Annual research report for:

Canadian Wildlife Service multiyear licence NUN-NWA-16-03
Nunavut Research Institute licence 02 001 18R-M
Mayor's Office, Sulukvait ACMC & HTO, Resolute NU

Project Title**: Lake Ice in the Canadian High Arctic**

Permittee name and contact information:

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2018 Research Team: Alexis Robinson, Alicia Dauginis, Justin Murfitt

Project Overview:

Lake ice is an important part of the cryosphere and recent projections suggest a pan-arctic reduction by the end of the century in ice duration (ranging from 20 to >100 days) and thickness (ranging from 30 cm to > 1 m). Since the majority of ground-based ice observations in Canada ceased by the 1990s, recent changes in ice regimes have been primarily noted through modelling and remote sensing. Observation data, essential for validating both remote sensing and modelling research, is currently inadequate though some volunteer monitoring efforts have emerged since the decline of Canada's monitoring network and have been utilized for ice research. As changes are noted in ice regimes, we need to fully understand the implications and response in terms of water and energy balance and their effects on other areas of research (e.g. limnology, transportation). To achieve this, in situ data of lake ice in Canada is being collected across a latitudinal gradient (temperate, sub-Arctic, High Arctic). The field data will be used to improve the effects of snow cover on modelled ice thickness, as well as to isolate how the duration of the modelled ice break-up season is affected by the shape/size of the lake. Resolute and Polar Bear Pass provide ideal locations for the High Arctic portion of this study and data collection is underway.

Date and Duration of research:

Our research visit in 2018 took place from August 6 to 14, with a 2 hour visit to Polar Bear Pass National Wildlife Area on Aug 10.

Transportation and Travel Routes

Exact helicopter flight route was not recorded from Resolute (PCSP) to Polar Bear Pass; we crossed Cornwallis Island, passing over the former Polaris Mine before crossing to Bathurst Island. We landed beside the small camera on the shore of Hunting Camp Lake (75.73N, 98.42W) (Figure 1), then moved over and landed at the cabin to download and do maintenance on the weather station. Transportation to the lakes outside Resolute was all by ATV on marked roads.

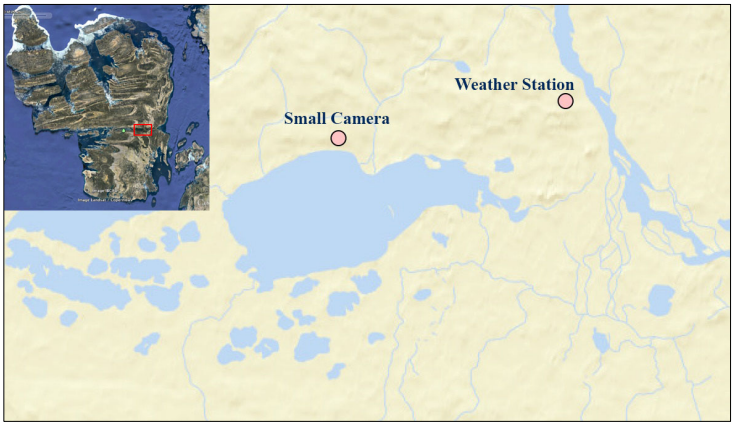

Figure 1. Location of landing and work sites in the NWA

Summaries of Activities

This year, my field party consisted for 4 members: Myself, Justin Murfitt (MSc student – now complete), Alexis Robinson (PhD student, year 3) and Alicia Dauginis (MSc student, year 1). Our group spent 9 days (Aug. 6 – 14) working from PCSP in Resolute, with A brief trip over to Polar Bear Pass, Bathurst Island (approximately 2 hours on the ground for equipment maintenance).

We had a very successful research trip and were able to complete all of our intended research goals. The main goal was to get the ice thickness sensor back in place in 3 Mile lake. We had deployed the sensor in 2016, however due to a power issue, it did not collect any data. I opted to leave it in storage at PCSP through 2017-2018 until we had a better system in place for deploying and retrieving it. I am very excited to retrieve the sensor this coming summer and see the full season of ice growth in the records. I have the same type of sensor in place in a mid-latitude lake, so a full season of thickness from both geographic locations will be very interesting to compare – particularly during the ice break up season. We were able to download and service the camera overlooking 3 Mile lake and replace fresh batteries for the current year, however, unfortunately, the camera on Resolute lake was destroyed not long after being serviced in July, so the motion of the ice decay in that region was not captured. We replaced that camera for the 2018-2019 season. Another accomplishment was the design of a small remote-control boat to record detailed lake depths for 3 Mile lake (and a few for Resolute Lake, however the ice cover was still present on parts of the lake during our visit). The remote control does not have a very far range, so we focused on mapping the near shore regions, extending into the centre regions where we could (Figure 2). We hope to use this data, in combination with satellite data, to help map the depth of nearby lakes. Detailed topographic surveying around the basin of 3 Mile lake were conducted to assist with validating a new digital elevation product available online, to ensure the data is suitable and accurate for basin-modelling.

Figure 2. Measuring the lake depth using a remote-control boat.

The camera structure on the NE shore of Hunting Camp Lake (PBP) was kindly checked on by the CWS researchers working from the cabin again this summer, and happily no major damage was reported. This allowed our maintenance trip to be quite brief, as we downloaded and repositioned the view angle slightly, as the camera had shifted over the winter (Figure 3). We were not able to use our remote-control lake depth boat this year as the waves on the lake were too high the day of our visit. We will try again during the summer 2019, and potentially bring a small inflatable boat along with us, to paddle across the lake and record some depths.

Figure 3. Research group repositioning the small camera on the shore of Hunting Camp Lake (Photo by Joshua Tomlin, Great Slave Helicopters). The stand is painted white and secured with stones.

