The Influence of Reintroduced Beavers on Sediment Processes in Post-wildfire Headwater Streams, Methow River, WA

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Project Context

During the summer of 2019, we collected samples from the Methow Valley, North Cascades, in order to investigate the **effects of beaver** (*Castor canadensis*) **and wildfires on sediment size and carbon content**, in the context of using reintroduced beavers for stream habitat restoration.

- Sampled 4 types of sites to investigate wildfire and beaver effects (Fig. 1)
- Beavers are ecosystem engineers[1,2,3,4,5]
  - remove fine sediment from the water and improve water quality[5,7]
- Aquatic ecosystems, including salmon[6,7] benefit from beavers.
- Wildfires increase erosion (and thus, fine sediment content) and decrease water quality[8].

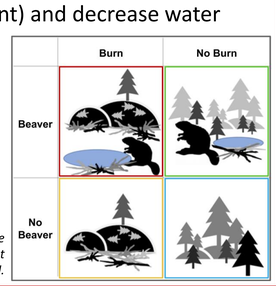


Fig. 1: A schematic showing the different kinds of effects that were sampled.

Background

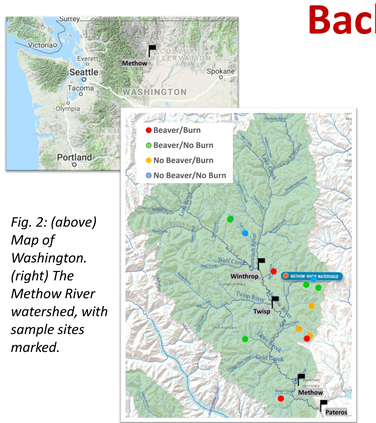


Fig. 2: (above) Map of Washington. (right) The Methow River watershed, with sample sites marked.

Located on the eastern side of the Cascades, the Methow River is a tributary of the Colombia River, and drains 4,900 km^2.

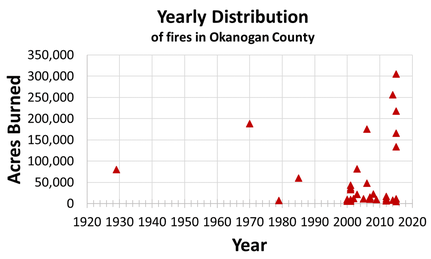


Fig. 3: Historical data showing the recent increase in bigger, more frequent wildfires near the Methow Valley.

The biggest and most destructive wildfires in the Methow Valley have occurred within the past five years. For example, the Okanogan Complex wildfires in 2015 burned over 304,782 acres and killed three firefighters.

Fig. 4: A beaver in the process of being relocated.

The Methow Beaver Project relocates 'problem beavers' from downstream sites to headwater streams where they were historically present. In headwater areas, beavers create wetlands, recharge groundwater systems, and change sediment transport.

Methods

Sampling Methods

Streambed Samples

- 57 samples collected in June 2019
- Baffle set up to slow the stream velocity
- 3-4 L shovelful taken, up to ~16 cm depth

Pond samples

- 47 sediment cores (~10cm) collected in June 2019
- Sampling done along pond transect
- Water depth recorded
- Pond sediment depth recorded
- 4-5 cores per pond

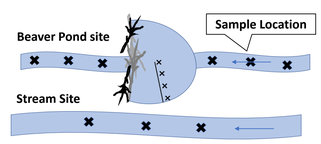


Fig. 6: Sampling schemes for different kinds of effects.

Lab Analyses

Streambed sediment size class

- Dried sample sieved in mechanical shaker for 15 minutes (-4Φ to >+4Φ)
- Each size class weighed
- Distribution curve established

Streambed sediment carbon content

- Fines sieved out of a 2oz random sample
- Sample homogenized in mortar and pestle
- Measured with Costech Elemental Analyzer (EA)

Fig. 5: Taking a transect along a fallen log in the beaver pond at Mission Creek with (left to right) Wimberger, Stewart, and Foster.

Fig. 6: The beaver pond (and den) at Upper Cub Creek with (from left to right) Rettig, Stewart, and Wimberger.

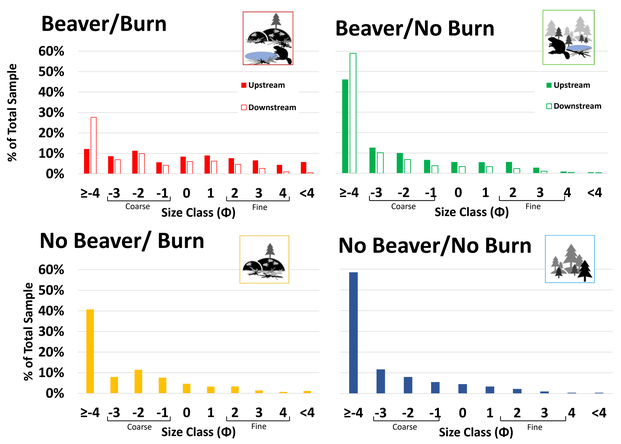
Fig. 7: (left to right) Stewart, Foster, and Rettig getting ready to hike out to a sampling site. Foster is holding the baffle.

