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June 16, 2022

State Water Resources Control Board
Attn: Clerk of the Board
commentletters@waterboards.ca.gov

Re: 6/21/2022 BOARD MEETING ITEM #5

Dear Board:

I am submitting herewith a Memorandum from Mike Podlech, Aquatic Ecologist, reflecting his review of California Department of Fish and Wildlife's recommendations for the 2022 readoption of drought emergency regulations on the Shasta River and his recommendations for alternative instream flow management during extreme drought conditions.

This Memorandum is supported and presented on behalf of a multitude of Shasta River water rights holders including, but not limited to, Shasta River Water Users Association, Big Springs Irrigation District, Grenada Irrigation District, Montague Water Conservation District, Huseman Ditch Co. and Shasta Springs Ranch. This Memorandum is also supported and presented by Siskiyou County Farm Bureau along with California Farm Bureau.

The individuals, entities and organizations supporting this Memorandum request the Board consider the Memorandum in setting minimum flows during spring and summer in the Shasta River. Mr. Podlech concludes that reducing the Yreka gauge flow target to 30 cfs during summer would protect juvenile salmonids while enabling diverters lower in the watershed to exercise their rights and divert water that is, according to best available science, largely unsuitable for juvenile rearing. Then, at the beginning of September, these lower watershed users could reduce or cease their diversions to allow canyon flows to ramp up to the CDFW-recommended 50 cfs prior to September 15th and to 75 cfs from September 16-30 to support the early fall Chinook migration period. Mr. Podlech also provides justification for reducing early spring flow volumes for minimum drought conditions.

State Water Resources Control Board
Re: 6/21/2022 BOARD MEETING ITEM #5
June 16, 2022

We respectfully request that you seriously consider this Memorandum in setting minimum flows in the Shasta River in amending and/or re-adopting the drought emergency regulations for the Shasta River watershed. Thank you for your consideration

Very Truly Yours,
Law Office of Darrin W. Mercier

By: Darrin W. Mercier

DWM:tmb
Enclosure

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memorandum

date June 13, 2022

to Darrin Mercier, Law Office of Darrin W. Mercier

from Mike Podlech, Aquatic Ecologist

subject Review of CDFW Recommendations for the 2022 Readoption of Drought Emergency Regulations on the Shasta River and Recommendations for Alternative Instream Flow Management During Extreme Drought Conditions

Purpose of Memorandum

On May 10, 2021, California Governor Newsom declared a drought emergency for 41 counties, including Siskiyou County. On August 30, 2021 the State Water Resources Control Board (State Water Board) adopted emergency regulations authorizing curtailments of diversions "where flows are insufficient to protect fish" within certain watersheds in the Klamath River basin, including the Shasta River watershed. The stated purpose of the emergency regulation is to "prevent the diversion of water that would unreasonably interfere with an emergency minimum level of protection for commercially and culturally significant fall-run Chinook salmon and threatened Southern Oregon/Northern California Coast coho salmon" [*emphasis added*]. In September 2021, the State Water Board issued Order WR 2021-0082-DWR imposing curtailments on water right holders in the Shasta River. The order established monthly minimum instream flow targets based on input from the California Department of Fish and Wildlife (CDFW). The CDFW minimum instream flow targets were based on recommendations presented in the 2014 *Shasta River Canyon Instream Flow Needs – Final Report* developed by McBain & Trush, Inc. and Humboldt State University ("M&T" hereafter). The M&T (2014) instream flow needs (IFN) recommendations themselves were based on a Tier 2 "fish in good condition" standard, defined as "extensive habitat available for all life history tactics and all life history stages and their required habitats should have a sufficiently broad distribution to sustain the species indefinitely" that arguably exceeds the State Water Board's "emergency minimum level of protection" standard.

On November 11, 2021, I prepared a memorandum reviewing the best available information referenced by CDFW as support for the 2021 minimum flow recommendations adopted by the State Water Board. The memorandum concluded that the 2021 CDFW-recommended target flows for adult salmon spawning (1) exceeded the "emergency minimum level of protection" standard set forth in §875(a) of the State Water Board's drought emergency regulation, and (2) did not consider all of the "best available science". The memorandum also cautioned that the burden of compliance with an excessively high spawning flow target in winter 2021, when most diversions in the watershed had ended, would fall on Dwinnell Reservoir and thus result in loss of storage available for environmental releases in spring and summer 2022.

On May 16, 2022, the State Water Board proposed to reissue and amend the emergency regulation for the Shasta River. In addition to Chinook and coho salmon, the proposed regulation now includes protection of "culturally significant steelhead". In addition, the State Water Board is proposing slightly modified minimum flow requirements, primarily in the form of reduced instream flow targets during the period of October through March. For the period of May through September 15, the proposed 2022 summer rearing flow target at the USGS Yreka gage (11517500) remains at 50 cubic feet per second (cfs) before ramping up to 75 cfs for the remainder of September, 105 cfs in October, and 125 cfs for November through March 24.

At the request of a group of Shasta Valley water users, I have conducted a detailed follow-up review of the M&T (2014) IFN report, proposed State Water Board curtailment orders and regulations, pertinent CDFW communications and recommendations, existing water conservation and salmonid protection and enhancement programs in the Shasta River watersheds, as well as Biological Opinions issued by the National Marine Fisheries Service (NMFS) analyzing the anticipated effects of these programs. Due to the fact that curtailments in the Shasta River watershed are ongoing and proposed for continuation, this review is focused primarily on the summer juvenile salmonid rearing (through September 15) and early adult Chinook salmon migration (September 16 through September 30) periods. Additional thoughts are provided for the later winter/early spring juvenile rearing period of March and April. Based on this review, I have concluded that (1) the CDFW-recommended target flows for summer and later winter/early spring juvenile rearing are not supported by the M&T (2014) data and exceed the "emergency minimum level of protection" standard set forth in §875(a) of the drought emergency regulation, and (2) the continued disregard for other best available information, such as instream flow and habitat protection strategies developed in coordination with NMFS and CDFW for the upper watershed, results in a curtailment scheme that favors protection of warm-water habitat in the canyon largely unsuitable for juvenile salmonid rearing over a targeted, cooperative approach to protecting critically important cold-water rearing habitat in Big Springs complex. This memorandum summarizes my findings.