I hope to maintain the location of the camera long term, as funding allows, to create a data set of the spatial variation of ice cover on the lake. I have not yet connected with anyone who has measured the depth before, but would be quite happy to hear about some first-hand observations on the timing of when the ice over formed/retreated in previous years. 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. The weather tower at Polar Bear Pass required 2 sensors to be replaced, including a new camera to record pictures of the snow melt.

Record of Wildlife observed:

While we did not observe any wildlife during our brief visit to Polar Bear Pass, we did observe two sets of mother/cub polar bears, one set to the south of Polar Bear Pass, and one set on the north of Cornwallis Island. We also observed three separate herds of Muskox: 2 on Cornwallis Island, and 1 on Bathurst Island. We kept our distance to try and minimize disruption; so although I do not have exact numbers from the herds, I estimated 5 in 1 herd, 8 in another on Cornwallis and ~ 12 in the herd on Bathurst.

Community consultation and involvement:

One of my graduate students, Alexis Robinson, compiled a poster about our research focusing on the ice cover modelling work for Resolute and 3 Mile lake, which we dropped off for the Qarmartalik School in Resolute this summer. Hopefully the research catches the interest of some of the local students who might then be interested in working with us in future years. Once we collect the 2018-2019 data from the cameras and the ice thickness sensor, I would like to make an updated poster for the school (and the community as a whole) that puts the local lakes in context with the rest of the Arctic. The timing of our field work does not coincide with the school year, but we would be more than happy to try and provide more information on the overall project and future results, and will maintain communication with the school in case other opportunities arise that we could participate in.

Thank you to the Resolute HTO for helping connect us with Debbie Iqaluk, who put up a new camera for us on Resolute Lake in the early summer, and coordinated the exchange of equipment with us when we were in Resolute. We plan to reach out again in the spring for assistance with the camera maintenance on that lake, and potentially with some ice thickness measurements, depending on a current funding proposal. I would very much like to connect

with anyone who might be drilling through the lake ice at any point over the winter / spring, as any measurements of the thickness would be very helpful to compare to our modelling results.

Overall Project Progress and plans for 2019:

Field data collected (imagery) is now being analyzed, with some ice formation and melt dates posted on my website: http://sites.utm.utoronto.ca/brown/content/lake-ice-cover-dates. The climate data from the Polar Bear Pass 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 (1953 for Resolute, 2006 for Polar Bear Pass). The modelled ice formation/decay dates have been compared to historical ice dates from the Canadian Ice Database (1960s-1990s), as well as the recent years to satellite imagery (>2000, primarily from the MODIS sensor). The model results are quite good so far, with a mean error of 1 day for ice formation and 9 days for ice break up. Some uncertainty in the break up dates remain, but can be explained by snow cover variability and floating ice pans that remain after the initial ice break up in the summer. We are currently working on better accounting for the residual ice pans in the modelled dates.

Table 1: Current modelling results and the dates from the outdoor digital cameras

Ice season	Simulated freeze date	First appearance of ice	Full freeze over	Simulated ice break up date	First open water	Full open water
2015-2016				July 14	June 16	July 21
2016-2017	Sept 11	Sept 11	Sept 26	Aug 1		Aug 1
2017-2018	Sept 9	Sept 7	Sept 12	July 18	June 10	Aug 6
	Mean error: 1 day			Mean error: 8.6 days		

Field observations from May 2016 are included in a publication currently in review, as context for showing how the thinner and warmer mid-latitude ice covers have different formation methods from the thick Arctic ice. The first publication using the images collected from the High Arctic cameras is in preparation and will hopefully be published in 2019. The initial results from this work have been presented at several scientific conferences in the last year:

*Robinson A, *Ariano S, Brown LC. Improving Lake Ice Simulations for Temperate Region Lakes, American Geophysical Union, C52B-06, Oral Presentation, Dec. 14, 2018.

*Dauginis, A and Brown LC. Linkages between sea ice, snow cover, and temperature in the Canadian Arctic from 2000 – 2017. Poster presentation, ArcticNet 2018, Ottawa Dec. 11&12.

*Robinson A and Brown LC. Modelling Melt-onset and Breakup Dates from Southern Ontario to the High Arctic. Poster Presentation, Canadian Geophysical Union Annual Meeting, June 11, 2018 [Also, Poster presentation Canadian Geophysical Union Eastern Section Student Conference, London ON, March 17, 2018].

*Dauginis, A and Brown LC. An investigation of sea ice, snow cover, and snow melt conditions between 2000 – 2017 on Bathurst Island, Nunavut, Canada. Poster Presentation, Canadian Geophysical Union Annual Meeting, June 11, 2018. [Also, Oral presentation, Canadian Geophysical Union Eastern Section Student Conference, London ON, March 17, 2018].

I aim to have my research students present results from the field campaigns throughout 2019, with intended presentations at the Canadian Geophysical Union Student meeting (March 2019), University of Toronto

Mississauga Graduate Student Research Colloquium (spring 2019) and the large International Union of Geodesy and Geophysics meeting (July 2018).

We aim to return to both Resolute and Polar Bear Pass in 2019 during the summer, to download/reprogram the cameras, re-install the ice thickness sensor for the next season, and service/download the weather tower data. We also hope to add two more cameras on lakes outside of Resolute. In future years, I aim to work with a new ice thickness satellite (ICESat2) for both the mid-latitude and High Arctic lakes, so additional cameras placed on larger lakes (within driving distance from Resolute) will be extremely beneficial to help compare to this new dataset and further advance my research.

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

Signature of permit holder: 

Date (yyyy/mm/dd):____Dec 17, 2018_____