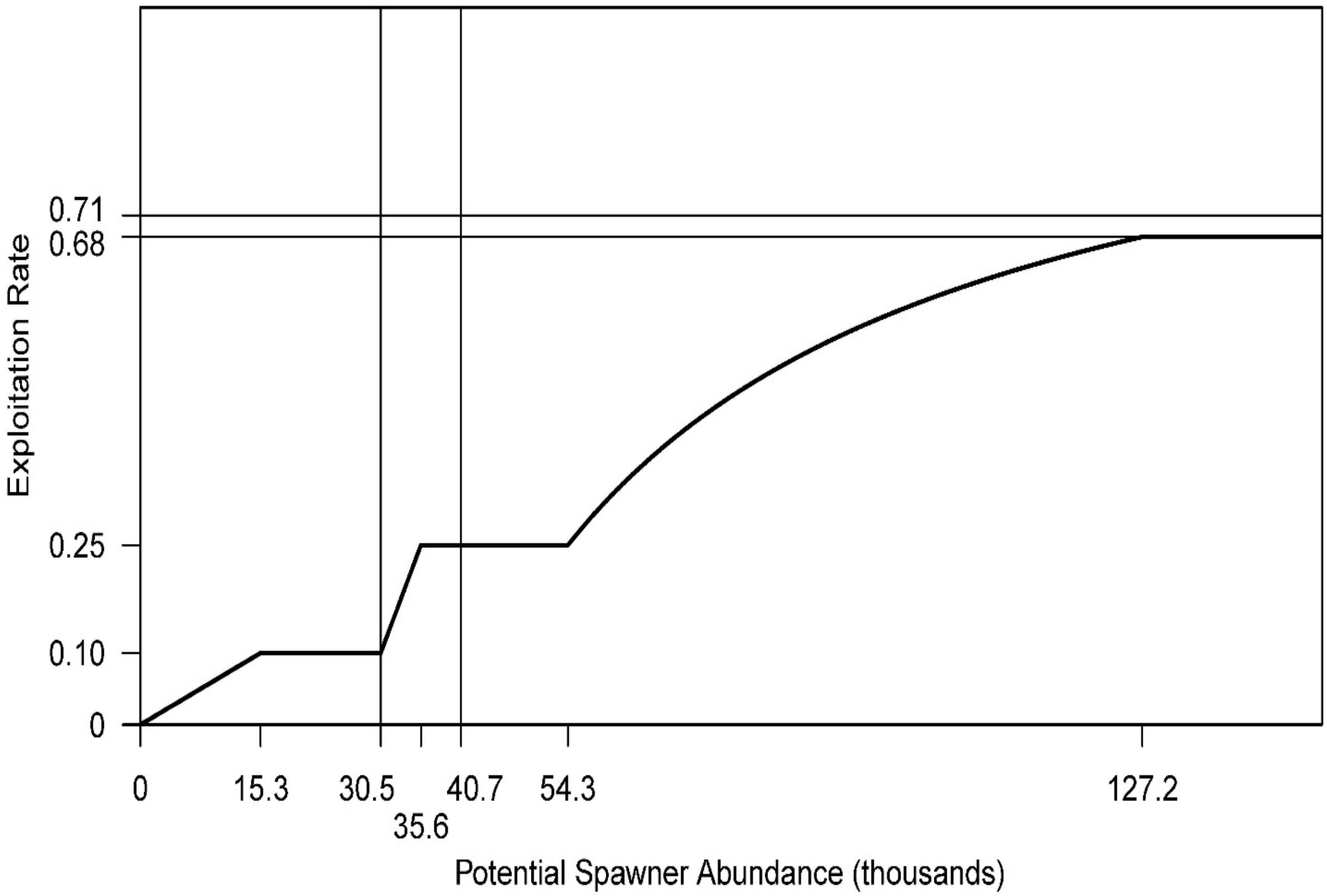

Figure 4.1. Current Klamath River fall Chinook HCR since 2012. Potential spawner abundance is the predicted natural-area adult spawners in the absence of fisheries. The minimum stock size threshold (MSST) of 30,525 natural-area adult spawners, and the number of natural-area adult spawners associated with Maximum Sustainable Yield (S_{MSY}) of 40,700, are denoted on the x-axis of the figure.

4.2 Updated Stock Recruit Analysis

4.2.1 Purpose of performing the update

The Workgroup had several reasons for updating the stock recruit analysis. First, the stock was last assessed in 2005 (STT 2005), covering brood years 1979-2000 ('old data'). We now have 17 more years of data, corresponding to brood years 2001-2017 ('new data'). Second, we wanted to assess whether the population dynamics of the stock has changed in the recent period compared to the previous period.

We envision a two-step process in conducting this assessment. The first step (reported here) is to replicate, as much as possible, the assessment conducted in 2005. In doing this, we will determine whether the more recent data are consistent with the historical data contained in the 2005 report. We will also use the results of this analysis to inform current management of the stock. In the second phase (to be completed), we will ask whether we can improve the analysis by including indices of marine and/or freshwater survival in the analysis.

4.2.2 Procedure / methods

We employed the same methods as used by the 2005 Report. That report used a simple Ricker stock-recruit analysis that related $\log(R_t/S_t)$ to S_t in a linear relationship, where R_t and S_t are recruits and spawners referenced to brood year. The analysis was expanded to include $\log(s_t)$ in the linear relationship, where s_t is the survival of hatchery fish from release to age-2 (reconstructed from CWT data). This estimate of juvenile survival is based on releases from the Iron Gate and Trinity River hatcheries and are weighted according to spawners in each river referenced to brood year. The data for this analysis were all contained in the 2005 report (Tables A1 and B1). We were able to replicate the analysis based on the data from the report.

The data to update the analysis were derived from three files:

1) Table B4 from "escapements-to-inland-fisheries-and-spawning-areas-salmon-review-appendix-b-excel-file-format.xlsx". This file is maintained on the PFMC website and provided data on spawners, apportioned to abundance in the Trinity and Klamath rivers.
2) "CohortPopTotal.xls" provided by CDFW. This file contains estimates of the age-specific abundance of adults in the ocean, along with data on natural mortality, maturation and stray rates. These data were used to estimate recruits.
3) "age2survival.dbf.xls" provided by CDFW. This file contains estimates of juvenile survival from the hatcheries.

Because these sources of data overlapped with the data from the 2005 report, we could assess consistency in data between the older and newer sources.

4.2.3 Results

The older and newer datasets were mostly consistent with two notable exceptions. The recruits estimated for brood years 1999 and 2000 differed substantially between the two data sources. The estimates of recruitment were lowered for these two brood years in the more recent dataset. We believe that this was the result of adjustments made by CDFW staff (personal communication with Mr. Brett Kormos), but further investigation on this is needed to confirm the reasoning for the differences. Also, in the 2005 report, some spawners were identified as “unknown origin”. In the recent data, these unknown origin fish were assigned to the Klamath River. We note that the estimate of total spawners was similar between the two datasets, but the re-assignment affected the weightings of the juvenile survival. The Workgroup decided to use the more recent data for comparisons between periods.

Table 4.1 contains the results from the basic stock-recruit analysis that contained spawners and recruits. When comparing the old time period (BY 1979-2000) with old and new data, the parameter estimates and reference points were similar, but the reference points decreased slightly with the new data. When comparing the old time period to the new time period (BY 2001-2017), the productivity parameter (α) decreased substantially while the capacity parameter (β) remained roughly the same.

