Arctic Freshwater Biodiversity in Cambridge Bay
2019 field season report from lake sampling in Cambridge Bay

NRI license # 04 036 19R-M
Fishing additionally under the DFO license issued to Marlene Evans S-19/20-1024-NU

No sampling was carried out under this license in 2020 due to the Covid-19 pandemic

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PROJECT SUMMARY AND SAMPLING IN 2019

A field sampling campaign was carried out in Cambridge Bay (Ekaluktutiak) in August 2019, with the aim to fill the knowledge gap in Canadian Arctic freshwater monitoring and to evaluate the ecosystem health of Arctic freshwaters. Additional aim was to study how hydrological connectivity among lakes determines productivity and biodiversity in lake food webs.

This work continued the research we had initiated with the Canadian High Arctic Research Station (CHARS) and was done under the NSRI license # 04 036 19R-M. The part of the sampling that included fish was done under the DFO licence to Dr. Marlene Evans. The research also contributed to our Polar Knowledge Canada supported project “Ecosystem Health of Arctic Freshwaters” and to the

Circumpolar Biodiversity Monitoring Program (CBMP) that has been created in collaboration with all eight circumpolar countries. Each country aims to follow the same sampling protocol with the aim to provide high quality and comparable information of different environments in the Arctic and their biodiversity.

The primary aim of the 2019 sampling was to identify and quantify fatty acid and mercury (Hg) stocks and fluxes in the freshwater food webs in the lakes near the Ekaluktutiak community. Fatty acids are essential nutrients for animal growth, health and immune system, including humans, and their abundance and composition are considered as indicators of the ecosystem health. While being essential health substances they may also correlate with the abundance of Hg in the food web. The Hg in the aquatic organisms is bioaccumulated in Arctic char and lake trout which contribute substantially to traditional Inuit meals and can be a source of mercury and persistent organic contaminant. The results will provide tools for the Ekaluktutiak community to maintain essential ecosystem services (e.g. fishing) in the region.

Sampling

24 lakes were sampled in the Greiner Lake watershed in August (Fig. 1).

In each lake, measures of temperature, oxygen and conductivity were taken to understand the physical environment in Arctic lakes. The lakes were sampled for nutrient regimes, carbon composition, bacterial, primary and zooplankton production and species composition. We further sampled different trophic levels from plankton to fish for lipid composition and contaminants.

