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Impacts of Beaver Dams on Channel Hydraulics and Characteristics on Curtis Creek Near Hardware Ranch, UT: Stream Restoration Implications

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I. Introduction

Beaver dams have significant impacts on the hydrology, temperature, biogeochemical processes, and geomorphology of streams and riparian areas. It has been shown that beaver dams decrease flow velocities, increase surface water storage, decrease flood peaks, and increase base flow during summer months (Nyssen, et al. 2011). Decreased velocities through beaver ponds result in increased sediment deposition and stream bank stability (Pollock, et al. 2007). Beaver dams encourage floodplain development, channel meandering, and the creation of more complex channels by introducing spatial heterogeneity in stream depth, channel width, cross sectional area and instream velocities. Although there is concern that dams could impede movement of fish upstream and may increase stream temperatures above thermal tolerance of some fish species, the increased habitat availability and diversity for aquatic species has been cited as an overall benefit to the system (Kemp et al., 2012). For these reasons, beaver are starting to be used as a viable tool in restoring and improving impaired stream and riparian habitat. One indicator of improved habitat availability and diversity is the increased variability in hydraulic characteristics.

To better quantify the impacts of beaver dams and their effectiveness in meeting restoration goals of diversity in hydraulic characteristics, we developed a 1-D hydraulic model of Curtis Creek near Hardware Ranch, UT. We compared responses within a reach that includes seven beaver dams and a reach with no beaver dams present. We also compared observations of substrate sizes for both reaches to illustrate geomorphic changes due to changing hydraulics. Collectively, these measures provide an understanding of the influences of beaver dams on stream restoration.

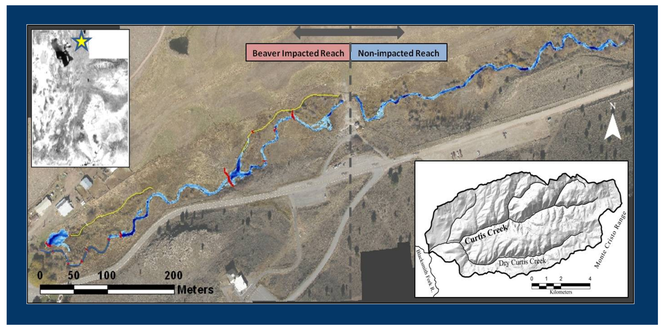

Figure 1. Site map of Curtis Creek near Hardware Ranch, UT with bathymetric map overlaying the actual water surface. The lower portion of the study reach (Beaver Impacted Reach) was part of a stream restoration project in 2001 and portions of the channel were relocated. The abandoned portion of the channel is shown in yellow and beaver dams are indicated in red. Direction of flow is from right to left.

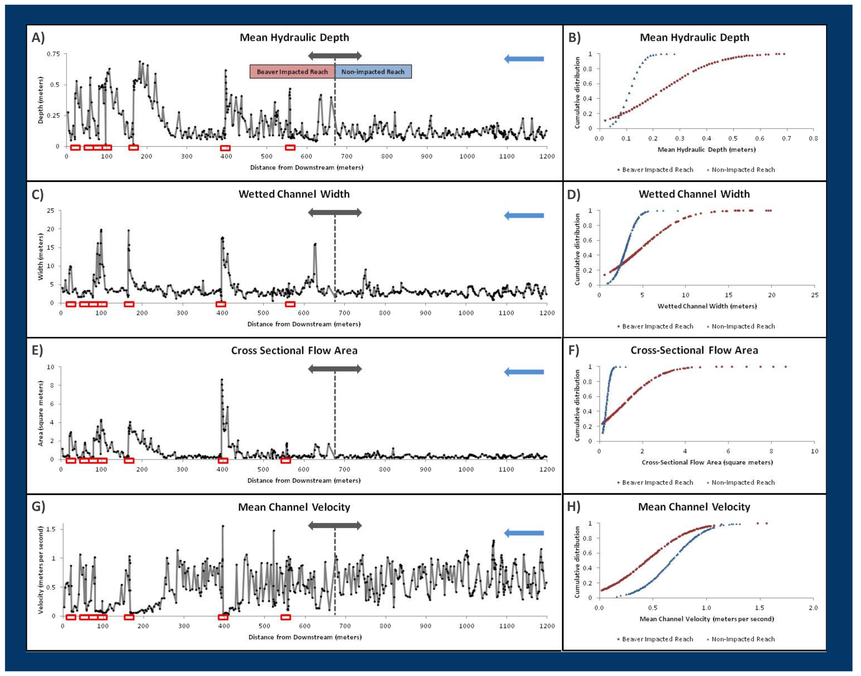

Figure 2. Modeled results for several hydraulic characteristics are shown. Beaver dam locations are indicated by red squares. Mean hydraulic depth (2A), wetted channel width (2C), and cross-sectional flow area (2E) increased on average by 104%, 60%, 242%, respectively, when comparing the beaver impacted reach to non-impacted. Mean channel velocity (2G) decreased on average by 34%. Greater heterogeneity in depth, width, cross-sectional area and velocity was also introduced by the presence of beaver dams as shown by the differences in the distributions (2B, 2D, 2F, 2H).