Table 4.1. Results from the basic stock-recruit analysis

	Productivity (α)	Capacity (β)			
	α (95% CI)	β (95% CI)	S_{msy}	S_{max}	$Sueq$
Old data, old time period	8.53 (4.66, 15.59)	2.52e-05 (1.53e-05, 3.5e-05)	32,700	39,700	101,300
New data, old time period	8.50 (4.70, 15.38)	2.57e-05 (1.6e-05, 3.53e-05)	31,900	38,900	98,600
New data, new time period	4.70 (2.19, 10.10)	2.74e-05 (1.44e-05, 4.03e-05)	25,300	36,500	68,200

Table 4.2 contains results from the stock recruit analysis that contained juvenile survival. When comparing the old time period with the old and new data, there were slight differences in the parameter estimates and reference points. In particular, S_{msy} decreased by 3,000 fish. When comparing the old time period to the new time period, the productivity parameter decreased substantially, but the capacity parameter and the juvenile survival parameter (θ) remained similar.

Table 4.2. Results from the stock recruit analysis that included juvenile survival.

	Productivity (α)	Capacity (β)	Juvenile Survival (θ)			
	α (95% CI)	β (95% CI)	θ (95% CI)	S_{msy}	S_{max}	$Sueq$
Old data, old time period	5.93 (3.70, 9.51)	1.76e-05 (9.60e-06, 2.56e-05)	0.539 (0.303, 0.775)	40,700	56,900	112,300
New data, old time period	5.48 (3.34, 9.00)	1.85e-05 (1.04e-05, 2.66e-05)	0.516 (0.276, 0.756)	37,700	54,000	102,600

These results are further demonstrated in Figures 4-2 and 4.3. These plots show the decreased productivity of the population in the newer time period as compared to the older time period. Also, Figure 4.3 shows the relatively strong effect of juvenile survival on estimates of recruitment.

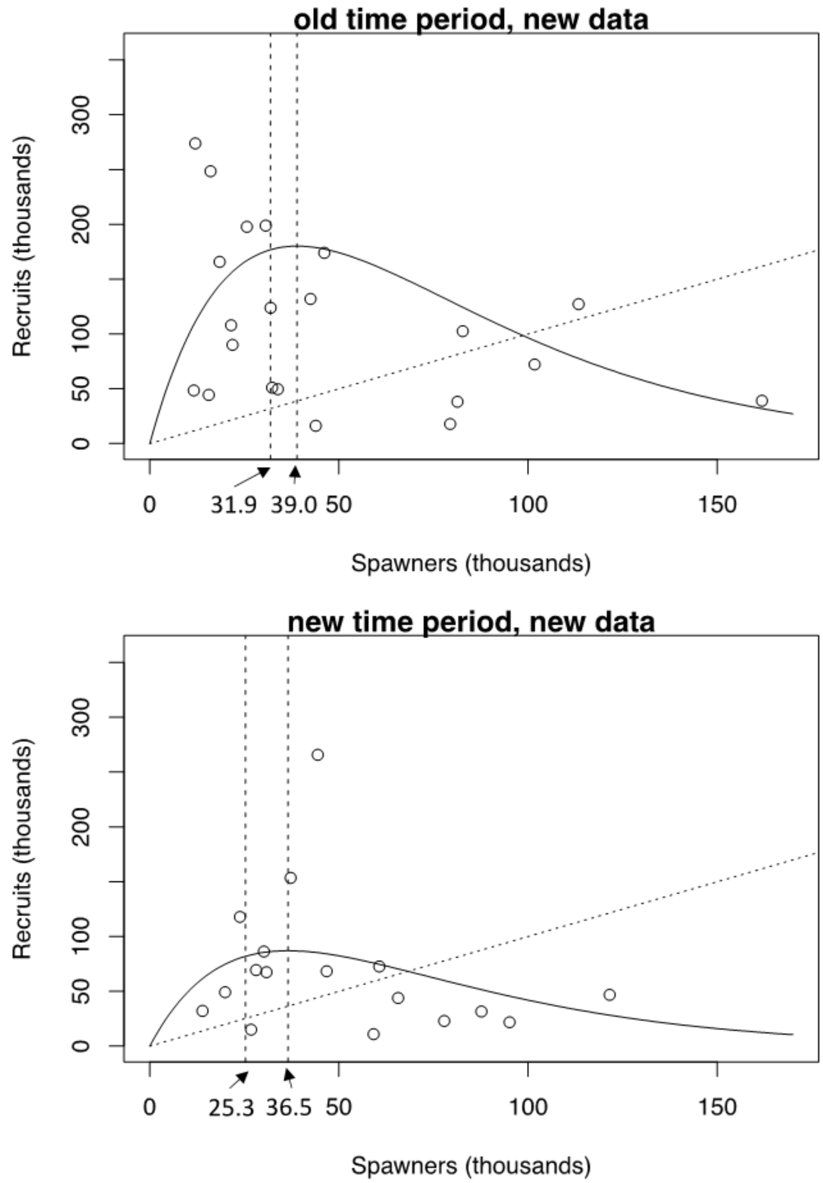

Figure 4.2. Results from the basic stock-recruit analysis. The points are data, the solid curved line is the best fist model, the dashed line is the one-to-one replacement line, the left vertical dashed line is Smsy, and the right vertical dashed line is Smax.