Shasta River Canyon Instream Flow Needs Assessment

Summer Juvenile Rearing

In 2014, M&T completed an instream flow assessment for the Shasta River Canyon reach using regional regression models, standard setting methods, riffle-crest measurements, 1- and 2-dimensional hydraulic modeling, direct habitat mapping, and photo documentation to develop Instream Flow Needs (IFN) recommendations measured at the USGS Yreka gage 115117500 (SRY). For the summer juvenile salmonid rearing/summer baseflow period, M&T (2014) recommend an IFN of ≥70 cfs in normal/wet years and ≥50 cfs in dry years. CDFW used M&T's dry year recommendation to set the Shasta River target curtailment flows. Please refer to my previous (November 2021) memorandum for a discussion of problems associated with using IFNs based on only two water year categories as the basis for determining flow targets aimed at providing an "emergency minimum level of protection" during severe drought. CDFW acknowledged those concerns in a December 17, 2021 letter to the State Water Board, but indicated that the authors of M&T (2014) "did not have an immediate suggestion" for what a critically dry year flow might look like without additional analysis. Five months have passed since then and, to the best of my knowledge, no additional evaluation of this issue has been conducted. The proposed 2022 flow targets are therefore again based on a two-water year analysis that was never intended to establish severe drought IFNs.

M&T (2014) indicate they considered four sources of information in the analysis of the juvenile salmonid rearing/summer baseflow period: key findings from Null et al. (2010, Section 6.5.1), water temperature monitoring and analysis (Section 6.5.2), and two analytical methods: standard setting methods (Section 5.2) and 2-D modeling (Section 5.5). However, as indicated in Section 7.5 of the report, the primary analytical data used to develop summer rearing IFN recommendations consisted of the Null et al. (2010) findings, additional water temperature analysis results, and 2-D modelling results. These data analyses and their interpretations in M&T (2014) are discussed below.

Please note that much of the analyses and justifications for IFN recommendations presented by M&T (2014) relate directly to the normal/wet year IFN recommendation of ≥70 cfs. Their dry year recommendation of ≥50 cfs is based largely on a professional judgment call adjustment of the normal/wet year recommendation. Therefore, the following discussion focuses primarily on data used for the normal/wet year recommendation with reference to the dry year adjustment where appropriate.

Null et al. (2010)

Several sections in the M&T (2014) report provide brief summaries of the results of the Null et al. (2010) water temperature modelling study, including the following statement (p. 103): "It is unlikely that even unimpaired streamflows would have provided desirable water temperatures for rearing salmonids in the Shasta Canyon during the late summer period (Null et al. 2010); however, due to its high productivity, and the opportunity for thermal variability in side channel habitats, summer rearing in the Shasta Canyon may have been a viable, and important life history tactic." It is important to put this statement into perspective with the quantitative findings from Null et al. (2010). The fully unimpaired scenario modelled by Null et al. (2010) yielded a summer canyon streamflow of approximately 150 cfs with water temperatures "largely below 23°C at the mouth" and a maximum weekly average water temperature (MWAT) of 19.5°C. These temperatures fall well within the range considered by CDFW as detrimental to rearing juvenile coho salmon (Stenhouse et al., 2012). In other words, the complete cessation of water diversions, removal of Dwinnell Reservoir, and full riparian restoration in the Shasta River watershed would produce canyon conditions unsuitable for juvenile coho salmon. All other scenarios modelled by Null et al. (2010) resulted in even higher temperatures. The "current conditions" (i.e., 2001) scenario estimated water temperatures at the mouth of the river exceeding 30°C at streamflows of up to 50 cfs, the same flow level that is now proposed by CDFW and State Water Board to be re-adopted as a summer juvenile rearing target.

Water Temperature Monitoring

M&T (2014) synthesized and analyzed water temperature data collected at several locations within the Shasta River Canyon during water years 2007-2010. Focusing on temperatures measured during the July 1-Septemvber 14 summer juvenile rearing period, M&T (2014) summarize their findings very briefly in Section 6.5.2:

- 68% of mainstem daily maximum water temperatures were below the lethal water temperature limit (75.2°F [24°C]) for streamflows ≥ 70 cfs;
- 92% of the Salmon Heaven Side Channel daily maximum water temperatures measured fell below the lethal water temperature limit (75.2°F [24°C]) for a mainstem streamflow ≥ 70 cfs; and
- For mainstem streamflows ≥ 70 cfs, daily maximum water temperatures within the Shasta River Canyon mainstem channel and Salmon Heaven Side Channel rarely fell below the detrimental water temperature threshold of 68.5°F [20.3°C], 5% and 8% respectively (see Table 20).

Although not specifically clarified in the above summaries, it is important to note that the referenced lethal threshold of 75.2°F (24°C) was established by the North Coast Regional Water Quality Control Board (NCRWQCB) for the Shasta River TMDL and pertains to steelhead while the detrimental threshold of 68.5°F (20.3°C) was established by Stenhouse et al. (2012) and pertains to coho salmon. Although not discussed in further detail by M&T (2014), these results indicate that even at streamflows of 70 cfs and above, daily maximum water temperature was lethal to steelhead on 32% of monitored days. Considering that a lethal threshold, by definition, needs to be exceeded only once to result in death, that is a high frequency of steelhead mortality events. Moreover, the results confirm that the Shasta River Canyon is uninhabitable to juvenile coho salmon at the M&T (2014) IFN for normal/wet water years.

