Recommendations for Averting Another Adult Salmonid Die-off

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Averting another adult salmonid die-off - A case for using an emergency allocation of Trinity River water, and possible scenarios to induce migration of Trinity River Fish through the lower Klamath River

BACKGROUND

Causative factors for the epizootics last fall of *Icthyopthiris multifilis* (ICH) and *Flavobacter columnare* (columnaris) and the resulting unprecedented large scale fish die-off in the lower Klamath River may have included a relatively large return of adult fish compared to recent years, and potential behavioral or physical migration barriers that resulted in high densities of adult fish in the lower river. These pathogens are transmitted to fish through the water column. Crowded conditions have been implicated in epizootic outbreaks of these pathogens in hatcheries, aquaria, fish culture operations, and in river systems. Water temperatures near 20-21º C like those measured last year are typical in the Klamath River in late summer. These temperatures may behaviorally inhibit migration (EPA 2002), are conducive for ICH and columnaris, and can induce physiological stress that reduces a fish's immunological defenses.

Conditions similar to those that existed in the lower Klamath prior to and during the die-off are likely to occur again this summer. Recent water supply forecasts for the Klamath Basin predict dry conditions similar to those experienced last year. In addition, the preliminary fall chinook run-size projections for the Klamath Basin are expected to be close to last year's run size (D. Hillemeier , Yurok Tribe, pers. comm..). These conditions, in combination, may cause high densities of physiologically stressed fish to be exposed to conditions favorable for an ICH or columnaris outbreak.

Many of the fish that will return to spawn this year are cohorts of the same broods affected by last year's fish die-off. Chinook that spawn in the Klamath Basin are mainly comprised of three year old fish and progressively smaller fractions of four and five year old fish. Maximizing survival of all age classes of returning salmon for this year's run is especially important to avoid two consecutive years of significant loss of the population and will help stabilize Klamath and Trinity basin salmonid populations. Successful spawning of the four and five year old components of this year's run is important for the longer term success of the brood years most affected by last year's die-off.

A pro-active approach is required to avoid conditions that could result in another fish die-off. The diseases implicated in last years die-off can be rapidly transmitted and are ubiquitous in the system necessitating a management plan that is orchestrated well in advance of conditions that result in fish die-offs. Some triggering mechanisms selected to activate a response to relieve hazardous conditions are proposed

RECOMMENDATION

Two of the potential causative factors for last year's fish kill, run-size and migration inhibition, lead to high densities of adult fish that increased physiological stress, reduced immunological-defense, and increased the likelihood of successful transmission of the disease vectors. This year, under potentially similar circumstances, providing additional Trinity River water above normal water year flows may reduce fish densities in the lower Klamath and draw Trinity fish out of the Klamath and into the Trinity River. This would be done by eliciting a movement response through the "migration cue" offered by increased flow, and may relieve the physical

and/or behavioral migration barriers that contributed to the high densities of fish observed last year. In sufficient quantity, the cooler Trinity River water will also slightly reduce water temperatures of the lower Klamath, thereby decreasing physiological stress on the fish and reducing their susceptibility to ICH and columnaris. The additional water volume will also serve to dilute the infectious forms of these pathogens and reduce their likelihood of encountering fish to infect.

The primary approach recommended focuses on the goal of preventing high densities of adult salmon from occurring in the lower Klamath River. Mid-August to mid September was chosen as the target period to consider management options for density reduction. These target dates are based on historical run timing of fall-run Chinook salmon as determined by the Yurok Tribal harvest monitoring, CDFG estuary beach seining activities, Trinity River weir operations, and the period when fish densities of last year contributed to rapid infection and spread of ICH and columnaris. Mid September was chosen as the end date to avoid dewatering of spring chinook redds at Lewiston that may be constructed at higher flows only to become dewatered when flow is reduced to base levels. Flows of the magnitude being considered in these options take about one and a half to two days to travel from Lewiston Dam to the lower Klamath. Pulse flow timing of all the scenarios developed coincides with the timing of the Hoopa Valley Tribal dance flow tentatively scheduled for September 2.