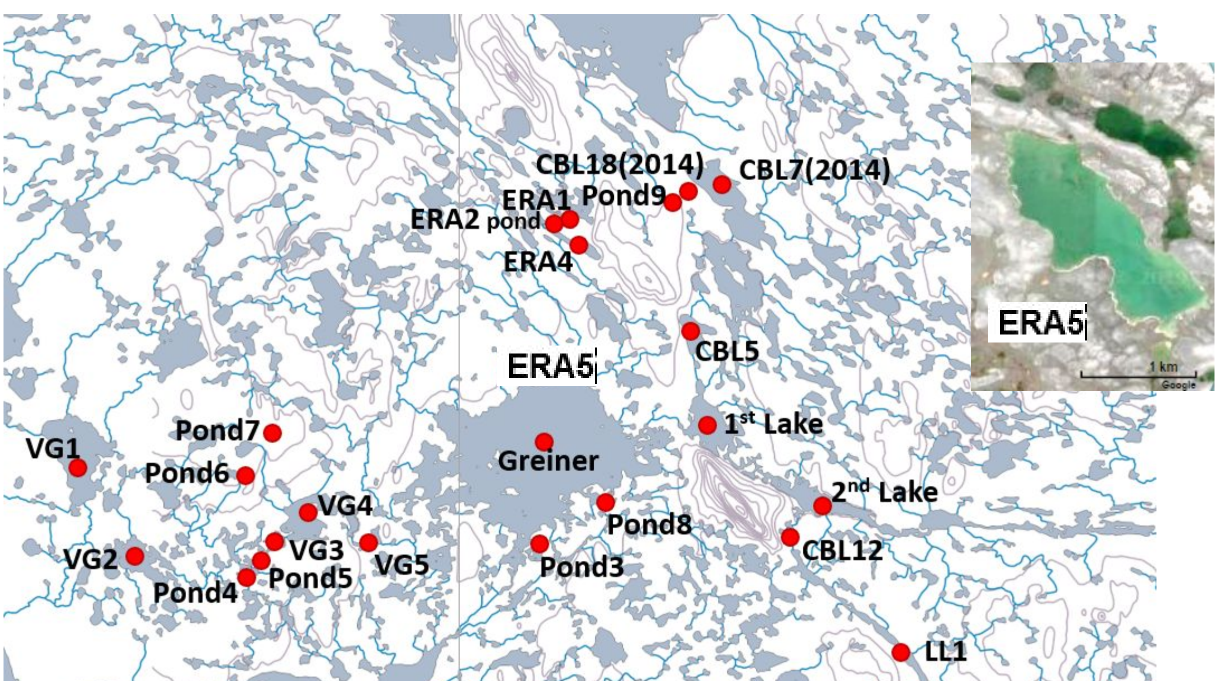

Fig. 1. Sampling sites in the 24 lakes that were sampled in August 2019 to collect limnological and biological data. The insert shows the Lake ERA5 that, according to our results, is highly productive and can be considered eutrophic.

PHOTOS OF SAMPLING

Fig. 2. Hydrologically connected lakes and ponds near Cambridge Bay in August 2019 (Photocredit: Milla Rautio).

Fig. 3. Limnological sampling with Inuit guides near Cambridge Bay in August 2019 (Photocredit: Milla Rautio). Our work in Cambridge Bay builds on the solid foundation of respect, cooperation and knowledge exchange that we have built up from many years of working with the Ekaluktutiak community.

Fig. 4 Limnological field laboratory near Cambridge Bay in August 2019 (Photocredit: Milla Rautio).

Fig. 5. Limnological sampling near Cambridge Bay in August 2019 (Photocredit: Paola Ayala Borda).

Fig. 6. Our Inuit guide Henry Ohokannoak at Second Lake in Cambridge Bay in August 2019. (Photocredit: Beatrice Carrier)

RESULTS

First evidence of a eutrophic Arctic lake with no direct human impact

We evidenced eutrophication in one lake. A lake we call ERA 5 showed signs of eutrophication based on satellite imaginary data (Fig. 1 insert). Trophic index in this lake was also the highest based on the nutrients and chl-a (Fig. 7). The lake phytoplankton was largely composed of cyanobacteria (42.9%) and the bacteria production in this lake was the highest of all lakes studied (Fig 8). This may be the first report of eutrophication for an Arctic lake that has no direct human influence in its watershed and sets a precedent of eutrophication in the North, and calls for monitoring studies of freshwater quality in the Arctic.