Nevertheless, M&T (2014) present this temperature data as justification for their IFN recommendation. In fact, in Section 7.5 under the heading of *Primary Analytical Data Considered*, the authors state:

> "When daily average streamflows were ≥70 cfs, maximum water temperatures were below lethal thresholds 68% of the time (Table 20). As daily averaged streamflows drop below 70 cfs, daily maximum water temperatures rapidly climb above the 75.2°F, exceeding the lethal water temperature threshold 58% of the time (Figure 62 and Table 20);"

This statement appears to be intended to suggest that summer streamflows of 70 cfs or higher are preferrable (i.e., lethal on fewer days) than streamflows below 70 cfs. However, a careful review of their methodologies and the data presented in Figure 62 suggest that both the analysis and the conclusions are overly simplistic. A simple count of temperature data points falling above or below a certain threshold during the 2.5-month period of July 1-September 14 compared to recorded streamflows on those days entirely ignores (1) the wide range of climatic conditions, particularly air temperature and solar input, that strongly influence daily maximum water temperatures, and (2) differences in streamflows during that 2.5-month. In other words, while Figure 62 does not provide the days on which the various data points were recorded, it is reasonable to assume that higher streamflows and lower water temperatures were more common in early July than in mid-August. As such, the count of lower water temperature days is naturally biased toward the higher streamflow events early in the season. Contrary to the authors apparent suggestion, streamflow levels alone do not control water temperatures. In fact, the data presented in Figure 62 make this abundantly clear: Approximately 2/3 of all temperature data points were collected at streamflow levels below 70 cfs (and approximately 1/2 of the measurements were collected at streamflows below approximately 35 cfs), yet the daily maximum water temperatures at those low flows ranged from a high of about 85°F (29.4°C) to a low of about 66°F (18.9°C) in the main channel. The wide range of recorded water temperatures at streamflows of less than about 35 cfs, in particular, provide a clear indication that seasonality and ambient air temperatures are likely far more important factors than just streamflow.

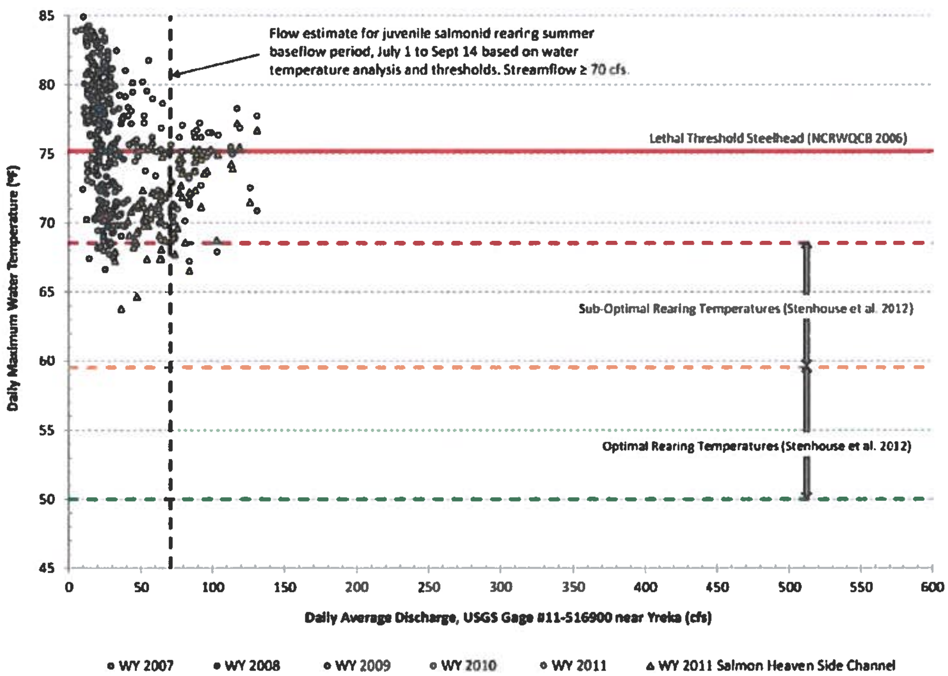

Figure 62. Daily maximum water temperatures plotted for the period of July 1 through September 14 for WY 2007 to WY 2011 within the mainstem Shasta River and for WY 2011 within the Salmon Heaven Side Channel Study Site.

It also worth noting that applying the same simplistic analysis used by M&T (2014), the 2011 Salmon Heaven Side Channel data points (yellow triangles) in Figure 62 could be used as evidence that daily maximum temperatures increase steadily from about 35 cfs to 120 cfs, suggesting that lower flows result in more favorable temperatures.

Notwithstanding my critique of the water temperature analysis and interpretation above, I acknowledge and commend that fact that M&T (2014) make it abundantly clear throughout the report that their analysis should be considered preliminary and that a more detailed temperature model should be prepared to assess whether IFN recommendations should be modified. Most notably, the authors state:

> "Until a water temperature model or more rigorous water temperature analysis is completed and available for the Shasta River Canyon, IFNs for juvenile salmonid rearing habitat in summer (July 1 through September 16) are based on available temperature data and considered preliminary. Summer flow recommendations may change as future data becomes available." (p. 91)
>
> and
>
> "There is insufficient evidence in this report to determine whether future over-summering in the Shasta Canyon is a viable life history tactic for juvenile coho and steelhead." (p.103)
>
> and
>
> "If summer rearing is not determined to be a viable future life history tactic, a lower summer instream flow which promotes juvenile migration and BMI productivity would be recommended. In addition to water temperature modeling, an adaptive management approach (evaluate temperature based on experimental releases) is recommended to refine the instream flow needs to meet water temperature criteria, specifically during the late spring recession and summer periods." (p. 103)

It is highly unfortunate that in 2022, eight years after the completion of the M&T (2014) IFN report, the recommended water temperature model and rigorous analysis are still not available for the Shasta River Canyon, yet summer curtailment flows are being implemented based on information that is considered insufficient and preliminary by its authors. As described later in this memorandum, a detailed water temperature model and empirical flow validation experiment consistent with the authors' recommendation were developed for the upper Shasta River watershed, but those sources of best available information apparently continue to be disregarded during curtailment flow deliberations.

