The effect of *Castor canadensis* dams on suspended sediment, water temperature, and particle size

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Introduction

The North American beaver (*Castor canadensis*) is a powerful ecosystem engineer—their dams shape the landscape and manipulate ecosystems (Figure 1). Often, when found on a property, they are trapped, relocated, or killed. However, conservationists have discovered that by encouraging beaver to colonize in specific locations, humans can speed the restoration of incised streams, wetlands, and riparian habitat.

Figure 1: Previous studies in the Midwest and England found that beaver dams significantly reduce suspended sediment concentration downstream during high flows because the dams slow and filter water (Elliott, 2017). This is a picture of beaver in a field (Bouf16, 2015).

This study explored the effects of beaver dams on suspended sediment concentration, water temperature, and average particle size in Maryland geography. Excessive amounts of fine particles in a stream are detrimental to fish spawning habitat. Fine particles fill in gaps in the streambed between larger substrate where fish lay their eggs. Warmer water temperatures also disrupt the timing of fish spawns and can be dangerous to vital SAV (submerged aquatic vegetation) productivity. High temperatures also lead to fish die-offs of certain species that cannot survive in warm water. Results indicating that beaver have a positive impact on their local ecosystems in Maryland by decreasing suspended sediment concentration and average particle size can be used to justify beaver-aided restoration projects on the East Coast.

Materials and Methods

Temperature data was collected continuously from September through November at the Island Branch site, to capture the warmest temperatures that occurred during the data collection period. Six suspended sediment collectors (Figure 2) were placed at four beaver dam sites. At each site, collectors were installed upstream and downstream of the dam.

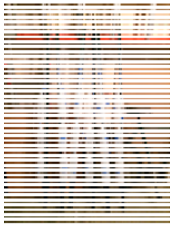
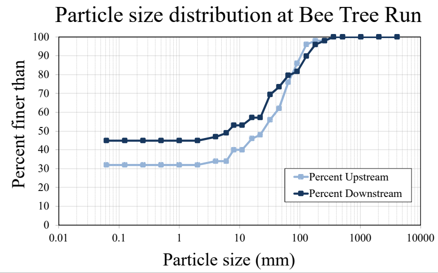


Figure 2 (left): Sediment collectors consisted of three bottles with tubing through the caps that extends to three different heights on a six foot tall garden stake.
Figure 3 (right): At each site, one sediment collector was installed upstream, above ponding, and downstream.

Materials and Methods (cont.)

Sediment collectors were left in the stream for about five months (Figure 3). Bottles were checked and replaced after high flow events. Water samples were filtered, dried, and massed to find the total sediment weight in the bottle (in mg). The volume of water (in cm^3) was used to find the ratio of suspended sediment to water. Standard procedure pebble counts were also performed (Wolman, 1954), at each collector location, as well as the dam. These particle sizes were used to calculate the D50 (median grain size) upstream and downstream. See Graph 1 for an example of a particle distribution for a site.



Graph 1: This graph displays both the upstream and downstream particle size distributions at Bee Tree Run on April 13th. The 100 data points collected from this site on this date have a higher concentration of fine particles upstream than downstream.

Results

Paired *t*-tests were performed on suspended sediment, particle size, and temperature data to assess for differences between upstream and downstream values. All five of the sites were very different in terms of dam radius, impoundment, and base flow, so comparisons were not conducted. Half of the *t*-test results in both particle size and suspended sediment data calculated *p*-values under the 0.05 significance level (Table 1).

Comparative average D50s

Site (*N*)	Upstream D50 (mm)	Downstream D50 (mm)	Particle Size (*p*-value)
Island Branch (4)	18	14	0.122
Thomas Run (4)	47	31	0.026
Bee Tree Run (2)	3	14	0.267
Cabbage Run (4)	19	8	0.024

Table 1: The *p*-values show that two out of the four sites display significantly different upstream D50s than downstream D50s, specifically at Thomas Run and Cabbage Run.

However, in the suspended sediment concentration data that was tested to be significant, the relationship was opposite of what was expected—concentration was higher downstream than upstream (Table 2).

Results (cont.)

Additionally, the difference between upstream temperature (μ = 56.54 °F, SD = 5.82 °F) and downstream temperature (μ = 56.86 °F, SD = 5.64 °F) was found to be 0.32 °F, with a sensor accuracy of ±0.95 °F in the range measured.

Comparative average suspended sediment concentrations

Site (*N*)	Upstream (mg/cm^3)	Downstream (mg/cm^3)	Concentration (*p*-value)
Island Branch (3)	0.147	0.510	0.008
Thomas Run (3)	0.264	0.659	0.058
Cabbage Run (2)	0.014	0.034	0.420

Table 2: The *p*-values show that one out of the three sites display significantly different upstream concentrations than downstream concentration, specifically at Island Branch and Thomas Run.

Discussion

In general, this study had unexpected results, but the conflict with established studies, like that done by the Devon Wildlife Trust (Elliott, 2017), emphasizes the need for further research.

The results from this study found a significant decrease in downstream particle size and increase in suspended sediment concentration at two of the four sites tested. While this conclusion differs from results reported in other studies on effects of beaver dams, the variance is likely due to the limited time and resources available. An ideal study would take place over many years with multiple sites and with controlled stream characteristics. Ecological processes sometimes take hundreds of years, so the short time frame of this data collection period limits this study in its applicability.

The specific locations for sediment and pebble counts, in relation to distance from the dam, could be modified to minimize effects of the raised water table that may have skewed data. Additionally, a study of tree cover in relation to temperature data would be beneficial, as that was potentially a cause of error in results.

References

Bouf16. (Photographer). (2015). *Beaver* [digital image]. Retrieved from Pixabay website: https://pixabay.com/en/beaver-animal-canadian-1997344/

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Wolman, M. G. (1954). A method of sampling coarse river-bed material. *Transactions American Geophysical Union, 35*, 951-956.