THE ROLE OF BEAVER IN SHAPING STEELHEAD TROUT HABITAT COMPLEXITY AND THERMAL REFUGIA IN A CENTRAL OREGON STREAM

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1. INTRODUCTION

The incised and degraded habitat of Bridge Creek, tributary to the John Day River in central Oregon, is thought to be limiting the local population of ESA-listed steelhead trout (*Oncorhynchus mykiss*). Restoration efforts for this watershed involve partnering with beaver to encourage dam building activity to aggrade an incised channel, promote floodplain reconnection, and overall improvement of in-channel and riparian habitat quality and complexity. The restoration efforts are part of the Integrated Status and Effectiveness Monitoring Program (ISEMP), a program with goals to test monitoring protocols and restoration strategies for ESA-listed salmonid species in the Columbia River Basin. The restoration strategy being tested in Bridge Creek involves the installation of over 100 beaver dam support (BDS) structures that are designed to either mimic beaver dams or support existing beaver dams.

Objective:
The overall objective of this study is to quantify the role that beaver play in shaping stream habitat complexity and stream temperature in selected sections of Bridge Creek.

While this project is currently in planning stage, the purpose of this presentation is to receive feedback from the audience on the project's design and overall scope.

2. BRIDGE CREEK STUDY SITE

Bridge Creek is a 710 km^2 watershed draining northwesterly into the lower John Day River in central Oregon. The Utah State University Ecogeomorphology & Topographic Analysis Lab collected topography and bathymetry data for the lower 30 km of Bridge Creek in 2009, 2010 and 2011. This data was collected using a combination of the following methods: rtkGPS, terrestrial laser scanner and total station. Aerial photography was collected using unmanned aerial vehicles in 2009 and 2010.

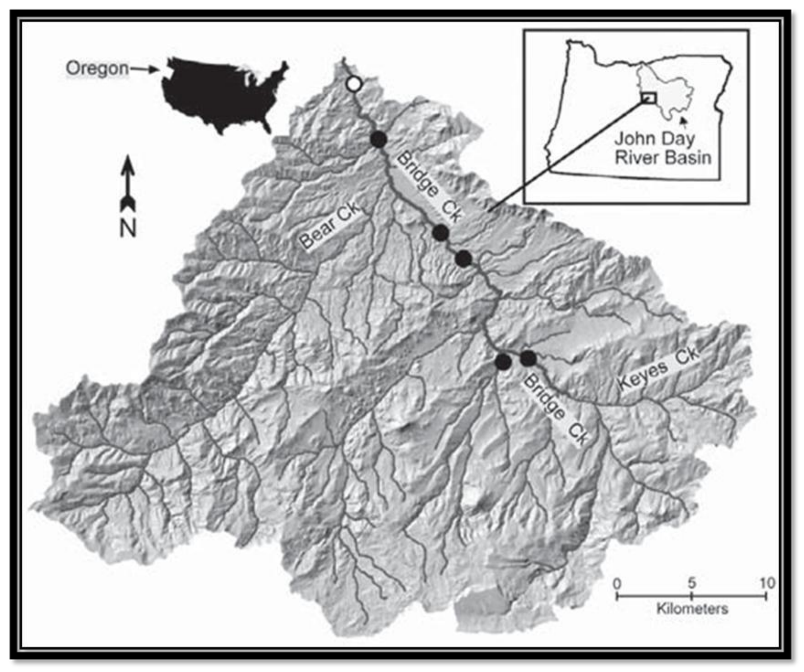


Figure 1: Bridge Creek Watershed in the John Day River basin, central Oregon.

3. HABITAT COMPLEXITY

We define habitat complexity in this study as habitat that contains structural components, a variety of physical dimensions of channels and substrates, hydraulic variation and variation in flow regime. This definition of habitat complexity from Kaufmann and Faustini (2011) was chosen because these characteristics directly relate to the degree to which thermal refugia is provided.

We will use methods outlined in the River Styles Framework (Brierley and Fryirs, 2005) to categorize geomorphic units. This tiered approach is an appropriate method for this study as it deconstructs river forms to a scale meaningful to fish. Level I and II geomorphic unit types are shown in the Table 1 below.