2-Dimensional Hydraulic Modeling

As noted by M&T (2014, p. 104), the summer IFN recommendations are based on two critical components; water temperature (discussed above) and physical habitat availability. The primary physical habitat availability data considered for the IFN recommendations were developed with the use of a two-dimensional (2-D) model. In Section 6.5.4, the authors indicate that 2-D modeling findings from the winter rearing period analysis (Section 6.3.3) apply directly to the summer baseflow period. The validity of this approach is questionable considering that CDFW documented seasonal variability in steelhead habitat selection (Holmes et al. 2014). For example, young-of-the-year (6-9 cm forklength) in the Big Sur River of Monterey County showed a preference for riffle habitat in the summer and pool habitat in the fall (Holmes et al. 2014). Presumably, juveniles would also preferentially select the lower velocity pool habitats in the winter. However, since M&T (2014) did not develop seasonally-adjusted habitat suitability curves, they had to rely on a single set of modelling runs. While not ideal, I acknowledge that the M&T (2014) approach is consistent with many other instream flow needs assessments.

M&T (2014) modelled juvenile rearing habitat availability at five study sites: Otolith, Hudson Road Units 1-3, and Salmon Heaven Side Channel. In their rational for a ≥70 cfs summer IFN recommendation for normal/wet year, the authors state (p. 104) that "independent of water temperature, high quality juvenile salmonid rearing habitat is supported by flows of 33 cfs to 70 cfs" and that "coho rearing habitat drops sharply in runs at the Hudson Road Study Site when streamflows exceed 70 cfs."

Habitat availability was modelled separately for coho salmon and steelhead based on the habitat suitability criteria of the two species (see Table 10 of the IFN report). The individual results of the modelling are described thus (p. 93):

- "Extensive juvenile coho rearing habitat was provided below 80 cfs at the Hudson Road Study Site, between 30 cfs and 160 at Otolith Run/Pool, and peaked in the Salmon Heaven Side Channel at a main channel streamflow of 200 cfs (with a side channel streamflow between 9 cfs and 12 cfs)."

- "Juvenile steelhead rearing habitat was abundant between 30 cfs and 160 cfs for the two Hudson Road runs, between 65 cfs and 320 cfs for Otolith Run/Pool, and peaked in the Salmon Heaven Side Channel at a mainstem streamflow of 220 cfs."

The Salmon Heaven Side Channel results are not discussed in the following summary of my review of the modelling results because mainstem flows far higher than the recommended IFNs would be needed to achieve near-negligible rearing habitat availability at this side channel survey site.

Table 10. Depth, velocity, and substrate/cover habitat suitability criteria for mapping productive BMI riffle habitat and spawning, fry, juvenile Chinook, juvenile coho, and juvenile steelhead rearing habitat.

Species	Life Stage	Depth (ft)	Velocity (ft/s)	Substrate	Cover	Source
Salmonid	Spawning	1.0 - 2.3	0.8 - 2.2	Dominant (>50%): Small (0.2–1 in), Medium (1–2 in), and Large (2–3 in) Gravel, Small Cobble (3–6 in); Subdominant (<50%): Small, Medium, Large Gravel, and Small Cobble, and includes Medium Cobble (6–9 in).		Min Depth: SWRCB (2010); Max Depth: Hampton (1988) (suitability>0.5); Velocity: Hampton (1988) (suitability>0.5); Substrate Hardin et al. (2005)
Chinook	Fry	0.5 - 1.6	0.0 - 1.0		non-emergent rooted aquatic vegetation, grasses, willows, sedges, within 2 ft	Hardy et al. (2006) (suitability>0.5)
Chinook	Juveniles	1.2 - 4.8	0.0 - 1.6			Hardin et al. (2005) (suitability>0.5)
Coho	Juvenile	> 0.8	0.0 - 1.1		non-emergent rooted aquatic vegetation, grasses, willows, and sedges	Hampton (1988) (suitability >0.5) (dropped upper depth criterion to target larger coho juveniles and pre-smolts)
Steelhead	Juvenile	0.8 - 2.6	0.6 - 2.6	6 - 102		Hardy et al. (2006) (suitability >0.5) (increased lower velocity criterion to target larger juveniles and pre-smolts)
BMI		> D_{50}*	2 - 5			Gore 1978 (suitable velocity 2.46–4.1 ft/sec); Gard 2006 (Total BMI suitable velocity 2.2–5 ft/sec); and Giger 1973 (velocity ≥ 2 ft/sec)

*The D_{50} represents the median coarse sediment size for a particle distribution within the area being evaluated.

The casual reader may interpret statements such as extensive rearing habitat being provided below 80 cfs to indicate that rearing habitat steadily increases up to 80 cfs, but even a cursory review of the modelling results for juvenile coho salmon presented in Figure 49 reveals that rearing habitat availability actually peaks at the lowest flow modelled (i.e., 33 cfs), decreases at variable rates as flows increase to the dry year recommendation of 50 cfs, and then decreases further as flows increase to the normal/wet year recommendation of 70 cfs. At the Otolith site, coho salmon rearing habitat availability increases slightly between 30 cfs and 50 cfs and then remains essentially identical up to approximately to 120 cfs. Compositing the results for the four sites clearly shows the greatest habitat availability at approximately 30 cfs and declines, at first steadily and then rapidly, with increasing streamflow. This trend would be fully expected due to the widely documented juvenile coho salmon preference for low velocity habitat, as reflected in the authors use of a 0.0-1.1 ft/s velocity suitability range for the species. In other words, as streamflows increase, localized and averaged velocities increase and begin to exceed the 1.1 ft/s maximum threshold. Based on the coho salmon results alone, the most logical recommendation for an "emergency minimum level of protection" instream flow standard would be approximately 30 cfs.

