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Expert Witness Report

SEPTEMBER 11, 2023

Prepared for Protestant Nez Perce Tribe

BEFORE THE DEPARTMENT OF WATER RESOURCES OF THE STATE OF IDAHO

In the Matter of Application for Permit No. 77-14377, 77-14378, 77-14379;
Applications for Transfer 85396, 85397, 85398, 85399;
and Application for Exchange 85538
In the Name of Perpetua Resources Idaho, Inc.

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Fisheries Expert Report

East Fork South Fork Salmon River Fish Habitat Loss Concerns Due to Perpetua Resources' Proposed Water Withdrawals

1 Introduction

The Nez Perce Tribe requested that we evaluate the effect that water right applications for permit nos. 77-14377, 77-1437, and 77-14379, applications for transfer nos. 85396, 85397, 85398, and 85399, and application for exchange no. 85538, submitted by Perpetua Resources Idaho, Inc. ("PRII") to the Idaho Department of Water Resources, will have on aquatic species and their habitat in the headwaters of the East Fork South Fork Salmon River ("EFSFSR"). Additionally, we were asked to evaluate the proposed water right conditions outlined in PRII's June 27, 2022, technical memorandum ("PRII 2022 Proposed Conditions") describing proposed water right conditions and proposed fishery and aquatic habitat measures for the EFSFSR.[3]

The PRII 2022 Proposed Conditions include:

1. Percent depletion is equal to net diversion divided by unimpaired streamflow.
2. Net diversion is the sum of groundwater and EFSFSR diversions minus discharge of treated water to EFSFSR and its tributaries.
3. Unimpaired streamflow is defined as the gaged flow at Sugar Creek (USGS 13311450), plus the gaged flow at EFSFSR above Sugar Creek (USGS 1331250), plus the net diversion from EFSFSR and groundwater under rights 77-7122, 77-7285, 77-7293, and 77-14378.
4. Calculations shall be based on running 3-day averages of net diversion and gaged stream flows.
5. Diversion rate from the EFSFSR surface intake POD shall not exceed 20 percent of the unimpaired EFSFSR stream flow below its confluence with Sugar Creek (point of quantification).

The purpose of this report is to list our concerns, summarize existing data and evaluation limitations, and summarize our conclusions regarding the potential effect of PRII's proposed water rights, without and with the PRII 2022 Proposed Conditions, on aquatic species and their habitat in the headwaters of the EFSFSR.

[3] This technical memorandum was appended to a August 2, 2022, letter from the Idaho Governor's Office of Species Conservation and the Idaho Department of Fish and Game to James Cefalo, Regional Manager, Idaho Department of Water Resources.

1.1 Documents Reviewed

In developing this report, we reviewed the following resources provided by PRII and their contractor Rio Applied Sciences and Engineering ("Rio ASE"). In addition, we reviewed and considered the scientific literature listed in the "Literature Cited" section at the end of this report.

- Perpetua Resources Idaho, Inc. (PRII). 2023. SGP Proposed Water Right Conditions: Nez Perce Tribe Briefing. July 18, 2023.
- Perpetua Resources Idaho, Inc. (PRII). 2022. Technical Memorandum - Subject: Request for Technical Assistance Review. June 27, 2022.
- Rio Applied Science and Engineering (Rio ASE). 2023. Stibnite Gold Project Fish Passage Evaluation. Technical memorandum to Perpetua Resources Idaho, Inc. from Rio ASE. Project 023-090-001-16. March 21, 2023.
- NOAA National Marine Fisheries Service (NOAA). 2021a. Comments on Water Right Permit Applications 77-14377, 77-14378, and 77-14379. Letter to State of Idaho Department of Water Resources from Michael P. Tehan, NOAA National Marine Fisheries Service. December 14, 2021.
- EFSF_HEC-RAS_Hyd_Output_WR_Fish_Passage_08222023.csv, provided by Rio ASE on August 23, 2023.
- Low_Flow_Depth_Analysis_09012023.xlsx, provided by Rio ASE on September 5, 2023.

1.2 Data Limitations Summary

We conducted our evaluation of the potential impacts to aquatic species and their habitat in a data-limited environment (i.e., there was a scarcity of data for us to use for some analyses, decision-making, and modeling purposes to fully evaluate impacts to fish). Where possible, we used local data from the EFSFSR headwaters or from adjacent watersheds; however, when local data were not available, our assessments leveraged non-local (e.g., regional) data, reviews of the scientific literature, and/or expert judgment. Our evaluation of the effects of PRII's proposed water withdrawals on ESA-listed fish and other species was rigorous when possible; however, for some of our evaluations the necessary information or data were lacking to fully evaluate potential negative effects.

PRII provided a limited assessment of the effect of PRII's water right applications on fish effects, focusing solely on fish passage through a 1,617 ft stream reach downstream of the proposed EFSFSR point of surface water diversion. PRII's assessment excluded impacts caused by ground water diversions further upstream. Our evaluation included fish passage downstream of the proposed surface water diversion, and also of the potential loss of fish habitat downstream of the ground water diversions along Meadow Creek. We found evaluations could be improved through both hydraulic models at a greater number of flows (discharge) and stream reaches, and implementation of appropriate fish-habitat models, plus additional data on other factors important to fish (temperature, substrate, cover, etc.) under existing and proposed conditions. PRII's proposed point of quantification for withdrawals within the water rights conditions does not adequately reflect water and habitat loss in the EFSFSR upstream of the confluence with Sugar Creek. Additionally, PRII did not propose ramping rates for any withdrawal locations in the PRII

2022 Proposed Conditions; ramping rates should be required to minimize risk of fish stranding or flushing.

PRII has also provided no information on how proposed water withdrawals are expected to influence stream temperatures, particularly during summer and winter months, and in the context of climate change. Stream temperature outside of optimum temperatures or at sub-lethal levels can reduce salmonid growth, increase stress, affect reproduction, or create disease problems (EPA 2003). Finally, PRII's assessment of the water right applications did not consider projected changes to stream temperatures resulting from climate change (Isaak *et al.* 2017). In the Pacific Northwest, summer months are anticipated to become progressively more stressful for salmonids as stream temperatures increase with warming air temperatures due to climate change, which is likely to shift and reduce suitable habitat for many species (Isaak *et al.* 2017; Jones *et al.* 2014).

In the body of this report, we did our best to provide a rigorous evaluation in this data-limited environment and describe a preliminary scope of expected effects to salmonids and their habitat as a result of PRII's proposed water rights and the PRII 2022 Proposed Conditions; however, when data or information were lacking, we provide detailed descriptions of data gaps and recommended additional analyses.

