Apr 5th, 11:30 AM - 1:30 PM

Long-term water quality trend analysis in the Lone Tree Creek watershed and surrounding marine waters

Shannon Buckham
Swinomish Indian Tribal Community, United States, sbuckham@swinomish.nsn.us

Nicole Casper
Swinomish Indian Tribal Community, United States, ncasper@swinomish.nsn.edu

Long-term water quality trend analysis in the Lone Tree Creek watershed and surrounding marine waters

Shannon Buckham, Nicole Casper
Department of Environmental Protection, Swinomish Indian Tribal Community

Background

- Analyses focused on Lone Tree Creek watershed and the associated nearshore environment (Figs. 1 - 2).
- Lone Tree Creek flows ~1.5 miles before discharging into Lone Tree Pocket Estuary and Lone Tree Lagoon. These areas provide important habitat for juvenile Chinook salmon, and 30 other fish species[1].
- The nearshore environment is a historic and active fishing and shellfishing area.
- Lone Tree Creek is an intermittent, run-off dominated stream. The creek consistently flows November through April each year.

Figure 1. Swinomish Indian Tribal Community Reservation boundary in red. Lone Tree Creek watershed in green.

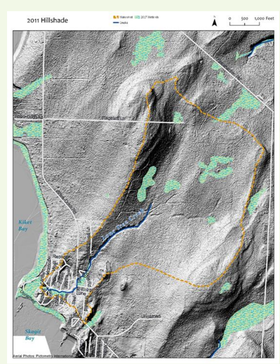

Figure 2. Lone Tree Creek watershed encompasses 627-acres. The primary hydraulic support for Lone Tree Creek is the large upland/wetland mosaics[1].

Water Quality Monitoring

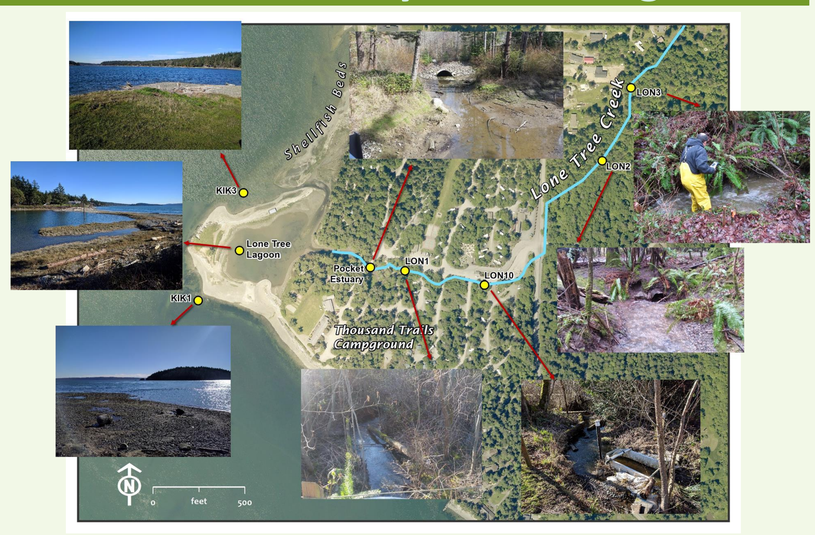

Figure 3. Monitoring sites in the Lone Tree Creek watershed.

- Monitoring began in the late 1990s at some sites.
  - **Upper basin**: LON2 and LON3 are not monitored frequently enough for long-term trend analysis, but are used for comparison to the lower basin sites.
  - **Lower basin**: LON1 flume location until 2006, relocated to LON10 in 2007.
  - **Pocket estuary** (LONPE) monitoring began in 2007.
  - **Marine water sites**: Lone Tree Lagoon (KIK2) and Kiket Bay.
- Analyses were run on pH, dissolved oxygen (DO), temperature, salinity, turbidity, and fecal coliform bacteria.

Figure 4. (left to right): J. Thompson Hydrolab sampling, B. Kasayuli Hydrolab sampling by boat, S. Buckham collecting turbidity and bacteria samples.

Nonparametric Analyses

- Seasonal Mann-Kendall for long-term trend analysis and individual analysis by season for Lone Tree Creek.
- Locally Weighted Smoothing (LOESS) lines were used for trend visualization.
- Pettitt's homogeneity test was used to determine breaks in homogeneity and data were analyzed over the identified shortened time periods, in addition to the entire dataset.
- Kruskal-Wallis test and post-hoc Conover-Iman test for comparisons between sites.

Results

- **Temperature** increases after 2010 in the pocket estuary and at KIK1; could be from deforestation or climate stressors.
- **pH** decreases at KIK3 after 2011, which could be informative of potential future climate stressors (ocean acidification).
- **Salinity** increases in the pocket estuary and decreases in the lagoon could indicate more exchange between the creek and the bay.
- Results for **dissolved oxygen, turbidity, and fecal coliform** were more interesting and complicated as shown in Figs. 5-10.