Scenario One - Sustained Flow:

Summary points:

- Ramps Lewiston discharge up to a sustained 1,500 cfs for the entire critical period August 15 to September 15
- This scenario will have the largest effect on lower Klamath River temperatures, perhaps as much as 1.0-1.5ºC or more depending on volume and temperature of Klamath River contribution
- Increases river stage about 0.6 ft at Terwer gage near the estuary
- May have some negative impact on early spring chinook redds in the Trinity River due to potential dewatering
- Largest volume scenario at 69,206 acre-feet

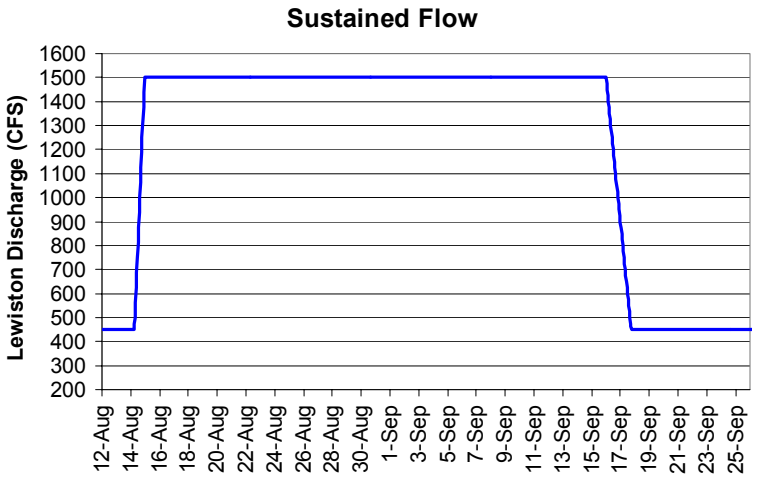

Figure 1. Scenario One - Sustained Flow. Flows would be increased at Lewiston Dam from 450 cfs summer baseflow to 1,500 cfs August 15 and maintained until September 15. Total additional volume over baseflow is 69,206 acre-feet.

This approach is intended to provide a sustained flow of cold Trinity water of sufficient quantity to significantly increase the stage and discharge of the lower Klamath, relieve potential migration barriers and encourage Trinity River fish to migrate out of the lower Klamath and into the Trinity (Figure 1). The sheer volume of a sustained high flow release of cold Trinity River water from Trinity Dam will have a significant thermal mass and will reduce water temperatures in the lower Klamath. In late August 2001, a one-day pulse release of 1,600 cubic feet per second (cfs) from Lewiston Dam reduced temperatures about 1.5º C in the lower Trinity at its confluence to the Klamath. Temperature reduction would be expected to be even greater over a multi-day pulse release and could influence temperatures in the lower Klamath River a degree C or more under circumstances similar to last year. The effectiveness of temperature control in the lower Klamath River is largely dependent on the volume and temperature of the Klamath River at the point of mixing – the smaller the proportion the greater the effect.

Under this scenario, flows would begin ramping up August 14 from 450 cfs summer base flows to reach 1,500 cfs August 15. Flows would be held at 1,500 cfs through September 15 and ramp back down to 450 cfs by September 17. The descending limb should discourage early spawning spring chinook from constructing redds in zones at risk of dewatering. The 1,050 cfs net increase in Trinity River discharge would increase the stage in the lower Klamath roughly 0.6 feet at the Terwer Gage near the estuary. The total additional volume of water over baseflow required to implement this scenario is 69,206 acre-feet.

Scenario Two - Pulsed Flow

- Uses a number of significant pulses intended to periodically induce migration
- First pulses have two-day duration peaks to maximize the influence Trinity Water will have on the Klamath when temperatures conditions in the lower Klamath are highest
- Later one-day pulses to continue to induce migration as more fish enter the River over the critical period
- Lowest volume scenario at 39,857 acre-feet
- Pulse timing designed to coincide with pulse for tentatively scheduled Hoopa Valley Tribal dance

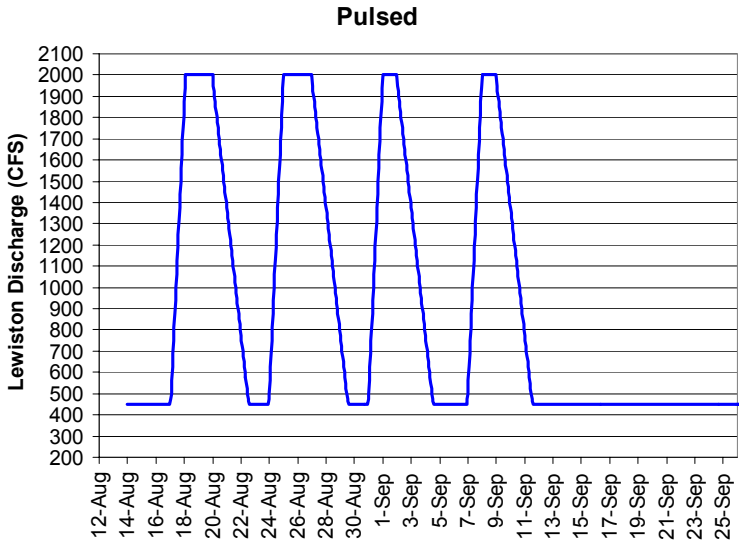

Figure 2. Scenario Two - Pulsed Flow. Flows would be periodically pulsed to 2,000 cfs at Lewiston Dam. The first two peaks would be of two-day duration each to maximize thermal benefits to the lower Klamath. The second two peaks would be of one-day duration each to minimize spring chinook risk. Total additional volume over baseflow is 39,857 acre-feet.