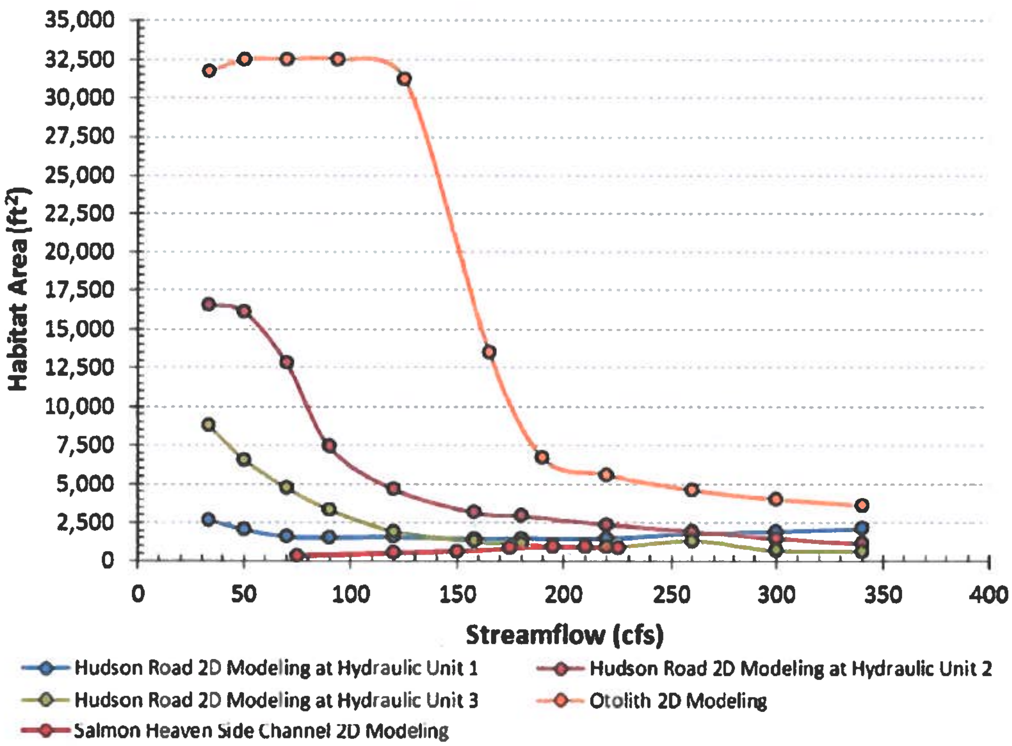

Figure 49. 2-D model predictions of Juvenile 1+ coho habitat rating curves.

However, in its May 16, 2022 proposal for readoption of the curtailment flows, the State Water Board added steelhead to the list of salmonids the flow targets are intended to protect. CDFW's observation of "over summering steelhead in cool pockets of the Shasta River Canyon in 2021" (see April 20, 2022 CDFW letter to State Water Board) appears to have been the impetus for this addition. The presence of steelhead in the canyon are not surprising considering the tolerance of steelhead for somewhat higher water temperatures (e.g., Sullivan et al. 2000; Spina 2007) than coho salmon.

The modelling results for steelhead rearing habitat availability are presented in Figure 50 (see below) of M&T (2014). In contrast to the coho salmon modelling results, the steelhead results certainly seem to suggest a clear upward trend in rearing habitat availability as streamflows increase from 30 cfs to 50 cfs to 70 cfs and beyond. However, a review of the habitat suitability criteria presented in Table 10 show that M&T (2014) applied a velocity suitability range of 0.6-2.6 ft/s to their 2-D model. The ability of steelhead to utilize habitat with higher velocities than coho salmon has been widely documented (e.g., Bisson et al. 1988). However, I do not agree with M&T (2014) setting the minimum velocity for suitable steelhead habitat at 0.6 ft/s in place of the 0.0 ft/s minimum used for coho salmon. For steelhead, Table 10 includes a note stating that the authors "increased lower velocity criterion to target larger juveniles and pre-smolts", but this modelling approach decision (1) highlights the problem with relying on the winter rearing modelling results (when age 0+ juveniles would not be expected to be present in the canyon) for assessing rearing habitat availability in summer (when that age class would be as likely to occur in the canyon reach as older juveniles), and (2) is not supported by CDFW's own research.