Fig. 9: Representative sample, showing the sieved streambed samples.

Fig. 8: Putting samples out to dry back at camp with (left to right) Stewart, Foster, and Rettig.

Do beavers and/or wildfires influence the size class distribution of streambed sediments?

Burned sites have more evenly distributed size classes. A difference between upstream and downstream (of dam) sites is more apparent in burned areas.



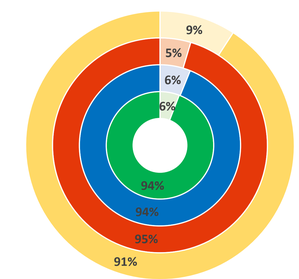
The largest size class, (-4Φ) includes large cobbles and small boulders

Fig. 10: Size class distribution. Graphed using the average of ~9 samples for each non-beaver setting, and the average of ~18 samples for beaver settings (total n=53).

- There was high heterogeneity among streams. This complicated our comparisons between site types.
- Headwater streams are high energy systems, and pebble to cobble sized sediment were abundant at all sites.
- The burned sites have more intermediate sized sediments than unburned sites, which leads to more even size class distributions.
- Beaver ponds store fine sediments, especially in burned areas, where this difference can be up to 33%.

How do beavers impact fine sediment transport in wildfire-burned areas?

On average, fine sediments in downstream (of dam) sites in burned areas are comparable to an unburned stream. Beavers ponds capture fine sediments, and ameliorate the effects of wildfire on steam ecosystems.



- Beaver/ No Burn
- Beaver/ Burn
- No Beaver/ No Burn
- No Beaver/ No Burn

Fig. 11: Pie chart showing average percentages of fine versus coarse classes under different effects. Beaver sites use data from downstream of the beaver dam in order to assess the difference that beavers make (total n=53).

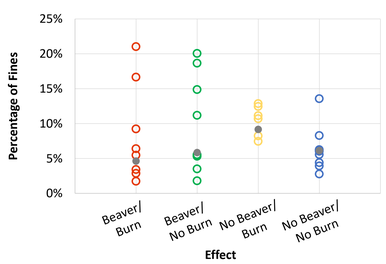


Fig. 12: Scatterplot of percentage of fines as they relate to the percentage of coarse clasts (n=36). The black point in each effect is the median.

- Fine sediment is detrimental to macroinvertebrates[7] and salmon[9,10], it can clog gills and fill pore spaces in streambed sediments. Beaver ponds capture fine sediment, resulting in higher quality aquatic habitat downstream.
- We expect enhanced erosion in recent wildfire areas, due to loss of surface vegetation, as seen in the higher percentage of fine sediments in burned sites without beavers.
- Beavers ponds store fine sediments and can buffer downstream aquatic ecosystems from the negative effects of erosion after wildfires.

What effect do beavers and/or wildfires have on sediment organic content?

Sediment organic content is generally low in headwater streams, although on average higher in unburned areas.

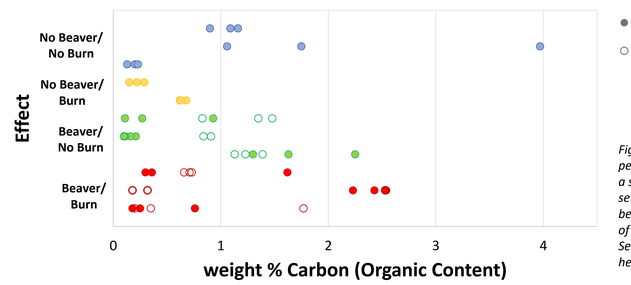


Fig. 13: Weight percentage of carbon in a sample, for each setting (n=51). %C can be used as an indicator of organic content. Sediments show high heterogeneity.

- Differences in organic content are biologically important but are not statistically significant (p = 0.29). Beaver ponds store large amounts of organic material, but beaver activity can also be a source of organics to downstream sites.
- Wildfires remove organic material from an ecosystem, and this may lead to lower organic content in stream sediments in years immediately post-burn.

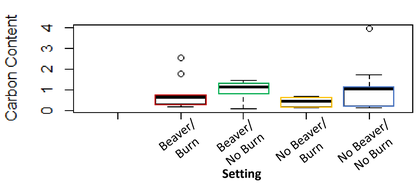


Fig. 14: Boxplot of weight percent carbon data (n=32).

- High variability among streams precluded any clear upstream-downstream patterns in sites with beavers. In general, headwater stream sediments have low organic content (<2 wt% carbon).

Acknowledgements

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