Final Project Report to NWMB – September 2018

1. **NWRT Project Number: 3-17-01**

2. **Project Title:** Cumberland Sound bowhead (*Balaena mysticetus*) and beluga whale (*Delphinapterus leucas*) photo-id, genetic mark-recapture, and assessment of the use of UAS for aerial surveys

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. The project also tested the use of UAS for photo-identification of beluga whales in and around Clearwater Fiord. While beluga whales possess unique markings, we tested whether or not they 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. If successful, the use of UAS 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.

In 2017, a total of 108 bowhead tissue biopsy samples, 1014 bowhead photographs, and 222 beluga photographs were collected in Cumberland Sound. Photograph analysis resulted in identification of 81 different individual bowheads photographed in 2017. Out of these 81 whales, length measurements were obtained from 50 individuals. Using bowhead biopsy samples, an updated abundance estimate for

Eastern Canada-West Greenland (EC-WG) bowhead whales using genetic capture-mark-recapture analysis was produced, resulting in an estimate of 11,916 individuals (95% HDI =9,073 - 16,185). Initial analyses of some of the 2017 beluga images indicate that at least 20 different belugas were photographed with markings that appeared to be unique and were likely to persist over long periods. Preliminary analysis of 2018 images has identified at least one match of a uniquely marked beluga photographed in both 2017 and 2018.

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
- Perform a small scale survey of beluga whales congregated in Clearwater Fiord to test the use of UAS to obtain abundance estimates in small areas
- Using UAS, collect high resolution aerial photographs of beluga whales for testing the possibility of photo-identification studies in this species

6. Materials and Methods:

Research methods did not change substantially from the research design detailed in the project proposal. From 15 to 24 August 2017 the field team conducted boat-based field work in Cumberland Sound to collect skin biopsy samples of 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. 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 were analysed to be used in genetic mark-recapture analysis to update abundance estimates of the Eastern Canada-West Greenland bowhead population. UAS photographs of bowheads were analysed to identify unique individuals for the development of a photo-id catalogue while UAS photographs of belugas have been evaluated to determine the potential for re-sighting unique individuals for future photo-id studies of Cumberland Sound beluga. Two previously trained Nunavut beneficiaries were employed as integral parts of the 2017 field team. In preparation for continuation of the project we hope to provide training to our Inuit team members to certify them to act as pilots of small unmanned air vehicles.

7. Results:

Over the 10-day period from 15-24 August 2017, a total of 7 days of at-sea work were conducted in Cumberland Sound. In total, 108 bowhead tissue biopsy samples, 1014 bowhead photographs, and 222 beluga photographs were collected. The majority of biopsy samples were collected in the western end of Kingnait Fiord. Bowheads that may have been present further into Kingnait Fiord were generally inaccessible as high winds and large waves prevented access to most of Kingnait Fiord on most days. Therefore, the locations of biopsy samples (Fig. 1) shouldn't be considered an indication of bowhead distribution. Examples of bowhead photographs obtained in 2017 are shown in Figures 2, 3, and 4.

