

Annual research report for:

Canadian Wildlife Service multiyear licence NF-NR-2019-NU-013
Nunavut Research Institute licence 02 012 21R-M
Mayor's Office, Sulukvait APMC & HTA, Resolute NU

Project Title: Lake Ice in the Canadian High Arctic

Lake ice is an important part of the cryosphere and recent projections suggest a pan-Arctic reduction in ice duration (20 - >100 days) and thickness (0.3 - > 1 m) by the year 2100 [1]. Documented changes in the ice covers of Arctic lakes have already been noted in recent years. On Cornwallis Island (NU), recent modelling work suggests a reduced ice-covered season on Resolute Lake since the 1960's [4], and recent field data has shown a reduction of maximum ice thickness by ~50 cm already on a small High Arctic Lake (Small Lake) compared to the early 1980's. As changes occur, there is a need to understand the implications and response of the water/energy balance and the effects on other areas of research (e.g. ecology, limnology, transportation). Of particular significance in the High Arctic is the effects of changing climate on lake biota (e.g. Char) as reduced ice cover on lakes will affect lake parameters such as available light conditions through the ice, longer open water seasons, and overall water temperature increases. The majority of ground-based ice observations in Canada ceased by the 1990s, and recent ice cover changes have been primarily noted through modelling and remote sensing. To monitor changes, and validate modelling and satellite imagery, lake ice data in Canada is being collected across a latitudinal gradient from Haliburton ON (temperate) to Nanuit Itillinga National Wildlife Area and Resolute (High Arctic). The field data is being used to improve the effects of snow cover on modelled ice thickness; to isolate how the duration of the modelled ice break-up season is affected by the shape/size of the lake; and to highlight the differences between northern vs. mid-latitude ice processes.

Permittee name and contact information:

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2021 Research Team:

Laura Brown, Brianna Lane, Daniel Serrano Cadena, Xiaomeng Zuo
Team that entered Nanuit Itillinga NWA: Laura Brown, Brianna Lane, Daniel Serrano Cadena, Xiaomeng Zuo, Helicopter pilot

Date and Duration of research:

Our research visit in 2021 took place from Aug 2 – 19, with a 3 hour visit to Nanuit Itillinga National Wildlife Area on Aug. 6 and 2 hours on Aug. 7.

Transportation and Travel Routes:

Exact helicopter flight route was not recorded from Resolute (PCSP) to Nanuit Itillinga. We landed beside the cabin to download and do maintenance on the weather station, before landing again at the small camera on the shore of Hunting Camp Lake (75.73N, 98.42W) (Figure 1). Transportation to the lakes outside Resolute was all by ATV on marked roads.



Figure 1. Location of landing and work sites in the NWA, and the cameras around Resolute lakes.

Summaries of Activities:

This year, our field party consisted for 4 members: Laura Brown, Brianna Lane (MSc student who joined UofT in Sept 2021), Daniel Serrano Cadena (MSc student, year 2), Xiaomeng Zuo (MSc Student, year 1). Our group spent 17 days (Aug 2 – Aug. 19) working from PCSP in Resolute, with two brief trips over to Nanuit Itillinga, Bathurst Island for equipment maintenance (day 1) and some lake depth measurements (day 2).

We were able to salvage some of the 2019-2020 data from the equipment and complete most of our intended research goals for the 2021 trip.

We successfully retrieved the ice thickness sensor from Small Lake, however it was damaged from being dragged by the ice too close to shore and experienced substantial data loss from both the 2019-2020 and 2020-2021 ice season. I am not sure yet if any of the data can be salvaged from those 2 seasons. We were able to use a replacement sensor for this year while the original is being repaired and we are hopeful for data through the 2021-2022 season. We were able to retrieve most of the camera imagery for 2020-2021 (2019-2020 was collected by D. Iqaluk in 2020); we did lose imagery from North Lake and Plateau Lake, but have a full season from Resolute, and Small lakes. This year we collected detailed lake depth measurements from Resolute Lake, and some from Small Lake, using leased equipment from Department of Fisheries and Oceans. The aim was to create digital shareable maps for anyone interested (Figure 2) and hopefully be used for satellite validation for a future project on lake depth from satellite data. If we are able to rent other equipment in the future we hope to map the lake bottoms on other nearby lakes as well. Once the digital maps are ready, I will make them available on my website.

