Is There Variability in Peatland Soil and Water Conditions in Proximity to Road Construction?

Theo Hilpert

Department of Natural Resources and Environment

Abstract

This research project is on the condition of soil and water in proximity of road construction in a peatland. To examine this, GLOBE data was collected at six different locations in the Peat Ponds Wildlife Area. This area is at a low elevation in the Goldstream Valley and is made up of black spruce wetland with dense moss as the ground cover. The pond consists of a few cattail islands and stands along the bank along with tall grasses and even small birch trees along the south bank. Through my time growing up in the Goldstream Valley I have noticed that the section of the Goldstream road north of the Peat Ponds has had lots of reconstruction and repaving due to damages from the permafrost. With such repeated paving I am curious if there is measurable pollution to the Peat Ponds environment. I hypothesized that the soil and water conditions in this environment would decrease with greater proximity to the road and parking lot. From the data I collected, it appears that there may be variability in the soil temperature.

Methods

There is a fair amount of research on peatlands because of their relationship with climate change and the unique habitat and ecosystem services that they provide. This invokes research on the factors that drive peat formation and the processes that occur in peatlands. However, I have not found a strong link with the known research and the question of damage from road construction for this location. Each of the six data collection points are spaced 100ft from each other with the first point being closest to the road and the sixth point being farthest from it. Soil pH and temperature along with water pH, temperature, and dissolved oxygen was measured where possible with the intention of comparing how these measurements change with distance from the road.

The area of study ranges from the ditch of the Goldstream road to the south side of the Peat Ponds Wildlife Area. The first and second sites, which are closest to the road, consisted of only soil measurements. The third and sixth sites are on the north and south bank of a pond, respectively, and consisted of both soil and water measurements. While the fourth and fifth sites consisted of only water measurements which were done from a kayak. I placed these sites along a transect to ensure that each point was 100ft from the other and because I thought it was representative of the main area of development.

All measurements were done according to GLOBE's soil pH and Temperature guided protocols (Pedosphere, *GLOBE Program*) and water pH, Temperature, and Dissolved Oxygen guided protocols (Hydrosphere, *GLOBE Program*). Dissolved oxygen was measured with the probe protocol while for both soil and water, pH was measured with pH paper and temperature was measured with an alcohol thermometer. Before I collected any data in the field, I calibrated my alcohol thermometers by keeping them in an ice bath until they read zero degrees Celsius and I used the dissolved oxygen probe on distilled water. In the field I stored my pH tape in tin foil to preserve the tape. Data was collected on 10/16/25, 10/19/25, and 10/21/25.

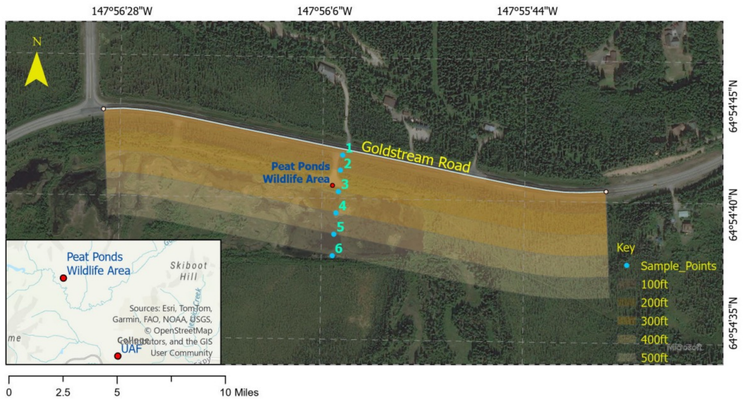

Figure 3. (above) This highlighted section of Goldstream road north of the Peat Ponds Wildlife Area has been annually damaged by permafrost and gone through many seasons of reconstruction. The gradient bars indicate 100ft intervals from the road. The scale bar is based on the mini map.

Figure 4. Alcohol thermometers calibrated in ice bath.

Figure 5. Dissolved oxygen being measured with a probe and water temperature being measured with an alcohol thermometer on 10/19/25 through a thin layer of ice.

Results

The collected Hydrosphere and Pedosphere data are in the two charts below. Note that the data from the site closest to the road is on the far left (#1), and the furthest is on the right (#6).

The Hydrosphere data show no discernable trend. The pedosphere data - both soil temperature at 5cm and 10cm - decreased with greater distance from the road.

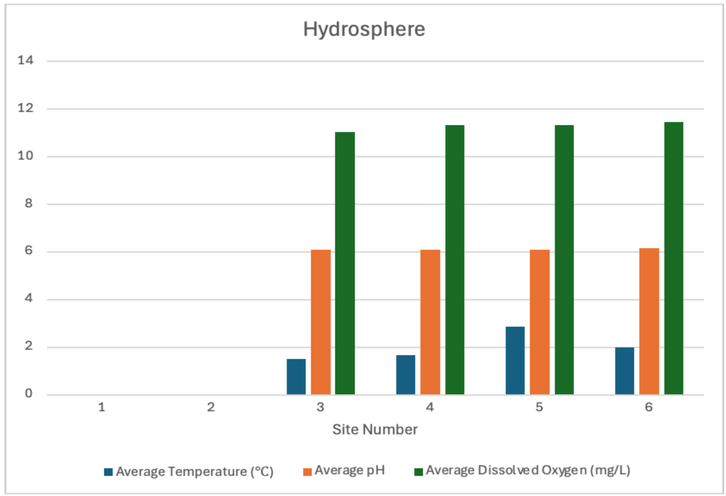

Figure 1. (above) Water temperature slightly increased with greater distance from the road. Water pH and dissolved oxygen did not show any notable differences between sights. There is no data at sites one and two because there is no open water present.