1.3 Conclusions Summary

The diversion of PRII's proposed water rights will reduce the amount of water available to aquatic resources using stream habitat in the EFSFSR and Meadow Creek, including ESA-listed Snake River spring/summer Chinook salmon, steelhead, and bull trout. Recent returns of ESA-listed adult fish across the entire Snake River basin are a fraction of historical abundance and established healthy and harvestable goals (CBPTF 2020). Additionally, recent abundance trends are negative with associated productivity below replacement for most populations within the Snake River basin (Ford *et al.* 2022). Given the species' low abundance and productivity, and assuming the negative trends continue, a recent analysis from the Nez Perce Tribe showed 77% of spring/summer Chinook salmon and 44% of steelhead populations will drop below a quasi-extinction threshold by 2025 (Johnson *et al.* 2021). The EFSFSR spring/summer Chinook salmon population within the Snake River ESU was identified by the Nez Perce Tribe as one of the populations reaching quasi-extinction by 2025. These ongoing abundance declines and threats to population persistence led to a National Oceanographic and Atmospheric Administration ("NOAA") report, which concluded abundance levels are concerning and warrant urgent restoration actions (NOAA 2022a).

From our evaluations, we identified the following areas of concern to ESA-listed salmonids and aquatic habitat within the stream environments affected by the proposed water withdrawals:

- Fish habitat loss below all points of diversions, including adult holding, spawning, incubation, and rearing,
- Fish passage below the EFSFSR point of surface water diversion,
- Proposed point of quantification and its concealed affect on fish within the EFSFSR above the confluence with Sugar Creek,
- Stranding and flushing of fish caused by immediate water withdrawals or shut-offs (i.e., ramping rates),

- Stream temperature increases during summer months and decreases during winter months caused by reduced flows,
- Fish productivity loss caused by reduced flows,
- Climate change impacts and the predicted increases in future stream temperatures and flow regime shifts,
- Limited amount of available hydrology and fish habitat information upstream of the proposed EFSFSR surface water diversion,
- Overall impacts to ESA-listed salmonids and the cumulative effects of the concerns listed above.

In the sections below, we describe the above concerns with the water right applications and proposed conditions, further explain areas of data gaps or limitations, identify missing evaluations, and provide our conclusions or recommendations for each concern. In some cases, the exact magnitude of water withdrawal impacts on fish is unknowable without more thorough evaluations. Our list of concerns is not exhaustive, and we caution that any water reductions in any stream environment generally has a negative effect on salmonids (NOAA 2021).

Reductions in flow have been found to reduce foraging opportunities and growth, increase mortality by reducing available habitat, alter feeding behaviors and associated food webs, and often change stream temperatures from optimal conditions (NOAA 2021b). Additional effects to fish include, but are not limited to, changes in water quality and chemistry (NOAA 2017), hindered fish passage (Thompson 1972), increased mortality from density dependence, scouring of redds from increased anchor ice during winter low-flow months, and/or dewatering of redds during critical egg incubation months.

2 Major Concerns

2.1 Fish Habitat Upstream of Surface Water Diversion Proposed Tunnel

2.1.1 Concerns

The potential for fish habitat loss in the stream reaches upstream of PRII's proposed surface water diversion, but below its various other proposed water withdrawals, is of major concern. This reach differs from the reach between the EFSFSR surface water diversion and the confluence with Sugar Creek in that it serves as habitat for adult holding and spawning, egg incubation, and juvenile (e.g., fry, parr) rearing.

During our review of PRII's water right applications and supporting technical documents, we found no evaluations of potential effects to aquatic species upstream of the EFSFSR surface water diversion, and are unaware of any data provided to the Nez Perce Tribe which quantifies effects to fish habitat. However, Rio ASE did survey and evaluate the reach downstream of the EFSFSR surface water diversion for impacts to fish passage, even though it has minimal habitat (PRII 2022, Rio ASE 2023). It is alarming that PRII ignored in its evaluations areas upstream of the EFSFSR surface water diversions with existing critical habitat for ESA-listed fish species.

Given PRII's lack of evaluation and readily available data for upstream habitat, we must extrapolate habitat availability using available flow data. In the absence of fish habitat data, we can alternatively assume that flow reductions in this reach of the EFSFSR have a linear relationship with overall fish habitat loss in the reach; i.e., we can calculate potential loss of habitat as being equal to the proportion of surface water removed from the stream reach of interest. For example, removing 1 cfs from a stream with 10 cfs of discharge would result in an estimated 10% reduction of available habitat.

Meadow Creek contains critical habitat for ESA-listed fish and is in close proximity to proposed water diversions (Figure 1; PRII 2022). The median monthly flow, calculated from a 3-day rolling mean of daily averages (using the historical record and downloading from USGS), in Meadow Creek ranges from 2 to 40 cfs (Table 3), with only May and June being greater than 10 cfs. Under low flow (95% exceedance) conditions, all months except May are at or below 10 cfs (Figure 1). Given the location and proposed amount of water that is possible for diversion under PRII's proposed water rights, approximately all of Meadow Creek surface water could be removed with the exception of the spring months May and June. This would result in an assumed 100% loss of critical habitat for ESA-listed species.

Table 1: Discharge flow values of 3-day rolling mean of daily averages for monthly 95%, 50% (median), 5% exceedance at USGS gage site #13310850 (Meadow Creek near Stibnite, ID) for recent years in which complete data were available.

Month	95%	50%	5%
January	1.7	2.1	3.7
February	1.6	1.9	4.5
March	1.7	2.5	12.7
April	2.3	8.0	33.3
May	16.2	39.3	91.6
June	10.2	36.8	101.1
July	3.8	7.1	20.5
August	2.2	3.4	5.6
September	1.9	2.6	4.5
October	1.9	2.9	7.4
November	2.0	2.9	7.5
December	1.8	2.3	4.7