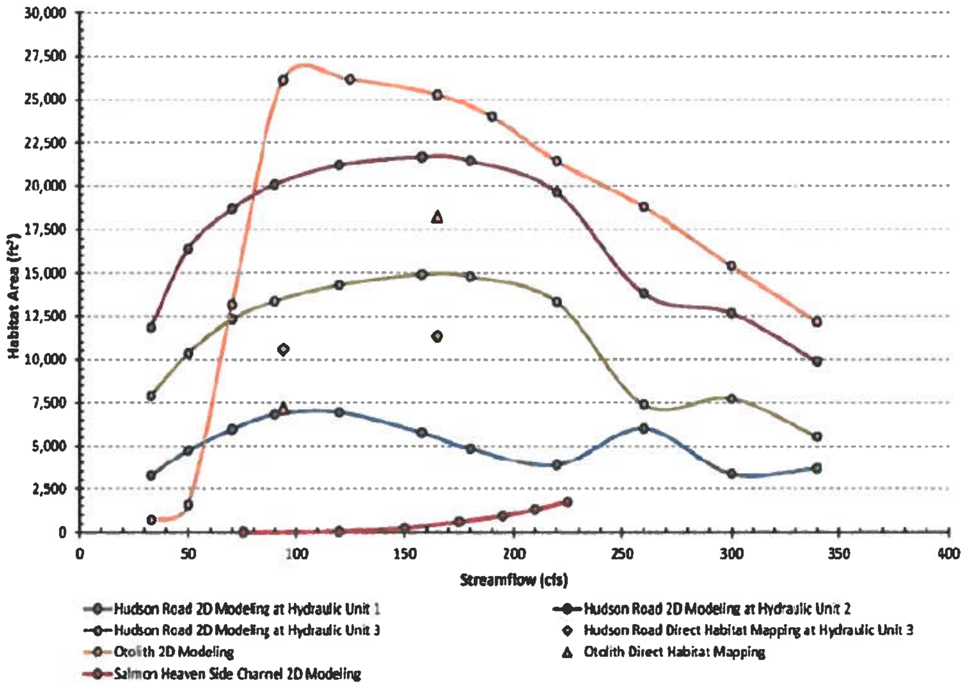

Figure 50. 2-D model predictions of steelhead juvenile habitat rating curves with total measured DHM juvenile steelhead habitat at 95 cfs and 165 cfs.

CDFW conducted an extensive instream flow needs assessment for the Big Sur River in Monterey County.[1] As part of the study, Holmes et al. (2014) collected microhabitat utilization data to develop habitat suitability criteria for juvenile steelhead and found that (1) habitat selection changed with fish size, season, discharge, and habitat availability; and (2) water depth and water velocity were of primary importance in habitat selection for all size groups of rearing steelhead. Specifically, CDFW found that

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[1] Technical reports pertaining to the study are available at https://wildlife.ca.gov/Conservation/Watersheds/Instream-Flow/Studies/Big-Sur-Study

steelhead in the size range of 10-15 cm (i.e., the "larger juveniles and pre-smolts" for which M&T [2014] increased the velocity suitability range) selected habitats with velocities ranging from 0.06-5.25 ft/s (average 1.47 ft/s) in summer and 0.0-5.36 ft/s (average 1.27 ft/s) in fall. In fact, a review of the frequency distribution for average water velocities used by 10-15 cm juvenile steelhead in summer (see Figure 45 in Holmes et al., 2014) reveals far more frequent utilization of habitats in the low (0.0-0.6 ft/s) velocity range excluded by M&T (2014) than at the upper end (2.0-2.6 ft/s) of the range include in the M&T (2014) analysis. Based on Big Sur River findings, Holmes et al. (2014) assigned habitat suitability criteria scores for larger (10-15 cm) steelhead at 0.48-0.90 for the velocity range of 0.0-0.59 ft/s that was excluded from the M&T (2014) analysis, reflecting the moderate to high suitability of those velocities for rearing.

Clearly, the M&T (2014) decision to exclude age 0+ steelhead from their habitat availability analysis and to deem velocities less than 0.6 ft/s as unsuitable for larger juvenile steelhead introduced a significant and unsupported bias into the development of the juvenile summer rearing IFN recommendations by selecting for higher streamflows. If velocities as low as 0.0 ft/s had been included in the steelhead suitability criteria, as they were for coho salmon by M&T (2014) and for steelhead by Holmes et al. (2014), the low flow range of the steelhead habitat rating curves presented in Figure 50 would be comparable to those presented for coho salmon in Figure 49 with streamflow of approximately 30 cfs revealing peak or near-peak habitat availability.

Summary

M&T (2014) note in Section 7.5 of the report that the primary analytical data used to develop summer rearing IFN recommendations consisted of the Null et al. (2010) findings, water temperature monitoring and analysis, and 2-D modelling of physical juvenile habitat availability. As discussed above, none of these data offer strong support for their recommendations. Null et al. (2010) suggest that even at an unimpeded streamflow of 150 cfs (i.e., three times higher than the dry water year recommendation proposed as a curtailment target), water temperatures would likely be unsuitable for coho salmon and stressful for steelhead. The analysis of water temperature monitoring data is not sufficiently granular to differentiate between low flow water temperatures during different parts of the summer season, as evidenced by the wide range of temperatures (67-85°F) recorded at streamflows of less than 30 cfs, and suggests increasing temperatures in the Salmon Heaven Side Channel with increasing flows in the main channel. Lastly, 2-D modelling revealed peak rearing habitat availability for coho salmon at approximately 30 cfs and would very likely indicate similar results for juvenile steelhead if a more accurate velocity suitability range had been applied to the model for that species.

Based on my review of the best available information cited by CDFW in its curtailment target flow recommendations, a Shasta Canyon summer streamflow of approximately 30 cfs would provide abundant rearing habitat for any juvenile steelhead that may utilize this reach during the summer and would thus more than adequately meet an "emergency minimum level of protection" standard for severe drought years. A lower inflow of warm water to the canyon would also help to protect the thermal refugia (e.g., stratified pools and/or spring/hyporheic inputs) in which steelhead were observed in 2021. To put this recommendation in context, it bears noting that in a July 29, 2021 letter to the State Water Board, CDFW noted it had observed juvenile steelhead rearing in deep pools during a July 26, 2021 snorkel survey of the canyon. Note that this survey preceded the implementation of curtailments and flows at the Yreka gage ranged between 16.7 cfs at night and 13.4 cfs in late afternoon on the day of the survey. Flows during the preceding month were generally hovered slightly below 20 cfs.

Late Winter/Early Spring Juvenile Rearing

M&T (2014) provide separate IFN recommendations for a "Fry and Juvenile Salmonid Winter Rearing" period (January 1 – March 31) and a "Juvenile Salmonid Growth and Smolt Outmigration, Snowmelt Streamflows" period (April 1 – June 30). The IFNs for the latter period are further separated into monthly IFNs for April, May, and June. While M&T (2014) applied a variety of methods and justifications in their instream flow needs assessment for these two life-stage periods, the analyses fall into two broad categories: (1) promoting productive habitat for growth by maximizing benthic macroinvertebrate (BMI) habitat, including with "bench inundation"; and (2) rearing habitat availability. Although my review of the M&T (2014) the IFN methods and conclusions raised a number of concerns, these are not discussed in detail here since the CDFW curtailment target flows for March (125-105 cfs) and April (70 cfs) are considerably lower than the excessive IFN recommendations provided by M&T (2014). A detailed analysis of the IFNs can be provided upon request.