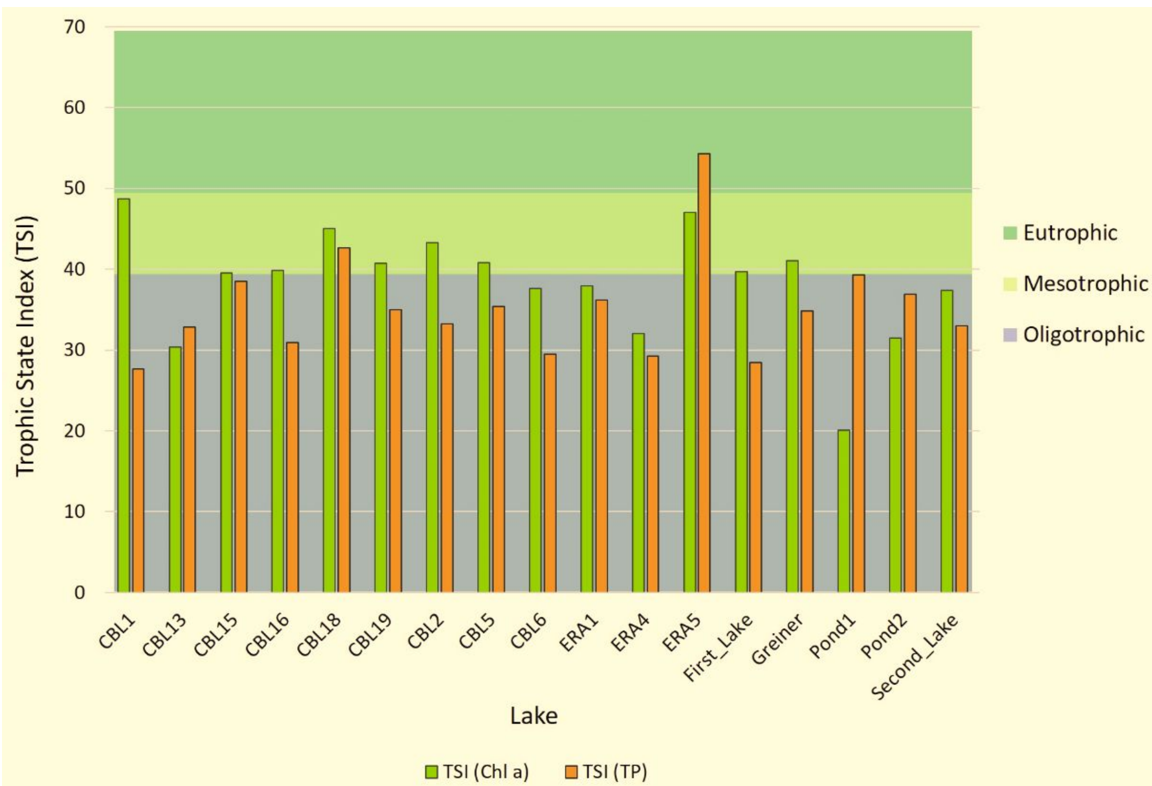

Fig. 7. Majority of lakes in Cambridge Bay are low productive lakes, with Lake ERA 5 being an exception and highly productive.

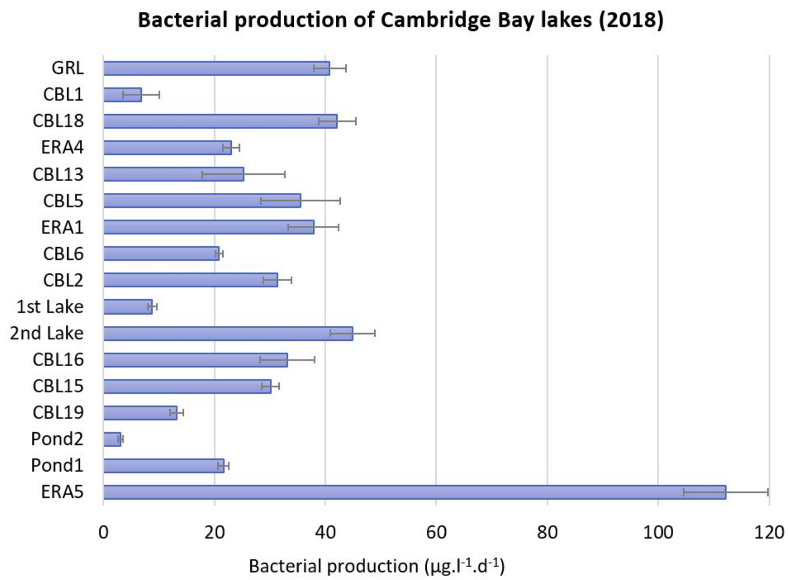

Fig. 8. Bacteria production in Cambridge Bay lakes showing the extreme high production in Lake ERA5.

Omega-3 fatty acids and mercury in the food web of Greiner Lake

We investigated Arctic char, whitefish, lake trout and lake cisco from Greiner Lake which supports a major domestic fishery for the community of Cambridge Bay. Essential ω3 fatty acids, which are manufactured by phytoplankton, move up through the food web via zooplankton, benthic invertebrates, to fish and ultimately humans. Mercury is bioaccumulated by all biota and biomagnified in food webs with apex predators having the highest mercury concentrations. Consumption advice for fish is based, in part, on their mercury concentrations. Thus, there is a balance between the benefits and risks of consuming top fish predators.