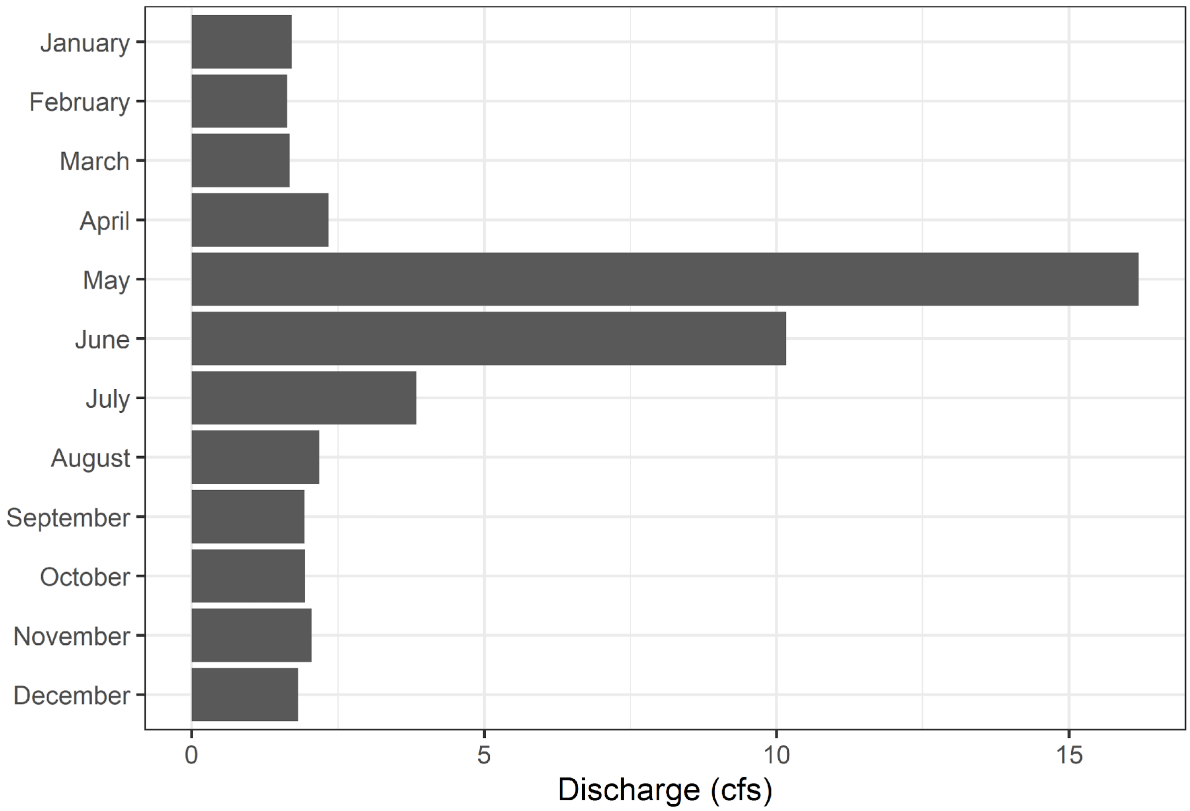

Figure 1: Low flow (95% exceedance) at USGS gage site #13310850 (Meadow Creek near Stibnite, ID) for recent years in which complete data were available.

Further, Figure 2 below demonstrates a decrease in weighted usable area (WUA) for Chinook salmon associated with decreased stream discharge. Weighted usable area is an index of relative habitat suitability and is useful for comparisons among different flows (Payne 2003). We generated Figure 2 using habitat data collected by the U.S. Forest Service in lower Sugar Creek approximately one half mile upstream from its confluence with the EFSFSR in 1990. Data were analyzed using the Instream Flow Incremental Method ("IFIM") commonly used to determine relationships between stream flows and fish habitat (Stalnaker *et al.* 1995). Hydraulic conditions at varying flows were compared to fish habitat preferences to calculate WUA. Using Chinook salmon and the juvenile rearing life stage as an example, Figure 2 shows that going from 10 cfs to 1 cfs, a similar reduction as could occur under the proposed water rights conditions, results in a decrease of approximately 80% in WUA. When examining the adult, and spawning and incubation life stages the reductions of relative habitat suitability is close to 90%.

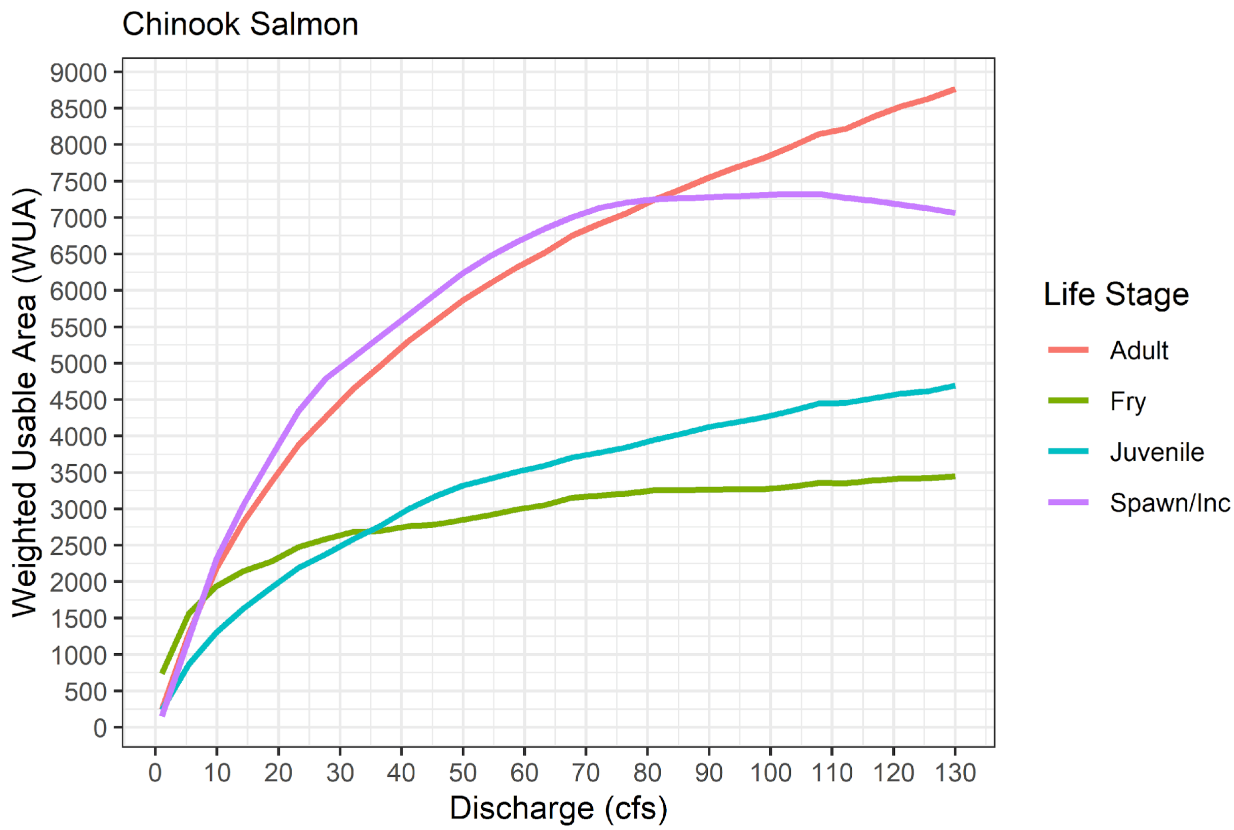

Figure 2: Estimates of weighted usable area at varying levels of discharge for four life stages (adult holding, fry, juvenile, and spawning/incubation) of Chinook salmon in a section of lower Sugar Creek approximately one half mile upstream from its confluence with the East Fork South Fork Salmon River.

2.1.2 Data Gaps and Recommended Analysis

Accurately quantifying potential loss of fish habitat and resulting effects on fish due to proposed water withdrawals is difficult without collecting additional data and conducting additional analysis; however, we provide two simple methods above to predict potential losses using existing data.