Table 1: Geomorphic Unit Classification Framework

Level 1 Geomorphic Units (columns); Level 2 Geomorphic Units (rows)

Sculpted, Erosional Geomorphic Unit	Midchannel Geomorphic Unit	Bank Attached Geomorphic Unit
Bedrock Step (waterfall)	Riffle and Pool	Lateral Bar (alternate or side bar)
Rapid	Longitudinal Bar (medial bar)	Scroll Bar
Cascade	Transverse Bar (linguoid bar)	Point Bar
Run (glide, plane-bed)	Diagonal Bar (diamond bar)	Tributary Confluence Bar (channel junction bar, eddy bar)
Forced Riffle	Expansion Bar	Ridge and Chute Channels (cross-bar channels)
Forced Pool	Island	Ramp (chute channel fill) and Point Dune
Plunge Pool	Boulder Mound	Bench and Point Bench (oblique-accretion bench)
Pothole	Bedrock Core Bar	Ledge
Beaver Dammed Pool	Sand Sheet	Boulder Berm (boulder bench)
	Gravel Sheet (basal or channel lag)	Concave Bank Bench (convex bar)
	Forced Midchannel Bar (pendant bar, wake bar, lee bar)	Compound Bank-Attached Bar
		Forced Bank-Attached Bar

4. PLANNED TOPOGRAPHIC ANALYSES

We have started working with the topographic and bathymetric data and are considering a variety of methods to analyze these data to show how the BDS structures may be impacting stream habitat complexity over time. One of these methods is explained below.

Vector Analysis
Using a combination of river bathymetry and water depth GIS layers, and aerial imagery, geomorphic units will be categorized. Each geomorphic unit will be drawn using the polygon editing tool in ArcGIS. An example of this is shown in Figure 3 below. This will allow for the comparison of how the number, size and type of geomorphic units have changed over time as a result of the restoration project.

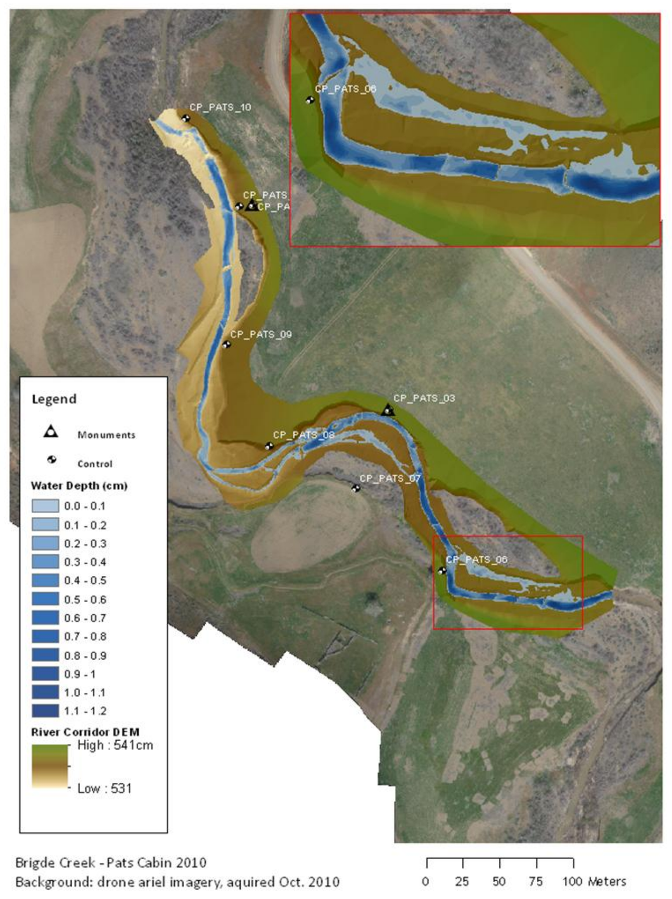


Figure 2: Digital elevation model and water depth raster derived from topographic data.

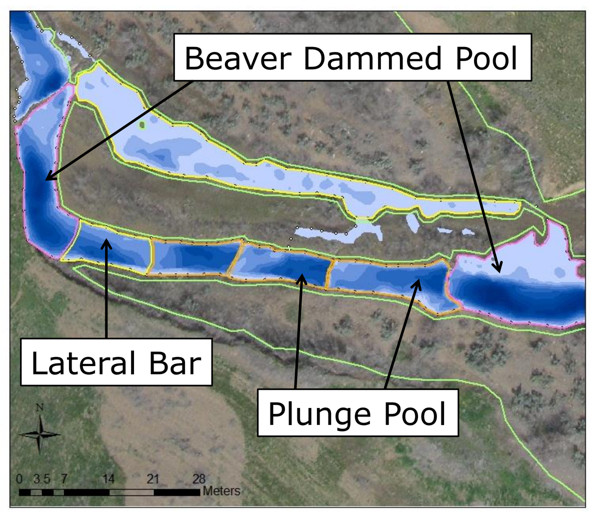


Figure 3: Water depth raster derived from topographic data and polygons drawn around geomorphic units.

