1/30/2015

TO: David Murillo, Mid-Pacific Regional Director, USBR

FROM: Dr. Joshua Strange, Stillwater Sciences, josh@stillwatersci.com

RE: Comments on Draft Lower Klamath Long-Term Plan

I have reviewed the USBR's Draft "Long-Term Plan for Protecting Late Summer Adult Salmon in the Lower Klamath River" and provide my independent comments below. It is very encouraging to see the USBR moving forward with developing a long-term planning document that recognizes the importance of flows and proper flow management to protect fish health in the lower Klamath River. I applaud your leadership on these issues and your use of the best-available science as your agency strives to strike a balance between competing water demands that allows for productive irrigated agricultural without sacrificing salmon runs and associated dependent communities and economies. That being said, I have highlighted the following major areas from improvements in the plan in my comments below. While the Ich outbreak of 2014 was way too close to causing a fish kill for comfort, it provides important lessons to build upon moving forward. It will be important to take these lessons into account starting in 2015 as the unusual weather pattern responsible for the drought has returned, along with dissipation of El Nino conditions, after a promising start to the hydrologic water year. In addition, the leading hypothesis for the cause of this persistent storm-blocking high pressure weather pattern is related to global warming and has the potential to persist into the future (i.e., shifts to the amplitude of the jet stream's wave-lengths due to decreasing thermal gradient from the equator to the North Pole with more rapid heating of the artic compared to the equator with global warming). Please feel free to contact me, or have your staff contact me, if I can be of any further assistance.

1. One of the lessons from the Ich outbreak of 2014, is the need to buffer flows more in the face of severe, on-going drought and run-size uncertainty by increasing the minimum flow target to 2,800 to 3,200 cfs (as opposed to 2,500 to 2,800 cfs) during the fall Chinook salmon run and to explore periodic summer pulsed flows to help keep background levels of Ich low prior to the arrival of the fall run. Brief but sufficiently large pulsed flows in the summer would help by preventing late-spring and summer run Chinook salmon from being stuck in the lower Klamath River in thermal refugia during periods of water temperatures in excess of their upper thermal limits to migration (mean daily temperatures > 22°C; Strange 2010) and by helping to flush out any accumulating Ich parasites. The poor river conditions and Ich infections during the late spring/summer appeared to be a contributing factor to the Ich fish kill in 2002 and the Ich outbreak in 2014 (adult spring run Chinook salmon with light Ich infections were documented at TRH by CDFW with the infections almost certainly acquired while migrating in the lower Klamath River). In addition, the larger than predicted run-size of fall run Chinook salmon in 2014, and therefore lower than required minimum flows during the fall migration, also appeared to be an important contributing factor to the outbreak. Unfortunately, there is not enough certainty in the run size forecast projections to use these to confidently decide to release a lower flow target

with little to no margin for error for the flows. For example, if 2,800 cfs had been maintained in the lower Klamath River for the full 4 week target period, then the Ich outbreak may have been prevented without the need for the amount of water that was released. Again, preventing Ich outbreaks is more effective and water efficient than trying to interrupt an outbreak once it has started.

2. Another lesson of 2014 is the importance of colder, cleaner Trinity water relative to warmer and more polluted Klamath water. This is in part due to the effect of cooler water temperatures on Ich development rates, the importance of which may have been underestimated given its significance when dealing with exponential growth curves once an outbreak initiates (i.e., colder water temperature will decrease the slope of the parasite infection exponential growth curve for the population and within an individual fish, which could mean the difference between a mass mortality event or not). Related to this, I would not recommend releases of Klamath water, such as for the Yurok ceremonial flows, after Trinity releases have stopped or diminished. Rather, such flows should be scheduled to piggy back on the peak of Trinity releases. The water quality during the 2014 Yurok ceremonial release was some of the worst I have personally witnessed in the Klamath Rivers over the last decade (e.g., warm, very high microcystin levels, and exceptionally foul odor).
3. While flow releases are the indeed the only viable tool in the short-term, the long-term plan should discuss the most promising tool for the long-term, which is removal of the Klamath hydroelectric dams. Removal of Klamath hydroelectric dams as an action that is likely to have significant benefits to fish health in the lower Klamath River, including the risk of an Ich outbreak, by reducing potentially stressful toxic blue-green algae (*Microcystis aeruginosa*), concurrent infections with myxosporidian pathogens (*Ceratonva shasta*, *Parvicapsula minibicornis*), and adult salmon residence time in the lower Klamath River for Klamath stocks by removing the thermal lag on autumn cooling from these reservoirs (Bartholow et al. 2005) to re-create a decreasing longitudinal thermal profile as fall run Chinook salmon migrate up the Klamath River. This thermal lag is the leading hypothesis as to why Klamath fall stocks delay to such an unusual extent in the lower Klamath River (Strange 2012), which greatly increases the risk of a disease outbreak by increasing the exposure duration to such fish to any Ich parasites that are present. While higher flows will help to interfere with Ich's ability to find and infect fish and potentially flush parasites out to the ocean, it does not result in decreased residence time of fall run Chinook in the lower Klamath River (Strange 2012). The only promising way to do that is to remove the Klamath hydroelectric dams, resulting in restoration of a decreasing longitudinal thermal profile as fish migrate upstream, an outcome that can only be tested by dam removal. The reduced thermal lag in seasonal cooling would also decrease Ich development rates in any infected fish as they continued to migrate up the Klamath River. As such, the long-term plan should emphasize this hypothesis and state the importance of removing these dams on schedule without delay (i.e., 2020).
4. The plan should be broadened to encompass fish health considerations and protective measures in the lower Klamath River for all life-stages, times of year, and salmon species within an adaptive management framework.

5. The plan needs to be updated with more specific results and outcomes from 2014 as they become available (e.g., run size, infection and outbreak numbers, potential impacts, pre-spawn mortality rates, etc).
6. The plan would benefit need to for more enforceable/mandatory timelines and preventative criteria.

Literature Cited

Bartholow, JM, SG Campbell, and M Flug. 2005. Predicting the thermal effects of dam removal on the Klamath River. *Environmental Management* 34: 856–874.

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