This approach is intended to periodically cue migration of Trinity River fish from potentially high density areas of the lower Klamath River over the immigration period with four significant pulses of Trinity River water (Figure 2.). These pulses would involve ramping up weekly from 450 cfs baseflow to 2,000 cfs at Lewiston Dam. The duration of peak flows would be two-days for the initial two peaks, and one day each for the latter two peaks. The two day pulses will provide greater temperature benefits to the lower Klamath early in the target period when temperature conditions are expected to be the most challenging. The shorter duration one-day pulses later in the period are an extra measure to minimize risk to early spawning spring chinook redds in the Trinity River.

Target dates for the 2,000 cfs peaks of the Pulsed scenario would be August 18-19, August 25-26, September 1, and September 8. The total additional volume of water over baseflow required to implement this scenario is 39,857 acre-feet.

Scenario Three - Hybrid Pulsed/Sustained (Recommended)

- This option is the recommendation of the biologists that developed these scenarios
- Adaptable combination of scenarios one and two
- First attempts to elicit migration response with two pulse flows of 2,000 cfs
- If the desired responses in fish movement are observed with pulse flows, continue to pulse through the critical period or until fish densities are relieved
- If pulses fail to elicit the desired response in fish migration, fall back to a longer sustained Lewiston discharge of 1,500 cfs from September 1 to September 17 to deliver a high volume of cooler Trinity water and effect greater temperature change on the lower Klamath
- Fall-back option may have some impact on early spring chinook redds in the Trinity River
- Requires real-time monitoring to determine effectiveness of first two pulses in order to determine the appropriate operation for the remainder of the critical period
- Pulse timing designed to coincide with pulse for tentatively scheduled Hoopa Valley Tribal dance

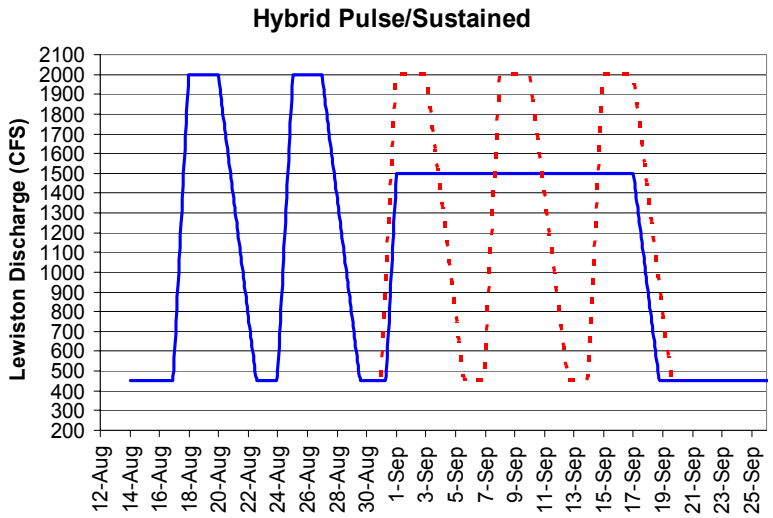

Figure 3. Scenario Three - Hybrid Pulse/Sustained. The first two pulses of 2,000 cfs would be similar under any option of this scenario. Additional pulses (red dashed line) could be used to continue to disperse adult fish that immigrate over the target period, or dropped in favor of a sustained release of 1,500 cfs if the pulses are ineffective and hazardous conditions persist in the lower Klamath River. The solid blue line represents the worst case scenario and would require the highest volume of water over baseflow at 59,096 acre-feet. If pulses are shown adequate to significantly move fish, pulses would continue throughout the target period or until conditions are no longer hazardous for disease epidemic.

This scenario is an adaptable combination of the two previous and is the preferred of the group that conceptualized these scenarios. It provides for two 2,000 cfs peaks early in the critical period, then an option to continue with similar pulses for the remainder of the period or to release a sustained block of water similar to Scenario 1 (Figure 3.). The option to continue similar pulses of flow for the remainder of the period would be selected *only* if the first two pulses are shown to be effective at dispersing fish and reducing densities. If the desired fish response to pulse flows is not observed, flows would be increased from base 450 cfs to 1,500 cfs for the remainder of the target period to attempt to alleviate challenging environmental conditions in the lower Klamath River.