5. PLANNED TEMPERATURE DATA COLLECTION

The literature has thoroughly documented that water temperature is the most important abiotic factor controlling fish growth and survival (ex: Bettinger and Fitzpatrick, 1979). Temperature data will be collected using a combination of Thermal Near Infrared (NIR) imagery and temperature sensors.

Thermal Near Infrared (NIR) Imagery
Thermal NIR imagery of lower Bridge Creek will be collected in summer 2012. This imagery will show the larger scale temperature patterns of the creek's water surface, at snapshots in time. Figure 4 shows results of the thermal NIR imagery that was collected at a dam location on Bridge Creek in 2003, prior to restoration implementation. Circled in green is the area downstream of the beaver dam containing cooler stream temperatures. We hypothesize that this cooler water is upwelled groundwater, caused by the downwelling of water at the beaver dam upstream. These temperatures were reduced by approximately 3°C on average, from 22.3°C to 19.4°C. This is important to the steelhead trout inhabiting Bridge Creek, as temperatures in lower Bridge Creek often exceed maximum temperature limits for juvenile steelhead trout, which can be seen in Figure 4. Hicks (2000) recommends that in order to fully protect rearing juvenile steelhead, stream temperatures should be 16°C to 17°C.

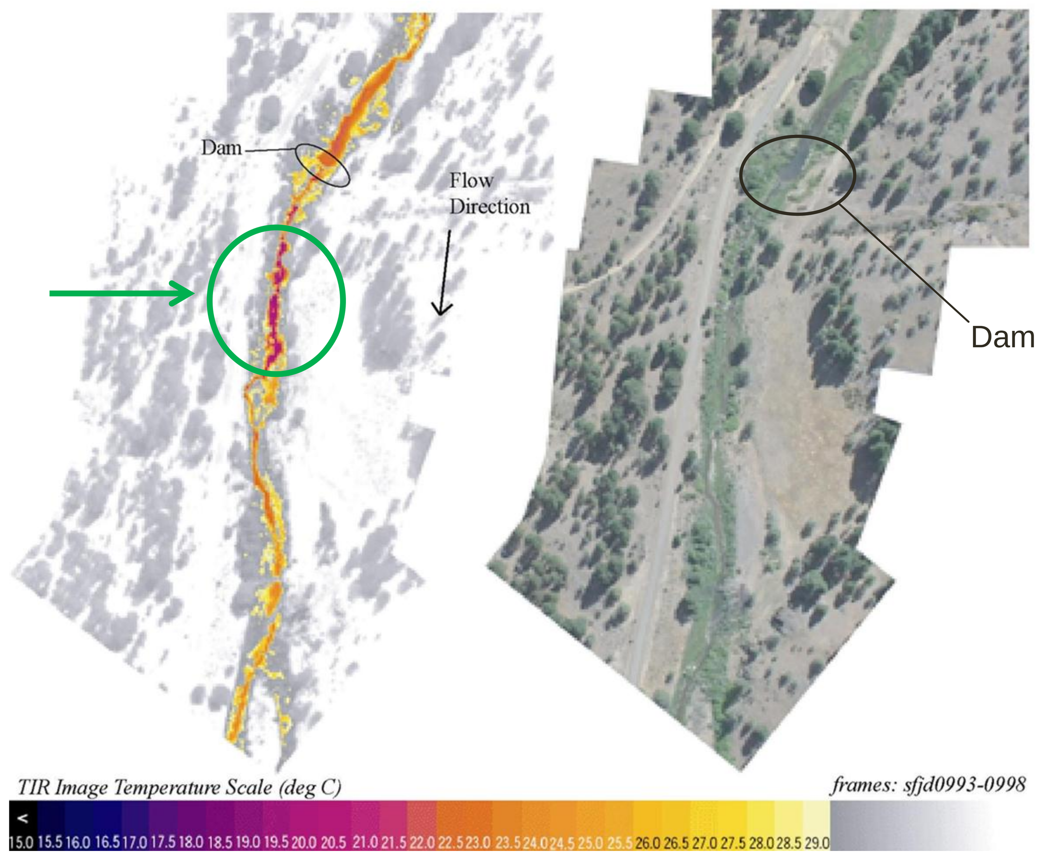


Figure 4: Thermal Near Infrared imagery at a beaver dam, Bridge Creek, 2003.