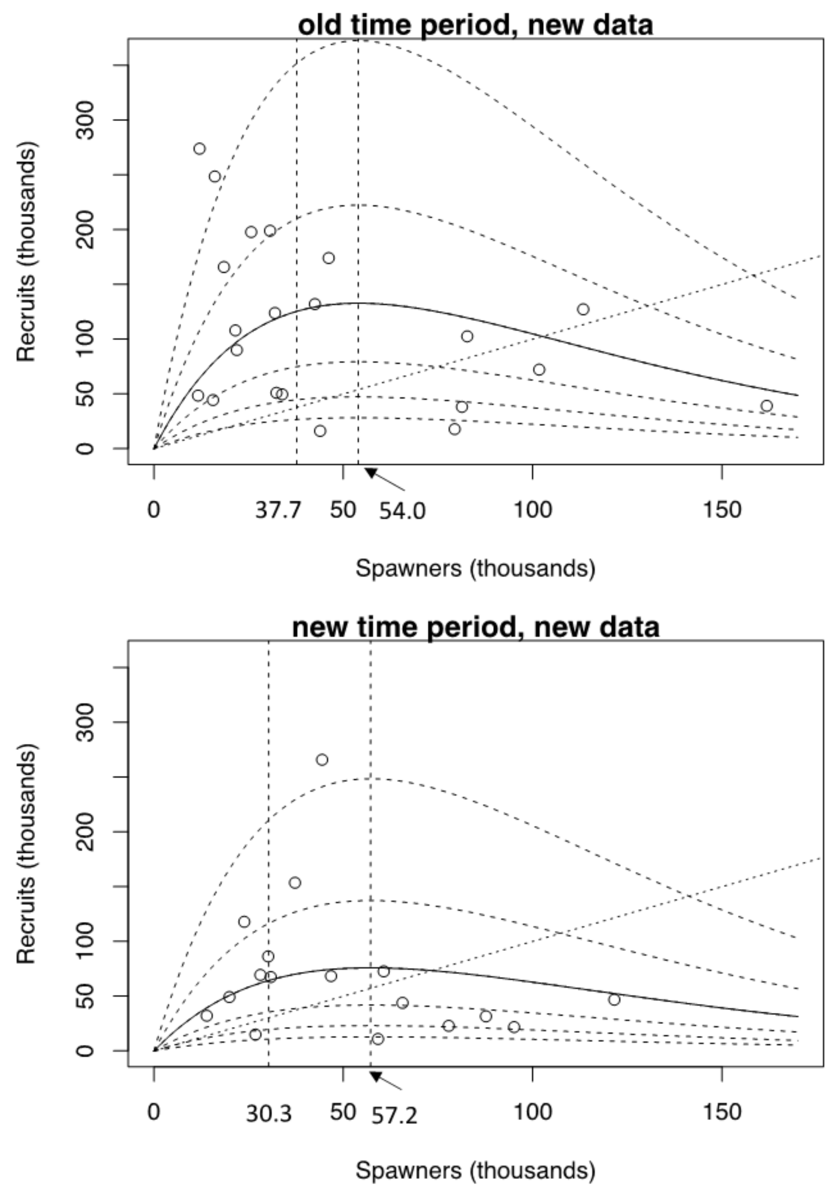

Figure 4.3. Results from the stock-recruit analysis that contained juvenile survival. The points are data, the solid curved line is the best fist model (with juvenile survival set to mean juvenile survival), the dashed line is the one-to-one replacement line, the left vertical dashed line is Smsy, and the right vertical dashed line is Smax. The dashed curved lines demonstrate the effect of varying juvenile survival across its range.

4.2.4 *Comparison to 2005 productivity/capacity*

One of the primary questions from this analysis was did the population dynamics change between the old and new time periods. We believe that these results demonstrated that the productivity of the population declined substantially while the capacity remained roughly the same.

From the basic analysis (Table 4.1), the productivity parameter (α) for the recent time period was only 55% of the parameter for the older time period. *Smsy* for the later period was 79% of *Smsy* for the older time period. For the analysis that included juvenile survival (Table 4.2), the productivity parameter for the recent time period was only 57% of the parameter for the older time period. *Smsy* for the later period was 80% of *Smsy* for the older time period.

Lower productivity suggests that recruitment to ocean and inland fisheries, and inland escapement will be reduced at any given spawner escapement objective. In other words, the number of fish that arise from the spawner escapement in any year that will be available for harvest and escapement are expected to be lower than was estimated some 20 years ago. As a result, the capacity of the stock to produce fish available for harvest, to rebound and recover from an overfished status, and to repopulate newly available habitat is reduced as compared to two decades ago. Managers may want to take this into account when determining what precaution is warranted during annual fishery planning processes, especially as it relates to the current KRFC HCR and spawner escapement target and the possibility of targeting maximum production versus maximum yield. Maximizing production (targeting or exceeding *Smax*) and recruitment to escapement is likely the best strategy to achieve the objectives of the KRFC rebuilding plan and the Klamath Dam Removal Project. This is especially true given this new analysis is based on available habitat prior to dam removal. With the addition of new habitat with dams removed, more spawners will be needed to increase or maximize productivity.

5 ALTERNATIVE MANAGEMENT OPTIONS AND CONSIDERATIONS

The Workgroup developed a range of potential control rules for Council consideration during the planning of 2024 salmon fisheries. A description and graphical representation of these alternative control rules follows. For each alternative, tick marks inside the x-axis indicate the abundance levels categorized as: very low (2017, N = 12,383), low (2023, N = 26,238), moderate (2019, N = 87,893), and high (2013, N = 230,473). The high abundance scenario does not appear on the control rule plots because the abundance exceeds the range of the y-axis. In the plots that follow, the thick black line represents the status quo control rule, and the thin red line represents the alternative control rule.

5.1 Summary of the Range of alternatives

Alternative 1 – No action. Status quo HCR (Figure 4.1).

Alternative 2 – Application of a buffer that reduces the allowable exploitation rate (ER) at all levels of abundance (Figures 5.1 and 5.2).

2.a – Reduce the allowable ER by 10 percent at all levels of abundance.

2.b – Reduce the allowable ER by 25 percent at all levels of abundance.

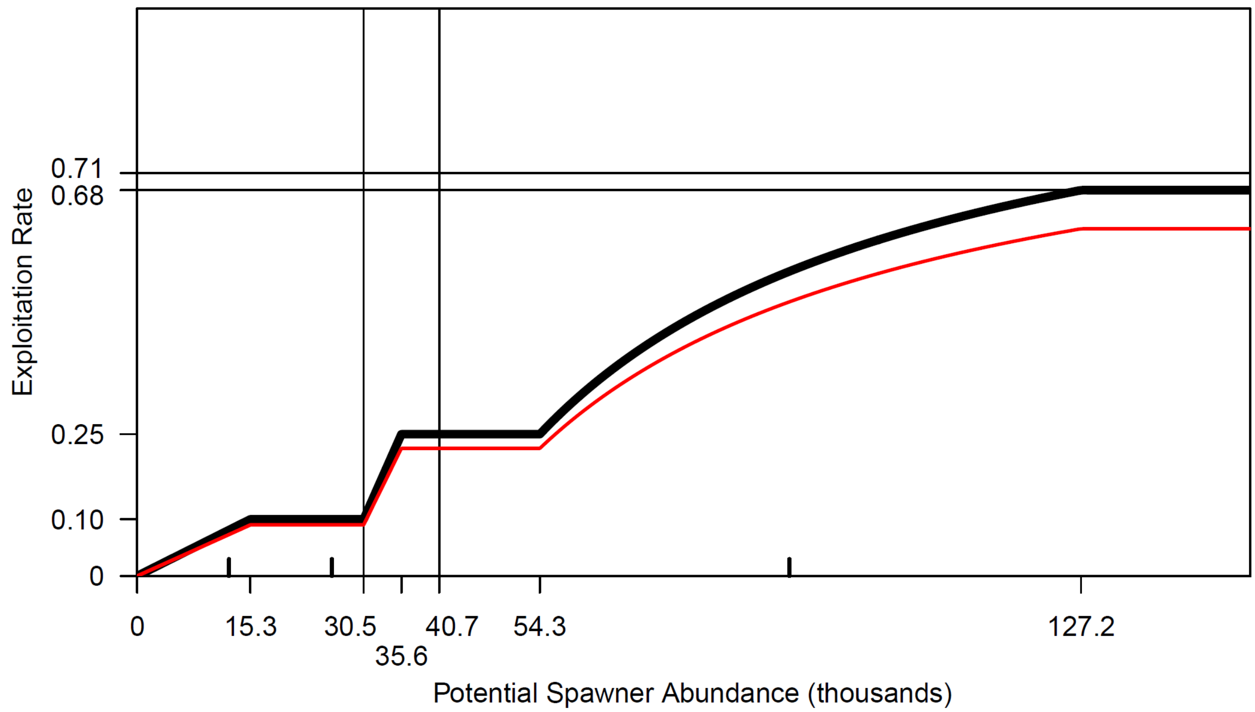

Figure.5.1. Alternative 2.a: Reduce the allowable ER by 10 percent at all levels of abundance.

