

Proposal for Detailed Analysis and Report on Water Temperature Data Collected in July-August 2018 from Colorado's Dolores River Basin

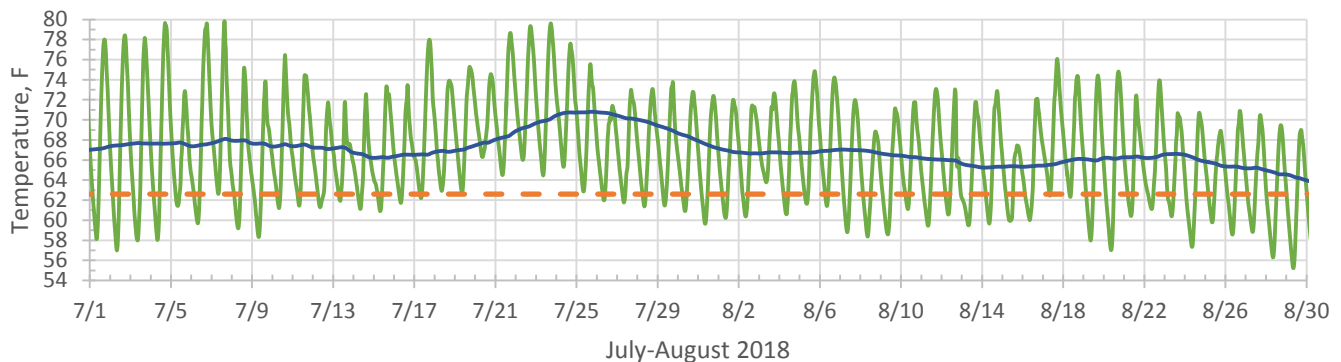
Introduction

Due to rising air temperatures, water temperatures in rivers and streams are increasing, too. This is a problem for trout populations, which rely on cold water for habitat. In general, we expect water temperatures to be colder as elevation increases. Therefore, we would expect trout to migrate upstream as downstream temperatures rise, that is, to move further up a river's main stem and into tributaries. Typically, there are many more miles of tributaries than total length of main stem. This makes tributaries a critical part of the notion of upstream thermal relief for trout. Tributaries are shallow, however, as compared with most of main stem flow. Being shallow may mean they are more susceptible to heating as air temperatures rise, which may worsen with increasing elevation as flow diminishes. On the other hand, groundwater input may keep tributaries cold enough. The problem, instead, may be decreasing access to tributaries. That is, as trout move upstream for habitat in a generally warming main stem, fewer tributaries will remain available to them as "off ramps" for seeking thermal relief during particularly stressful heating conditions, for example, July-August.

Two key questions result: (1) Do temperature versus elevation relationships indicate that tributaries can provide thermal relief for trout? (2) If so, how much tributary access will remain as main stem temperatures rise?

Background

Water temperature measurements were made at five elevations from 7000 to 9500 ft in the Dolores River over the warm-weather period of 2018. Temperatures at 7000 ft were found to exceed the Colorado (CO) chronic criterion for trout habitat, as shown below:



The CO chronic criterion, 62.6 F, is indicated by the dashed (orange) line. The daily temperatures are the jagged (green) line. The rolling, weekly (7-day) average water temperatures are the smoother (blue) line. *Rolling* refers to averages that are calculated again after moving ahead one day. Colorado instructs that the chronic criterion be compared with the *maximum weekly average temperature* (MWAT). The figure shows that the criterion was exceeded by the maximum and *all other* weekly average temperatures over July-August at the 7000-ft elevation.

Water temperature measurements also were made at 16 locations, from 7,800 to 10,600 ft, in eight tributaries of the Dolores River over that warm-weather period of 2018.

Partners and Previous Funding

Dryland Solutions LLC (DS) was a partner and a primary author in the initial study that produced the 2017 document *Climate Change and the Upper Dolores Watershed: A Coldwater-fisheries Adaptive Management Framework*. Funding and participating personnel were provided by Trout Unlimited (TU), the Colorado Water Conservation Board, and the Mountain Studies Institute. It was coordinated with the San Juan National Forest (SJNF) office of the U.S. Forest Service.

DS provided guidance and labor in 2018 in the placement of temperature sensors in the Dolores River basin, and then in the collection of data from 25 of those locations. This was coordinated with The Dolores River Chapter of TU (TU-DRA) and with SJNF, which contributed participating personnel and equipment.