Current best practices to evaluate fish habitat and potential losses due to changes in the habitat, or gains resulting from rehabilitation actions, typically use hydraulic and associated fish-habitat models. Examples include habitat suitability models (Raleigh *et al.* 1986), bioenergetic habitat suitability models (Naman *et al.* 2020b; Naman *et al.* 2020a), net rate energy intake models (Hayes *et al.* 2007), and life-cycle models (Zabel *et al.* 2013), among others. These models often associate water depth and depth averaged velocities, as well as other factors important to fish (e.g., drift or macroinvertebrates, cover, substrate, temperature), and correlate them with fish preference or suitability for various life stages. Developing these models typically requires bathymetric data and hydraulic flow models to be run for all flow conditions of interest based on existing and proposed conditions. Outputs from the flow models and measurements of habitat, as well as information on fish preference and tolerances, can then be used to quantify differences in fish habitat between various existing and proposed conditions, and relate the difference to fish effects.

We recommend PRII conduct an evaluation of habitat loss due to water diversions to all stream reaches affected, using an above mentioned best practice, to evaluate and establish minimum flows for each reach that would protect fish and their habitat at an agreed upon level. Our recommended approach is to develop bathymetric and hydraulic flow models for appropriate flows to relate existing and proposed conditions, using appropriate fish-habitat models (Raleigh *et al.* 1986), preferably incorporating information on other factors important to fish. This approach follows best practices, can accommodate multiple species and life stages, and is capable of identifying specific areas of the habitat of most concern.

2.1.3 Conclusions and Recommended Conditions

PRII's lack of concern, or evaluation, of their proposed water rights' effects on ESA-listed fish habitat is troubling; particularly during low flow scenarios. PRII has not proposed water withdrawal limits or minimum stream flow conditions for impacted streams upstream of the EFSFSR surface water diversion. Without withdrawal limits or established minimum stream flows for all reaches, PRII could divert almost all of the flow in Meadow Creek causing a complete loss of fish habitat. Existing steelhead redds, created during higher stream flows, would be dewatered in early summer months, and the gravels necessary for Chinook salmon and bull trout spawning would be dry.

2.2 Fish Habitat Downstream of Surface Water Diversion

2.2.1 Concerns

Sufficient flow to enable fish passage is of concern, particularly in the EFSFSR between the major point of diversion and downstream to the EFSFSR's confluence with Sugar Creek. This reach is high gradient, contains a large amount of waste rock and other remnants of past mining activity, and generally lacks necessary habitat components to support quality fish habitat. Although a few adult Chinook salmon construct redds in this reach each year, the substrate is embedded and likely leads to poor incubation and low juvenile productivity, and those redds likely exist because upstream passage to more suitable habitat is blocked by the fish passage barrier in the EFSFSR above the Yellow Pine Pit. Thus, we conclude that fish passage through this reach (and PRII's proposed tunnel) to higher quality habitat upstream is of critical concern for this downstream reach, and is primarily limited by the requirements of adult Chinook salmon. Passage through the EFSFSR reach immediately downstream of Sugar Creek is also of concern, but to a lesser degree due to the influx of water from Sugar Creek.

Water right conditions and recommendations provided in the PRII (2022) technical memorandum reflect findings in a memorandum sent to Gene Bosley (PRII) on March 21, 2023, titled "Stibnite Gold Project Fish Passage Evaluation" (Rio ASE 2023). We are concerned with Rio ASE's fish passage analysis because the criteria used to determine fish passage compliance did not follow the guidance as stated in Rio ASE's cited resources correctly.

The Rio ASE memorandum provides details regarding a hydraulic model they developed for the EFSFSR stream downstream of the proposed tunnel outlet. They used hydraulic model outputs and associated surveyed stream cross-sections to evaluate fish passage at low and high flows from PRII's proposed tunnel outlet to the confluence with Sugar Creek. Low and high flows evaluated were derived from the historical record and the 95% (low) and 5% (high) exceedance values (i.e., 5th and 95th percentiles). Rio ASE used minimum depth criteria for adult Chinook salmon, steelhead, bull trout, and westslope cutthroat trout in the fish passage evaluation to determine potential limitations to upstream migration resulting from proposed low-flow conditions. Rio ASE (2023) selected the minimum depth criteria based on a literature review (CDFW 2017; Thompson 1972) and requirements from the NOAA National Marine Fisheries Service (NOAA 2022b); however, their evaluations were not fully in compliance with recommended approaches.

In the initial fish passage evaluation, Rio ASE completed an analysis for each surveyed cross section within the reach of interest, excluding interpolated cross sections, following this statement, "when the maximum flow depth at a surveyed cross section (or multiple cross sections) in the hydraulic model is below the species-specific minimum depth criterion, the cross section is considered out of compliance with the depth criterion". When comparing the maximum estimated flow depth for each cross section to the minimum depth criteria for a species, Rio ASE found, using adult Chinook salmon as an example, that 20 locations (individual or consecutive cross sections) were "out of compliance" under existing conditions with an additional 6 locations out of compliance under proposed conditions (Table 12 in Rio ASE 2023). These values represent approximately 160 and 234 linear ft of stream, respectively, in the 1,617 linear ft reach of interest.

However, CDFW (2017) and Thompson (1972) provide more stringent criteria than that used by Rio ASE:

1. At least 10% of the maximum wetted transect length must be contiguous for the minimum depth criterion established for the target fish; and
2. A total of at least 25% of the maximum wetted transect length must be at least the minimum depth criterion established for the target fish.

These criteria, based on measurements in critical stream reaches and minimum depth criteria, can be used to estimate suitable depths for upstream fish passage (Bjornn and Reiser 1991), and are more stringent than those used in Rio ASE (2023). We recommended that PRII re-analyze their cross section data (Rio ASE 2023) fully using these criteria (CDFW 2017; Thompson 1972).[4]

Using the criteria as intended by the California Department of Fish and Wildlife (CDFW 2017) and Thompson (1972), Table 1 shows the linear stream length and percentage of reaches that are in compliance with passage criteria under existing and proposed conditions for adult Chinook salmon. Results show that under proposed conditions, an additional 206 (12.7%) linear feet of stream in the reach of interest (downstream of YPP; EFSFSR DS YPP) would be out of compliance for passage criteria. We acknowledge that CDFW (2017) typically apply these criteria to gravel/cobble dominated pool-riffle streams with less than 4% gradient, but Thompson (1972) doesn't specify stream types and Bjornn and Reiser (1991) suggests these criteria for all anadromous salmonid bearing streams. We therefore conclude that any further reduction in stream depths or flows in the reach of interest will reduce fish passage to an unknown degree.

[4] PRII provided the Nez Perce Tribe with Rio ASE's cross section data and results using the CDFW (2017) and Thompson (1972) criteria on September 5, 2023.

Table 2: The length (ft) and percentage of each reach estimated to be in compliance relative to the total reach length for adult Chinook salmon passage using minimum depth and passage criteria (CDFW 2017; Thompson 1972).

