WATER TEMPERATURE TRANSACTION TOOL (W3T)

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1. Introduction

The Water Temperature Transaction Tool (W3T) is an easy-to-use, interactive model for evaluating stream temperatures associated with flow transactions and alternative flow scenarios. Using site-specific data, the model creates a simulation of water temperatures that would result from implementation of potential flow transactions. The tool allows users to characterize existing conditions of a river reach and to quantitatively evaluate the potential water temperature benefit resulting from changes in flow magnitude, flow timing, water temperature, riparian and topographic shade, and location of inflows and diversions.

Table 1. W3T Attributes.

Attributes of W3T Application
• Quantification of Flow Augmentation
• Assists water Conservation Planning
• Allows for Comparisons of Water Management Strategies on Streamflow and Stream Temperature
• Assists with Optimization of Water Temperature Benefits from among Multiple Flow Scenarios
• Identification and Maximization of Cold-water Refugia and Reach Inputs
• Rapid Stream Reach Characterization (one season)

Model Development

The model requires site-specific data such as channel geometry, riparian vegetation and topographic shade information, meteorological data, water temperature and flow data, and locations of tributaries and diversions. The attributes of using the W3T model are displayed in Figure 1; data requirements are listed in Table 2.

Table 2. Data Requirements for the W3T model application.

Data Type	Specific Datasets	
Flow	Headwater inflow Tributary Inflows	Diversions Instream Flow Rates
Channel Geometry	Representative Cross Section Channel Slope	Manning Roughness, n
Water Temperature	Headwater and Tributary Instream (calibration)	
Meteorological	Air Temperature Cloudiness Wind	Relative Humidity Wet Bulb
Riparian Vegetation Shade	Height Density (Species)	
Topographic Shade	Elevation Angle	

Figure 1. Water Temperature Transaction Tool Application Locations

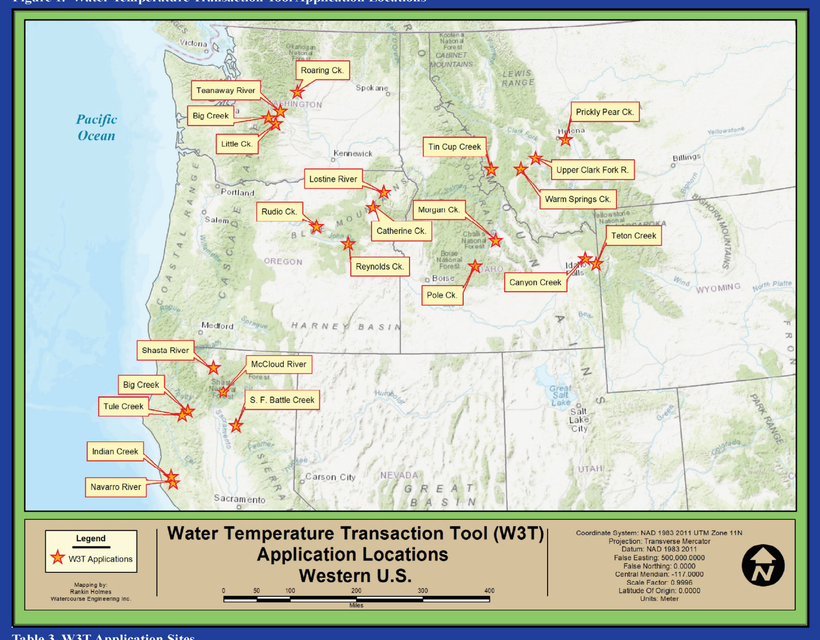


Table 3. W3T Application Sites.

State	Site	
California	-Shasta River -McCloud River -Navarro River	-Tule Creek -Indian Creek -Big Creek
Oregon	-Lostine River -Rudio Creek	-Catherine Creek
Washington	-Teanaway River -Big Creek	-Little Creek -Roaring Creek
Idaho	-Morgan Creek -Pole Creek	-Teton Creek -Canyon Creek
Montana	-Tin Cup Creek -Prickly Pear Creek- -Warm Spring Creek	-Upper Clark Fork Creek

A map of all locations where W3T applications have been applied around the Western US (Figure 1). Key of all rivers and creeks displayed on the map organized by water basin. The bold underlined location represents the application discussed in this poster (Table 2).

Fish species with critical habitat in Pole Creek, Idaho.

Pictures of Pole Creek, Idaho. Site of successful W3T application.

2. Model Application at Pole Creek, Idaho

The W3T model was utilized at Pole Creek, Idaho, to compare outcomes of increasing the later summer instream flows resulting from a series of minimum-flow agreements developed the Idaho Water Resources Board (IWRB), and supported by the Columbia Basin Water Transactions Program (CBWTP) since 2005. The resulting differences in water temperatures (Tw) informed the relative effectiveness of each scenario.

Project Background: During the late summer period of August 2001, irrigation water withdrawals created extremely low flow conditions in Pole Creek. Stream flow fell below 1.7 cubic feet per second (cfs) and stream temperatures rose to the mid-20's oC, making conditions uninhabitable for various ESA listed fish species (pictured above). Passage and migration through the lower 4.5 river miles (RM) were impossible. To improve stream flow and assist the fish species of interest, the IWRB developed an initial minimum-flow agreement with irrigators on the creek to maintain a minimum of 5 cfs instream during the irrigation / summer season (2005-2010). The minimum-flow agreement was increased to 6 cfs for 2011-2014. In 2015, a 12-18 cfs dry/wet year minimum-flow agreement was reached to enhance conditions instream for 2016 (Table 2).

