4. Preliminary Results of the Effects of Beaver Activity on Water Quality in Fanno Creek at Greenway Park

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Goals and Objectives

Beaver dams and ponds alter the movement and storage of water as well as the water quality in a stream reach. To date, little work has been done to quantify the effects of beaver activity on water quality in urban streams.

In this part of the Tualatin beaver study, USGS assessed changes in water quality along beaver-affected reaches of Fanno Creek at Greenway Park and Bronson Creek (upstream of Kaiser Rd) using three methods. This poster highlights the Fanno Creek results.

Findings will be helpful for quantifying the advantages and disadvantages of beaver dams and ponds on water quality and any associated changes in habitat diversity.

Figure 1. Multi-parameter water-quality instrument used in this study. USGS photo.

Data Collection Methods

This study used three methods to measure water-quality conditions along the beaver-affected reach of Fanno Creek in Greenway Park:

1. Sensors measuring continuous water temperature, dissolved oxygen, turbidity, conductance, and pH were installed at the upstream boundary, between the north and south ponds, and at the downstream boundary of the study reach (fig. 2).
2. Temperature loggers were deployed throughout the ponded area and downstream to capture the spatial variation in water temperature and any downstream effects (fig. 2).
3. Hundreds of point measurements of water temperature and dissolved oxygen were made on four different dates throughout the reach to capture any spatial variation in these parameters that might be tied to a diversity of habitat conditions.

The continuous datasets are available online at: *https://or.water.usgs.gov/cgi-bin/grapher/graph_setup.pl?basin_id=tualbeav*

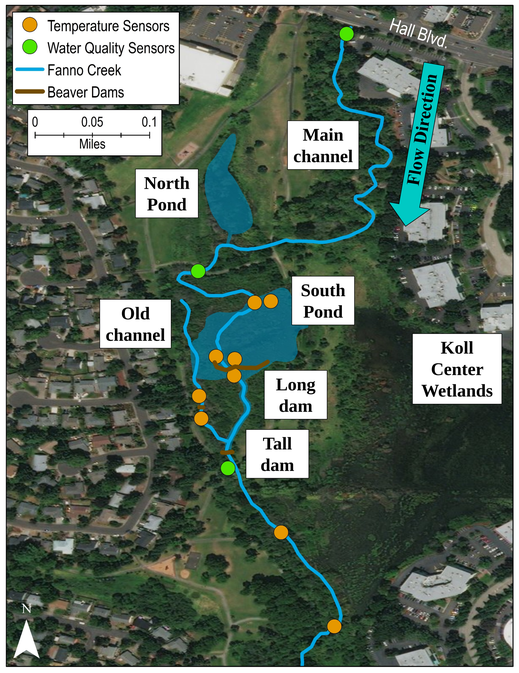

Figure 2. Map of the Fanno Creek at Greenway Park reach, showing the locations of water-quality sensors, water-temperature loggers, and beaver dams.

pH Results

1. Measurements at the upstream sensor were below the State of Oregon pH minimum criterion of 6.5 standard units for 157 hours in winter 2016 (fig. 3). These measurements coincide with large storm events, indicating that naturally acidic rainwater (pH= 5.65) temporarily decreases the stream pH during storms. This is typical for many streams in Oregon.
2. Multiple instantaneous pH measurements collected in the south pond (fig. 2) on 9/12/2017 exceeded the State of Oregon pH maximum criterion of 8.5 standard units. An algal bloom was occurring in the shallow south pond at that time, and an elevated pH would be expected as a result of the algal photosynthesis.