Reach	Conditions	Reach Length In Compliance (ft)	Reach Length (ft)	% Stream Length In Compliance
EFSFSR DS YPP	Existing	955.4	1616.5	59.1
EFSFSR DS YPP	Proposed	749.3	1616.5	46.4
EFSFSR DS Sugar	Existing	180.5	221.1	81.6
EFSFSR DS Sugar	Proposed	154.7	221.1	70.0
Sugar	Existing	283.5	831.6	34.1
Sugar	Proposed	283.5	831.6	34.1

2.2.2 Data Gaps and Recommended Analysis

Thompson (1972) provides additional guidance on how these passage criteria could be used to determine minimum flow to maintain fish passage through a stream reach:

> To determine the flow to recommend for passage in a given stream, the shallow bars most critical to passage of adult fish are located and a linear transect marked which follows the shallowest course from bank to bank. At each of several flows, the total width and longest continuous portion of the transect meeting minimum depth and maximum velocity criteria are measured (Fig. 4). For each transect, the flow is selected which meets the criteria on at least 25 percent of the total transect width and a continuous portion equaling at least 10 percent of its total width (Fig. 5). The results averaged from all transects is the minimum flow we have recommended for passage. I might caution that the relationship between flow conditions on the transect and the relative ability of fish to pass has not been evaluated.

This approach would require that hydraulic model results be available for the reach of interest across a range of flows (e.g., 5-10 cfs in increments of 0.5 cfs). Each cross section would then need to be evaluated for the cfs in which it meets compliance. The average cfs across all cross sections could then be used to calculate a minimum flow recommended for passage.

Bjornn and Reiser (1991), citing Baxter (1961), provides one additional technique to determine streamflows that provide suitable water velocities and depths for successful upstream passage of adult salmonids. Baxter (1961) reported, "Salmon needed 30-50% of the average annual flow for passage through the lower and middle reaches in Scottish rivers and up to 70% for passage up headwater streams." This translates to streamflows in excess of the 95% exceedance flows evaluated in the fish passage evaluation (Table 2).

Table 3: Values for 30%, 50%, and 70% of average annual daily flows for USGS gage site 13311250 (EFSFSR above confluence with Sugar Creek) for recent years in which complete data were available.

Year	30%	50%	70%
2017	15.5	22.3	41.0
2018	12.6	14.3	21.8
2019	10.2	14.3	22.0
2020	10.1	11.9	18.9
2021	9.9	10.7	17.9

2.2.3 Conclusions and Recommended Conditions

Passage in the EFSFSR between its confluence with Sugar Creek and upstream to the proposed surface water diversion is currently viable for Chinook salmon, steelhead, bull trout and westslope cutthroat trout under existing conditions; however, results in Rio ASE (2023) and Table 1 indicate that existing depths approach those unsuitable for passage, particularly for adult Chinook salmon migrating upstream. Table 1 shows that 59.1% of the reach's stream length meets established fish passage criteria (CDFW 2017; Thompson 1972) under current conditions, but that number decreased to 46.4% of stream length meeting criteria under proposed conditions. Any decrease in flow in this reach will have adverse effects to fish passage, but to an unknown degree. We recommend adding proposed conditions for minimum flow to maintain fish passage using the established criteria at agreed upon compliance levels.

2.3 Point of Quantification

2.3.1 Concerns

The proposed point of quantification ("POQ") for PRII's water right applications is located on the EFSFSR downstream of the confluence with Sugar Creek. Characterizing fish impacts and changes to their accessible habitat using the proposed POQ location obscures the proportional impact of PRII's proposed diversions on fish residing in the EFSFSR upstream of the confluence with Sugar Creek.

To illustrate the potential effect of PRII's 2022 Proposed Conditions on available fish habitat within the EFSFSR upstream of the confluence with Sugar Creek, we summarized the water diversion's proportional effect on the flow within the EFSFSR versus the proposed POQ. We downloaded the historical record of stream flows representing the most impacted reach of the EFSFSR from the USGS EFSFSR gaging site above Sugar Creek (#13311250). We then calculated flows for the proposed POQ as the sum of USGS sites #13311250 and Sugar Creek (#13311450). USGS discharge data included flow measurements from September 15, 2011, to September 1, 2023. We calculated monthly 95% exceedance flows from the 3-day moving daily averages as suggested in section 3.1 of PRII (2022). We set the amount of water diverted at 9.6 cfs, or 20% of the proposed POQ flow when flows at the proposed POQ were less than 25 cfs, as stated in PRII's 2022 Proposed Conditions. We then calculated the percent of water withdrawn from each stream reach equal to the amount of water diverted divided by the monthly 95% exceedance (Figure 3).

The amount of water diverted under the PRII 2022 Proposed Conditions is greater than 30% of the total flow in the EFSFSR above the confluence with Sugar Creek for 10 months of the year (Figure 3). Within the month of July, the percent of water diverted is 55%, as compared to the maximum allowed amount of 20% when quantified at the proposed POQ. Following statements made in Section 2.1, this results in a 55% reduction in fish habitat during an important time of juvenile fish rearing and adult Chinook Salmon migrating to holding and spawning areas.