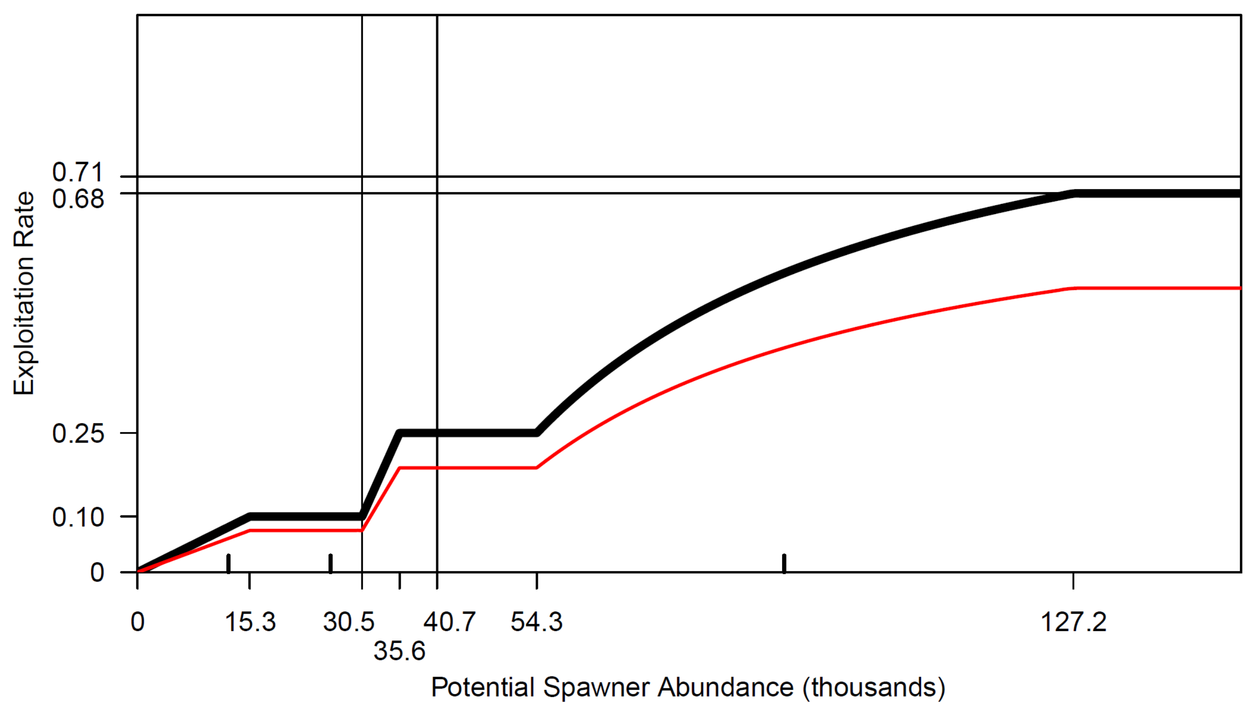

Figure.5.2. Alternative 2.b: Reduce the allowable ER by 25 percent at all levels of abundance.

Alternative 3 – Reduce *de minimis* fishing provisions (Figures 5.3 and 5.4).

3.a – Modify the *de minimis* fishing rule at low abundance.

3.b – Modify the *de minimis* fishing rule at a higher level of abundance relative to 3a.

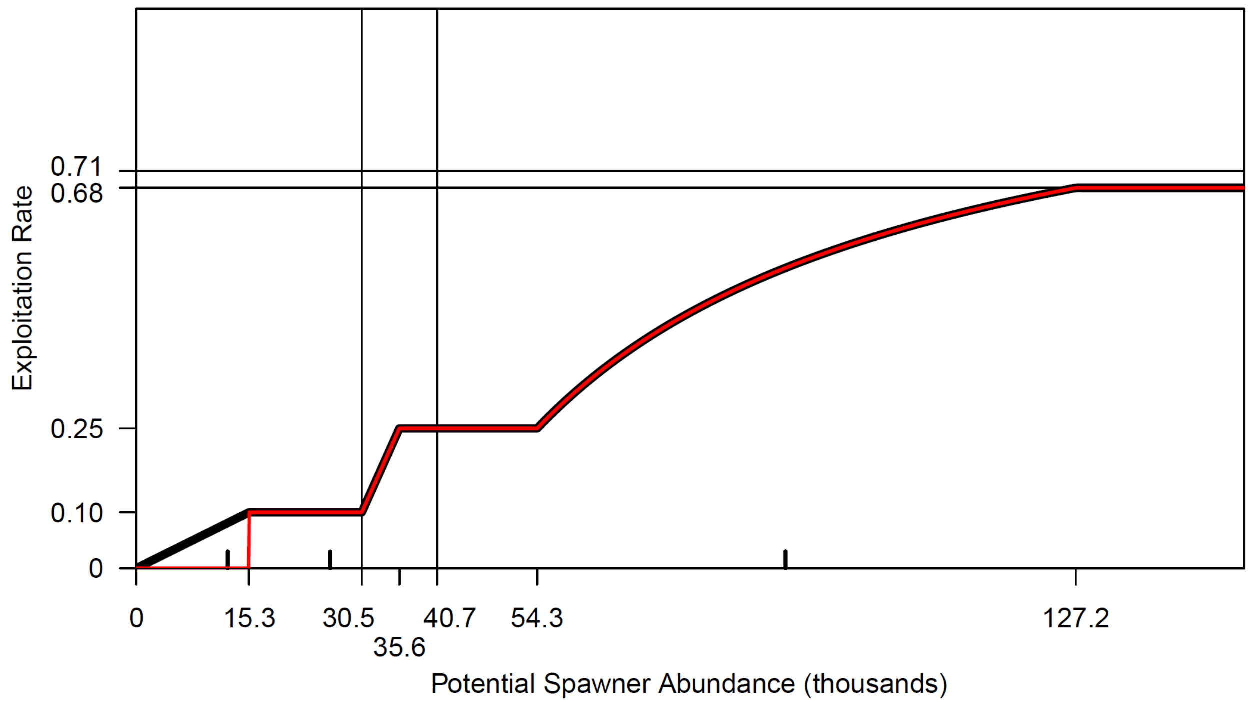

Figure.5.3. Alternative 3.a: Modify the de minimis fishing rule at low abundance.

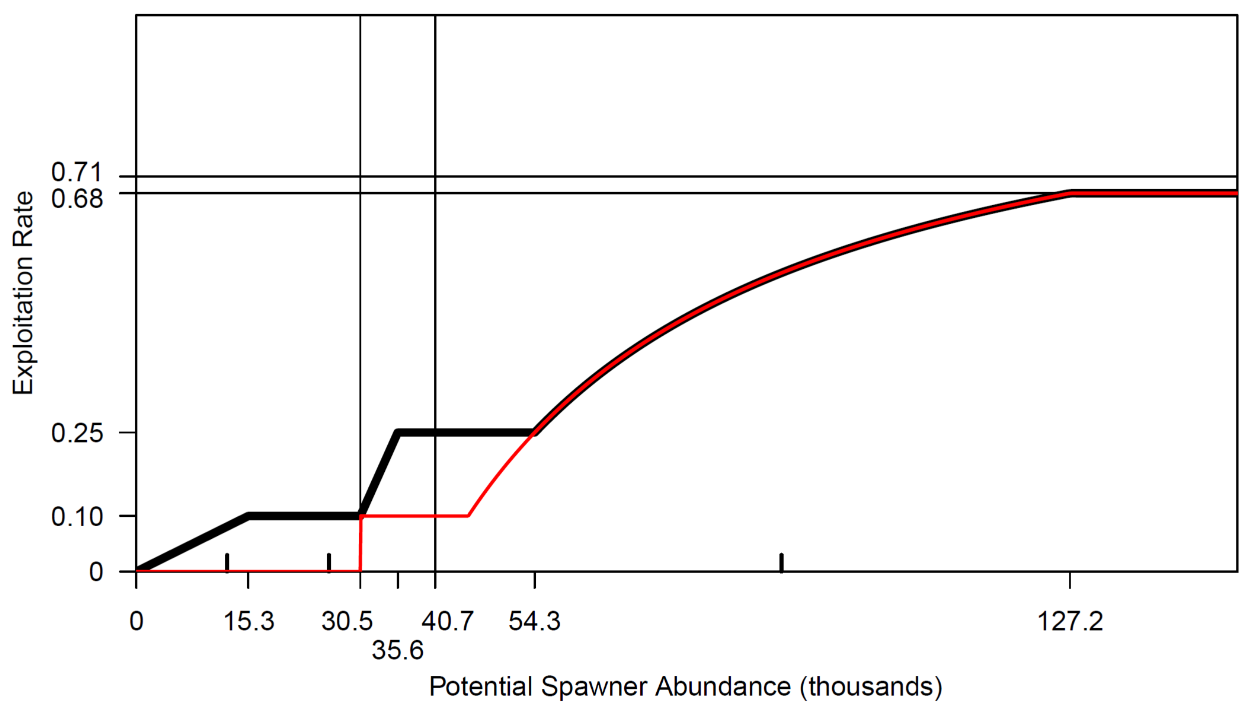

Figure.5.4. Alternative 3.b: Modify the de minimis fishing rule at a higher level of abundance relative to 3.a.