We sampled 26 resident Arctic char, 29 whitefish, 17 lake trout and 28 least cisco. The average age of Arctic char were 9.2±2.6 years, whitefish were 14.4±6.4 and lake trout 25.6±9.5 years old.

Arctic char fed on sticklebacks, amphipods and other organisms close to the shore and bottom, but also on zooplankton in the open water, and had the highest concentration of ω3 fatty acids, followed by whitefish that fed on open water zooplankton (Fig. 9). Lake trout had similar feeding habits as char and a low amount of ω3 fatty acids, and least cisco had even less of these health-determining compounds.

Mercury concentrations in fish increased with fish size and trophic feeding (Fig. 10). Concentrations were highest in lake trout, possibly because of the extreme age and slow growth rates of these predators. Lake whitefish had surprisingly high mercury concentrations which may in part be related to where they are feeding in the lake. Resident Arctic char had lower mercury concentrations which were more typical of that expected for resident and land locked populations.

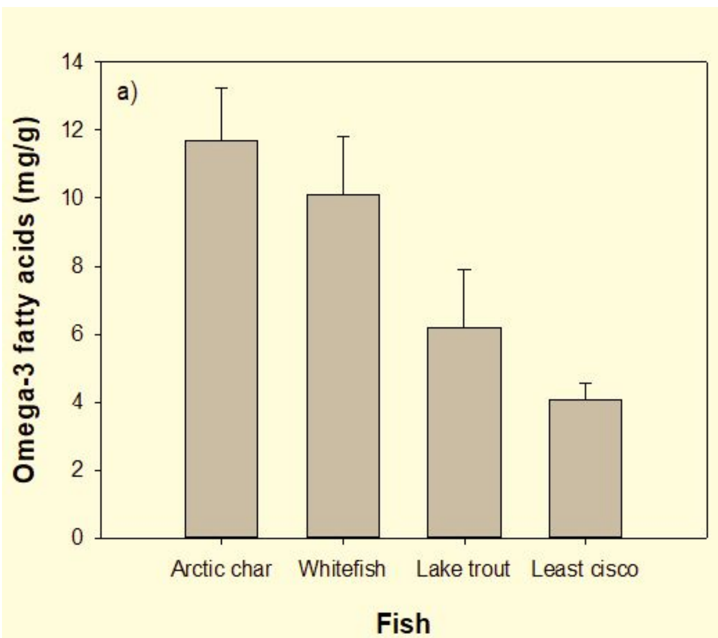

Fig. 9. Omega-3 fatty acid concentrations in fish in Greiner Lake

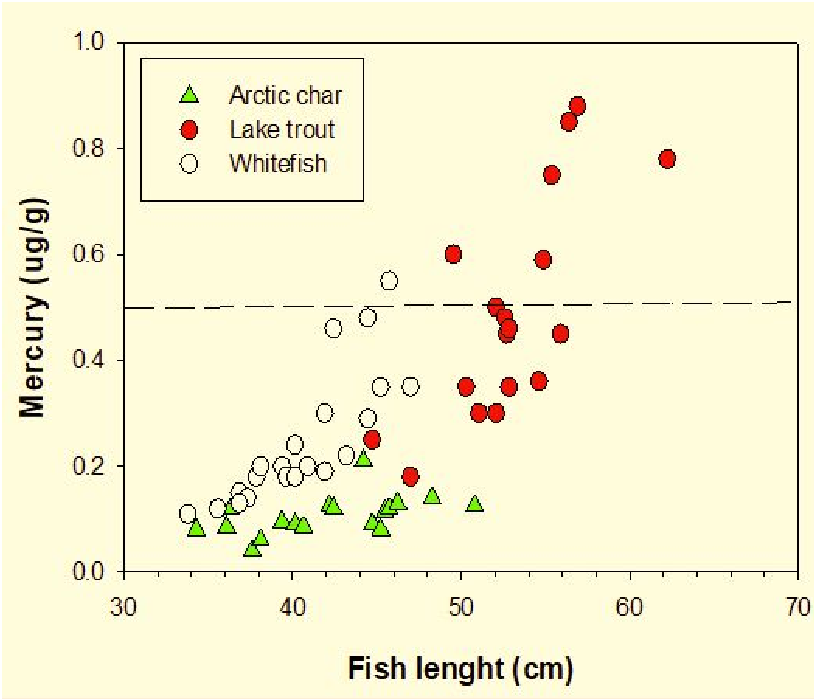

Fig. 10. Mercury concentrations in Greiner Lake fish. The dotted line indicates the 0.5 µg/g commercial sale guideline.

Consult and share knowledge

Results have been consulted to academic and northern communities in ArcticNet annual meeting in December 2019, Center for Northern Studies symposium in January 2020 and during the Open House in Cambridge Bay in August 2019.

The community has been informed of our fish mercury and ω3 fatty acid results through plain language posters and presentations; fish mercury finding also have been made available to Nunavut Health. With their very low mercury concentrations and high ω3 fatty acids, arctic char provide the best nutritional balance between risk and benefits in fish consumption.

Posters made and translated in Inuinnaqtun to present the project to the Ekaluktutiak community (see example in Fig. 11). The posters were designed according to the advice from the Ekaluktutial HTO how to best present scientific research questions to the locals.

Presentations of our 2019 sampling and results

Ayala Borda, P., Lovejoy C., Power, M., and Rautio, M. 2020. First evidence of eutrophication in Arctic lakes. Poster presentation in Center for Northern Studies meeting (13 February, 2020). Awarded as a best PhD poster.

