Nunavut Wildlife Management Board Final Project Report – September 30, 2023

1. **NWRT Project Number:** NWRT-0000000012

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, population size and trends, and shifts in distribution.

In summer 2022, 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 2022 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:**
With expanding Arctic killer whale presence, our objective is to study Arctic killer 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, 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 histories;
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 2022 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 biopsies will be collected using a Dan Inject CO_2 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) 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. 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.

[4] Acoustic recordings: 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 and Tremblay Sound. Acoustic recordings will be analysed using a combination of automated and manual detection using acoustics software (JASCO and Raven Pro). Killer whale calls have not been extensively studied in the eastern Canadian Arctic before, and the first step will be to build a call repertoire that will be compared to existing killer whale calls, particularly those from other populations in the North Atlantic, to assess unique attributes of killer whales in the ECA.

[5] Behavioral observations and aerial photographs: Killer whale behavior will be recorded using shore and boat-based observations, drone based aerial cameras, and quantified using animal-borne tags (CATS; Customized Animal Tracking Solutions) fitted with accelerometers and hydrophones. CATS tags will be deployed by slowly approaching the whale by boat and using an 8-m pole to attach the tag behind the dorsal fin using suction cups. The tags will remain attached for approximately 2-10 hours before detaching and being retrieved. 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. Aerial photographs using drones will be analysed to assess killer whale body condition (e.g., pregnant females) and group composition for comparison among years to assess growth trends.

7. Project Schedule:

Output or Step	**Start Date**	**End Date**	**Status/Changes**
HTO consultation	09/01/2022	N/A	Completed.

HTO contracts and local participant hiring	01/04/2022	N/A	Completed.
HTO meeting RE: Field work preparation	31/07/2021 (virtual?)	N/A	An in-person meeting was held with members of the Mittimatalik HTO in June 2022.
Field work	01/08/2021	30/09/2021	Completed.
Present results to Mittimatalik HTO/Pond Inlet residents	31/03/2022	N/A	Completed.
NWMB Interim Report	15 Dec 2022	15 Dec 2022	Completed.
NWMB Interim Financial Report	15 Dec 2022	15 Dec 2022	Completed.
NWMB Final Project Report	30 Sep 2023	-	Completed. Same as interim report since their were no killer whales encountered during the field work.

8. Preliminary Results/Discussion:

Summer 2022 was the first year post COVID that DFO and University of Manitoba researchers were able to travel to Pond Inlet for field work. The field team worked with Enookie and Michael Inuarak, with everyone arriving between August 10-12. The researchers searched for killer whales from a single research vessel over a period of several weeks, during which they set up a satellite camp in an area where killer whales are usually sited. Unfortunately, killer whales were not encountered or even sighted by the research team over that period, and so plans to deploy satellite tags, collect biopsies, take photographs for photo identification, and collect behavioral data using hydrophones and drones were not completed as planned. While scientific research objectives were unfortunately not completed, project goals to involve Inuit in DFO research projects and train local teams to collect scientific data were successful. This is particularly true because Enookie Inuarak, who has been involved with the killer whale research project for close to a decade, has independently trained members of his research team on satellite deployment and biopsy techniques, and one of those people (Michael) led much of the field work this past summer.

9. Reporting to Communities/Resource Users:

Consultation	Date	Type	Status/Changes
Before Research	January and June 2022	Jan 2022/emailed letter; June 2022/virtual or in-person	Completed.

		meeting	
During Research	August to September 2022	Frequent email, phone calls, and texts to update on field work situation.	Completed.
Post Research	October to present 2022	Emails and phone calls with HTO/As. In-person visits tentatively scheduled for winter 2022.	Completed.