The 4.6 RM reach of Pole Creek being examined, included three sites for continuous flow monitoring and cross-section measurements and one irrigation point of diversion (POD). Seven Onset Pro-V2 Tw loggers were placed throughout the reach to map and model the longitudinal Tw signal.

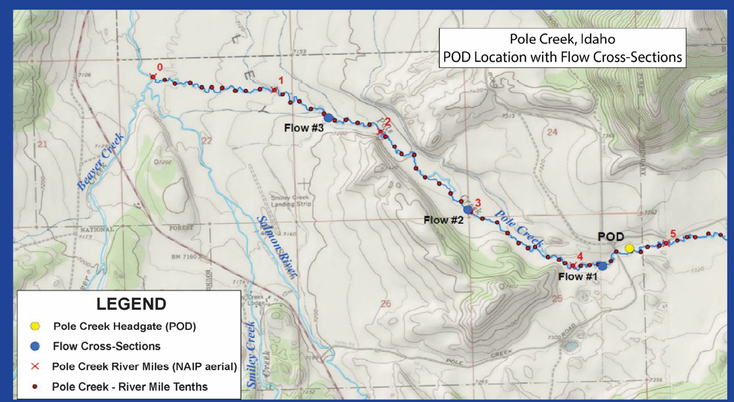


Figure 2. Pole Creek total reach (4.6 miles), point of diversion (POD), and flow cross-section locations."

3. Results

The W3T model was successfully applied to Pole Creek and multiple flow scenarios were analyzed to quantitatively estimate the benefit to instream temperatures resulting from each scenario. Calibration of the W3T model was completed by comparing measured conditions to those simulated by the model, resulting is a 0.59°C mean absolute error (Figure 4).

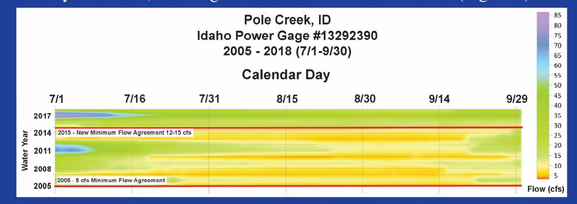


Figure 3. A Raster Hydrograph from Idaho Power Gauge #13292390 showing streamflow response from water transactions.

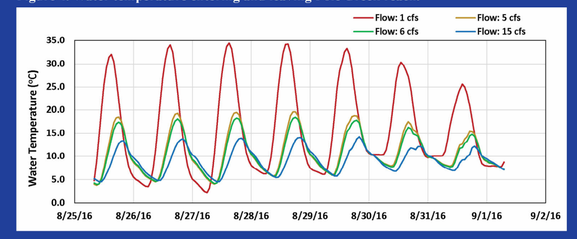
Table 4. Flow transaction scenarios modeled with W3T to assess water temperature impacts on Pole Creek.

Scenario	Date	Pre-Transaction Instream Flow at RM 4.5 (cfs)	Pre-Transaction 7-DADM* Temperature at Mouth (°C)	Post-Transaction Instream Flow at RM 4.5 (cfs)	Post-Transaction 7-DADM* Temperature a Mouth (°C)	Project Effect [Reduction] (°C)
(a)	(b)	(c)	(d)	(e)	(f)	(g)=(d)-(f)
1	2004	1.0	32.0	5.0	19.9	12.1
2	2010	5.0	19.9	6.0	17.7	1.2
3	2016	6.0	17.7	15.0	13.2	4.5

* 7-day average of the daily maximum (7DADM) temperature

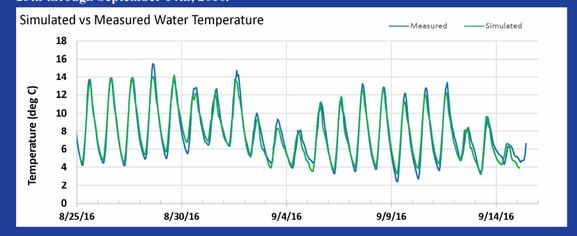
Each flow scenario is summarized in Table 4, which includes flow conditions pre and post transaction, year of transaction, location along reach, and overall effect on instream temperature.

Figure 4. Water temperature entering and leaving Pole Creek reach.



Baseline represents pre existing temperature and flow conditions. For scenario 1 pre transaction flow is 1cfs, post transaction flow is 5cfs. For scenario 2 pre transaction flow is 5cfs, post transaction flow is 6cfs. For scenario 3 pre transaction flow is 6cfs, post transaction flow is 15cfs.

Figure 5. Simulated vs. Measured water temperature in Pole Creek at RM 0.75 for AUgust 25th through September 14th, 2016.



Each flow scenario has its own representation, comparing flow temperature over time (Figure 5). From the year 2004 to 2016, the acquisition of greater flow in Pole Creek has resulted in cooler water temperatures and a more ideal habitat for fish species such as Bull Trout, Steelhead, and Chinook Salmon.

Acknowledgements

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