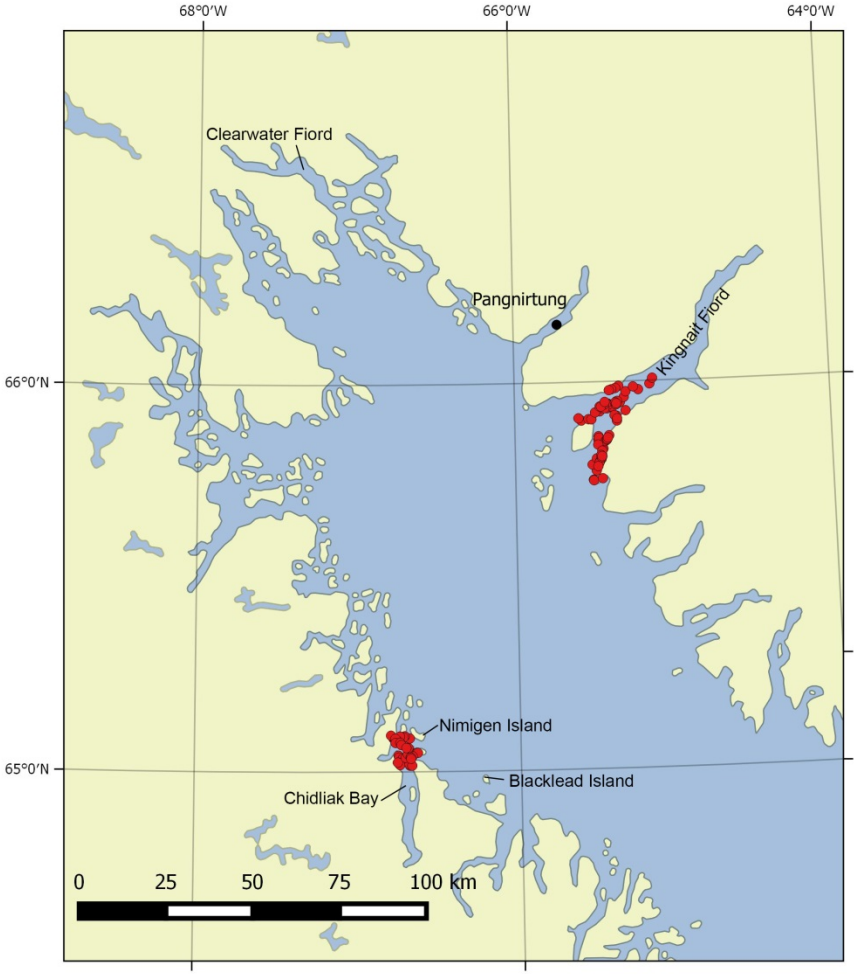


Figure 1. Locations of bowhead biopsy samples collected in Cumberland Sound 15-24 August 2017.

Figure 2. Whale number 50519, photographed in Kingnait Fiord on 17 August (left) and 29 August 2017 (right).

Figure 3. Whale number 50560, photographed on 22 August 2017 in Kingnait Fiord.

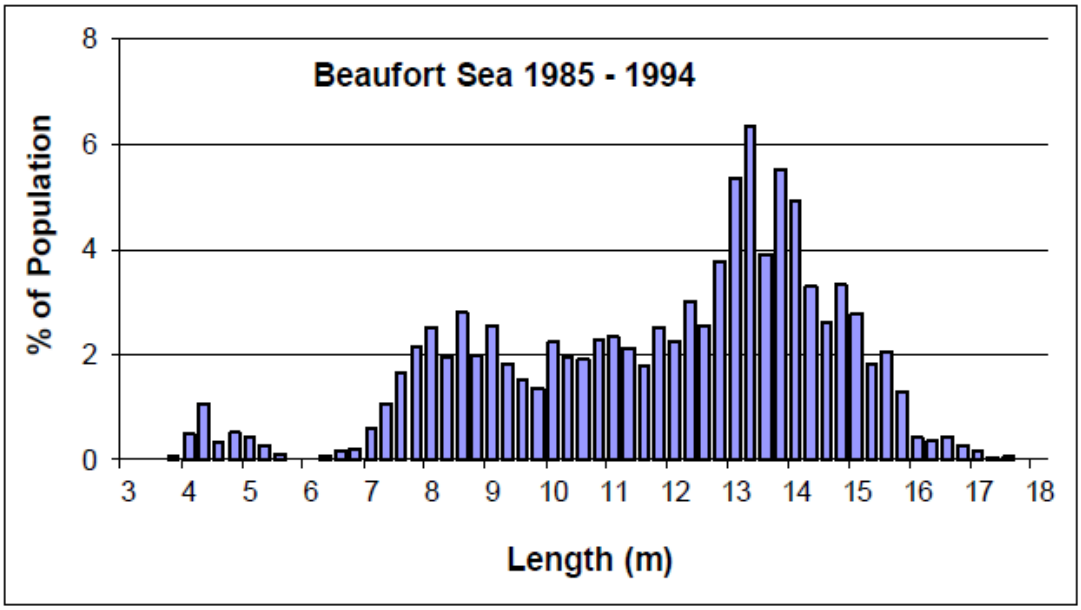
On 24 August, the team travelled to the western side of Cumberland Sound after hearing reports of large numbers of whales in the vicinity of Chidliak Bay, Nimigen Island, and Blacklead Island. The number of whales in this area was far greater than the number encountered in Kingnait Fiord in previous days and 38 biopsy samples were collected. Light rain and drizzle throughout the day limited the use of the UAS, though over 200 photographs were still collected on this day. The whales encountered on the western side of Cumberland Sound included a number of larger