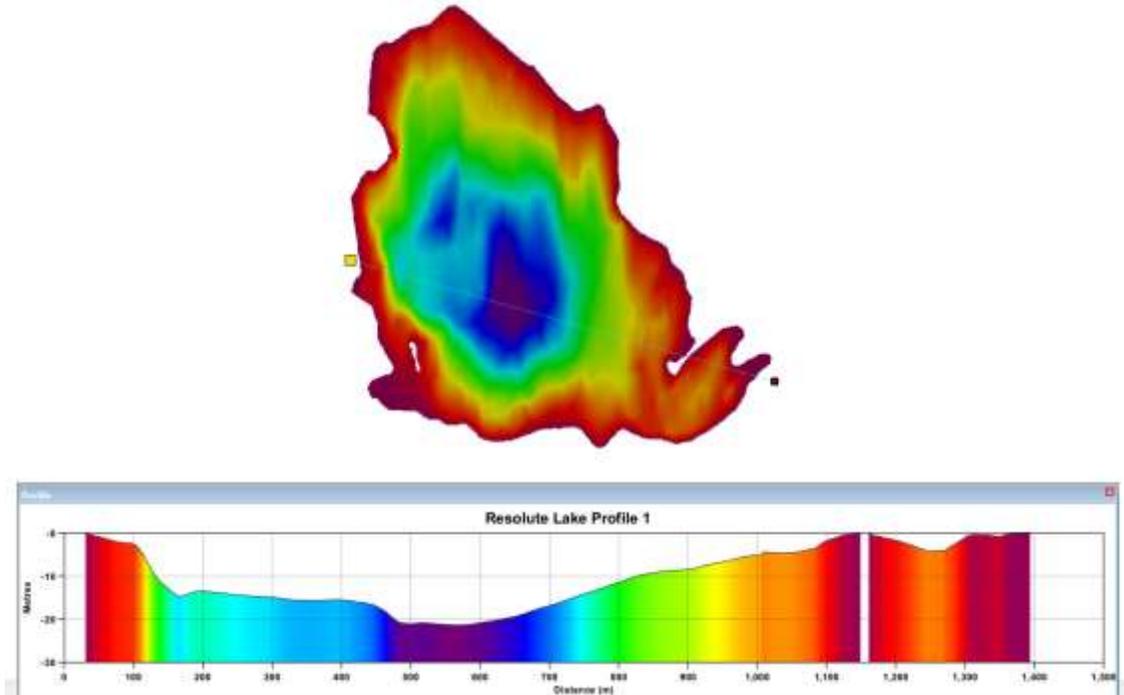


Figure 2. Lake depth and cross section of Resolute Lake.

At Nanuit Itillinga NWA we were able to download and service the small camera structure on the NE shore of Hunting Camp Lake and happily, all was working well. The weather tower was serviced, the temperature and wind sensors replaced, and the rain gauge repaired. We were able to collect some manual lake depths from Hunting Camp Lake in the view of the shore camera using a small inflatable boat. While we know from the ACMC that the ice likely freezes the bottom of the lakes (suggesting less than 3 m depth), we needed some detailed measurements of the region in view of the camera. I plan to continue to use Hunting Camp Lake as a representative lake for the area in terms of modelling, as there is an existing climate record and snow cover data available. Claude Labine from Campbell Scientific was not with our team this year but is still an active participant with respect to the tower maintenance and data records.

Record of Wildlife observed (NWA):

On Aug 6 we observed 13 Muskox in the valley near the CWS Cabin, 1 lemming near the weather tower, 1 weasel, and 1 white bird flying near the shore of Hunting Camp Lake. On Aug 7 we observed a group of 3 muskox in a valley near the cabin, with 1 additional muskox on its own not too far away from the group of 3.

Community consultation and involvement:

Due to covid-19 restrictions we were not allowed to hire a field assistant or go into town to speak with the HTA in person as we had hoped. We were in communication with the SAO regarding research permissions though so that we were able to carry out our August research. We were not able to drop off a UBS stick with the past years camera imagery to the HTA, but will do so when we are there next.

We were not able to travel to Resolute in May as planned due to covid-19 restrictions, so we were not able to attend the fishing derby in Resolute as hoped to measure some ice thickness. Our research poster at the school is a bit out of date now and we would like to make a new one to send, or perhaps come by next year for science day if our May trip takes place and timing works. Thank you to Debbie Iqaluk who serviced the cameras for us again in 2020 on the lakes around Resolute. We plan to reach out again in the spring for assistance with the camera maintenance and

hope to chat with the HTA about potentially hiring some assistance for Nanuit Itillinga during the year if anyone is travelling there. It would be very helpful for checking on the tower and potentially downloading the data.

Future Plans within the Protected Area and Overall Project Progress:

Overall project plans are to continue monitoring the lake ice conditions to build a record of annual variability. Within the NWA we hope to service a few more instruments on the weather tower and potentially add a satellite modem (unlikely for 2022 as I do not have enough funding left, but hopefully in the next funding cycle). We would like to hire a field assistant from Resolute to work with us for one or two day trips to the NWA in 2022 if we are allowed and will reach out in the late spring once funding and travel dates have been confirmed to see if anyone would be interesting in that.

Ice formation and melt dates from the camera imagery are all posted on my website: <https://sites.utm.utoronto.ca/brown/content/lake-ice-cover-dates-nunavut>. The climate data from the NWA weather tower and the Resolute weather stations are being used for lake ice modelling work, simulating the ice cover for as far back as the climate records allow.

One new publication is out using the camera imagery for ice cover dates, and one other publication that might be of interest though not directly related to our field data (both open access if anyone would like to read them):

1. Dauginis A and Brown LC. 2021. Recent changes in pan-Arctic sea ice, lake ice, and snow-on/off timing. *The Cryosphere*, 15, 4781–4805, <https://doi.org/10.5194/tc-15-4781-2021>
2. Robinson AL, Ariano SS, Brown LC. 2021. The Influence of Snow and Ice Albedo towards Improved Lake Ice Simulations. *Hydrology*, 8(1), 11, <https://doi.org/10.3390/hydrology8010011>

Most conferences were cancelled through 2020 and 2021 so we have no new presentations to update with. In the coming year however, I do expect at least one graduate student to present work using field data collected in Aug. 2021, at two or three conferences if they take place in 2022.

I certify that the information is correct and complete to the best of my knowledge.

Signature of permit holder:



Date (yyyy/mm/dd): ___2021/11/01_____