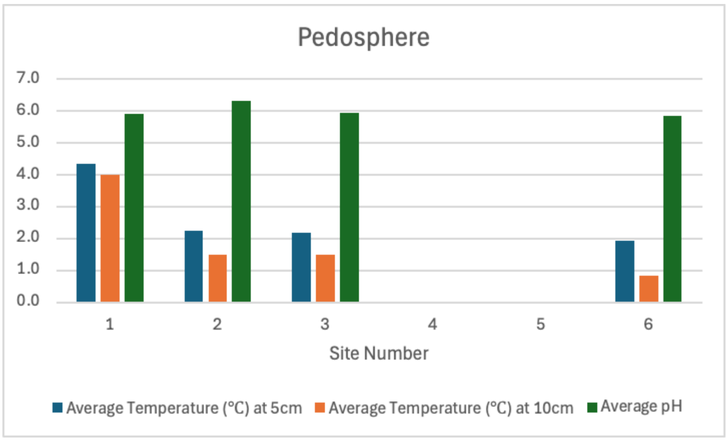

Figure 2. (above) Soil temperature decreased with greater distance from the road at both 5cm and 10cm deep in the soil. There is no notable difference between the soil pH at each site. There is no data at sites four and five because there is no soil present.

Figure 6. Soil pH being measured from a 1:1 ratio solution with distilled water. pH tape stored in tin foil.

Figure 7. Taking soil measurements at site two.

Discussion

The most interesting data is the soil temperature because of its relationship with permafrost and the proximity to the road. Higher soil temperatures should indicate thawing or less permafrost. Higher soil temperatures recorded near the road supports the hypothesis. There have been many efforts to preserve the Goldstream road from permafrost thaw such as insulating the permafrost with foam board before reconstruction (Allen 2013). A slight variation in water temperature can be seen in the measurements. This occurs at site five which is in the middle of the water body. I think this may be due to the water depth and location of the site or just a lack of measurements at sites four and five. There are no significant differences in the measurements of pH for both the soil and water and dissolved oxygen between each site. This makes sense because the area should be in good condition as it has been preserved by the Interior Alaska Land Trust since 2006 (Raynolds et al. 2012). With my pH measurements averaging around six, this fits the acidic conditions in peatlands (Priest 2012) which contributes to peat soil formation (International Peatland Society).

However, this area was excavated for peat mining in 1996 (Raynolds et al. 2012) so some further research could be done to investigate any lasting impacts to this peatland. I believe that my sources of error come from measuring equipment and the time of year that I took measurements. I was only able to take two sets of measurements from sites four and five due to the water freezing over on 10/21/25 which could account for the variation in water temperature in my graph. Using pH tape in the soil solution was difficult because the tape would get dirty and make it hard to identify the exact color of the tape. I also found some trouble with the dissolved oxygen probe once ice had covered water. After breaking through the ice my initial reading would match that of the first sample before rapidly declining. This research could have benefitted from a different type of pH and dissolved oxygen measurement.

The soil temperature measurements support the hypothesis that the road construction may have an effect on the peatland environment but there is no support from the soil pH and water temperature, pH, and dissolved oxygen data. This topic is important because globally, peatlands cover 3-4% of the total land surface while storing one third of the soil carbon on the planet. It has been found that longer periods of warmer and dryer conditions increase the decomposition of peat which results in the release of stored carbon and pollutants in the organic matter (Martinez Cortizas et al., 2007). The destruction of 12% of current peatlands has contributed 4% of global anthropogenic emissions (*UN Environment Programme* 2022). For watershed managers of peatlands, the preservation of peat soil is a critical part of management in climate change which involves permafrost, hydrology, ecology, and a world of feedback mechanisms (Ran, et al. 2022).

References

Allen, Sam., (2013). Goldstream Road Construction Project Uses Rare Techniques. *Fairbanks Daily News Miner.* https://www.newsminer.com/news/local_news/goldstream-road-construction-project-uses-rare-techniques/article_80c1f4cc-0c6a-11e3-aa6e-0019bb30f31a.html

Hydrosphere. *GLOBE Program.* https://www.globe.gov/web/hydrosphere/protocols

International Peatland Society. https://peatlands.org/peat/peat-formation/

Martinez Cortizas A., Biester H., Mighall T., and Bindler R. (2007). Climate-driven enrichment of pollutants in peatlands. *Biogeosciences*, 4, 905–911. bg.copernicus.org/articles/4/905/2007/bg-4-905-2007.pdf

Pedosphere. *GLOBE Program.* https://www.globe.gov/web/soil/protocols

Priest, Susan., (Ed.) Davis, B. Ronald., (2012) Peatland Acidification and Understanding pH. *University of Maine.* https://umaine.edu/oronobogwalk/wp-content/uploads/sites/393/2015/03/Peatland-Acidification-pH.pdf

Ran, D., et al. (2022). The Role of Peat on Permafrost Thaw Based on Field Observations. *CATENA*, 208. https://doi.org/10.1016/j.catena.2021.105772

Raynolds, Martha., Prichard, Alex., Paragi, Tom. (2012). Baseline Documentation and Management Plan. *Interior Alaska Land Trust.*

(2022). Global Peatlands Assessment: The State of the World's Peatlands. *UN Environment Programme*. https://www.unep.org/resources/global-peatlands-assessment-2022

Land Acknowledgement

This project took place on Dena Athabascan lands of the lower Tanana river.

Acknowledgements

Thank you to Kelsey Aho for providing measuring equipment and instructing the NRM 370 course and to Christi Buffington for providing measuring equipment.