

Final Project Report to NWMB – September 2019

1. **NWRT Project Number:** 3-18-07
2. **Project Title:** Cumberland Sound bowhead and beluga whale photo-identification and genetic mark-recapture analysis
3. **Project Leader:** Steve Ferguson, Fisheries and Oceans Canada, 501 University Crescent, Steve.Ferguson@dfo-mpo.gc.ca, 204-983-5057

4. **Summary:**

The purpose of the project was to continue efforts to collect biopsy samples from bowhead whales in Cumberland Sound for use in developing updated abundance estimates of Eastern Canada-Western Greenland bowhead whales using genetic mark-recapture methods. In addition to the collection of biopsy samples, Unmanned Aerial Systems (UAS) were used to collect high resolution photographs of bowhead whales for use in photo-identification studies. Unique scars and markings captured in the photographs allow for individual whales to be identified and tracked over time through subsequent sightings. The development of a photo-id catalogue will contribute to our overall understanding of important life history traits and, over time, will provide measures of body condition, growth rates, and calving intervals. We also used UAS to collect photos of beluga whales in and around Clearwater Fiord. Findings from field work conducted in 2017 and 2018 have shown that unique markings and scars found on Cumberland Sound beluga appear distinct enough in photographs to be used in photo-identification studies.

As a result of commercial whaling, both the Eastern Canada-West Greenland bowhead whale population and the Cumberland Sound beluga population experienced significant declines. While the bowhead population has been recovering, the Cumberland Sound beluga population remains depleted in comparison to historical levels. Continued monitoring is required to allow DFO to update advice on population status, sustainable harvest, and habitat conservation of Eastern Canada-West Greenland bowhead whales and Cumberland Sound beluga. The development of a photo-id catalogue could provide a cost-effective way to monitor Cumberland Sound beluga on an ongoing basis using local guides and boats, without relying so heavily on manned aerial surveys which are expensive and logistically difficult to perform.

5. **Project Objectives:**

The specific objectives of the proposed project, as outlined in the original proposal to NWMB, were to:

- Collect bowhead biopsy samples for use in genetic mark-recapture abundance estimates of Eastern Canada-West Greenland bowhead population as a whole and for Cumberland Sound
- Using UAS, collect high resolution aerial photographs of bowhead whales to develop a photo-id catalogue and to assess calving intervals, growth rates, and body condition over time
- Using UAS, collect high resolution aerial photographs of Cumberland Sound beluga whales for the development of a photo-identification catalogue to eventually assess abundance and overall health of the population

6. Materials and Methods:

Research methods did not change substantially from the research design detailed in the project proposal. From 30 July to 13 August 2018 the field team conducted boat-based field work in Cumberland Sound to collect skin biopsy samples from bowhead whales and aerial photographs of bowhead and beluga. Biopsy samples were collected using crossbows and bolts equipped with floats and 40mm biopsy tips. Photographs were collected using a small quadcopter UAS, the DJI Phantom 4 Pro. Fieldwork consisted of day-trips from Pangnirtung, primarily to Kingnait Fiord (for bowhead) and Clearwater Fiord (for beluga), using a 27-foot aluminum boat equipped with two 150 horsepower motors, operated by Ricky Kilabuk.

Biopsy samples have been analysed to be used in genetic mark-recapture analysis to update abundance estimates of the Eastern Canada-West Greenland bowhead population. An updated population estimate using biopsies collected in previous field seasons has been produced. UAS photographs of bowheads have been analysed to identify unique individuals for the development of a photo-id catalogue while UAS photographs of belugas were analysed to determine re-sightings of unique individuals between 2017 and 2018. Two previously trained Nunavut beneficiaries (Ricky Kilabuk and Noah Ishulutaq) were employed as integral members of the 2018 field team.