Assuming CDFW and the State Water Board agree that it is reasonable to eliminate bench inundation and peak BMI productivity objectives from discussions regarding "emergency minimum level of protection" flows, the primary metric to focus on should be juvenile rearing habitat availability. As discussed above, juvenile coho salmon rearing habitat at the study sites is highest at 30 cfs and the same would be expected to be true for juvenile steelhead if a more scientifically justifiable velocity suitability range had been applied to the 2-D model. In addition, M&T (2014, p. 98) found Chinook fry rearing habitat availability to be greatest at 33 cfs. Juvenile (i.e., larger than fry) Chinook habitat peaked at approximately 90 cfs at the three Hudson Road sites and began to peak at the Otolith site at approximately 125 cfs. Note however, that M&T (2014) used a depth suitability range of 1.2-4.8 ft for juvenile Chinook (see Table 10 above). This range is based on depths with a suitability score of 0.5 or higher derived from Hardin et al. (2005). However, a review of Hardin et al. (2005) reveals that (1) depths of as little as 0.6 ft were being utilized by juvenile Chinook salmon, and (2) the majority of focal point depths observation (i.e., depth of fish position from the surface of water column) were made below 1.2 ft, suggesting that the total depth below the fish may not be as important a factor in habitat selection. Applying an excessively high depth suitability range, and more importantly discrediting all habitat outside of that range as unsuitable, creates the same bias toward higher flows as the excessive velocity range used for steelhead discussed above. Therefore, expanding the minimum juvenile Chinook salmon depth suitability to 0.8 ft (the same as used for juvenile coho salmon and steelhead) in the 2-D model would have resulted in significantly higher rearing habitat availability at lower flows.

Viewed cumulatively, late winter/early spring rearing habitat availability for juvenile coho salmon, juvenile steelhead, and Chinook fry and juveniles would be more abundant at flows lower than the CDFW recommendations for late March (105 cfs) and April (70 cfs). Flow targets of approximately 125 cfs through March 24 of 125 cfs (as proposed by CDFW), followed by 70 cfs for the remainder of March and 50 cfs in April would provide abundant rearing habitat while maintaining flows high enough to support smolt outmigration. Spring pulse flow releases from Dwinnell Reservoir would provide additional outmigration cues.

Alternative Management

As recognized by most biologists familiar with salmonid habitat utilization in the Shasta River, the upper portion of the watershed, including the reach below Dwinnell Reservoir, Parks Creek, and Big Springs Creek provide the most suitable and productive over-summering habitat for juveniles due to its cool, nutrient-rich water sources. It is these areas, not the Shasta River Canyon, where most fish are successfully rearing during the summer. The protection of instream flows in general, but cold-water inflows in particular, in this area would therefore ensure the greatest level of success in protecting salmonids from the adverse effects of severe drought conditions. The current focus of the emergency regulation's flow thresholds measured at the Yreka USGS gage do not accomplish that. Under the current (and proposed for re-adoption) regulation, the watershed is considered in compliance so long as the Yreka gage reads 50 cfs, regardless of how, when, and where water is diverted upstream of that gage. This approach is not only burdensome for landowners and diverters but fails to protect the fisheries resources the regulation is intended to protect.

The emergency regulation provides for the development of alternative means of reducing water use to meet or preserve drought emergency minimum flows, or to provide other fishery benefits (e.g., as cold-water refugia), in lieu of curtailment. These include individual or tributary-wide Local Cooperative Solutions (LCS). The regulation states that the "Division of Water Rights and the Executive Director may coordinate with the California Department of Fish and Wildlife, National Marine Fisheries Service, ... and others in evaluating local cooperative solutions." My previous November 11, 2021 memorandum on the subject of Shasta River curtailment flows discusses instream flow and salmonid habitat management strategies that have already been developed for the upper Shasta River watershed in coordination with NMFS and CDFW, but continue to be disregarded in CDFW flow recommendations and State Water Board emergency drought regulation.

Under the *Conservation and Habitat Enhancement and Restoration Project* (CHERP), the Montague Water Conservation District developed flow strategies in close coordination with NMFS for five water year types (very dry, dry, normal, wet, very wet). In its Biological Opinion (BiOp) (WCR-2015-2609), NMFS concluded CHERP "will improve coho salmon numbers, reproduction, and distribution, as well as the conservation value of critical habitat". Under the *Template Safe Harbor Agreement for the Conservation of Coho Salmon the Shasta River* (Shasta SHA), developed over a six-year period in close coordination with NMFS and CDFW, landowners are implementing a wide range of water efficiency projects, riparian planting and fencing, and instream flow dedications for fish and wildlife to promote the conservation, enhancement of survival, and recovery of coho salmon. The NMFS Biological Opinion (WCRO-2020-02923) analyzing the effects of the issuance of the Enhancement of Survival Permits and SHA implementation states that "NMFS expects the net effects of the proposed action on the Shasta River population of SONCC coho salmon to be an overall improvement to population viability."

