Effects of Beaver Dams on Urban Streams in the Tualatin River Basin

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Study Overview

This study, in collaboration with Clean Water Services, aims to estimate beaver dam distributions and quantify the effects that beavers have on hydrology, water quality, and geomorphology in the urban streams of the Tualatin River basin.

Year 1 efforts of this 3-year study included:

(1) Applying and modifying the Beaver Restoration Analysis Tool (BRAT) to estimate beaver dam capacity,
(2) Continuous measurements of water quality at locations upstream, in, and downstream of beaver influenced reaches,
(3) Measurements of the spatial variation in temperature and dissolved oxygen in beaver ponds,
(4) Hydraulic modeling of stream velocity, water depth, and inundation patterns along a beaver influenced reach, and
(5) Surveys of sediment deposition.

Findings will help Clean Water Services and other management agencies evaluate the effectiveness of using beavers to restore urban streams and including them in best management practices for addressing stormwater and water quality in urban streams.

Figure 1. Beavers in urban streams of the Tualatin River basin. Photos by Erin Poor, USGS.

Estimating Beaver Dam Capacity in the Tualatin River Basin with the Beaver Restoration Analysis Tool (BRAT)

BRAT was developed by Mcfarlane and others (2015) to estimate beaver dam density throughout a watershed and help the restoration community identify where, and where not, to target beaver restoration strategies. BRAT combines hydrologic, topographic, and vegetation data in a fuzzy inference system to calculate dam density potential, and can incoporate landuse data to identify where human-beaver conflicts may occur.

Tailoring BRAT to the Tualatin River Basin

BRAT was originally developed for Utah streams, which are generally high gradient streams with snow-melt dominated hydrographs. The Tualatin River basin is largely a low gradient system with a hydrograph driven by winter rains. We modified BRAT to account for how these differences influence beavers in the Tualatin basin.

Preliminary BRAT Results

Preliminary results show that, while the highest expected density of dams is in the upper forested reaches of the watershed, a considerable amount of habitat exists for beavers in urban and suburban streams. However, this habitat tends to be more variable and fragmented compared to the rural and forested streams. At this preliminary stage, the results are best interpreted as a range of available habitat, rather than potential dam density.

Verifying Beaver Dam Capacity Estimates

Efforts are ongoing to verify and calibrate the BRAT model. USGS is counting dams on targeted reaches in different landuse types and sub-watersheds. These data will help fine-tune the dam density estimates from the model.

Next Steps

Future analyses may include assessing potential dam buildout in specific sub-watersheds or reaches, identifying areas most likely to support beaver introduction, comparing current density and expected capacity, and identifying habitat limitations for beaver. Results may also be used to help set goals for beaver restoration.

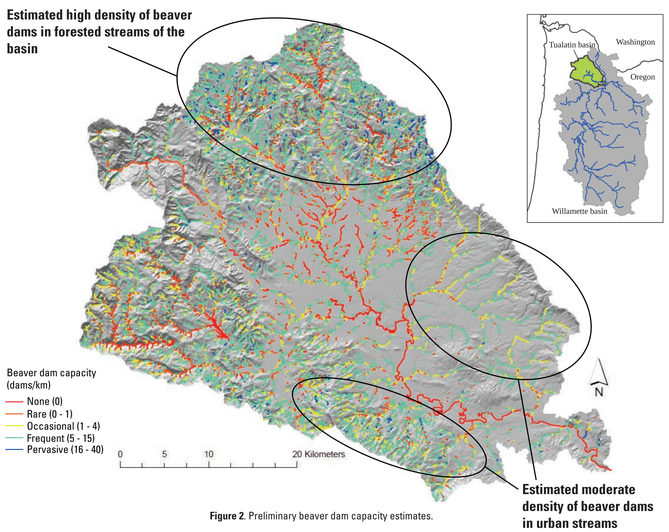
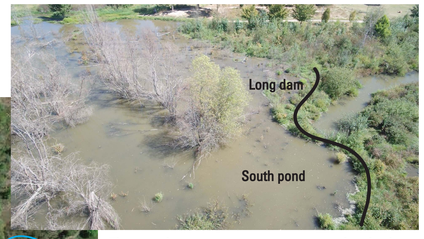


Figure 2. Preliminary beaver dam capacity estimates.