7. Results:

Over the 15-day period from 30 July to 13 August 2018, weather conditions allowed for a total of just 4 days of at-sea work in Cumberland Sound. In total, 37 bowhead tissue biopsy samples, 192 bowhead UAS photographs, and 367 beluga UAS photographs were collected. Locations of biopsy samples and UAS photographs are shown in Figure 1 and 2. Preliminary analysis of UAS photographs of bowhead whales have identified 27 different whales photographed in 2018, with length measurements from 3 whales (Table 1). With limited opportunities to photograph bowheads in 2018, efforts were focused on obtaining images taken at lower altitude, showing greater detail in scars and markings as opposed to higher altitude images (with the boat as a scale) that can be used for obtaining length measurements. Examples of bowhead and beluga photos taken in 2018 are shown in Figure 3 and 4.

Measurements of bowhead whales photographed in Cumberland Sound from 2016 to 2018 indicate that the majority of whales in this area are likely sub-adults between 8 and 11 m long. Ongoing analyses will continue to investigate the population structure of bowheads in Cumberland Sound, and further measurements will be conducted to assess body condition.

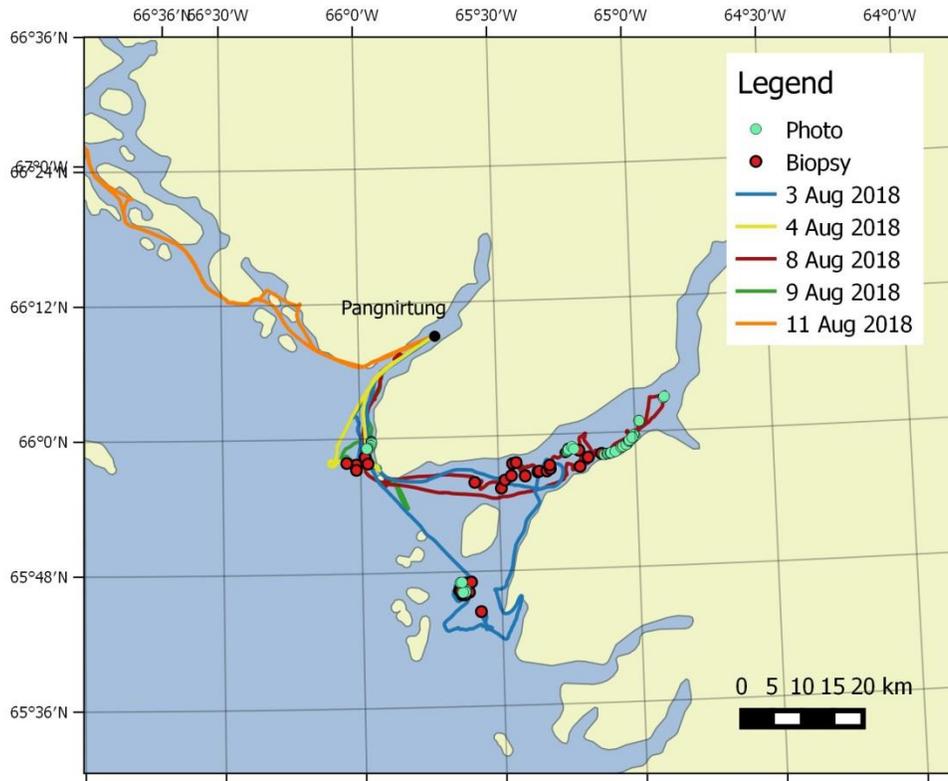


Figure 1. Locations of bowhead biopsy samples and UAS photographs collected in Cumberland Sound 3 – 8 August 2018.

