**Nunavut Wildlife Management Board Final Project Report – September 30, 2024**

1. **NWRT Project Number:** NWRT-2023-0000000023

2. **Project Title:** Ecology and demography of killer whales in the eastern Canadian Arctic

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4. **Summary:**
Killer whales (*Orcinus orca*) move into bays and inlets in the eastern Canadian Arctic (ECA) during summer, where they prey on narwhal, beluga, and bowhead whales, as well as seals. There is growing concern among Inuit communities that increasing killer whale presence in the Arctic with declining sea ice may have adverse impacts on their marine mammal prey. Our research aims to assess impacts of killer whale predation in the ECA by determining killer whale diet, interactions with prey species, population size and trends, and shifts in distribution.

In summer 2023, we will continue with core research methods including satellite telemetry, tissue biopsy, and photo-identification. We have recently compiled results of this work conducted over previous years to better understand how killer whales and prey interact (satellite telemetry), to estimate killer whale population size (mark-recapture analysis of photo-identified whales) and population structure (genetics analysis of biopsies), and to characterize diet (stable isotopes analysis) and potential prey consumption (bioenergetics modeling). Expanded project goals in 2023 include recording killer whale calls using hydrophones and recording behavior using drones. This work will allow us to study interactions between Arctic killer whales and their prey with greater detail than we have previously. Ultimately, characterization of killer whale calls and behavior (e.g., hunting) will provide baseline information with which to develop acoustic monitoring of killer whale behavior and impacts on prey populations throughout the Arctic. We will also do more in-depth analyses of genetics data and photographs to assess individual condition and population growth (demographics).

5. **Project Objectives:**
Our objective is to study Arctic killer whale distribution and range expansions, population structure and trends, and foraging ecology to determine how to incorporate killer whale predator-prey interactions into marine mammal stock

assessments. We propose a multidisciplinary study based at Eclipse Sound and Admiralty Inlet, Nunavut, to assess killer whale:

1. distribution and spatiotemporal range expansions using sightings reports, photographic identification, passive acoustic monitoring, state-space modelling of satellite telemetry data, and biochemical analysis of tissues;

2. population abundance, historic and current demographic trends, and genetic structure using capture-mark-recapture analysis of photographically identified individuals, whole-genome sequencing of biopsies, and drone footage to assess reproductive state;

3. genetic variation across environmental gradients as evidence of local adaptation to Arctic conditions (via whole-genome analysis);

4. diet, including existence of ecotypes, using a) biochemical dietary proxies (stable isotope, fatty acid, and contaminant analyses of biopsies), b) whole-genome sequencing, c) morphological differences assessed using photo-ID and drone footage, and d) observations of predatory interactions (bioacoustics, drone and boat-based focal follows, satellite telemetry);

5. consumptive and non-consumptive (e.g., displacement) impacts on prey by incorporating abundance, spatiotemporal distribution, and diet into bioenergetics models of prey consumption, as well as distribution and behavior shifts of prey species in the presence of killer whales.

**6. Materials and Methods:**

Our planned research program in 2023 will focus on new field research methods (acoustic and drone recordings and behavioural observations) to allow for more detailed study of killer whale behavior, condition, and population structure. Core field work methods, including satellite tagging, biopsy, and photo-identification, will be implemented if unknown groups are encountered (to add genetics data and photographs of any 'new' whales to previous databases).

[1] Satellite tag deployment: Killer whales will be slowly approached by boat to within 10 m. Limpet model satellite tags (Wildlife Computers) will be deployed onto the dorsal fin using crossbows. Tags will be surface-mounted using 6-cm metal darts that will anchor the tag below the skin into the cartilage upon contact. Deployed tags will transmit location and dive data up to 300 times daily, as the whale surfaces, to satellites that store data on the ARGOS system. Transmitters affixed to killer whales using this technique typically last several weeks but have remained on individuals for up to ~120 days. Telemetry data acquired from satellite tags will be fed through state space models to better characterize killer whale movements in the Eclipse Sound area (i.e., foraging), and tags that transmit long enough will provide data on killer whale movements and distribution into the winter season.

[2] Biopsy: Skin and blubber biopsies will be collected using a Dan Inject CO2 gun to fire biopsy darts fitted with a 25 mm long x 6 mm diameter sterile stainless steel biopsy tip. The core of skin and blubber will be removed from the biopsy tip using sterile forceps, wrapped tightly in foil, and frozen until genetics and chemical analyses (stable isotopes, fatty acids, trace elements, and contaminants) are completed at Fisheries and Oceans Canada or commercial labs. Genetics analyses (e.g., whole-genome sequencing) will provide information on group and population structure of ECA killer whales, as well as evidence of gene expression in response to local adaptation to Arctic conditions. Epigenetic analyses will be conducted to estimate the age class structure of the population. The suite of microchemistry analyses will provide information on both diet and distribution.

[3] Photo-identification: Encountered killer whales will be photographed using digital SLR cameras. Individual killer whales have unique natural features (dorsal fin shape, size, and scarring, and saddle patch and eye-patch shape) that can be used to identify them. Photo-identification has been used to understand killer whale movements and distribution, social structure, and population size. Estimates of killer whale abundance will be updated using statistical models that compare the rates of newly identified and re-sighted whales. Photographs of encountered groups will be used to determine group composition.