whales with noticeable white areas beginning to show on peduncles, indicating older whales than those seen in Kingnait Fiord in either 2016 or 2017. Other notable observations from the western side of Cumberland Sound on 24 August include a mother with calf and an individual with killer whale rake marks on flukes. The photograph of a mother with a calf (Fig 5) is the first confirmed occurrence of a mother with a calf in Cumberland Sound. The calf in Figure 4 is likely about 2-3 months old or born about late May to late June based on its size relative to its mother and the fact that it is sloughing its neonatal skin which is light gray in colour. The calf was approximately 6.0 m long, which is shorter than the typical 6.5-7.0 m length of bowhead calves photographed in the Beaufort Sea in late August (Koski et al. 1993), and its mother was 13.8 m long, which is about the length that most female bowhead whales are believed to become sexually mature (Koski et al. 1993). Ricky Kilabuk also received a report from a hunter who witnessed a bowhead whale giving birth in the area in early August.

Figure 4. A mother and calf bowhead whale photographed near Nimigen Island, Cumberland Sound on 24 August 2017

Analysis of UAS photographs of bowhead whales has identified 81 unique individual bowheads in the photographs collected in 2017. Out of these 81 whales, length measurements were obtained from 50 individuals in 2017 (Fig. 4). Future analyses will assess body condition of whales for comparison with the Bering-Chukchi-Beaufort (BCB) population. As more photos are collected whales will be scored on re-identifiability and photo quality and then compared to determine re-sightings between years.

Figure 5A shows the length-frequency distribution of the overall population of bowhead whales in the Beaufort Sea from Koski et al. (2006) and Figure 5B shows the length-frequency distribution of bowhead whales photographed in 2016 and 2017 in Cumberland Sound. The data in Figure 5B indicate that Cumberland Sound whales are primarily subadult whales. At this time, we do not know whether these whales are primarily a different age class than subadults found in Foxe Basin and southern Prince Regent Inlet (Cosens and Blouw 2003), but the whales in Foxe Basin and Prince Regent Inlet include significant numbers of mothers with calves; whereas, our photograph of a young mother with a calf is the first confirmed occurrence of a mother with a calf in Cumberland Sound.