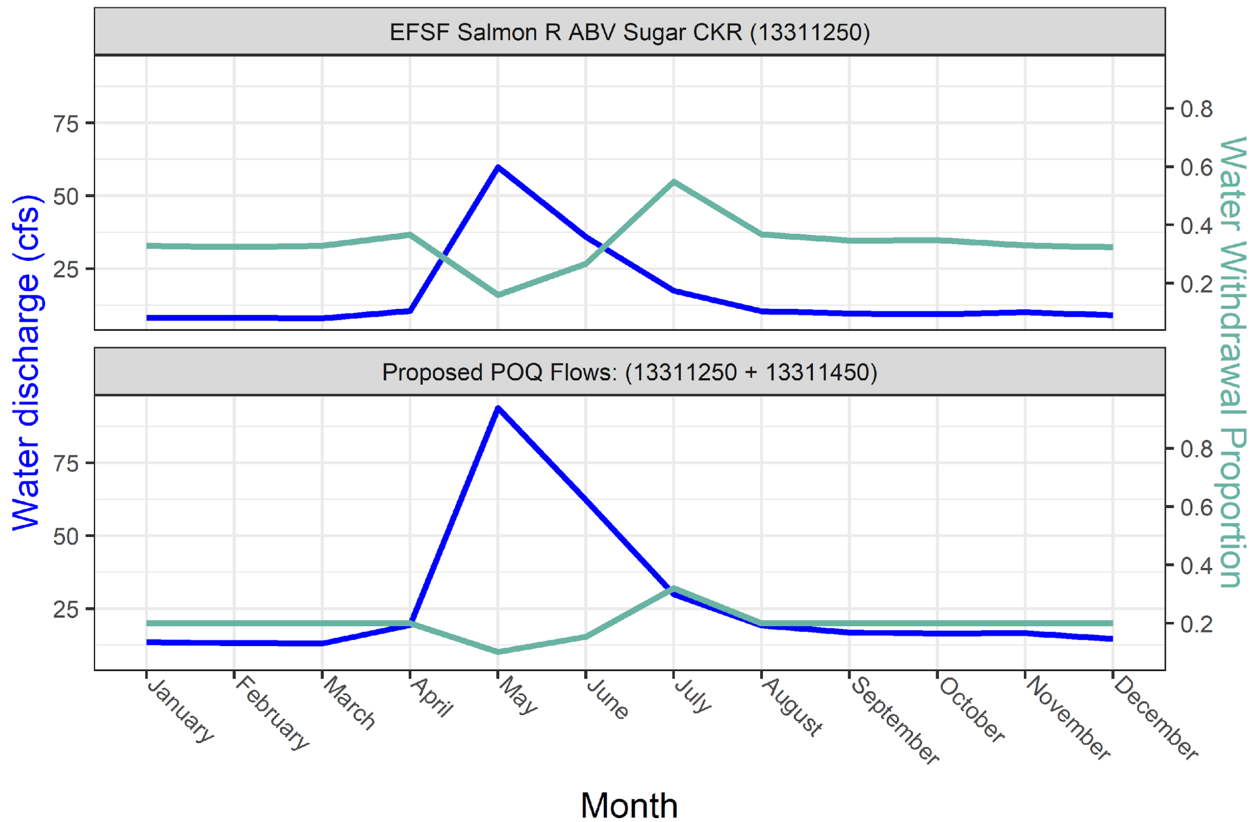

Figure 3: Water discharge expressed as monthly 95% exceedance flows of 3-day moving daily averaged for the EFSFSR above Sugar Creek (#13311250) and the proposed point of quantification (#13311250 + 13311450) under the proposed water rights conditions and estimates of the proportion of water withdrawn each month.

2.3.2 Data Gaps and Recommended Analysis

We suggest at least two points of quantification are necessary to accurately assess flows in the EFSFSR stream reach from which PRII proposed to divert water. A downstream site within the EFSFSR, but above the confluence of Sugar Creek, is recommended to monitor the total amount of water remaining in the EFSFSR after all proposed diversions, and available for fish use (e.g., migration, holding, rearing, incubation). Additionally, one or more sites are necessary to quantify stream flow upstream and prior to any diversions. The difference between these two recommended gage sites would represent the amount of water diverted, the remaining instream flow and the proportional effect of the diversions on fish habitat, in lieu of better quantification methods as stated in Section 2.1. Multiple points or locations of water diversion through different stream reaches (e.g., EFSFSR surface water diversion and groundwater diversion points along Meadow

Creek) may require additional gage sites to partition and quantify fish effects to the correct stream reach.

2.3.3 Conclusions and Recommended Conditions

Proportionally, the amount of water PRII is proposing for diversion from the EFSFSR upstream of the confluence with Sugar Creek is greater than 30% for the majority of the year. These water reductions will impact the ability of fish to find suitable holding and rearing habitat, and their passage to spawning locations. Multiple points of quantification should be established to better monitor impacts to fish within the EFSFSR and the proportion of water diverted should be less than proposed.

2.4 Ramping Rates

2.4.1 Concerns

The rate at which surface water is diverted is called the "ramp" or "ramping" rates. PRII does not propose water diversion ramping rates in their water right applications or in the PRII 2022 Proposed Conditions. From a fish perspective, ramping down the river has the potential to strand fish (Nagrodski *et al.* 2012) whereas ramping up the river has the potential to "flush" fish and other aquatic biota downstream. These effects are generally exacerbated for smaller fish (e.g., salmonid fry or parr), due to their smaller body size and reduced ability to tolerate increased stream velocities.

2.4.2 Data Gaps and Recommended Analysis

The risk for juvenile fish stranding or flushing or flushing of aquatic biota within the EFSFSR should be assessed. Assessments should take into account existing and proposed streamflows and stream bathymetry and should provide a review of the available literature on ramping rates appropriate to minimize fish stranding or flushing or flushing of aquatic biota. At a minimum, a thorough literature review is needed to understand the effects of water withdrawals on similar species and streams.

2.4.3 Conclusions and Recommended Conditions

Appropriate "up-ramping" or "down-ramping" rates should be established at surface water withdrawal locations to minimize risks to juvenile fish and aquatic biota.

2.5 Instream Temperatures

2.5.1 Concerns

PRII's 2022 Proposed Conditions do not address situations where water withdrawals might result in increased stream temperatures during warm months or decreased stream temperatures during winter months, or alternatively, situations when temperatures approach thresholds for ESA-listed species (Table 4) (Carter 2005; Selong *et al.* 2001). Stream temperature influences feeding and growth rates, metabolism, timing of life history events such as upstream migration, spawning, freshwater rearing and seaward migration (for anadromous species), and the availability of food for salmonids (Carter 2005). Temperatures at sublethal levels can reduce growth, increase stress, affect reproduction, or create disease problems (EPA 2003). The stressful impacts of increased water temperatures are cumulative and related to the duration and severity of exposure (Carter 2005). In the Pacific Northwest, summer months are anticipated to become progressively more stressful for salmonids as stream temperatures increase with warming air temperatures due to climate change, which is likely to shift and reduce suitable habitat for many species (Isaak *et al.* 2017; Jones *et al.* 2014) and increase the extinction risk for Snake River ESA-listed species (Crozier 2019).

Table 4: Life stage timing and optimum, maximum, and acute temperature (Celcius) thresholds for select species and life stages expected during summer months. Chinook salmon and steelhead temperatures are expressed as the 7-day Maximum Weekly Maximum Temperature (MWMT).

Species	Life Stage	Source	Timing	Optimum	Maximum	Acute
Chinook	Spawning	Carter 2005	6/30 - 9/30	7.2 - 14.5	17.7	20
Chinook	Juvenile Rearing	Carter 2005	6/10 - 10/15	10 - 16	19	22
Steelhead	Juvenile Rearing	Carter 2005	6/10 - 10/15	10 - 18	19	22
Bull Trout	All	Selong et al. 2001	7/8 - 9/30	10.2 - 16	18	20

Stream temperatures exceed optimum temperatures for some species and during some days in warm water months in the headwaters of the EFSFSR (Figure 4) and could approach maximum temperatures under climate change scenarios (Isaak *et al.* 2017).