Alternative 4 – Modify *de minimis* fisheries and buffer allowable ER. Alternative 4 combines attributes found in Alternatives 2.a, 2.b, 3.a, and 3.b. (Figure 5.5)

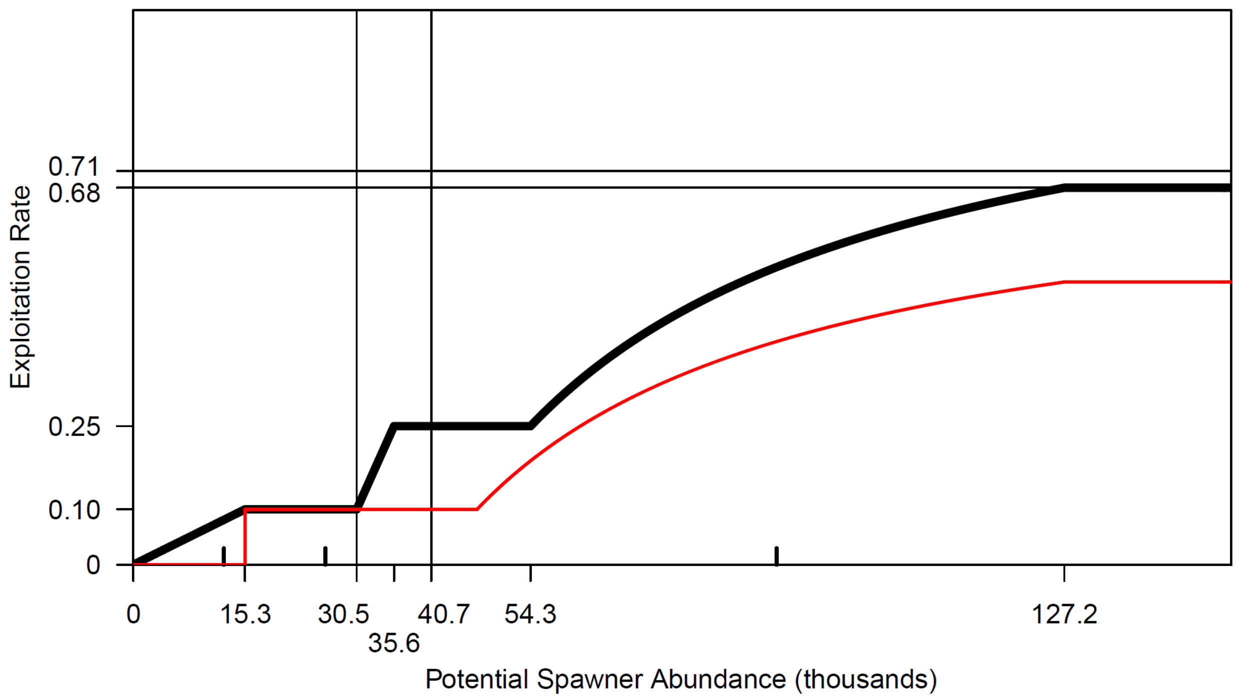

Figure 5.5: Alternative 4: Modify de minimis fisheries and buffer allowable ER.

Alternative 5 – Eliminate *de minimis* fishing provisions (Figures 5.6 and 5.7).

5.a – Eliminate all *de minimis* provisions.

5.b – Eliminate all *de minimis* provisions and reduce the maximum ER by 5 percent.

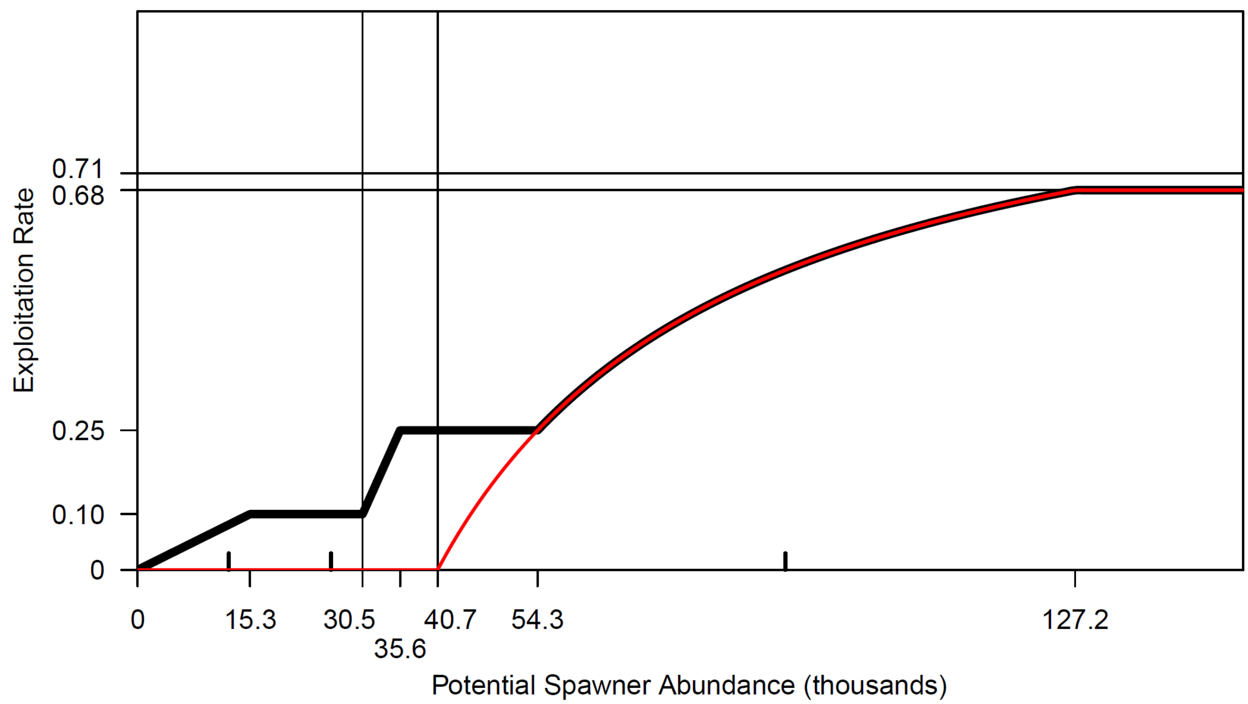

Figure 5.6. Alternative 5.a: Eliminate all de minimis provisions.