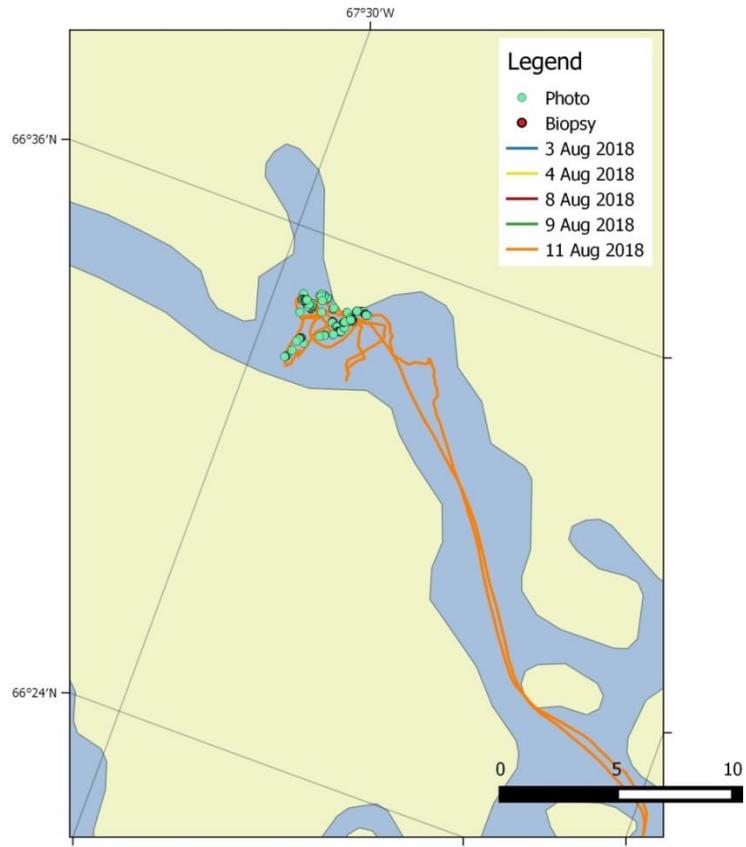


Figure 2. Locations of beluga UAS photographs collected in Clearwater Fiord, 11 August 2018.

Table 1. Bowhead biopsy samples and UAV photographs collected from 2016-2018

Year	Biopsies	UAV Photos	Whales	Measured
2016	87	1800	83	19
2017	108	1014	81	50
2018	37	192	27	3



Figure 3. Bowhead whale 50609 encountered in Kingnait Fiord on 8 August 2018

In 2018, an updated abundance estimate for EC-WG bowheads was obtained using genetic capture-mark-recapture analysis. The estimated abundance was 11,916 individuals (95% HDI = 9,073-16,185) and incorporated genetic samples collected up until 2016. From field work conducted in 2017 and 2018 there are 145 biopsy samples available to add to future analyses, with additional biopsy samples recently collected in Cumberland Sound in 2019.

Fieldwork conducted on August 11, 2018 resulted in 367 drone photographs and 5 videos collected of Cumberland Sound beluga whales. This was the pilot year of supplementing drone photographs with boat-based photographs using a Canon EOS 5D Mark II camera, which resulted in 2,054 boat-based photographs. The collection of photographs for photo-identification purposes was a continuation of the 2017 field season in which 224 drone photographs were collected, and the sampling continued in 2019 with 1,060 drone photographs, 13 videos, and over 3,000 boat-based photographs collected. Initial analyses of the 2017 and 2018 images indicate that approximately 36% of the population is identifiable with markings from hunting and natural sources. Five whales were photographed and identified in both 2017 and 2018 (Figure 4), and preliminary analyses of 2019 photographs indicate at least one whale from 2018 was resighted in 2019. Group sizes ranged from 1-16 whales with an average group size of 3.7 whales. Approximately 70% of the population were classified as adults, 16% as juveniles, 7% as calves, and the remainder were unknown; these classifications were made based on color, size, and proximity of young whales to adults.



Figure 4. Beluga whale #17, photographed on August 18, 2017 (above) and August 11, 2018 (below) in Clearwater Fjord, Cumberland Sound.

8. Discussion/Management Implications:

The use of bowhead biopsy samples to obtain abundance estimates using genetic capture-mark-recapture methods remains a promising approach to future monitoring. Collection and genetic analyses of samples are relatively inexpensive

when compared to aerial surveys and offer an efficient way to continue to obtain abundance estimates over time. Aerial survey estimates have been negatively biased due to logistical challenges to provide complete spatial coverage and are generally less precise (Doniol-Valcroze et al. 2015). Continued biopsy sample collection, and expanding sampling effort to new areas will improve density estimation from genetic mark-recapture methods, while the development of a Photo-id catalogue offers an alternative method for monitoring the EC-WG bowhead population.