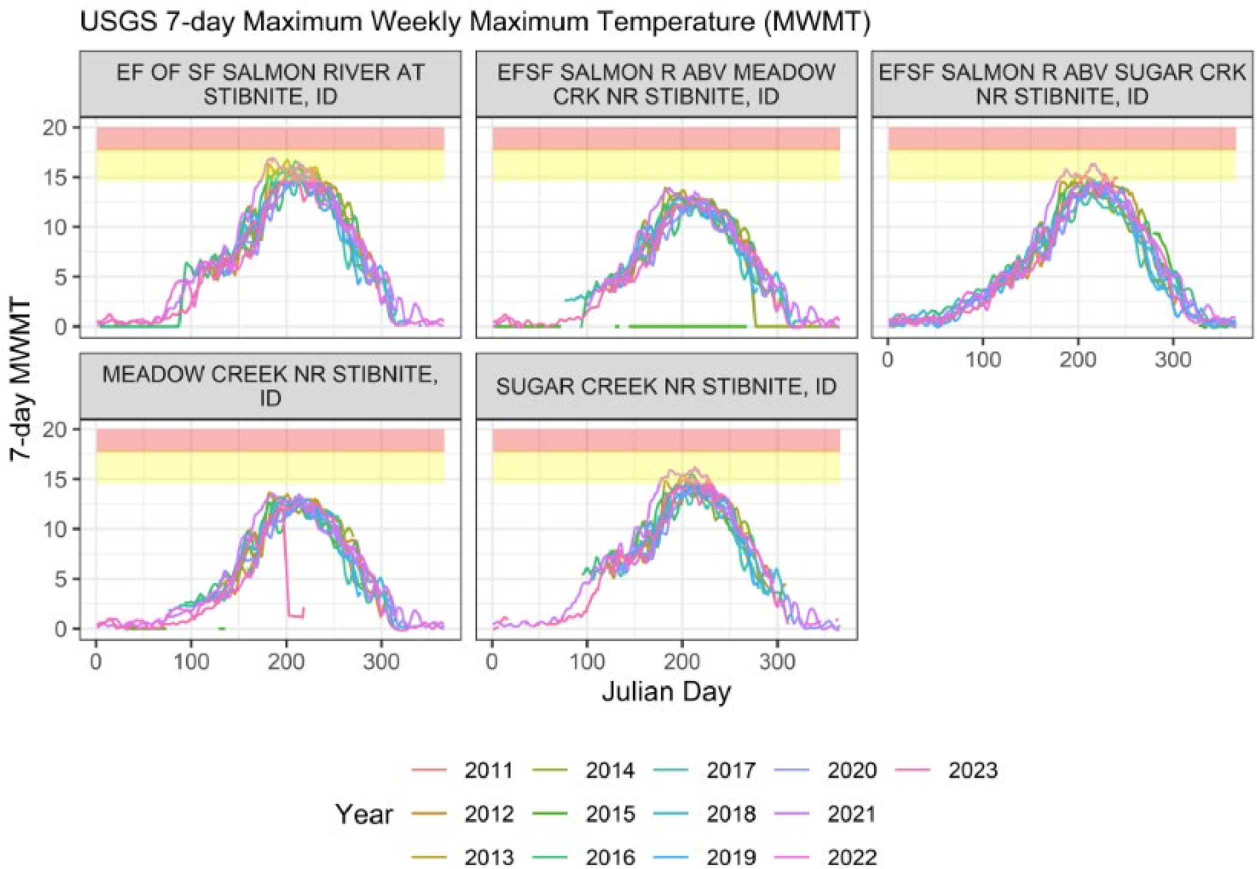

Figure 4: The maximum weekly maximum temperature (also known as the seven-day average of daily maximum temperatures [7-d MWMT]) at each of five USGS gage stations in the headwaters of the EFSFSR, 2011 - present. The yellow ribbon represents the maximum optimum temperature among the species and life stages of interest; e.g., the range of optimum temperatures for Chinook salmon spawning is 7.2 - 14.5°C and the range of optimum temperatures for juvenile steelhead rearing is 10 - 18°C (Carter 2005). The red ribbon represents the range of maximum temperatures among species and life stages, a temperature above which physiological stress occurs including reduced growth and activity. Prolonged exposure above this temperature can lead to eventual mortality (Carter 2005).

2.5.2 Data Gaps and Recommended Analysis

PRII's 2022 Proposed Conditions did not provide conditions for when water withdrawals influence stream temperatures or when stream temperatures approach sub-optimal, sublethal, or acute temperature thresholds for salmonids. Further, PRII's conditions did not account for changes to stream temperatures resulting from climate change. Isaak *et al.* (2017) provides a stream temperature model which provides spatially continuous predictions of stream temperatures across the stream network under existing and projected climate change scenarios, including projections for the years 2040 and 2080. PRII should provide an analysis that assesses potential risks or impacts to salmonids resulting from its proposed water rights, including additional impacts that would be expected under proposed conditions.

2.5.3 Conclusions and Recommended Conditions

Water rights conditions should account for scenarios where water withdrawals result in increases in stream temperatures during warm months and decreases in stream temperatures during winter months. And conditions should limit or cease water withdrawals if stream temperatures approach maximum thresholds (Table 4).

2.6 Fish-Flow Productivity Relationships

2.6.1 Concerns

The amount of water in a stream environment has a direct relationship with fish population productivity. For example, Entrix (2009) found a significant positive relationship between summer flow conditions and steelhead productivity, measured as adult recruits to adult spawners while (Morrow 2018) found a similar relationship for Chinook salmon productivity in Johnson Creek; a tributary to the EFSFSR downstream of PRII's proposed water rights. Because water withdrawals will have an immediate impact on juvenile rearing, and these previous studies examined adult-to-adult relationships which include hydrosystem and ocean survival, we examined flow relationships with a juvenile productivity metric–juvenile migrants per adult spawner. The juvenile metric indicates the number of juvenile fish surviving incubation and early rearing and leaving the natal habitat for each spawning fish. Thus, the juvenile productivity metric is a better gauge of incubation and rearing habitat conditions and potential changes from reduced flows than an adult productivity metric.

We found juvenile productivity for Chinook salmon in Johnson Creek was significantly (p-value = 0.04) correlated with average flows in September (Figure 5). For each unit increase in discharge (cfs), an additional 3.7 juveniles were expected to survive incubation and rearing. Using the developed model, and assuming the relationship is similar for fish within the project area, we can estimate the potential reduction in juvenile productivity based on proposed water withdrawals.

Section 2.3 indicates approximately a 40% reduction in September flows for the EFSFSR above the confluence with Sugar Creek. Using the reduction in September flows and the developed model (Figure 5) with estimated coefficients (y-intercept = -82; slope = 3.7), we calculate an approximate 36% reduction in juvenile productivity within the EFSFSR above the confluence with Sugar Creek.