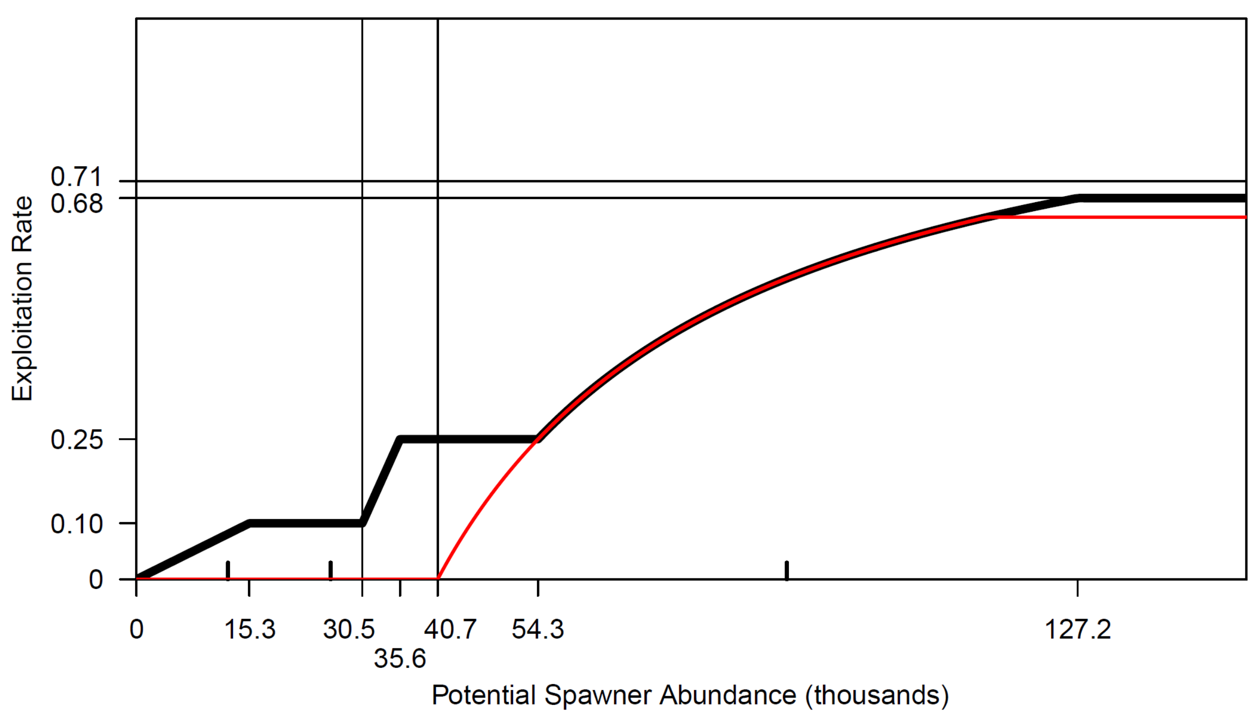

Figure 5.7. Alternative 5.b: Eliminate all de minimis provisions and reduce the maximum ER by 5 percent.

5.2 Analysis of Alternatives

Alternative control rules were evaluated by examining maximum allowable ERs and minimum allowable adult escapement levels for four years representing a wide range of KRFC abundance levels: very low (2017, N = 12,383), low (2023, N = 26,238), moderate (2019, N = 87,893), and high (2013, N = 230,473).

5.2.1 Alternative 1: No Action.

The No Action Alternative is the current KRFC HCR. Under each abundance scenario, Alternative 1 specifies a maximum allowable ER that is greater than or equal to each of the other Alternatives. As a result, minimum allowable escapement is less than or equal to each of the other Alternatives.

5.2.2 Alternative 2.a: Apply a 10 percent buffer on the allowable ER at all levels of abundance.

Alternative 2.a allows for a nonzero ER at all levels of abundance, with allowable ERs lower than the No Action Alternative. As a result, Alternative 2a results in minimum allowable escapement levels that are higher than the No Action Alternative.

Alternative 2.a would provide for modest increases spawners across the range of abundance. Increasing spawner abundance on the upper end of the HCR range represents potential benefits in terms of recruits to the new habitat, though increases across the complete range are all beneficial for various reasons (e.g. avoidance of extirpation or brood failure, promoting or maximizing repopulation of new habitat and stock recovery).

5.2.3 Alternative 2.b: Apply a 25 percent buffer on the allowable ER at all levels of abundance.

Alternative 2.b allows for nonzero exploitation rates at all levels of abundance, with allowable exploitation rates lower than both the No Action Alternative and Alternative 2.a. As a result, Alternative 2.b results in minimum allowable escapement levels that are higher than the No Action Alternative and Alternative 2.a.

Alternative 2.b would provide for more substantial increases in spawners across the range of abundance relative to Alternative 2.a. Increasing spawner abundance on the upper end of the HCR range represents potential benefits in terms of recruits to the new habitat, though increases across the complete range are all beneficial for various reasons (e.g. avoidance of extirpation or brood failure, promoting or maximizing repopulation of new habitat and stock recovery).

5.2.4 Alternative 3.a: eliminate de minimis fisheries at low abundance.

Alternative 3.a results in a zero ER at very low abundances, and ERs equal to the No Action Alternative under higher levels of abundance. As a result, the minimum escapement levels are higher than the No Action Alternative at very low abundance, but equal to the No Action Alternative under each of the other abundance scenarios.

Alternative 3.a retains aspects of the *de minimis* provisions specified by the current HCR except at very low abundances. It does not provide for the potential to increase spawner abundance, relative to the No Action Alternative, across mid to high levels of abundance. It could, however, reduce the likelihood of extirpation or brood failure in times of very low abundance.

5.2.5 Alternative 3.b: eliminate de minimis fisheries at a higher abundance than Alternative 3.a.

Alternative 3.b results in an ER under the very low and low abundance scenarios, and ERs equal to the No Action Alternative at moderate and high abundances. As a result, the minimum escapement levels are higher than the No Action Alternative at very low and low abundance levels, but equal to the No Action Alternative under the higher abundance scenarios.

Alternative 3.b retains aspects of the de minimis provisions specified by the current HCR except at very low and low abundances. It does not provide for the potential to increase spawner abundance, relative to the No Action Alternative, across mid to high levels of abundance. It could, however, reduce the likelihood of extirpation or brood failure in times of low abundance.

5.2.6 Alternative 4: reduce de minimis fisheries at low abundance and apply a buffer on ERs at higher abundance.

Alternative 4 results in a zero ER under the very low abundance scenario. Under the low abundance scenario, the allowable ER is equal to the No Action Alternative. For the moderate and high abundance scenarios, allowable ERs are reduced relative to the No Action Alternative. Minimum escapement levels for Alternative 4 are greater than the No Action Alternative at very low, moderate, and high abundance levels, but equivalent to the No Action Alternative at low abundance.

Alternative 4 retains aspects of the de minimis provisions specified by the current HCR except at very low abundance. In addition, it provides the potential for increased spawner abundance, relative to the No Action Alternative, across mid to high levels of abundance. Increasing spawner abundance on the upper end of the HCR range represents potential benefits in terms of recruits to the new habitat, though increases across the complete range are all beneficial for various reasons (e.g. avoidance of extirpation or brood failure, promoting or maximizing repopulation of new habitat, and stock recovery).

5.2.7 Alternative 5.a: eliminate de minimis fisheries.

Alternative 5.a results in an ER of zero under the very low and low abundance levels, and an ER equivalent to the No Action Alternative for the moderate and high abundance levels. Minimum escapement levels are greater than the No Action Alternative for the very low and low abundance levels, and equivalent to the No Action Alternative for moderate and high abundance levels.