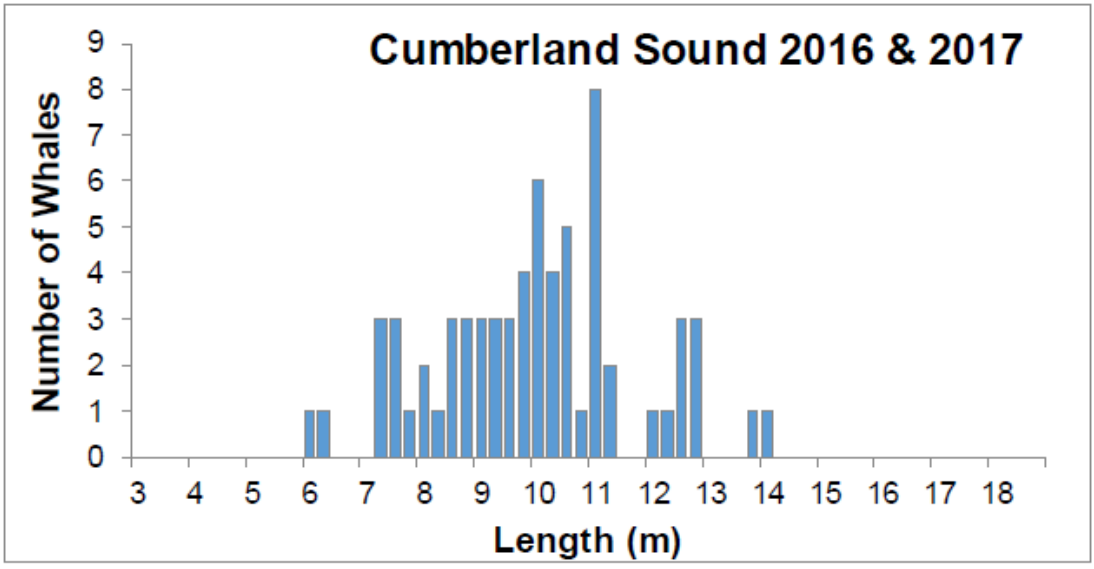


Figure 5. The length-frequency distribution of (upper panel) the BCB bowhead whale population (from Koski et al. 2006) and (lower panel) useable length measurements of bowhead whales collected during studies in Cumberland Sound in 2016 and 2017.

Evaluation of the UAS photos of belugas has indicated that the quality of the photos is adequate to determine the age class and body condition of whales and to identify individual whales based on unique scars and markings. Initial analyses of some of the 2017 images indicate that at least 20 different whales were photographed with markings that appeared to be unique and were likely to persist over long periods. The analyses of the 2018 images are also in the preliminary stages, but there has been one match of a whale photographed in both 2017 and 2018.

In 2018, an updated abundance estimate for EC-WG bowhead whales was generated using genetic capture-mark-recapture analysis. This updated estimate incorporated the biopsy samples collected between 2014 and 2016 that were not included in previous abundance estimates. At the time of analysis, the 2017 biopsy samples were not available to be used in the abundance estimates. The abundance estimate for EC-WG bowhead whales using genetic capture-mark-recapture analysis was 11,916 individuals (95% HDI =9,073 - 16,185) (Frasier 2018).

8. Discussion/Management Implications:

Data from long-term photo-identification studies are essential for calculating reliable estimates of population size, population growth (or decline) rates, survival rates, rates of killer whale attacks and changes in body condition for both the EC-WG bowhead whale and Cumberland beluga whale populations. The data from the early photogrammetry/capture-recapture studies for the BCB bowhead whale have been used in models to establish sustainable harvests from the BCB population by Alaskan natives 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 during the 2016 and 2017 studies established an economical method of collecting the needed data and provided photographs to supplement the few that have been collected to date. With the current low harvest rate for this population, it would take a century or so to collect adequate samples from harvested whales to fill the data gaps. In addition, 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.

In general, the collection of photos was successful in 2017 and despite the shorter field season for collection of bowhead whale photographs we collected similar numbers of photographs of unique whales in 2017 and 2016 which had a much longer field season than 2017. The reasons for the relatively greater success in 2017 were the use of a dedicated boat to collect biopsy samples and photographs rather

than relying on opportunities during behavior studies, the flexibility of the field crew and boat operator to work at times of the day when the sea conditions were most favourable, and the ability of the charter boat to travel to locations where whales were reported by locals. The ability of the charter boat to travel to southwestern Cumberland Sound when few whales were present in Kingnait Fiord allowed us to collect a larger number of photographs than if we remained near Pangnirtung and it also allowed us to collect photographs of a segment of the population that was not present in Kingnait Fiord in 2017.

