Summary of marine mammal aerial surveys in Norwegian Bay and Ellesmere Island, Nunavut in 2022

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SUMMARY OF MARINE MAMMAL AERIAL SURVEYS IN NORWEGIAN BAY AND ELLESMERE ISLAND, NUNAVUT IN 2022

by

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ABSTRACT

Florko, K.R.N., Edkins, T., Ferguson, S.H., Yurkowski, D.J., Michel, C. 2023. Aerial surveys for marine mammals in Norwegian Bay and Ellesmere Island, Nunavut in 2022. Can. Tech. Rep. Fish. Aquat. Sci. 3534: vii + 19 p.

The Canadian High Arctic is expected to be one of the last areas with summer sea ice. Ice-adapted marine mammals, such as ringed seals (*Pusa hispida*) and polar bears (*Ursus maritimus*), will likely rely on these areas as a last refuge. We surveyed Norwegian Bay and the nearby fiords on Ellesmere Island, Nunavut, which is a region that has limited current data, for marine mammals in August 2022. We recorded the species, number of individuals, and distribution of marine mammals using visual observations, photography, and infrared imagery. We recorded 72 marine mammal observations including polar bears, ringed seals, narwhal (*Monodon monoceros*), and bearded seals (*Erignathus barbatus*). Most of our observations were in western and central Norwegian Bay, which is the only area in our study area with concentrated sea ice, perhaps highlighting the importance of summer sea ice for marine mammals. There were few marine mammal sightings in the nearby (open-water) fiords. Further reductions in sea ice may change the distribution and abundance of marine mammals throughout the Canadian High Arctic and thus, there is a need for continued monitoring of these regions to understand how marine mammals respond to reduced sea ice.

RÉSUMÉ

Florko, K.R.N., Edkins, T., Ferguson, S.H., Yurkowski, D.J., Michel, C. 2023. Aerial surveys for marine mammals in Norwegian Bay and Ellesmere Island, Nunavut in 2022. Can. Tech. Rep. Fish. Aquat. Sci. 3534: vii + 19 p.

L'Extrême-Arctique canadien devrait être l'une des dernières régions à contenir la glace de mer estivale. Les mammifères marins adaptés à la glace, comme le phoque annelé (*Pusa hispida*) et l'ours blanc (*Ursus maritimus*), utiliseront probablement ces zones comme dernier refuge. En août 2022, nous avons effectué un relevé visant les mammifères marins dans la baie Norwegian et les fjords environnants sur l'île d'Ellesmere, au Nunavut, une région sur laquelle nous disposons de peu de données. Nous avons consigné l'espèce, le nombre d'individus et la répartition des mammifères marins à l'aide d'observations visuelles, de photographies et d'images infrarouges. Nous avons enregistré 72 observations de mammifères marins, dont des ours blancs, des phoques annelés, des narvals (*Monodon monoceros*) et des phoques barbus (*Erignathus barbatus).* La majorité de nos observations ont eu lieu dans l'ouest et le centre de la baie Norwegian, qui est la seule région de notre zone d'étude contenant une concentration de glace de mer, ce qui met peut-être en évidence l'importance de la glace de mer estivale pour les mammifères marins. Peu de mammifères marins ont été observés dans les fjords avoisinants (en eaux libres). Des réductions supplémentaires de la glace de mer pourraient modifier la répartition et l'abondance des mammifères marins dans l'ensemble de l'Extrême-Arctique canadien, et par conséquent, une surveillance continue de ces zones est nécessaire afin de comprendre comment les mammifères marins réagissent à la diminution de la glace de mer.

INTRODUCTION

The northernmost region of the Canadian Arctic and northwest Greenland are expected to be the last region with summer sea ice in the Arctic Ocean. Specifically, the region surrounding Ellesmere Island, Nunavut, is expected to be particularly important for remaining sea ice and its associated species and ecosystems. Consequently, this region is considered of unique ecological importance (DFO 2021). Conservation efforts led to the creation of the Tuvaijuittuq Marine Protected Area. Widespread knowledge gaps exist for Tuvaijuittuq and the Multidisciplinary Arctic Program Last Ice (MAP-Last Ice) was developed to establish baseline knowledge and information on the abundance and distribution of species in this High-Arctic ecosystem (Charette et al. 2020; Michel & Lange 2018; Michel et al. 2019). Arctic CORE (Conservation, Observation, Research and Engagement) is an ecosystem-based program following on the innovative surveys and research carried out during MAP-Last Ice, to further our understanding of the role of Tuvaijuittuq in Arctic marine ecosystems.

