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Sent: Tuesday, May 28, 2019 10:36 AM
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Cc: Evan Sawyer - NOAA Federal; Monica Gutierrez - NOAA Federal; Katherine Schmidt - NOAA Federal; Tom Holley
Subject: UCD Temperature Lit Review
Attachments: CWB Salmonid Thermal Review Paper.pdf

fyi, just received a copy of the UCD temperature literature review (attached). It concludes that Region 10 [EPA 2003] guidance should continue to be used in California, but it highlights emerging research indicating thermal plasticity, and future work needed, that can better refine Central Valley salmonid temperature thresholds. Excerpts below:

- In the absence of California-specific temperature guidance, Region 10 Guidance was recommended for use in California.

- For Central Valley Chinook salmon, the Region 10 recommended temperature for salmon/trout spawning, egg incubation, and fry emergence of 13 °C 7DADM will likely be effective as they are consistent with temperature thresholds currently applied by a biological opinion for winter-run Chinook on the Sacramento River (56 °F (13.3 °C) as a daily maximum between Balls Ferry and Bend Bridge (National Marine Fisheries Service 2009).

- Alevin of both Chinook salmon and steelhead trout will likely be protected by the Region 10 guidelines. Alevin of both species from northern populations appear be more thermally tolerant than eggs with thermal capacity exceeding temperatures prescribed for fry emergence by the Region 10 criteria. However, there is a lack of studies on the thermal performance of alevin from California and the Central Valley.

- Fall-run juvenile Chinook salmon from California appear to be thermally tolerant in excess of Region 10 recommended thresholds for core and non-core juvenile rearing of 16 °C or 18 °C 7DADM, respectively. However, there appears to be little work on the influence of temperature on growth rate or acute or chronic thermal limits associated with winter-, spring- or late fall-run Chinook. Given the sensitive state of the winter- and spring-runs as well as their extended residency in the Central Valley, understanding how temperature influences their growth and performance is essential to evaluating how Region 10 guidelines will affect them.

- The Region 10 guidance does not provide a specific smoltification threshold for Chinook salmon. This is cause for concern as Marine & Cech (2004) found that reduced smoltification success when Central Valley Chinook were reared at temperatures exceeding 17 °C. Furthermore, there is some evidence for considerable differences in smoltification thermo-regulatory behavior between seasonal runs amongst northern populations (Sauter et al. 2001). Research identifying thermal smoltification thresholds for spring- and winter-run salmon should be conducted to ensure that proposed management strategies will be protective.

- The Region 10 guideline for adult migrating salmonids is 20 °C 7DADM. There is little research on thermal barriers to migration for Central Valley salmonid populations and comparisons of work conducted on more northern populations imply potential for interpopulation variation. Management of

the adult life-stage of Chinook salmon is further complicated by the presence of four seasonal runs which migrate at different times throughout the year.

- For most life-stages and species for which thermal performance data exists, the Region 10 guidelines appear protective against temperature-induced mortality, but may be sub-optimal, either managing water too be warm or too cool. In both cases, exposure to sub-optimal temperatures can yield sub-lethal detrimental physiological and ecological effects (see Appendix: Thermal Performance Curves). Growth rates and predator avoidance rates can diminish, competitive dynamics can be skewed away from salmonids and diseases may change in virulence. Given the context of the Central Valley and predicted climatic changes, understanding of sub- or indirectly lethal effects of managed thermal regimes is important to properly conserving California's salmonids.