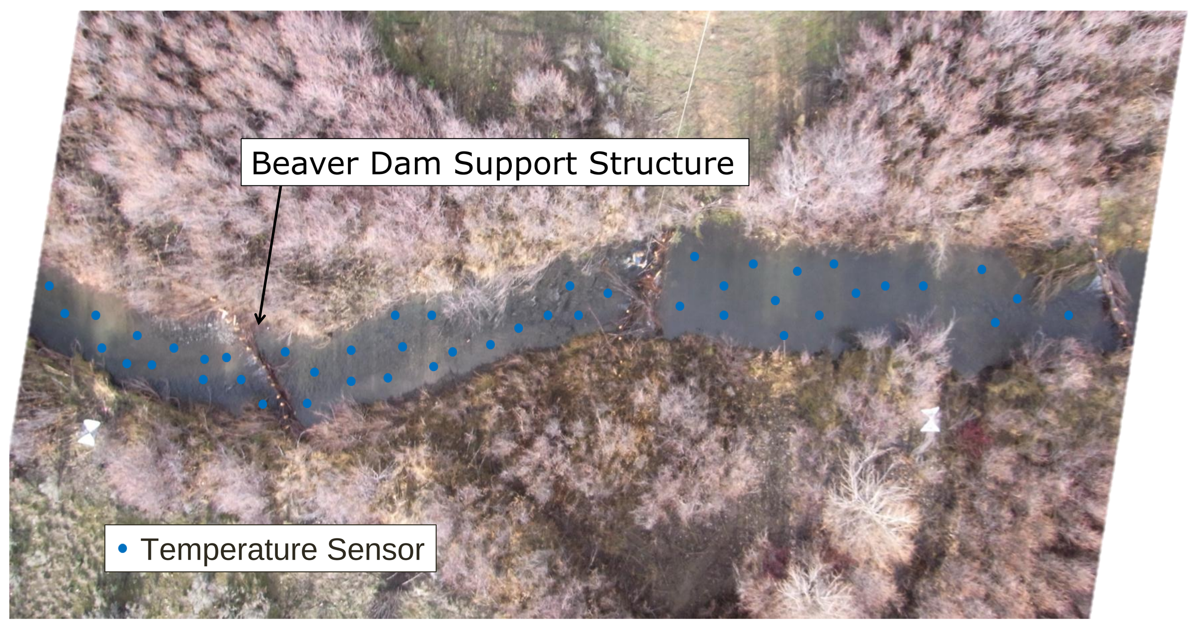


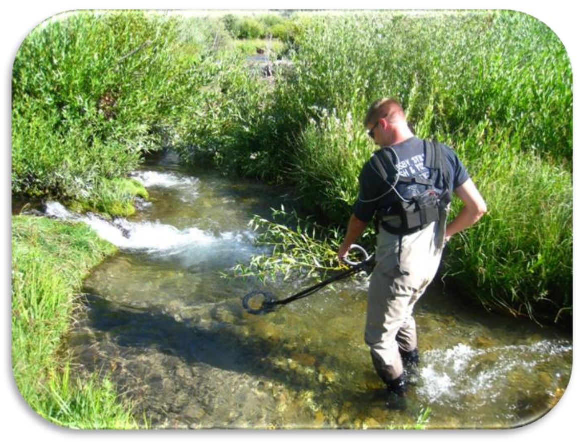
Figure 5: Schematic diagram of temperature sensor array.

Temperature Sensor Array
An array of temperature sensors will be deployed in selected sections of Bridge Creek, where sensors will be placed in high density at varying depths and widths within geomorphic units. The schematic above shows the potential distribution of temperature sensor deployment.

6. PLANNED FISH DATA COLLECTION

In order to detect fish use of stream habitat near beaver dams, a combination of snorkel surveys and mobile Passive Integrated Transponder (PIT) tag antennae surveys will be conducted in summer 2012.

Snorkel surveys and Mobile PIT antennae surveys will be conducted in areas where temperature is monitored. The mobile PIT tag antennae will document the location of individual fish that have already been tagged through ISEMP monitoring activities occurring in the watershed.



7. FUTURE WORK & IMPLICATIONS

Future work will focus on determining the methods that we will use in analyzing the topographic and bathymetric data to explain how habitat complexity has changed as a result of the restoration project. Temperature and fish data will be collected in summer 2012.

This project has large implications for the restoration of dwindling Pacific salmonid species, and for the practice of watershed restoration. This watershed wide restoration project is very cost effective. Over 100 structures have been implemented since 2009, for a cost of ~$14,000.

8. ACKNOWLEDGEMENTS

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