Alternative 5.a provides protection against potential brood failure through the removal of current HCR *de minimis* fishery provisions. The form of this alternative is similar to the KRFC management strategy prior to Amendment 16 of the FMP. It does not provide the potential for increased spawner abundance across moderate to high levels of abundance. Increasing spawner abundance on the upper end of the HCR range represents potential benefits in terms of recruits to the new habitat, though increases across the complete range are all beneficial for various reasons (e.g. avoidance of extirpation or brood failure, promoting or maximizing repopulation of new habitat, and stock recovery).

5.2.8 Alternative 5.b: eliminate de minimis fisheries and apply a buffer at high abundances.

Alternative 5.b results in an ER of zero under the low and moderately low abundance scenarios, an ER equivalent to the No Action Alternative for the moderate abundance scenario, and an ER lower than the No Action Alternative under the high abundance scenario. Minimum escapement levels are greater than the no-action alternative for the low and moderately low abundance scenarios. For the moderate abundance scenario, minimum escapement is equivalent to the No Action Alternative. For the high abundance scenario, escapement is greater than the No Action Alternative.

Alternative 5.b provides protection against potential brood failure through the removal of current HCR de minimis fishery provisions. It also provides the potential for increased spawner abundance at high levels of abundance. Increasing spawner abundance on the upper end of the HCR range represents the greatest possible benefit in terms of spawner recruits in the new habitat, though increases across the complete range are all beneficial for various reasons (e.g. avoidance of extirpation or brood failure, promoting or maximizing repopulation of new habitat and stock recovery).

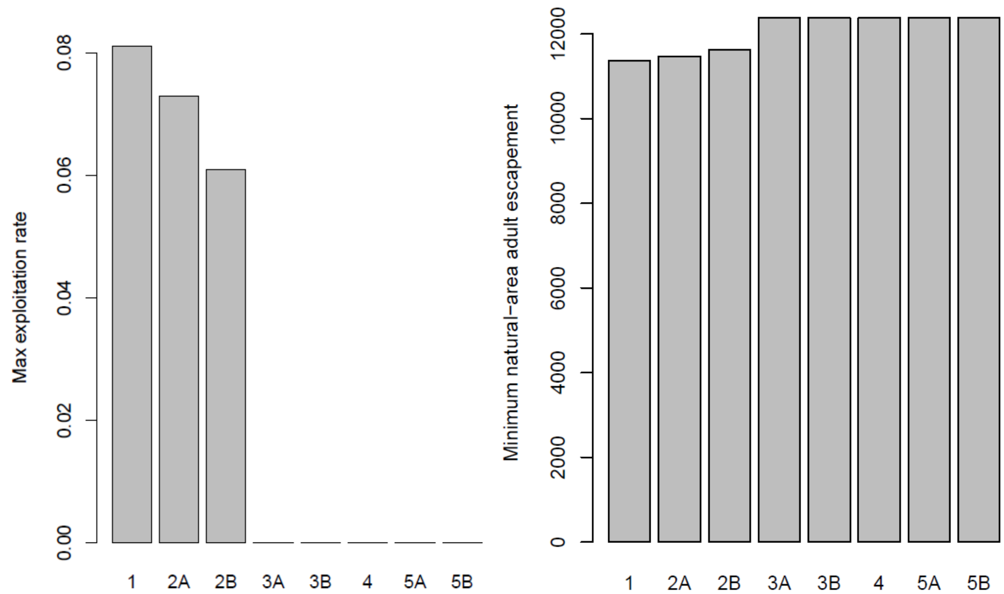

Figure 5.8. Maximum allowable ERs (left) and minimum natural-area adult escapement (right) for each of the control rules under a very low abundance scenario (management year 2017: KRFC abundance = 12,383 natural-area spawners in the absence of fisheries).

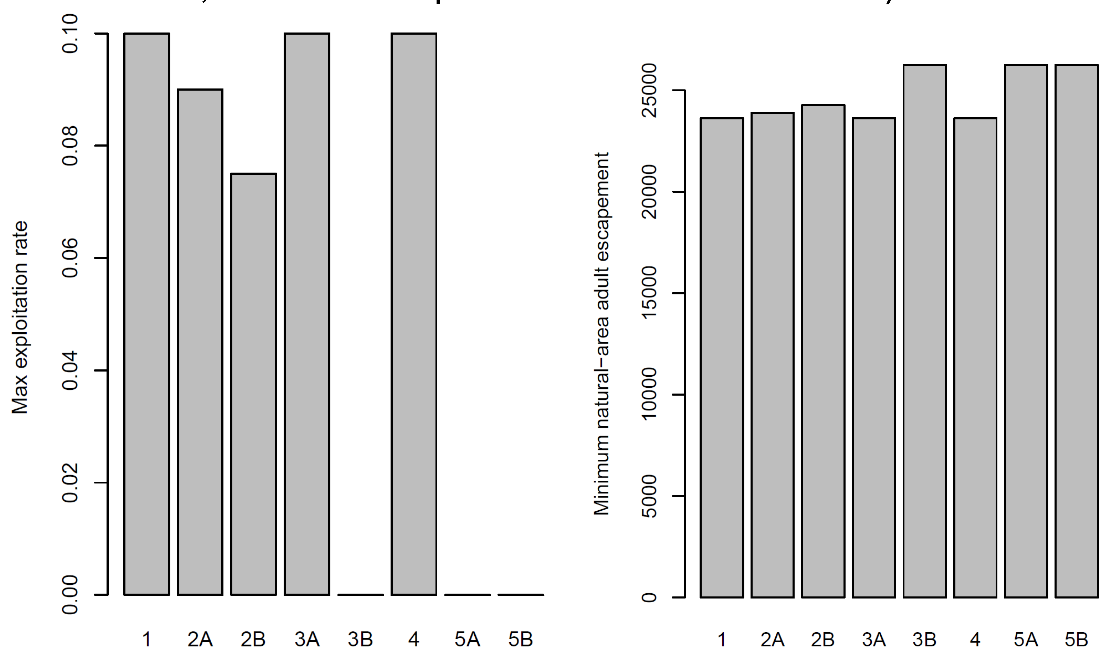

Figure 5.9. Maximum allowable ERs (left) and minimum natural-area adult escapement (right) for each of the control rules under a low abundance scenario (management year 2023: KRFC abundance = 26,238 natural-area spawners in the absence of fisheries).

