Impact of Forest Fire on Aquatic Invertebrates in Subarctic Lakes of the Taiga Plains

Thomas Pretty and Derek Gray, Department of Biology, Wilfrid Laurier University

Introduction

Fires represent a major natural disturbance in the boreal region, and their frequency is increasing in response to drought caused by climate change[1]. In 2014, severe megafires spread throughout Canada's Northwest Territories (NWT)[2], burning a landscape rich in lakes and ponds.

Background Information

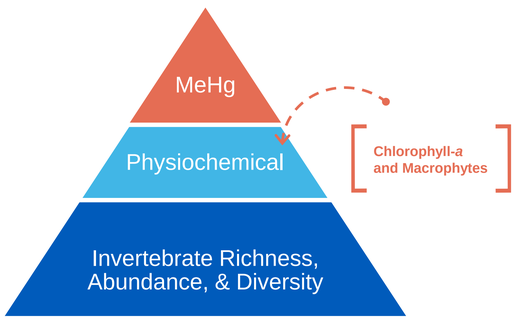
Lakes found in burned areas often experience large increases in nutrients and metals which can have negative impacts on aquatic communities, including sport and subsistence fish[3].

Permafrost Thawing and Mercury

- The Taiga plains ecozone consists of nutrient and trace metal rich soil[4].
- Thawed permafrost exposes more of the active layer to weather run-off.
- *"Permafrost regions contain twice as much mercury as the rest of all soils, the atmosphere, and ocean combined."* [5]

Objectives of Study

- Assessing three criteria that affect aquatic invertebrates (benthic and zooplankton):



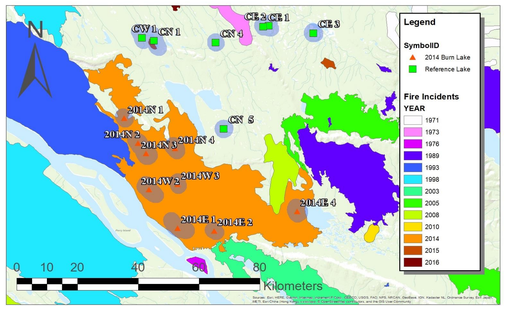
To what extent do forest fires impact aquatic invertebrates in the Taiga plains?

Site Selection

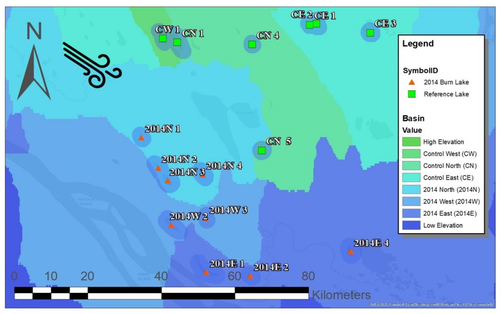
Sixteen lakes were sampled in August, 2018, northwest of Norman Wells in the Sahtú Settlement Area. Seven were affected by a 2014 burn, two were partially burned in 2015, and five are reference lakes not affected by any recorded burn.

A. Consideration of previous burns.
B. Drainage basins.
C. Delineated water catchment areas.

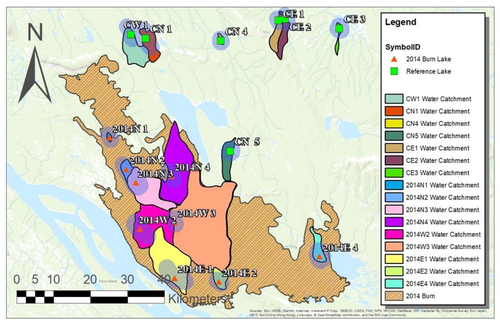
A



B



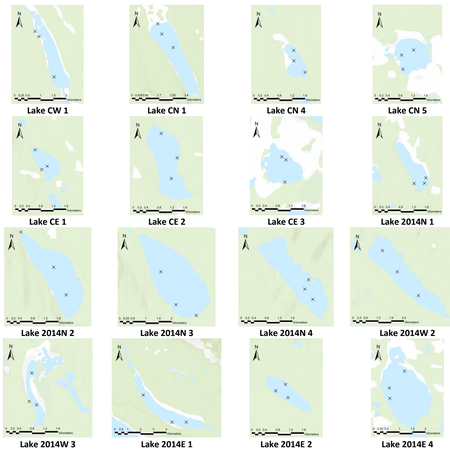
C



An additional 4-6 reference lakes at lower elevations are scheduled to be sampled in the upcoming 2019 field season.

Methodology

Three random locations per lake were sampled for aquatic invertebrates and physicochemical variables. Water for trace metals and nutrient analyses was collected at the center of the lake.