II. Methods

1. Field Data Collection

- Topographic data (GPS)
  - i. Construction of channel geometry for hydraulic modeling.
  - ii. Identification of geomorphic units (pools, riffles, bars). Geomorphic diversity in streams determines the diversity of the habitat, its availability and viability (Brierley and Fryirs, 2008).
- Substrate data
  - i. Used substrate data as surrogate for changes in hydraulic characteristics.
  - ii. Analyzed for diameter percentiles D16, D50, and D84.

2. HEC-RAS Model Development and Calibration

3. Data Analysis

III. Results

Model Results

The model showed significant differences in mean hydraulic depth, wetted channel width, cross-sectional flow area and stream velocity when comparing beaver impacted and non-impacted reaches (Figure 2). With beaver dams present, average depth, width and cross-sectional area increases and average velocity decreases. More importantly, the beaver impacted reach showed a wider distribution of values and indicated greater spatial heterogeneity in the aforementioned parameters.

Field Data Results

An analysis of the substrate data showed a relatively steady trend in sediment size distribution (Figure 3) and small downstream fining in the non-impacted reach as illustrated by the red D50 line for riffles. However, in the beaver impacted reach this trend was disrupted and greater variability in size distribution was observed. Beaver dams and ponded areas acted as a fine sediment trap and caused discontinuity in the sediment distribution trend throughout the reach.

IV. Conclusions

Our results showed that the presence of beaver dams on Curtis Creek has significantly altered channel hydraulics and stream characteristics such as sediment size distributions. Model results quantified these alterations and illustrated the spatial variability throughout the beaver impacted reach. Results showed increases of 104%, 60% and 242% in average values of hydraulic depth, wetted channel width, and cross-sectional flow area when comparing the beaver impacted reach to the non-impacted reach. These adjustments in channel geometry are also reflected in an average decrease of 34% in instream velocities. The variability in depth, width, cross-sectional area, instream velocity and substrate size provides diverse habitat for a wide range of aquatic species and promotes interaction with the flood plain and riparian zones. Further, the comparison of the beaver impacted reach to the non-impacted reach on Curtis Creek has demonstrated the potential influence of beaver dams in meeting restoration goals through increased hydraulic variability to improve habitat availability.

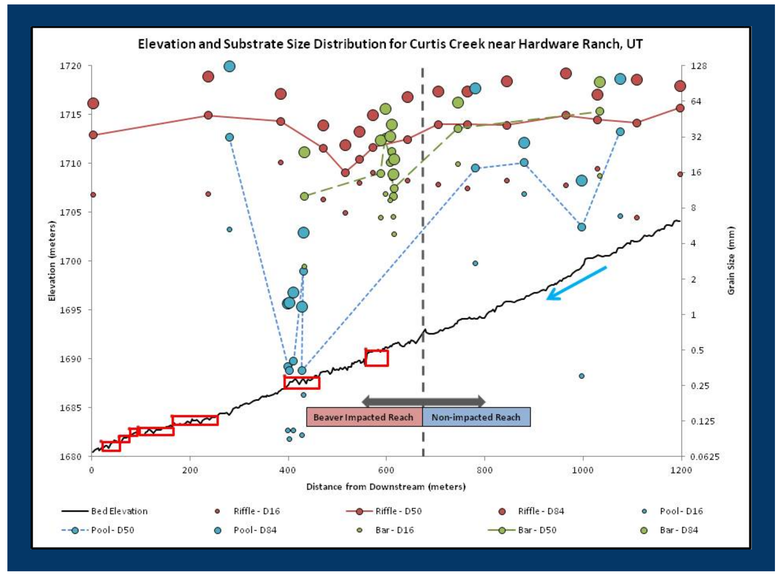

Figure 3. Substrate size distributions for riffles, pools, and bars are shown longitudinally. The size of each marker represents the corresponding size class. Beaver dams and ponded areas are outlined in red. The downstream trend in sediment size distribution observed in the non-impacted reach did not continue in the beaver impacted reach. The median (D50) size for, riffles, pools and bars are specifically shown by the red, blue and green lines respectively to illustrate variability introduced to substrate trends.

V. References

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VI. Acknowledgement

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