The adaptability of this alternative is "water-conservative" in that it first tries two significant pulses to test their effectiveness to move fish, and commits to a larger volume of water through sustained release of 1,500 only if monitoring indicates that fish are not significantly dispersed by the first pulses. This scenario likewise provides a measure of safety for the fish because the strategy can change from pulsed to sustained releases in the event that pulses do not work. Effective implementation of this scenario will require more intensive monitoring than the other scenarios, but will also provide more insight into fish response to potential migration cues and future management options to avoid fish die-offs.

Under the Hybrid Pulsed scenario, target dates for the 2,000 cfs pulse flows (minimum of the first two) would be August 18-19, August 25-26, September 1-3, September 8-9, and September 15-16. If the sustained flow option was implemented, it would reach 1,500 cfs on September 1 and continue through September 17. This scenario would require a maximum of 59,096 acre feet over baseflow volume. If the pulse flows were shown to be effective, 34,805 to 57,976 acre feet would be required over baseflow volume, depending on how many additional peaks were necessary to alleviate densities of fish immigrating over the target period.

IMPLEMENTATION STRATEGY

A strategy is proposed to minimize the risk of another significant loss of Trinity stocks to a fish die-off. This approach focuses on density as a primary causative factor and takes proactive action to encourage migration of Trinity fish if marginal conditions suggest that another large run or migration bottleneck may result in high fish densities. We selected targets to trigger implementation of the preferred scenario based on the critical need to protect this year's returning fish in a year expected to be similar to last.

We propose the following or similar process occur for implementation of potential relief scenarios:

1. A Technical Group formed of biologists representing the U.S. Fish and Wildlife Service, Bureau of Reclamation, Trinity Restoration Program Office, NOAA Fisheries, the Yurok and Hoopa Valley Tribes, and California Department of Fish and Game meets in late August to assess the impending risk of the immigrating salmonid population to a fish die-off. Three triggering criteria will be evaluated. Any one of the following criteria will trigger implementation of the relief action:
    - Run size – a fall chinook run-size greater than or equal to the long term average
        - Prediction of an average or larger run size through stock projections or other appropriate measure would indicate that high fish densities are potential and should be considered a triggering element
    - River discharge – projected discharge for August less than 3,000 cfs at Terwer Gage (long term average low summer baseflow at Terwer is approximately 3,200)
        - Water conditions from Terwer and Klamath Basin tributary gages combined with August release schedules for Klamath and Trinity Rivers will be evaluated
    - Water temperature – 19ºC or greater average daily temperature in the lower Klamath in early August
        - Water temperature as monitored at an appropriate site in the lower Klamath River will be evaluated

- In future years, an evaluation of meteorological projections for August to September may also provide insight to expected conditions for the lower Klamath. Development of meteorological criteria as a triggering mechanism may be warranted for future use

2. If implementation of the relief action is triggered, the Group provides final review of the relief strategy scenarios and coordinates to monitor the response of the fish and environmental conditions of the Klamath and Trinity Rivers. Implement an adaptive management strategy that evaluates pulse flow(s) effectiveness at averting a large scale salmon die-off.

MONITORING COMPONENT

Fish migration and environmental conditions should be monitored closely to determine the effectiveness of any Scenario eventually implemented in reducing die-off risk to Trinity River fish in the lower Klamath. For example, under Scenario Three there is a decision point after the second pulse flow on how to proceed for the remainder of the critical period. This will require relatively intensive monitoring to determine the effects of first Trinity pulse flows, but may provide the most insight into the effectiveness of pulse flows and fish migration response, and help determine appropriate future management actions to avoid large scale fish die-offs.

Tagging of fall chinook in the estuary and lower Klamath River with radio or sonic tags should occur. Tracking efforts are already planned this year for spring chinook and green sturgeon which should reduce costs associated with monitoring for this event. To detect response of fall chinook to pulse flows, changes in stage, water temperature, etc., data collection activities would be significantly intensified to include diurnal periods immediately before, during, and after pulses of water transit through the lower Klamath River. In addition, other monitoring methods including hydro-acoustic counting stations, weir counts, and direct observation will be evaluated and utilized as appropriate. While these pulses are intended to protect Trinity River stocks that were especially impacted by last year's fish die off, they will likely collaterally benefit Klamath stocks as well. Removal of Trinity fish from the affected area will reduce densities for Klamath fish. Klamath fish should be monitored closely however to detect any potential negative impacts to those stocks.