Intensive Monitoring Site: Fanno Creek at Greenway Park

Fanno Creek at Greenway Park is managed by Tualatin Hills Park and Recreation Department. The recreation paths and disc golf course attract many visitors each day.

Beavers in recent years have built at least four dams, including the tall dam at the southern end of the site and long dam creating the south pond.



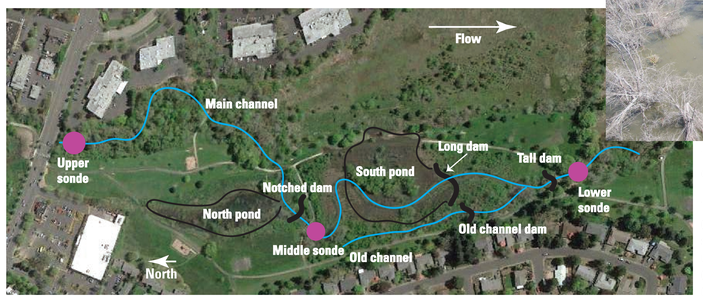


Figure 3. Map of the Fanno Creek at Greenway Park site and photo of the south pond and long dam.

Three sondes measure water temperature, dissolved oxygen, conductivity, turbidity, and pH.

These data are useful for evaluating changes between the:
(1) Upper and middle sites where the deep channel is shaded, confined, and ponded and receives water from the unshaded north pond, and
(2) Middle and lower sites where the deep channel runs through the south pond and then becomes confined and shaded between the long and tall dams.

Evaluating Temporal Trends in Water Temperature and Dissolved Oxygen (DO) at the Fanno Site

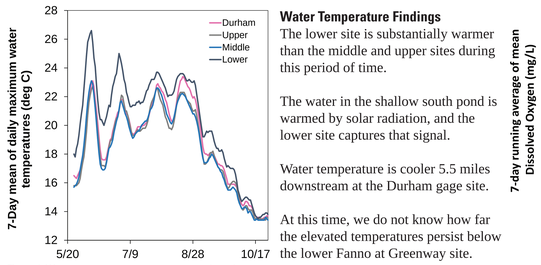


Figure 4. Water temperature measurements made at the Fanno at Greenway Park sondes and the downstream USGS gage at Durham.

Water Temperature Findings

The lower site is substantially warmer than the middle and upper sites during this period of time.

The water in the shallow south pond is warmed by solar radiation, and the lower site captures that signal.

Water temperature is cooler 5.5 miles downstream at the Durham gage site.

At this time, we do not know how far the elevated temperatures persist below the lower Fanno at Greenway site.

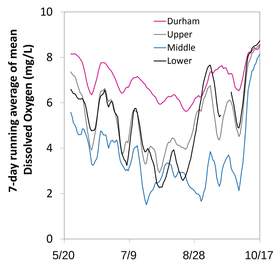


Figure 5. Dissolved oxygen measurements made at the Fanno at Greenway Park sondes and the downstream USGS gage at Durham

Dissolved Oxygen Findings

DO concentrations at the middle site become very low (<2 mg/L) in the late summer.

Water is more oxygenated when it exits the tall dam downstream.

The primary productivity occurring in the south pond area is captured by the lower sonde.

Next Steps

Keep sondes deployed through Fall 2017.

Analyze DO patterns to assess primary production and stream metabolism.

Modeling Beaver-Mediated Hydraulic Changes at the Fanno Site

We are building numerical models to compare inundation, velocity, and depth to examine:
(1) A range of flow conditions,
(2) With and without the beaver dams,
(3) Critical elevations of dams,
(4) Dam "blowouts" at higher discharges, and
(5) Storm attenuation throughout the site.

Initial Results

Model simulates flow dynamics in this reach reasonably well.

Water storage at low flow is greater with dams, but differences decrease as discharge increases.

Wetted area and depth increase with dams.

Velocity decreases with dams.

Next Steps

Collect high flow data and calibrate model as necessary.

Simulate actual storm events at Fanno Creek with and without dams.

Compare downstream hydrographs, peak flows, and flashiness indices with and without dams.

Combine with BRAT results to infer potential flashiness changes in sub-reaches/sub-watersheds.

Figure 8. Measured and modeled values for water surface elevations for the Fanno Creek at Greenway Park.