[4] Acoustic recordings and behavioural observations: Killer whale calls will be recorded using dip hydrophones from the research boat, as well as 5-6 passive acoustic monitors moored at the bottom of Milne Inlet, Tremblay Sound, and Admiralty Inlet. Acoustic recordings will be analysed using a combination of automated and manual detection using acoustics software (JASCO and Raven Pro). Killer whale behavior will be recorded during shore and boat-based observations, and using drone-based aerial cameras. For boat- and drone-based observations, the boat will be stopped approximately 300-500m from the focal animals to and behaviour will be observed for up to 30 minutes per session/focal group. Killer whale behaviors will be evaluated and quantitatively analysed with other covariates (e.g., killer whale call type, presence of prey such as narwhals) using mixed effects models to better understand correlations between behavior and call type. Quantifying these relationships will be the first step to using passive acoustic recorders to monitor killer whale presence and activity (e.g., predation) in the ECA.

[5] Aerial photographs: Aerial photographs taken by drone-based cameras will be analysed to assess killer whale body size and condition. Killer whale morphology varies among populations and ecotypes, and measurements from aerial photographs can be used to compare body condition and morphometrics with other groups. Aerial photographs may also be used to discern reproductive status (e.g., pregnant females) and demographic information (e.g. group composition, pregnancy rates) for comparison among years to assess growth trends.

## 7. Project Schedule:

| Output or Step | Start Date | End Date | Status/Changes |
|---|---|---|---|
| HTO consultation | ongoing; formal letter sent 2023/01/15 | N/A | Completed. A virtual meeting was held with members of the Mittimatalik HTO in Spring 2023. Despite months of planning, quorum was not reached but the meeting went ahead as planned and the board discussed the proposed and ongoing research at a later date. |
| HTO contracts and local participant hiring | 2023/04/01 | 2023/06/30 | Completed. |
| Field work | 2023/08/01 | 2023/10/15 | Completed. |
| Present results to Mittimatalik HTO/Pond Inlet residents | 2023/12/15 | 2024/03/31 | Ongoing. There is a plan to visit the community over the winter to discuss next year's plans. |
| NWMB Interim Reports | 2023/12/15 | / | Completed. |
| NWMB Final Project Report | 2024/09/30 | / | Completed. |

**8. Preliminary Results/Discussion:**

We conducted killer whale field work in Eclipse Sound and Admiralty Inlet during summer 2023.

The Eclipse Sound team was led by Enookie Inuarak and comprised local research assistants from Pond Inlet. Their team deployed in response to local killer whale sightings on August 26, September 12, 22, 23, and 24, and October 20 and 21. Unfortunately, they encountered killer whales only on August 26, during which time they took over 150 photos. Some of these photos were photo-ID quality images that allowed for confirmed re-sightings of several whales originally sighted during previous years of our project (Figures 1 and 2). The killer whales could not be approached close enough to attempt to biopsy them or deploy satellite tags using crossbows. This marked the fourth year in a row that Enookie, who has been involved with the killer whale research project for over a decade, has

independently trained local members of his research team on killer whale field research techniques.

The Admiralty Inlet field team comprised researchers from Fisheries and Oceans and the University of Manitoba, as well as several local Inuit from Arctic Bay. The field team spent three weeks during August camped either on the western coast of Admiralty Inlet or based in Arctic Bay, from which they conducted day trips to search for killer whales. A film crew was also present in the area and agreed to provide the researchers with any footage or photographs they obtained. Several days after the killer whale researchers left Arctic Bay, the film crew encountered killer whales over two occasions, and provided a large number of image and video files taken using drone and digital SLRs.

Graduate student Caila Kucheravy is currently working on assessing image quality and adding identified whales to the DFO photo-ID database (Figures 3 and 4). Matches have already been identified between killer whales photographed in both Eclipse Sound and Admiralty Inlet in 2023 and previous years (Figures 1 and 2). This represents the most extensive collection of aerial images we have of killer whales, which will be important for C. Kucheravy’s ongoing research on Arctic killer whale population structure (age and sex ratio). Updates on photo-ID derived abundance estimates and population structure are anticipated for the final report, along with updates and published results on microchemical analyses of killer whale tissues collected in previous years (e.g., contaminants, genetics, stable isotopes).


**Figure 1:** A killer whale that was originally sighted in Eclipse Sound in 2020 was re-sighed during our field work in 2023. The proportion of new sightings and re-sightings from previous years will be used to estimate abundance of killer whales that seasonally visit waters around Baffin Island.


**Figure 2:** A killer whale that was originally sighted in Milne Inlet in 2018 was re-sighed during our field work in 2023. The proportion of new sightings and re-sightings from previous years will be used to estimate abundance of killer whales that seasonally visit waters around Baffin Island.


**Figure 3:** Aerial (drone) image of killer whale group encountered in Admiralty Inlet, September 2023. The image shows five calves or juveniles in the group, and will be used in a study that estimates the age and sex structure of the killer whale population(s) that seasonally visit waters around Baffin Island.

**Figure 4:** Examples of images obtained of killer whales in Admiralty Inlet that will be entered into our existing photo database. The proportion of new sightings and re-sightings from previous years will be used to estimate abundance of killer whales that seasonally visit waters around Baffin Island.

**9. Reporting to Communities/Resource Users:**

| Consultation | Date | Type | Status/Changes |
|---|---|---|---|
| Before Research | January and June 2023 | Jan 2023/emailed letter; spring 2023/virtual or in-person meeting | Completed. |
| During Research | August to September 2023 | Frequent email, phone calls, and texts to update on field work situation. | Completed. |
| Post Research | October to present | Emails and phone calls with HTO/As. In-person visits tentatively scheduled for winter 2024. | Completed. |