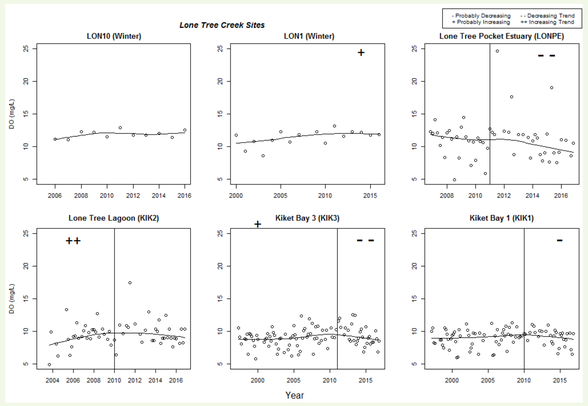

Figure 5. Dissolved oxygen (DO) trends. Some trends are only significant for specific time periods as shown by the vertical lines indicating homogeneity breaks. At KIK3 DO increases over the entire time series, but starts decreasing in 2011. LON1 shows similar trends of improving DO during spring and summer.

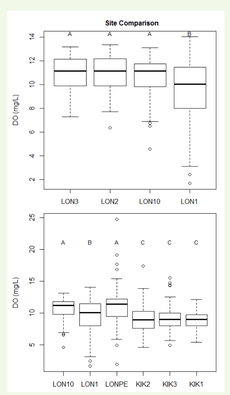

Figure 6. Comparison of dissolved oxygen (DO) in creek sites (top) and six trend analysis sites (bottom).

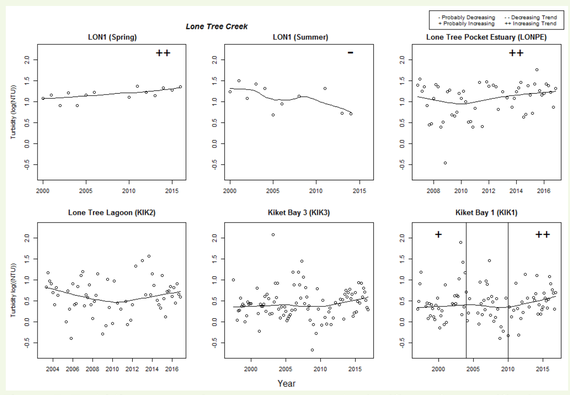

Figure 7. Turbidity trends. Some trends are only significant for specific time periods as shown by the vertical lines indicating homogeneity breaks in 2004 and 2010 (KIK1). Seasonal differences at LON1 could be contributed to precipitation and run-off.

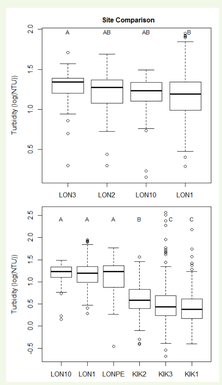

Figure 8. Comparison of turbidity in creek sites (top) and six trend analysis sites (bottom).

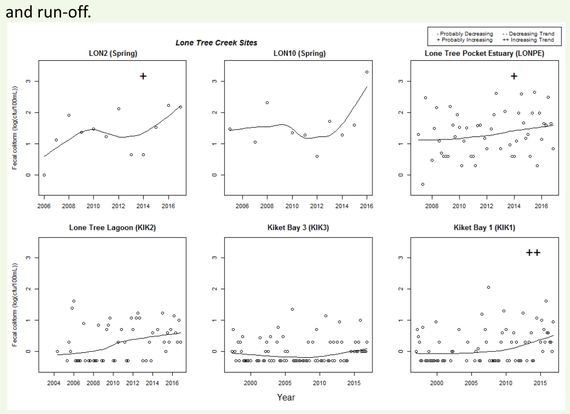

Figure 9. Trends in fecal coliform bacteria. LON2 data were provided by Thousand Trails Campground staff. Fecal coliform samples are no longer collected at LON1.

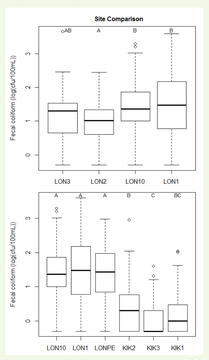

Figure 10. Comparison of fecal coliform concentration in creek sites (top) and six trend analysis sites (bottom).

Discussion

Forestry:
- ~95% of watershed is zoned for forestry.
- Logged areas (Fig. 11) overlap with wetlands that provide primary hydraulic support for Lone Tree Creek.
- Forestry practices during these years may have had cumulative negative effects on stream flow and water quality producing the observed increases in turbidity (Fig. 6) and fecal coliform (Fig. 8).