Proposed Analysis

In response to the two questions posed above in the Introduction, DS proposes a detailed analysis in three tasks of the warm-weather data that were collected in 2018 from the main stem and eight tributaries.

Task 1. Regression analysis for determining threshold elevations

DS will apply regression analysis to plot the continuous relationship of July-August 2018 water temperatures versus elevation for (a) Dolores River and (b) Priest Creek. Each have data from three or more elevation locations. Four plots will be generated. Two will show the relationship of MWAT values to elevation for Dolores River and Priest Creek. Two more will show *daily maximum* (DM) versus elevation. For the first two, a horizontal line will be added for the CO chronic criterion, 62.6 F. For the other two, a line for the CO acute criterion, 71.1 F. The elevation where the criterion lines intersect the regression lines will be noted. They will indicate threshold elevations, above which there was cold-enough water for trout habitat during this warm-weather measurement period, based on comparison with the Colorado criteria.

The slopes of the regression lines will be compared for the river and its tributary, Priest Creek. Larger slopes will indicate a greater elevation effect on temperature.

Task 2. Consideration of other tributaries

DS will add data from seven Dolores River basin tributaries to each of the four regression plots. That would be MWAT values from those tributaries for the two MWAT versus elevation plots; and DM values for the two DM versus elevation plots. DS will note whether the tributary data tend to associate with either the Dolores River or the Priest Creek data. For example, do the tributaries, including Priest Creek, seem to have similar temperature-elevation responses. If so, DS will plot regression lines for the combined tributary data—one for MWAT values and a second for DM. The slopes of those additional lines will be noted and compared with slopes for the two Priest Creek regression lines—for MWAT and DM versus elevation. Similar slopes will tend to confirm similar water temperature-elevation relationships among the tributaries.

Task 3. Remaining drainage area

As water temperatures increase, threshold elevations for cold-enough water will rise. DS will use the regression analysis results from Task 1 to estimate the remaining drainage areas that can support cold-enough tributaries as temperatures rise. One-degree-F increases in water temperatures (as MWAT and DM) will be considered, up to a 5-F rise. The threshold elevation for each will be determined. For each of the 1-F increases, the drainage area of tributaries above the threshold will be calculated and summed. The totals will be shown for each of the five 1-F increases, and compared with the drainage area determined for the warm-weather 2018 data. The U.S. Geological Survey program StreamStats will be used to make the drainage area calculations.

Cost

DS proposes to perform the proposed work on a fixed price basis for the amount of \$5,000. There will be no additional charges for the work.

Schedule

DS proposes to complete the work, including submittal of a report, by the conclusion of 90 days from authorization to proceed.

Company

The company proposing the work is Dryland Solutions LLC, based in Mancos, CO. Raymond Rose is primary investigator, and contact. He has a PhD in Environmental Engineering. He also has degrees in Water Resources Development and Chemistry, and has more than 45 years of experience in environmental engineering consulting.

Support to the Goals and Measurable Outcomes of the Southwest (SW) Basin Roundtable and the Needs of the SW Basin Implementation Plan (BIP)

The proposed work is part of one of the ongoing Implementation Projects and Processes (IPPs) described in the BIP to “evaluate...aquatic habitat quality” in the Upper Dolores River sub-basin of the Southwest Basin. [BIP, p. 97] The sensor placements and the data collection were conducted in close coordination with The Dolores River Anglers (DRA) chapter of Trout Unlimited. The same collaboration pertains to the proposed detailed data analysis, which is “aimed at applying the best science to support...monitoring...on important tributary streams for native and wild trout.” [BIP, p. 90] Trout Unlimited is a “partner” in the Roundtable’s specific “plans to use partnerships” in IPPs that “help evaluate environmental...gaps.” [BIP, p. 105] The Roundtable has noted “key data gaps that need to be addressed.” [BIP, p. 105] They include (1) identifying the “conditions necessary to sustain environmental...values associated with specific reaches around the Southwest Basin,” and (2) determining how “to maintain the conditions.” [BIP, p. 106] The proposed work is part of a timely response to assist in meeting those data gap needs. It is consistent with the Roundtable’s “Measurable Outcome” that “at least 50% of sub-basins have existing or planned IPPs that are protective of...environmental...areas and watershed health.” [BIP, p. 108]

Reference: Basin Implementation Plan (BIP), Southwest Basin Roundtable, 2015, Ann Oliver and Carrie Lile, Harris Water Engineering, Inc.