As also described in my previous memorandum, both of those programs include instream flow strategies that were informed by the results of a number of technical investigations. For example, a detailed water temperature model such as the one M&T (2014) recommend for the Shasta Canyon reach was actually developed for the Shasta SHA area to evaluate the benefits of various flow management strategies, including water exchanges in which diversions from warm water areas help protect important cold water refugia. An experimental flow study (AquaTerra Consulting, 2015) provided empirical evidence of

the significant water temperature benefits that can be achieved through implementation of SHA beneficial management activities and helped validate the temperature model. The SHA includes a comprehensive Flow Management Strategy (NMFS and Aquaterra 2020) developed by NMFS, CDFW, landowners and a Technical Advisory Committee (TAC). The Flow Management Strategy objectives are based on the biological requirements of coho salmon at each freshwater life stage but also considered the habitat and flow needs of Chinook salmon. The Flow Management Strategy is based on the results of the temperature model and experimental flow study, as well as M&T's own 2013 *Shasta River Big Springs Complex Interim Instream Flows Needs Assessment* and Shasta Canyon recommendations.

Some of the infrastructure changes needed to implement the full suite of Shasta SHA's beneficial management activities and flow strategies have not been constructed yet but opportunities to achieve some of the goals of the SHA/CHERP flows during critical drought periods exist. More importantly, the best available technical information to evaluate and support those strategies also exists. In other words, the basic structure and technical support for an effective LCS approach, developed in close coordination with NMFS and CDFW, are readily available for the Shasta River watershed upstream of Hwy A-12. I encourage the State Water Board and CDFW to use the extensive available information and work with SHA participants to develop either individual LCS' based on each landowner's SHA site plan or a tributary-wide LCS for the entire SHA program area in lieu of aiming to maintain a 50 cfs discharge of warm water to the Shasta River Canyon.

Conclusion and Recommendations

California is in the third consecutive year of severe drought conditions and in the midst of a "megadrought" that will likely present continued and increasing water management and fisheries protection challenges. A simplistic approach of "more water for fish is always better" will not address these challenges, neither for water rights holders nor for fish. As stated succinctly by Null et al. (2010): "This study shows the importance of focusing on the limitations of specific river systems, rather than systematically increasing instream flow as a one size fits all restoration approach."

It is widely understood that the Shasta River Canyon does not provide suitable summer rearing habitat for coho salmon and only marginal conditions for slightly more tolerant steelhead. Recognizing the need for maintaining summertime base flow in the canyon, data presented by M&T (2014), or corrected in the case of juvenile steelhead rearing habitat availability, provide sufficient scientific support for a 30 cfs "emergency minimum level of protection" target at the Yreka gage for the period of June through September 15.

The continued disregard of best available science and management strategies developed in coordination with NMFS and CDFW for the critically important upper watershed is perplexing and unjustifiable. Citing Null et al. (2010) again, "protecting cool spring-fed sources provides the most benefit for native salmon species from a broad range of restoration alternatives." Leveraging the available data and strategies to develop effective and viable Local Cooperative Solutions for the protection of summer juvenile rearing habitat should be the CDFW and the State Water Board's priority, not simply an option for landowners to develop on their own after they have already spent six years participating in the development of a federal Safe Harbor Agreement for this very purpose. As noted above, the infrastructure for full SHA implementation is not yet available, but opportunities for protecting cold water sources exist. In a July

29, 2021 letter to the State Water Board, CDFW cites a May 2021 event in which "landowners were meeting voluntary obligations identified in their mutually agreed upon Safe Harbor Agreement with NOAA while others were voluntarily reducing their diversion and/or supporting the flow staying in stream" as a "successful example of a temperature and flow relationship." I strongly recommend the State Water Board collaborate with CDFW, NMFS, and willing landowners to develop LCS's where cold-water habitats exist and implement the identified necessary projects to protect, expand, and enhance over-summering habitats at existing cold-water sources.

Focusing on Local Cooperative Solutions consistent with the goals and objectives of the SHA would protect juvenile salmonids through the summer, while reducing the Yreka gage flow target to 30 cfs would enable diverters lower in the watershed to exercise their rights and divert water that is, according to the best available science, largely unsuitable for juvenile rearing. Then, at the beginning of September, these lower watershed users could reduce or cease their diversions to allow canyon flows to ramp up to the CDFW-recommended 50 cfs prior to September 15 and to 75 cfs from September 16-30 to support the early fall Chinook migration period.

References

AquaTerra Consulting. 2015. Technical Memorandum: Upper Shasta Flow Experiment – July 2015. Prepared for: Amy Campbell, The Nature Conservancy. 11 pp.

Bisson, P. A., K. Sullivan, and J. L. Nielson. 1988b. Channel hydraulics, habitat use, and body form of juvenile coho salmon, steelhead, and cutthroat trout in streams. Transactions of the American Fisheries Society 117:262-273.

Hardin, T.S., R.T. Grost, M.B. Ward, G.E. Smith. 2005. Habitat Suitability Criteria for Anadromous Salmonids in the Klamath River, Iron gate Dam to Scott River, California. Department of Fish and Game Stream Evaluation Report 05-1. 73pp.

McBain and Trush, Inc. and Humboldt State University, Environmental Resources Engineering Department. 2013. Shasta River Big Springs Complex Interim Instream Flows Needs Assessment. Prepared for California Ocean Protection Council and California Department of Fish and Game. Arcata, CA. 140 pp.

McBain and Trush, Inc. and Humboldt State University, Environmental Resources Engineering Department. 2014. Shasta River Canyon Instream Flow Needs Assessment (Final Report). Prepared for: Ocean Protection Council and California Department of Fish and Game. Arcata, CA. 221 pp.

National Marine Fisheries Service (NMFS) and Aquaterra Consulting (Aquaterra). 2020. Shasta River Safe Harbor Agreement. Flow Management Strategy.

Sullivan, K., D. J. Martin, R. D. Cardwell, J. E. Toll, and S. Duke. 2000. An analysis of the effects of temperature on salmonids of the Pacific Northwest with implications for selecting temperature criteria. Sustainable Ecosystems Institute, Portland, OR. December 2000.

Spina, A. P. 2007. Thermal ecology of juvenile steelhead in a warm-water environment. Environmental Biology of Fishes 80:23–34