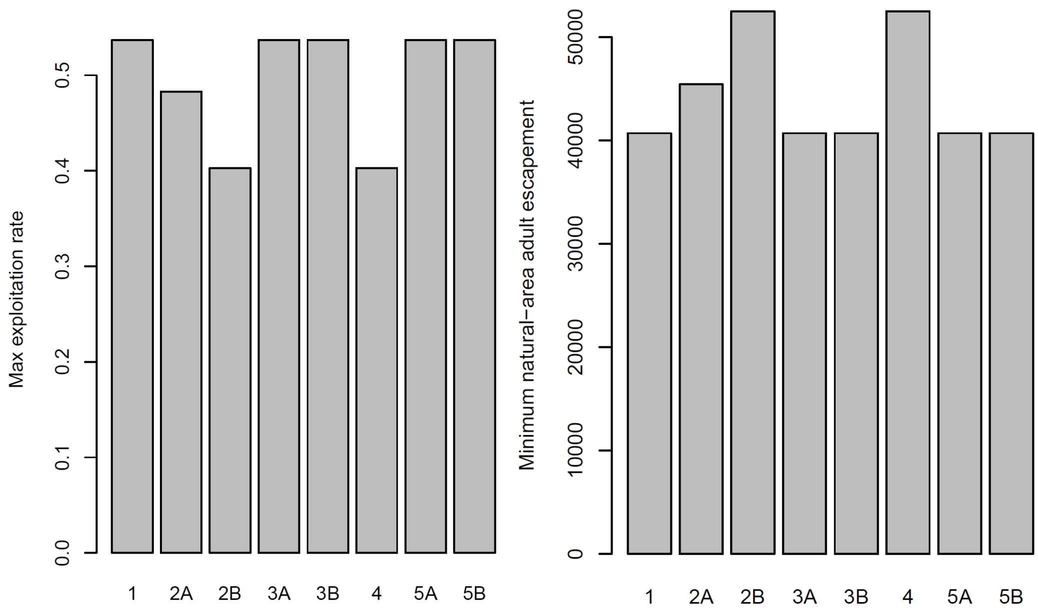

Figure 5.10. Maximum allowable ERs (left) and minimum natural-area adult escapement (right) for each of the control rules under a moderate abundance scenario (management year 2019: KRFC abundance = 87,893 natural-area spawners in the absence of fisheries).

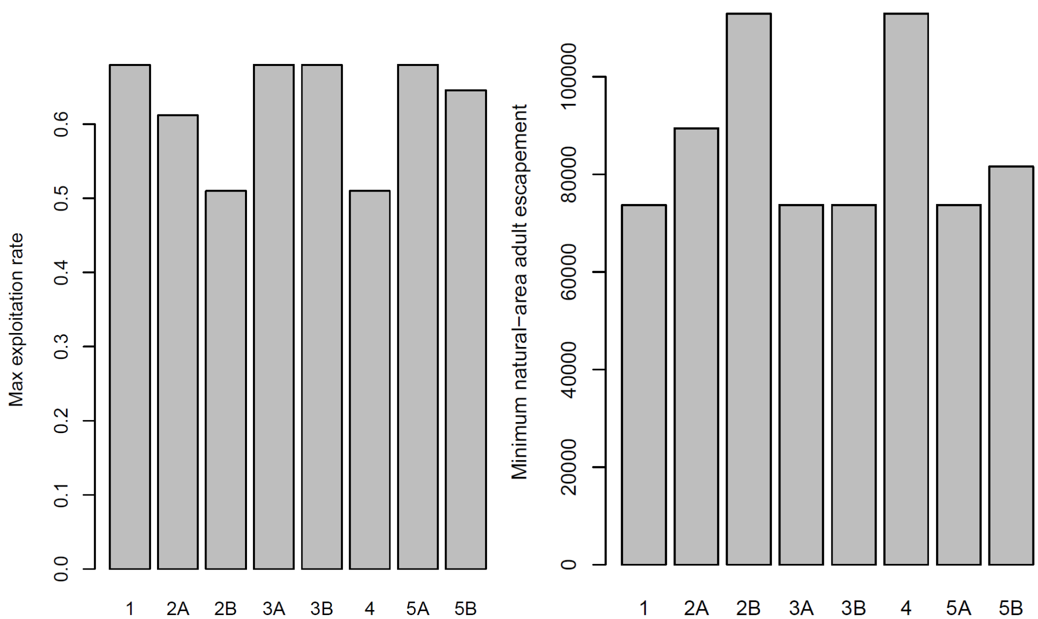

Figure 5.11. Maximum allowable ERs (left) and minimum natural-area adult escapement (right) for each of the control rules under a high abundance scenario (management year 2013: KRFC abundance = 230,473 natural-area spawners in the absence of fisheries).

6 MONITORING NEEDS

Maintaining the current level of inriver monitoring is essential to the management and conservation of this stock. The annual KRFC stock assessment relies on age-structured data from hatcheries, natural spawning areas, and river fisheries; coded-wire tag recoveries from ocean and river surveys; age structure estimates based on scale age analysis, and total escapement to the Klamath Basin derived from nearly comprehensive monitoring efforts. Reduction or elimination of efforts to obtain these data on an annual basis would have negative effects on the stock assessment. Additionally, information about juvenile production from tributaries and mainstem habitat would also be useful in evaluating habitat effectiveness, utilization, and juvenile distribution and emigration timing. Further, information specific to habitat and water quality will provide insight for habitat recovery associated with this restoration project, adult and juvenile habitat utilization, and help explain trends in spawner abundance, distribution, and juvenile productivity, among other things.

7 SUMMARY

The Workgroup's focus since formation in September 2023 has been to provide management alternatives for the Council to consider during the 2024 fishery planning process, and perhaps beyond. Short term reductions to stock productivity as a result of dam removal activities, the increase of available spawning habitat with these migration barriers removed, and current stock productivity in the habitat available prior to dam removal are all potential reasons for examining management alternatives that provide additional conservation. The States of California and Oregon have proposed a number of changes to in-river recreational fishing regulations that aim to address these considerations. These sport fishing regulations are anticipated to take effect in the spring of 2024. The short-term negative impacts associated with the dam removal project are real and significant. As sediment evacuates from the reservoir footprints, extremely high sediment loads, and extremely low levels of dissolved oxygen conditions are being realized in the mainstem Klamath River.

In this report, we describe changes in KRFC stock productivity and capacity since the last assessment was made in 2005. Results of that analysis suggested that stock productivity has decreased while capacity changed by a small amount. Lower productivity suggests that recruitment to ocean and inland fisheries, and inland escapement will be reduced at any given spawner escapement objective. In other words, the number of fish produced from the spawner escapement in any year are expected to be lower than was estimated some 20 years ago. As a result, the ability of the stock to produce fish available for harvest, to rebound and recover from an overfished status, and to repopulate newly available habitat is reduced as compared to two decades ago. This information could qualitatively inform fishery management decisions in the coming years while we wait for the habitat to stabilize and the development of a contemporary stock recruit analysis to become available for management considerations.

Each of the alternatives evaluated in this report would result in allowable ERs for KRFC that are equal to or lower than the current control rule, and thus would not require an amendment to the salmon FMP to implement. The range of alternatives is broad and allows for addressing a variety of management priorities across a wide range of abundances. For example, Alternatives 2.a and 2.b reduce allowable ERs across all levels of abundance. Alternatives 3.a and 3.b reduce *de minimis* ER at low abundance but retain status quo ERs at higher levels of abundance. Alternatives 5.a and 5.b eliminate all de minimis fishery provisions of the HCR, and 5.b includes a reduced maximum allowable ER at high abundances. The attributes of these HCRs can be combined to address Council priorities. The Workgroup developed Alternative 4, which has features found in each of the other alternatives, as an example.

The Workgroup envisioned that the Council may wish to prioritize lower ERs at low abundances for conservation purposes. Additionally, there could be a priority placed on capitalizing on a large run size by reducing ERs when abundance forecasts are high. Providing added conservation across all levels of abundance is another possible priority. The range of alternatives provided in this report allow the Council to consider each of these scenarios or identify an alternative that lowers ERs at all levels of abundance.

Each of the alternatives identified here are in the form of an HCR that specifies a maximum allowable ER when provided with a forecast of spawner abundance absent fishing. The Council can manage fisheries to an ER that is lower than, or equal to, the maximum ER specified by the HCR, as has been routine in the recent past. Maximizing production and recruitment to escapement is likely the best strategy to achieve the objectives of the KRFC rebuilding plan and the Klamath Dam Removal Project.

8 LITERATURE CITED

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