Blackburn-Desbiens, P, Grosbois, G. Power, M. and Rautio, M. 2020. Primary and secondary production in Arctic lakes and ponds. Poster presentation in Center for Northern Studies meeting (13 February, 2020).

Evans, M., Derek Muir, Beverly Maksagak, Milla Rautio, Guillaume Grosbois, Michael Power, Donald McLennan, Geoff Koehler, Les Harris, Jonathan Keating, and Xiaowa Wang. 2019. Mercury and food web investigations in sea-run char and the Greiner Lake ecosystem. Presentation to ArcticNet Annual Science Meeting, Halifax, December 2019.

Grosbois, G. 2019. Greiner Lake food web studies. Oral presentation at the Canadian High Arctic Research Station (CHARS). 17 August, 2019.

Rautio, M, Wauthy, M. and Grosbois, G. 2019. Effect of permafrost thaw on plankton and fish in Arctic lakes. Presentation to the Arctic Net Annual General Meeting, Halifax, Nova Scotia, December 2019.

Rautio, M. 2019. Cambridge Bay Actua Science Camp. Presenting freshwater organisms and food webs to youth. 16 August, 2019.

Rautio, M. 2020. Permafrost thaw and consequences on freshwater food webs. Center for Northern Studies Annual Meeting (plenary keynote). 14 February, 2020.

Rautio, M. The thrill that comes with science. Open House presentation in Cambridge Bay community Hall 20 August, 2019.

Kanogaalok kayangnaktukat ekaluit Ekaluktutiami Ekaluktutiak?

HOW MUCH MERCURY IS THERE IN FISH IN GREINER LAKE?

Marlene Evans, Michael Power, Milla Rautio
Environnement Canada, University of Waterloo, Université du Québec à Chicoutimi

Fig. 11. Poster about our mercury measures in fish in Cambridge Bay fish.

Sampling plan for 2021

In 2021 we plan to sample lakes in Greiner Lake watershed in spring summer, fall and winter. Some of this work will be carried out by our northern **collaborators who are residents of Cambridge Bay. If travel to Nunavut is granted by NRI, Department of health and approved by the Hamlet, team of researchers and their students will also go to Cambridge Bay to carry out more demanding sampling and to ensure student training. By more demanding** sampling we mean samples that require immediate treatment by procedures that involve training our northern collaborators have not received, e.g. separation of plankton species under microcope for species-specific analyses. Some samples also need to be stored at -80°C and analysed within a short time period after sampling requiring someone carries them to our southern labs soon after the sampling.