Campground Management:
- Wastewater, stormwater, and road management could influence bacteria (Figs. 9-10) and turbidity (Figs. 7-8) concentrations.
- Wastewater sprayfields effects (between LON2 and LON3) are likely diluted moving downstream. However, lower basin sites in the watershed have higher fecal coliform than in the upper basin (Fig. 10) because of additional sources of contamination within the campground.
- Possible sources include septic failure, run-off and spills at the dump station[1]. Stormwater inputs at Snee-Oosh road could increase fecal coliform in the lower basin while also diluting the more turbid water from the upper basin.

Climate stressors:
- Heavy run-off influence in watershed could effect discharge in the creek and water quality (e.g. temperature, pH, DO).

Restoration of lower basin 2006-2007:
- Significantly improved DO and likely contributed to the positive trends in DO prior to 2010/2011 (Fig. 5).
- LON1 has the most variability in DO (Fig. 6) possibly due to the restoration having the greatest effect at this site. Generally, DO varies more in the creek and pocket estuary than the marine sites.

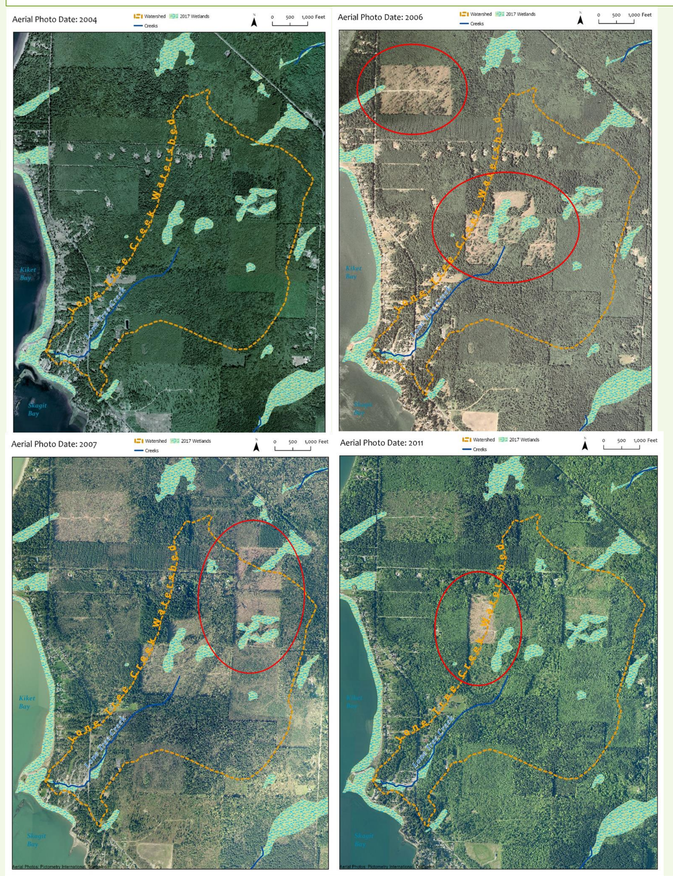

Figure 11. Aerial photo records of the Lone Tree Creek watershed from 2000-2017 with wetland boundaries as of 2017 in green. Between 2000 and 2004 there were no clearly visible cuts in or near the watershed boundary. Additionally, there were minimal changes to forestry cover and land use between 1937 and 2000[1]. Between 2004 and 2006 there were two areas of tree cutting (in red). Forest cuts also occurred between 2006 and 2007 in the northeastern corner of the watershed and between 2009 and 2011 in the northwest part of the watershed. Forestry practices at Swinomish Indian Tribal Community have changed, and since 2011 new cuts are not apparent in the Lone Tree Creek watershed.

Conclusions

- Overall shift toward poorer water quality in 2010/2011, possibly due to forestry practices, campground management practices, climate stressors.
- Next: Regression models to determine most influential parameters. Air quality and flume discharge data will help determine potential climate influences.

Contact: Shannon Buckham
Water Resources Specialist, Department of Environmental Protection
Swinomish Indian Tribal Community
Email: sbuckham@Swinomish.nsn.us
Website: http://www.swinomish-nsn.gov/resources/environmental-protection.aspx
Phone: (360) 853-5102

References

1. Boyer, D. 2005. Lone Tree Creek Watershed Assessment. Skagit River System Cooperative. Prepared for Swinomish Indian Tribal Community. Office of Planning and Community Development.

Acknowledgements

1. Todd Mitchell – Director, Department of Environmental Protection
2. Karen R. Mitchell – Hydrologist, Department of Land Management
3. Water Quality Technicians and Specialists over the years – Jason Thompson, Brendon Kasayuli, Joe Quintasket, Tanisha Gobert, Sarah Grossman, Tiffany Hoyopatubbi, Rachel Lovell-Ford
4. GIS Staff in Swinomish Land Management Department – Jacob Tully, Stella Spring