The preliminary findings from analysis of beluga photographs from 2017 and 2018 suggest that continued effort photographing belugas in Clearwater Fiord would capture a significant proportion of the population, making it feasible to obtain a population estimate as well as other important life-history information such as the proportion of calves in the population, calf survival and adult survival.

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

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. For example, local knowledge was used to locate a dead juvenile bowhead whale in 2016 that had been killed and partly eaten by killer whales. Also, during the 2017 field season, reports received from local hunters and communicated to us through Ricky Kilabuk, resulted in us altering our field work plans to expand our search area far beyond Kingnait Fiord. This information resulted in a much higher number of biopsy samples and UAS photographs than we would have obtained without the reports from our Inuit partners. Similarly, following the completion of the field work in 2017, we received a report from Ricky Kilabuk who had information from a local hunter who had recently witnessed a bowhead whale giving birth in the area of southwest Cumberland Sound in early August. The report

stated that “He said he seen lots more (whales) further down. He watched one whale giving birth couple weeks ago in very shallow water. And shore was all sticky and slimy.” This is notable because it is the latest in the season that a bowhead whale has been reported to calve and likely represents a first-time mother. Most calves are born from late April to early June. This type of information that we receive from our Inuit partners is invaluable, and in the future, we hope to have this information provided to us in a more formal report that can be included in future project reports to NWMB.

10. Reporting to Communities/Resource Users:

The schedule for consultation and reporting of results has been completed as anticipated. Near the end of the 2017 field season we met with the Pangnirtung Hunters and Trappers Organization to discuss findings from previous years, and observations made during the 2017 field season. Board members expressed considerable interest in our results and supported our research efforts.

Schedule of Consultations with Pangnirtung HTO

Consultation	Date	Type	Status/Changes
Before Research	Jan 2017	Email correspondence proposing project and requesting support	Completed
Prior to Research	Apr 2017	In person meetings with HTO board updating on previous years’ results and plans for 2017 summer research.	Completed
During Research	Aug 2017	In person meetings with HTO manager on a regular basis to update on field research activities	Completed
Completion of Research	Fall 2017	In person meeting to discuss findings from previous field season and plans for future research for next field season.	Complete: A field report and research update was provided by email. An in person HTO board meeting was held in August 2017 near completion of field work.

11. References

Cosens, S.E. and A. Blouw. 2003. Size- and age-class segregation of bowhead whales summering in northern Foxe Basin: A photogrammetric analysis. Mar. Mammal Sci. 19(2): 284–296.

Doniol-Valcroze, T., Gosselin, J.-F., Pike, D., Lawson, J., Asselin, N., Hedges, K., and Ferguson, S. 2015. Abundance estimate of the Eastern Canada – West Greenland bowhead whale population based on the 2013 High Arctic Cetacean Survey. DFO Can. Sci. Advis. Sec. Res. Doc. 2015/058. v + 27 p.

Frasier, T.R. 2018. Genetic Capture-Mark-Recapture Analysis of Atlantic Bowhead Whales. Report submitted by Dr. Timothy R. Frasier (Saint Mary's University) to Fisheries and Oceans Canada, 3 April 2018.

Koski, W. R. and S. H Ferguson. 2012. Review of methods for Eastern Canada-West Greenland Bowhead Whale (*Balaena mysticetus*) population abundance estimation. DFO Can. Sci. Advis. Sec. Res. Doc. 2012/017.

Koski, W.R., R.A. Davis, G.W. Miller and D. E. Withrow. 1993. Reproduction. Pages 239-274, Chapter VII. In: J.J Burns, J.J. Montague and C.J. Cowles (eds.), The Bowhead Whale. Special Publication No. 2, The Society of Marine Mammalogy. Lawrence, KS. 787 p.

Koski, W.R., D.J. Rugh, A.E. Punt and J. Zeh. 2006. An approach to minimize bias in estimation of the length-frequency distribution of bowhead whales (*Balaena mysticetus*) from aerial photogrammetric data. J. Cetacean Res. Manage. 8(1): 45-54.

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.