Photo-identification is a tool that allows for insight into the whales' site fidelity, reproductive histories, social structure, age structure, and habitat use. Using photo-identification, we can also infer life-history characteristics (e.g. calving and survival rates) which are important for monitoring fluctuations in the population size and predicting population growth (Michaud 2014). As the sampling efforts of Cumberland Sound beluga whales now spans three years, it is now possible to estimate population size through capture-mark-recapture techniques. The accuracy of this technique is greatly improved by collecting photographs over a long period of time, so continued sampling of the population will lead to more confidence in the abundance estimates and ultimately result in more informed management decisions (Fearnbach et al. 2012).

The data from the early photogrammetry/capture-recapture studies for the BCB bowhead whale population have been used in models to establish sustainable harvests from the BCB population, but such estimates of life-history parameters do not exist for the EC-WG population (Koski and Ferguson 2012; Koski et al. 2013). The images collected from 2016 - 2018 have established an economical method of collecting the needed data and provided photographs to supplement the few that have been collected to date. The body condition indices that can be collected from the photographed whales can provide an early warning of impending declines in the populations due to poor health or body condition before they are recognized as a declining population.

9. Report by Inuit Participants:

Although Inuit participants in this project have not provided a formal report, input from our Inuit partners is regularly requested and received through on-going discussions while in the field, communications during field work planning, and through follow-up discussions after completion of the field work. These reports from our Inuit partners are vital to the success of the project. Input we receive on bowhead traditional knowledge in Cumberland Sound, methods of locating, approaching, and sampling whales, and knowledge of the local area allow us to constantly improve our research methods and have resulted in safe and successful field seasons. In 2019, Ricky Kilabuk, contributed as a co-author on a manuscript recently accepted for publication in Arctic Science. The paper (Young et al. In Press) documents our observations of a bowhead carcass in Cumberland Sound which

shows evidence of predation from killer whales. Ricky provided significant contributions to the paper through his work in the field and through reports he provided on relevant sightings in Cumberland Sound, made by himself and other people from the community of Pangnirtung. As detailed accounts of killer whale predation on bowheads are relatively uncommon, and the outcome of attacks are usually unknown, the information provided in this note contributes to the overall understanding of killer whale prey selection and prey use in the Arctic. A better understanding of Arctic killer whale predation pressure is needed in order to predict the potential impact they will have on the Eastern Canada-West Greenland bowhead population.

10. Reporting to Communities/resource users:

The schedule for consultation and reporting of results has been completed as anticipated. In addition to the completed consultation schedule outlined below, results from ongoing analyses will be communicated to Pangnirtung HTO as they become available. This will include summary reports sent through email, as well as presentation of results at in-person meetings in the future, as monitoring of Cumberland Sound beluga and bowhead continues.

Schedule of Consultations with Pangnirtung HTO

Consultation	Date	Type	Status/Changes
Before Research	Jan 2018	Email correspondence proposing project and requesting support. This was followed up by an in-person meeting with the HTO.	Completed
During Research	Aug 2018	In person meetings with HTO manager before and during field work to update on field research activities.	Completed
Completion of Research	Nov 2018	In person meeting to discuss findings from previous field season and to propose work for the coming year.	Complete: An in-person meeting with Pangnirtung HTO was held in late November 2018

11. References:

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Koski, W.R., C.Q. da-Silva, J. Zeh and R.R. Reeves. 2013. Evaluation of the potential to use capture-recapture analyses of photographs to estimate the size of the Eastern Canada – West Greenland bowhead whale (*Balaena mysticetus*) population. Can. Wildl. Biol. Manage. 2(1):23-35.

Michaud, R. 2014. St. Lawrence Estuary beluga (*Delphinapterus leucas*) population parameters based photo-identification surveys, 1989-2012. DFO Can. Sci. Advis. Sec. Res. Doc. 2013/130. iv + 27 p.

Young, B.Y., Fortune, S.M.E., Koski, W.R., Raverty, S.A., Kilabuk, R., and Ferguson, S.H. In Press. Evidence of killer whale predation on a yearling bowhead whale in Cumberland Sound, Nunavut.