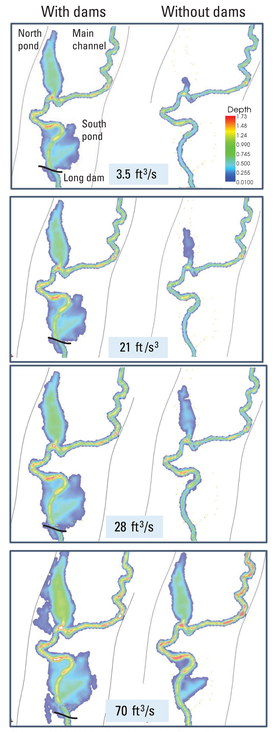


Figure 9. Modeled depth results for the Fanno Creek at Greenway Park site at a range of flow conditions.

Exploring Spatial Variation in Water Temperature and Dissolved Oxygen at the Fanno Site

Over 200 coupled measurements of water temperature and dissolved oxygen were collected to capture their spatial variability on August 11, 2016.

Measurements were made in a 3-hour window and along the "old" channel, main channel from the tall dam upstream to the north pond, and within the south pond.

Findings

The ponded reach above the long dam has the warmest temperatures and some of the highest dissolved oxygen readings.

The coldest water (<20°C) was at the head of the old channel and the deeper parts of the main channel.

Thermal stratification was found in the main channel.

Next Steps

Repeat measurements next year during key migration periods for steelhead and cutthroat trout.

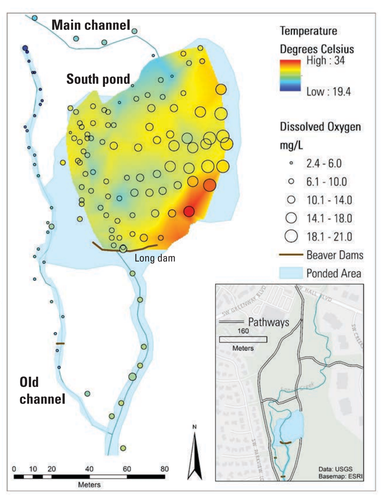


Figure 6. Water temperatures and dissolved oxygen measurements made in main channel, south pond, and old channel at the Fanno Creek at Greenway Park site during the synoptic sampling on August 11, 2016.

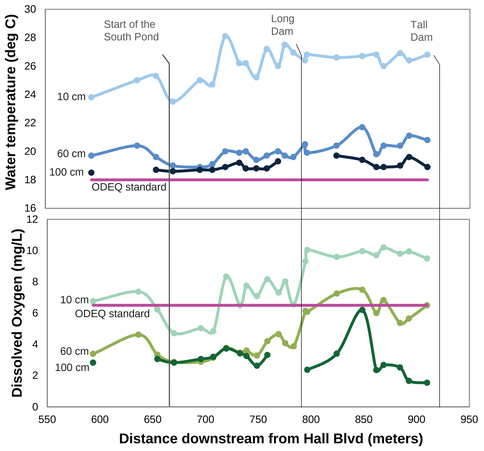


Figure 7. Longitudnal profiles of water temperature and dissolved oxygen measured along the main channel at Fanno Creek Greenway Park on August 11, 2016.

Estimating Beaver-Mediated Sediment Retention at the Fanno Site

We compared a survey of sediment depths against a survey of channel depths to estimate the volume of sediment stored by the ponds behind the long and tall dams.

Dam	Estimated stored volume (cubic meters)	Dump truck loads	African elephants
Long	1,800	150	720
Tall	80	7	32

Next Steps

Collect suspended sediment concentrations (SSC) this winter.

Relate SSC with turbidity.

Develop a surrogate discharge relationship so we can calculate annual suspended sediment loads above and below the Fanno Greenway reach.

Figure 10. Photo of surveying sediment depths near the beaver lodge in the south pond at the Fanno Creek Greenway Park site.

Related Publications

Mcfarlane, W.W., J.M. Wheaton, N. Bouwes, M.L. Jenson, J.T. Gilbert, N. Hough-Snee, and J.A. Shivik. 2015. Modeling the capacity of riverscapes to support beaver dams. Geomorphology. http://dx.doi.org/10.1016/j.geomorph.2015.11.019

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