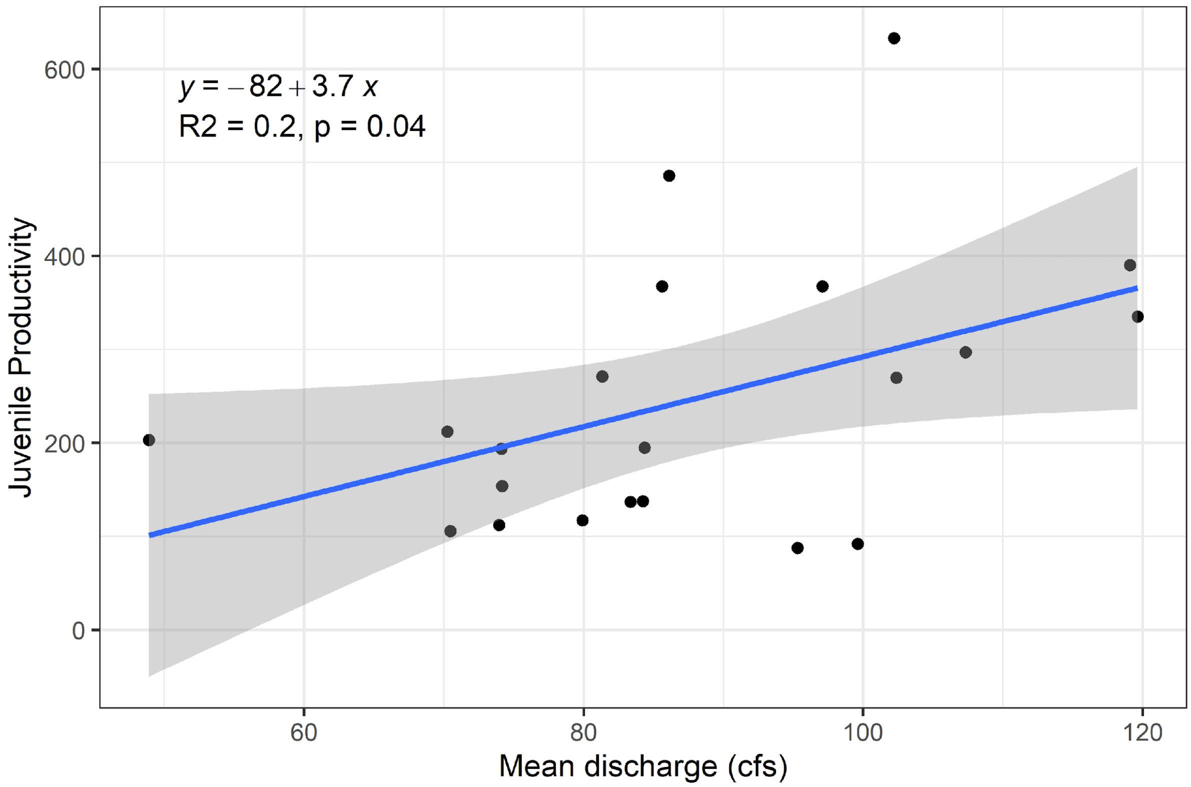

Figure 5: Juvenile productivities estimated as the ratio of juvenile migrants to adult spawners in Johnson Creek, a tributary to the EFSFSR, regressed on the mean stream discharge (cfs) in September.

2.6.2 Data Gaps and Recommended Analysis

Our analysis assumes a similar flow to Chinook salmon juvenile productivity relationship in the headwaters of the EFSFSR as in Johnson Creek. This assumption may be invalid due to Johnson Creek having much larger flow conditions and different fish densities and habitat quality. However, it is well documented that positive relationships exist between fish productivity and flow, and any reduction in flow will have a negative effect on fish. The overall extent of the water withdrawal impact on fish residing in the EFSFSR is unknown, but as shown above may be as high as 30-40% within the headwaters of the EFSFSR and in areas of reduced flow downstream.

PRII did not propose conditions related to direct impacts to fish productivity in their water right proposal. We recommend PRII conduct a thorough evaluation of flow and productivity relationships of each species and life-stage of concern throughout the EFSFSR reach in which they are proposing water rights. Evaluations should account for flow and water temperature changes due to the water withdrawals, and include future changes brought on by expected climate change.

2.6.3 Conclusions and Recommended Conditions

PRII did not assess impacts to fish populations that will result from their proposed water withdrawals. Given the limited data PRII has provided, and assuming the Johnson Creek juvenile productivity model represents fish populations and flows in the EFSFSR, we would expect up to a 36% reduction in productivity for an ESA-listed species in the EFSFSR headwaters. ESA-listed adult fish, including Chinook salmon and steelhead, returning to the EFSFSR from ocean rearing are currently at very low levels (Johnson *et al.* 2021; NOAA 2022a). Any reduction to early rearing productivity for these fish may push the EFSFSR population closer towards the quasi-extinction threshold.

3 Conclusions

The existing evaluations completed by PRII and their proposed conditions are incomplete and do not offer enough protections for ESA-listed fish and other aquatic species. Our list of major concerns is not exhaustive, and we caution that any water reductions in any stream environment generally has a negative effect on salmonids (NOAA 2021b). In our evaluations we did not consider cumulative effects (i.e., individual concerns are additive or multiplicative for a combined effect), and only consider a single effect on a single species or life-stage. Combining our concerns of PRII's water right applications and proposed conditions, including reduced fish passage, loss of spawning, incubation and rearing habitat, lower juvenile productivity, and exacerbated stream temperature shifts caused by climate change and water withdrawals will have a compounding effect on fish and other aquatic species.

Characterizing fish impacts and changes to their accessible habitat using PRII's proposed POQ location is difficult because the POQ obscures the proportional impact of PRII's proposed diversions on fish residing in the EFSFSR upstream of its confluence with Sugar Creek. The amount of water diverted following PRII's 2022 Proposed Conditions is greater than 30% of the total flow in the EFSFSR above Sugar Creek for 10 months of the year (Figure 3). Within the month of July, the percentage of water diverted is 55%, as compared to the proposed maximum allowed amount of 20% when quantified at the proposed POQ. These water reductions will impact the ability of fish to migrate through stream reaches downstream of the EFSFSR surface water diversion to find more suitable holding, spawning, and rearing habitat.

PRII's 2022 Proposed Conditions did not include withdrawal limitations or establish minimum stream flows for stream reaches upstream of the proposed POQ. Thus, allowing PRII to remove the full proposed water right at diversions along Meadow Creek. For 10 months in the year Meadow Creek median flows are less than 10 cfs; if the full water right was used in Meadow Creek during these months, approximately 90% of the adult spawning and incubation habitat would be lost.

Water rights conditions should account for altered stream temperatures caused by water withdrawals, and include "up-ramping" or "down-ramping" rates to minimize risks to juvenile fish and aquatic biota stranding and flushing. Water withdrawals will result in increases in stream temperatures during warm months and decrease stream temperatures during winter months, more frequently pushing temperatures out of optimum ranges.. Proposed conditions should limit or cease water withdrawals if stream temperatures approach maximum thresholds (Table 4). Additionally, proposed conditions should include ramping rates to avoid any negative effects to aquatic species.

ESA-listed fish, including Chinook salmon and steelhead, within the EFSFSR are currently at very low abundance levels (Johnson *et al.* 2021; NOAA, NMFS, 2022) and they are experiencing productivity rates below replacement (Ford 2022). Reductions in flows are shown to reduce adult productivity in salmonids (Entrix 2009; Morrow 2018), and we also showed juvenile productivity is expected to decrease by 36% under PRII's water right applications and their proposed conditions. This decrease in productivity will contribute to pushing ESA-listed EFSFSR fish closer towards the quasi-extinction threshold by further decreasing their productivity.

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