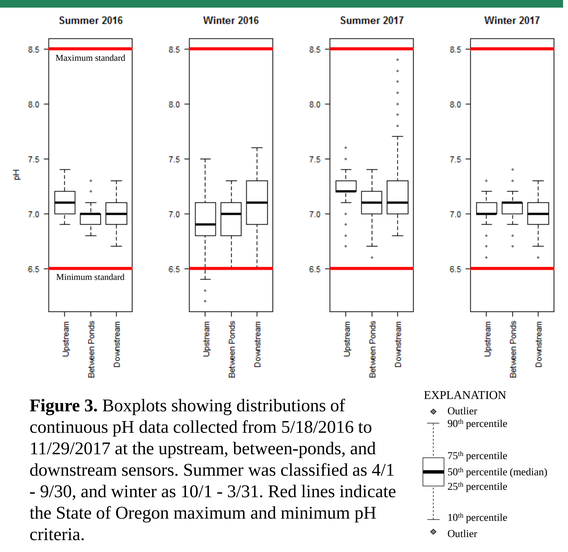

Figure 3. Boxplots showing distributions of continuous pH data collected from 5/18/2016 to 11/29/2017 at the upstream, between-ponds, and downstream sensors. Summer was classified as 4/1 - 9/30, and winter as 10/1 - 3/31. Red lines indicate the State of Oregon maximum and minimum pH criteria.

Water Temperature Results

1. During summer 2016, water at the downstream sensor was significantly warmer ($p<0.01$) than the between-ponds and upstream sensors (fig. 4). Water in the shallow south pond was warmed by solar radiation, and the downstream sensor captured that signal.
2. The 7-day moving averages of the daily maximum water temperature were not significantly different for the three sensors during October 2016 to March 2017 (winter).
3. Water at the downstream sensor exceeded the State of Oregon rearing and migration criterion for salmonids of 18°C for most of summer 2016, but was sometimes cooler than 18°C between 7 a.m. and 11 a.m. (fig. 5).
4. The warmer temperatures at the downstream sensor caused by the capture of solar radiation in the south pond tended to decrease about 600 m (or 0.37 river miles) downstream (fig. 6) where the channel was confined, shaded, and deep (fig. 7).
5. Point measurements revealed substantial spatial variation in water temperature and dissolved oxygen in the ponded area, with warmer water in shallow, open areas and cooler water in the deeper channel and shaded areas (fig. 8). Deeper areas showed less spatial variation in water temperature and dissolved oxygen.

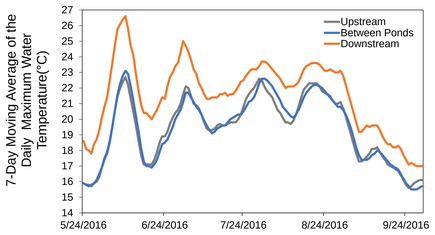

Figure 4. 7-day moving averages of the daily maximum water temperatures measured by the upstream, between-ponds, and downstream sensors from 5/24/2016 to 9/30/2016.

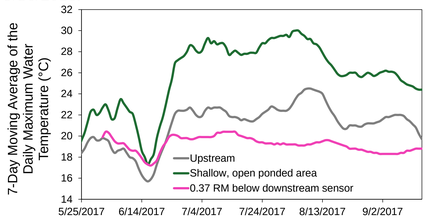

Figure 6. 7-day moving averages of the daily maximum water temperatures measured by 1) the upstream sensor, 2) a logger in the shallow, open ponded area, and 3) a logger 0.37 river miles (RM) downstream of the downstream sensor from 5/24/2017 to 9/15/2017.

Figure 7. Photograph of Fanno Creek 600 m downstream of the downstream sensor. Photo by USGS.

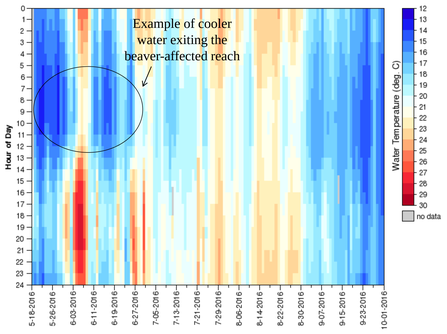

Figure 5. Color map showing variations in water temperature measured by the downstream sensor from 5/18/2016 to 9/30/2016.

