Effects of flow cessation on stream physicochemistry and Columbia River redband trout (*Oncorhynchus mykiss gairdneri)* condition in an ephemeral stream

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Introduction:

The Columbia River redband trout (*Oncorhynchus mykiss gairdneri*) is native to the Columbia River Basin east of the Cascades and below barrier falls (e.g. Shoshone Falls, Idaho) (Behnke, 1992). Like many salmonids, Columbia redband trout are threatened by introgression with hatchery stocks. Dry Creek (Figure 1), however, is the only stream along the Boise front known to support genetically pure redband trout (Richins and Walser, in preparation).

Dry Creek is an IRES (intermittent river and ephemeral stream) system, and as such, exhibits large seasonal fluctuations in stream flow (Figure 2). IRES systems are the most common water bodies in many parts of the world (Datry et al. 2017). Interestingly, far less research has been done on these systems than perennial waterways. Furthermore, climate change scenarios for semi-arid western North America predict longer and drier summers with decreases in mean annual stream flow (Seager et al. 2013). Changes in stream physicochemistry resulting from flow decline can be extremely stressful to aquatic organisms (Datry et al. 2017). This study set out to examine the potential effects of flow decline on stream physicochemistry and the subsequent effects on Columbia River redband trout.

Research Objective:

To investigate the impact of flow cessation on stream physicochemistry (dissolved oxygen and temperature) and Columbia River redband trout (*Oncorhynchus mykiss gairdneri*) condition.

Materials and Methods:

- 10 reaches of Dry Creek were chosen for study during June-September 2019 (Figure 1).
- Current velocity was measured weekly at 60% of depth using a Swoffer Model 2100 current velocity meter.
- HOBO U26 dissolved oxygen (DO) and HOBO Pendant temperature loggers were deployed in the deepest pool in each study reach.
- Fish were collected using a Smith-Root Model 12 backpack electrofisher on four separate occasions for each study reach.
- Total length (TL-mm) and weight (g) of each fish was measured with a fish measuring board and OHAUS model SPX8200 scale, respectively, during each sampling event.
- Fish were PIT tagged upon initial capture.
- Condition Factor (K) was determined for each fish using the Fulton equation (Froese, 2006).
- Statistical analyses were performed using SigmaPlot v13.0.

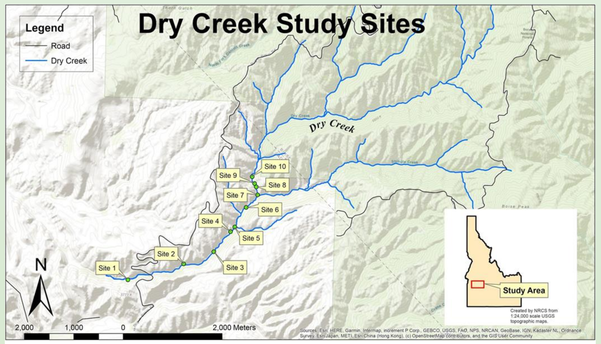

Figure 1. *Location of Dry Creek study sites. Dry Creek experiences drying every summer--beginning in the downstream reaches. The headwaters of Dry Creek remain perennial. Study sites span a distance of about 5-km.*

Figure 2. *Flow cessation in Dry Creek. These photographs were taken at the same location in June (left) and August (right).*

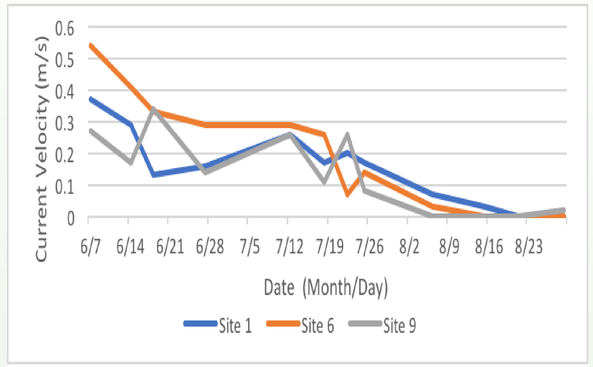

Figure 3. *Dry Creek current velocity (m/s) at sites 1, 6, and 9 from June through August 2019. The changes in current velocity are significantly different ($p<0.05$) from month to month across all sites.*

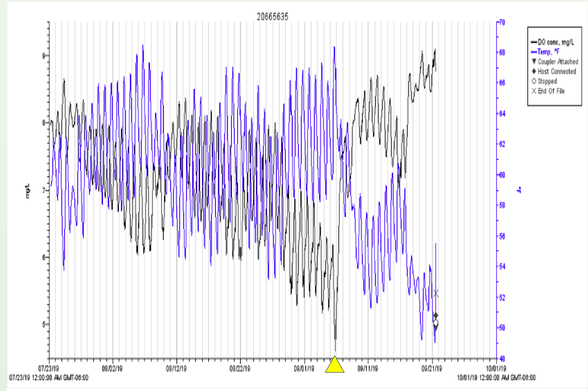

Figure 4b. *Site 6 dissolved oxygen and temperature profile.*

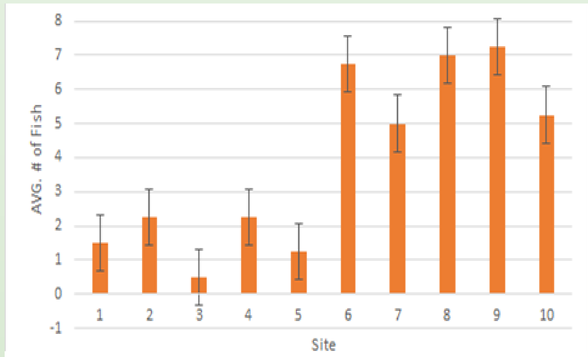

Figure 5. *This barchart shows the average number of redband trout across all sites over the study period. Abundance estimates were calculated using the 3-pass removal method, according to Ogle & Wheeler.*