Our sampling in 2021 will concentrate on some of the key arctic char lakes identified by HTO (Long Lake, Second Lake, First Lake, Inuhuktok (CBL5 on the map) and the streams that feed into these lakes. We will also sample CBL13 that has landlocked char and return to ERA5 to study more the eutrophication in this lake (Fig. 12). Some of the lakes will also be sampled in spring/early summer 2021 and fall/winter 2021 to continue to increase our understanding of the winter ecology in Arctic lakes.

We further plan to deploy up to four year-round temperature data loggers in the lower reaches of rivers in the Cambridge Bay region that Arctic char migrate through. High water temperatures can impair the ability of Arctic char to complete their migration. To determine how common such temperatures are we will deploy temperature data loggers in Freshwater Creek (69.1298°, -104.9954°), Kitiga (69.2855°, -106.1856°), Palik (Lauchlan River; 68.9456°, -108.5878°) and Halokvik (69.1759°, -107.1079°) rivers. The loggers (~10cm x 3cm) will be attached to a steel pipe (6cm diameter x 60cm length) that will be hammered ~40cm into the substrate. The loggers will be deployed between July and September 2021, exchanged in summer 2022 and the pipes and loggers will be removed in summer 2023. A small passive contaminant sampler (~5cm*10cm) will also be attached to the pipe to determine the concentrations of chemical contaminants (e.g. Polychlorinated biphenyls) in Arctic char habitats.

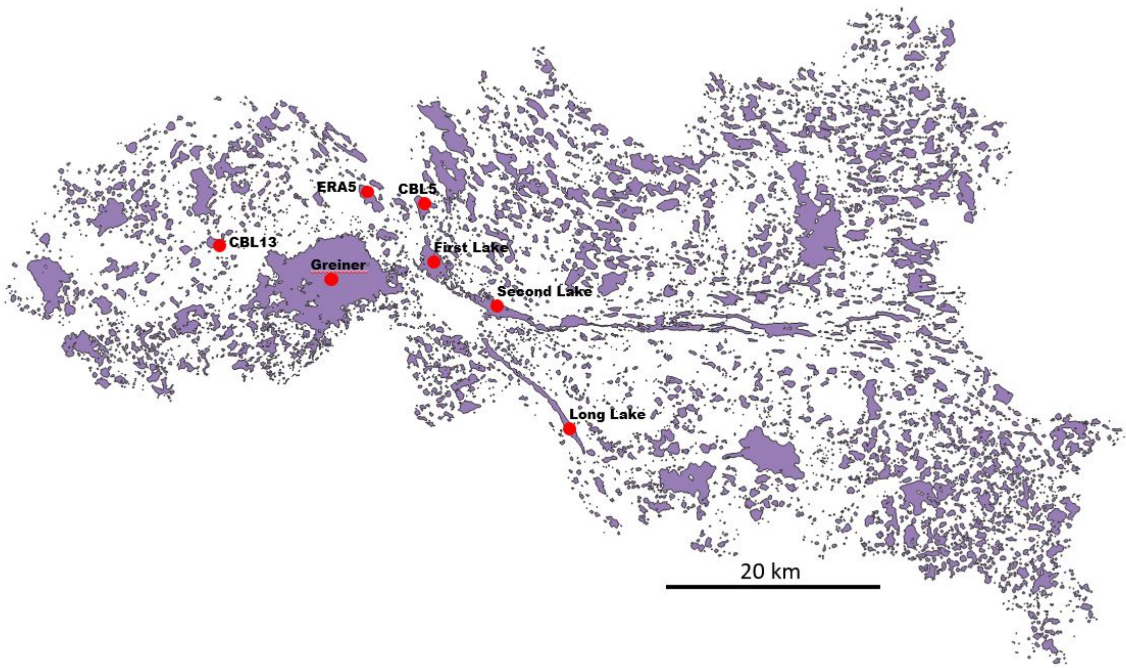

Fig. 12. Map of lakes that will be sampled in 2021.