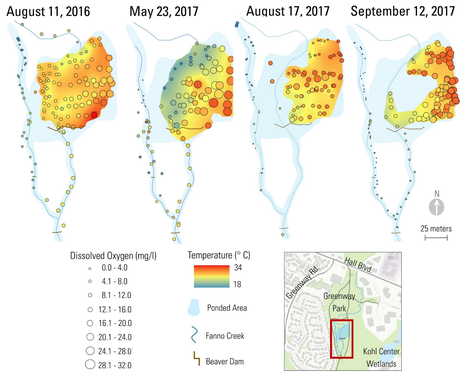

Figure 8. Point measurements of water temperature and dissolved oxygen concentrations taken throughout the south pond, main channel, and old channel during four single-afternoon sampling events.

Dissolved Oxygen Results

1. Dissolved oxygen (DO) reached low concentrations at all three sites in the summers of 2016 and 2017 (table 1).
2. The between-ponds site had a prolonged period of DO concentrations less than 2 mg/L during August 2017 (fig. 9).
3. DO concentrations at the downstream site varied greatly (fig. 9). Water leaving the ponded area was either oxygenated or hypoxic because of the primary productivity and respiration occurring in the shallow waters of the south pond just upstream.
4. The low DO concentrations in the ponded reach in summer were a result of slow water velocity, warm water temperatures, and biological processes. The large, unshaded areas where plants and algae grow (fig. 10) lead to elevated DO concentrations near the water surface due to photosynthesis. Increased oxygen consumption at the sediment-water interface can lead to low DO concentrations because of organic matter deposition and decomposition.

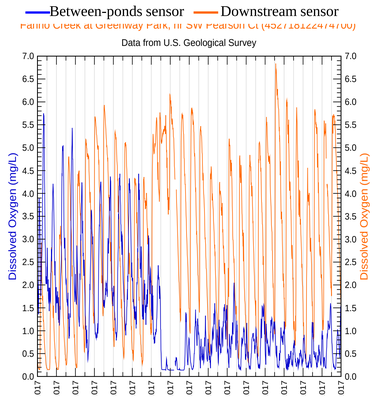

Figure 9. Dissolved oxygen concentrations measured by the between-ponds and downstream sensors from 8/1/2017 to 9/2/2017.

Figure 10. Photograph of algal growth in the south pond taken in August 2016. Photo by USGS.

	Instantaneous (hourly) values **less than 4.0 mg/L** (percent of hours)	7-Day Running Average of the Daily Minimum **less than 5.0 mg/L** (percent of days)	30-Day Running Average of the Daily Mean **less than 6.5 mg/L** (percent of days)
Low-flow 2016 (5/18- 9/30)			
Upstream	30 %	78 %	100 %
Between Ponds	68 %	99 %	100 %
Downstream	29 %	75 %	100 %
Low-flow 2017 (4/1- 9/30)			
Upstream	15 %	49 %	48 %
Between Ponds	46 %	60 %	60 %
Downstream	23 %	48 %	35 %

Table 1. Summary of the percentages of instantaneous dissolved-oxygen values less than 4.0 mg/L, 7-day running average of the daily minimum values less than 5.0 mg/L, and 30-day running average of the daily mean values less than 6.5 mg/L measured in the low-flow periods of 2016 and 2017. Low-flow 2016 was defined as 5/18/2016 to 9/30/2016, whereas low-flow 2017 was 4/1/2017 to 9/30/2017.

Next Steps for this Study

- Release the point measurement datasets for water temperature and dissolved oxygen to the public.
- Complete the water-quality analyses for Bronson Creek.
- Evaluate and compare primary productivity between sites and before and after beaver dam construction.

Considerations for Future Studies

- Monitor chlorophyll and phycocyanin (algal pigments) in beaver-affected reaches.
- Sample for trace metals and pesticides in water, sediment, and tissue to determine contaminant fate, storage, and burial by the beaver dams.
- Relate the water-quality findings to the ecology of the beaver-affected reaches.

All data and findings are provisional and subject to change.

09-Feb-2018

U.S. Department of the Interior
U.S. Geological Survey

Smith, C., E. Poor, S. Rounds, and K. Jones, 2018, Tualatin Beaver Poster 4 - Preliminary Results of the Effects of Beaver Activity on Water Quality in Fanno Creek at Greenway Park.