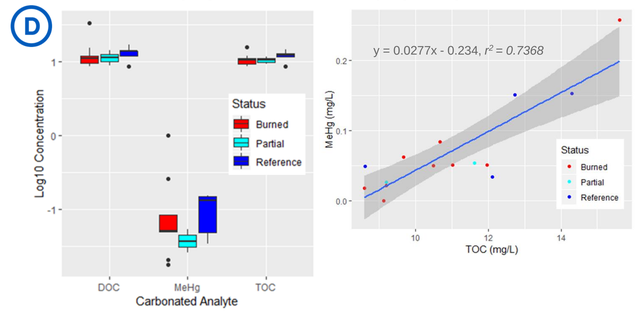
Parameter Analyzed	Area of Lake Sampled	Analysing Instrument
Alkalinity ($CaCO_3$), Ammonia (NH_3), Colour (Pt), Nitrite (NO_2-), Nitrate (NO_3-), Phenols (C_6H_5OH), Phosphate (PO_4), Sulfate (SO_4-), and Turbidity (TU)	Limnetic zone (center)	YSI-9500 (immediately upon returning from field)
pH, and Temperature (ºC)	3x Littoral zone/Limnetic zone (center)	Oakton 150 series Waterproof handheld meter
Conductivity, and Dissolved Oxygen (DO mg/L)	3x Littoral zone/Limnetic zone (center)	YSI-Professional Plus meter, polargraphic sensor probe (DO)
Dissolved Organic Carbon (DOC), Total Nitrogen (TN), and Total Organic Carbon (TOC)/	Limnetic zone (center)	Shimadzu TOC-LCPH Carbon and Nitrogen Analyzer
Total Phosphorous (TP)	Limnetic zone (center)	SEAL Auto-Analyser
Methyl-Mercury (MeHg)	Limnetic zone (center)	Cold Vapour Atomic Fluorescence-Digestion
Other Trace Metals (Ag, Al, Ba, Ca, Cd, Cu, Fe, K, Li, Mg, Mn, Na, Ni, Pb, S, Sr, Ti, and Zn)	Limnetic zone (center)	Perkin Elmer Optima 8000 ICP-OES /PinAAcle900T AA graphite furnace

Preliminary Results

One-way ANCOVAs were conducted to test for a difference in physicochemical and biological variables between burned and reference lakes, controlling for variation in lake surface area and catchment area. Only macrophyte species richness was significantly different between burn and reference lakes, $F(2, 10) = 4.891$, $p = 0.0330$.

Surprisingly, nutrient and trace metal concentrations did not significantly differ between burned and reference lakes:

D. Carbon and methylmercury.
E. Total phosphorous and total nitrogen.
F. Chlorophyll-*a* and macrophyte species richness



Conclusion

Our preliminary analyses suggest that there are very few significant differences in physicochemical variables between burned and reference lakes. Analyses of biological data is ongoing. Will this be consistent with the invertebrates? Does the increase in macrophyte species richness indicate biodilution?

References

1. Kasischke, E.S., Verbyla, D.L., Scott Rupp, T.S., McGuire, A.D., Murphy, K.A., Jandt, R., Barnes, J.L., Hoy, E.E., Duffy, P.A., Calef, M., & Turetsky, M.R. (2010). Alaska's changing fire regime — implications for the vulnerability of its boreal forests. *Canadian Journal of Forest Research, 40*(7), 1313-1324. https://doi.org/10.1139/X10-098

2. Walker, X.J., Rogers, B.M., Baltzer, J.L., Cumming, S.G., Day, N.J., Goetz, S.J., Johnstone, J.F., Schuur, E.A.G., & Turetsky, M.R. (2018). Cross-scale controls on carbon emissions from boreal forest megafires. *Global Change Biology*, (February), 1-15. https://doi.org/ 10.1021/es100544d

3. Smith, H.G., Sheridan, G.J., Lane, P.N.J., Nyman, P., & Haydon, S. (2011). Wildfire effects on water quality in forest catchments: A review with implications for water supply. *Journal of Hydrology*, *396*(1-2), 170-192. https://doi.org/10.1016/j.jhydrol.2010.10.043

4. Soil Classification Working Group. (1998). The Canadian System of Soil Classification, 3rd ed. Agriculture and Agri-Food Canada Publication 1646.

5. Schuster, P. F., Schaefer, K. M., Aiken, G. R., Antweiler, R. C., Dewild, J. F., Gryziec, J. D., … Zhang, T. (2018). Permafrost Stores a Globally Significant Amount of Mercury. *Geophysical Research Letters*, *45*(3), 1463–1471. https://doi.org/10.1002/2017GL075571

Department of Biology
Wilfrid Laurier University
www.wlu.ca

Northern Water Futures