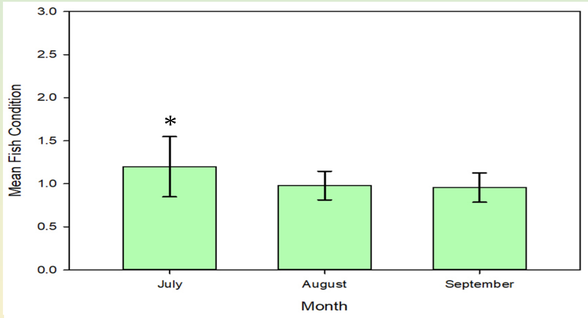

Figure 7. *This bar chart shows the difference in average redband trout condition (K, condition factor) in Dry Creek over the study period. Fish condition in July was significantly better than in August and September.*

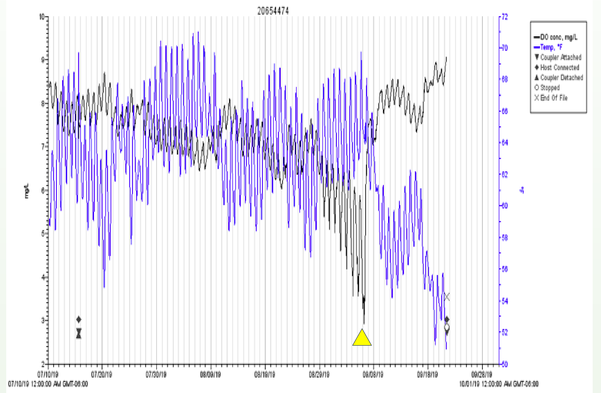

Figure 4a. *Site 1 dissolved oxygen and temperature profile.*

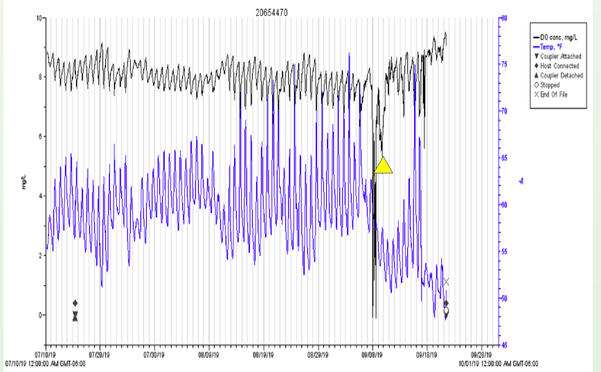

Figure 4c. *Site 9 dissolved oxygen and temperature profile.*

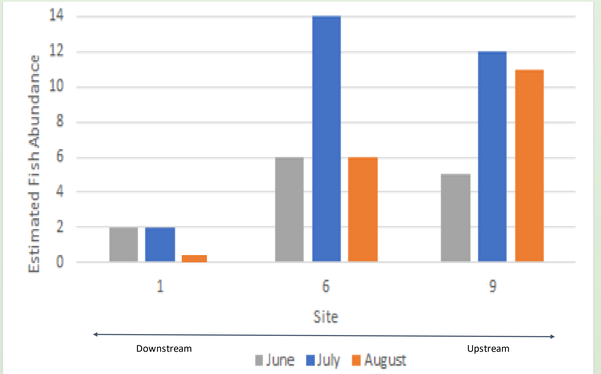

Figure 6. *This grouped bar chart shows the difference in estimated redband trout abundance across space and time in Dry Creek.*

Columbia River redband trout in Dry Creek.

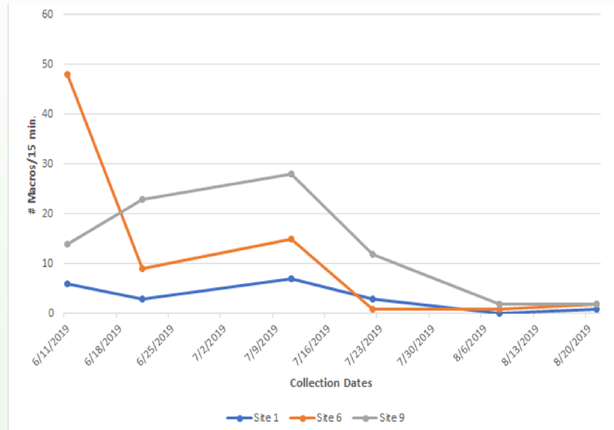

Figure 8. *Macroinvertebrate drift density over study period, at sites 1, 6, and 9, collected weekly.*

Study Conclusions:

- Current velocity decreased across all sites during the study period with Site 1 experiencing complete flow cessation. (Figure 3)
- Mean daily water temperatures increased during the summer across all sites but were within an acceptable range for redband trout. (Figure 4)
- The most downstream pool experienced the lowest dissolved oxygen (3 mg/l) upon flow cessation. (Figure 4a)
- Redband trout were able to persist in pools with dissolved oxygen levels below 6 mg/l for at least 9 days. (Figures 4a and 4b)
- Redband trout were more abundant in upstream than downstream reaches. (Figures 5 and 6)
- Redband trout captured early in the study were in significantly better overall health than those caught later. (Figure 7)
- We attribute the drop in redband trout condition over the summer, in part, to decreased oxygen levels brought about by reduced stream flows and higher water temperatures, as well as decreased food availability.
- With climate change, we expect stream physicochemical conditions to become more stressful for redband trout in Dry Creek.

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