Tuvaijuittuq is inhabited by marine mammals such as narwhal (*Monodon monoceros*), ringed seals (*Pusa hispida*), bearded seals (*Erignathus barbatus*), Atlantic walrus (*Odobenus rosmarus rosmarus*), and polar bears (*Ursus maritimus*). Marine mammals in this area are largely understudied, however, occurrence records exist from explorer records in the late 18th and early 19th centuries (Greely 1886; Peary 1910), aerial surveys for narwhal in 2013 (Doniol-Valcroze et al. 2020), and more recently since 2018 for marine mammals as part of the MAP-Last Ice program at the northern tip of Ellesmere Island (Yurkowski et al. 2019; Carlyle et al. 2021; Florko et al. 2021). The MAP-Last Ice surveys found more biodiversity than expected in northeastern Ellesmere Island (i.e., Archer Fiord), including the northernmost recent records of Atlantic walrus (Yurkowski et al. 2019) and narwhal (Carlyle et al. 2021).

The objective of these surveys were to 1) identify and count marine mammals in Norwegian Bay and fiords to its north and east in Ellesmere Island, and 2) collect infrared videos and visual wavelength photographs of the sea ice/water directly below the aircraft to improve detection (e.g., Young et al. 2019; Florko et al. 2021) and further characterize observations, respectively. Results from the central and eastern Norwegian Bay and Baumann Fiord transects can be compared to previous years (i.e., 2013 from Doniol-Valcroze et al. 2020 and 2021 from Carlyle et al. unpub. data). Results from transects in the other areas (Eureka Sound, Greely Fiord, Bay Fiord, western Norwegian Bay) serve as the first available systematic survey data for marine mammals during the open water period.

METHODS

STUDY AREA AND TRANSECT LINES

This aerial survey was completed as a part of the Arctic CORE program. Surveys were conducted from 25 to 28 August 2022 in Norwegian Bay and fiords off the coast of central and southern Ellesmere Island, Nunavut in the Canadian High Arctic (Fig. 1). We flew approximately 2345 km of transect lines; 1349 km in Norwegian Bay, 392 in Baumann Fiord, and 604 in Eureka Sound, Greely Fiord, and Bay Fiord (Fig. 2). Our total airtime was 32.6 hours (Table 1). We flew the transect lines that were flown one year prior (August 2021, Carlyle et al. unpub. data) which included Norwegian Bay lines 03-10, Baumann Fiord, and western Ellesmere Island lines 05 and 08. The 2021 survey followed the systematic design of Doniol-Valcroze et al.

(2020). This 2022 survey built on the 2021 survey by extending the Norwegian Bay transect lines further westward than the 2021 survey and Doniol-Valcroze et al. (2020), where the lines ended at approximately 92°W (Fig. 1). Additionally, due to unseasonably good weather, we added transect lines beyond the 2021 survey: large zig-zag transects throughout Eureka Sound, Greely Fiord, and Bay Fiord (Fig. 1).

DATA COLLECTION

We conducted our survey from a de Havilland Twin Otter (DH-6) aircraft with a target altitude of 1000 ft (305 m) and ground speed of 110 knots (204 km/hr). The aircraft was equipped with a forward-looking infrared (FLIR) T1020SC video camera with a 45° wide-angle lens, and a digital single-lens reflex (DSLR) NIKON D810 camera with a 35 mm lens. Given our altitude and lens, the FLIR and DSLR had strip-widths of 250 and 313 m, respectively. The FLIR recorded video in SEQ format, at a resolution of 1024 x 768 pixels and a rate of 5 Hz. The DSLR took photographs in JPEG format, at a resolution of 8256 x 5504 pixels and at a rate of every two seconds (~40% overlap between photographs in sequence). Both the FLIR and the DSLR were mounted in the open belly of the aircraft and recorded footage of the area directly below the aircraft. We logged aircraft altitude, speed, position, and time with each photograph using a Bad Elf Pro+ global positioning system (GPS).

In addition to the FLIR and DSLR, a visual observer was positioned at a bubble window and recorded environmental conditions and marine mammal occurrence. Environmental metrics included sea ice cover (0-10), sea state (0-10 Beaufort Sea Scale), cloud cover (0-100%), fog, or precipitation. Marine mammal observations included species and count. The observer recorded associated time of environmental and marine mammal records to later be linked to appropriate location (from the GPS). This allowed us to characterize the habitat associated with occurrence, as well as detect animals outside of the strip width of the cameras or animals that evade infrared detection (i.e., those that dove into the water before the plane passed over them).

FOOTAGE PROCESSING

We reviewed the infrared video for a thermal indication of animals using ResearchIR Max software (version 4.40.9.30; FLIR Systems, Wilsonville OR, USA). We looked for thermal hotspots to detect animals directly on the sea ice, or thermal indications of whale blow or flukeprints to indirectly detect animals in the water. When thermal cues were detected, we reviewed the concurrent DSLR images to verify presence and identify species.

RESULTS

The weather was characterized by clear skies and low wind which allowed us to complete all of our planned survey and fly supplemental transect lines.

OBSERVATIONS

We observed a total of 72 marine mammal individuals throughout our survey: five polar bears, 13 narwhal, one walrus, 35 ringed seals, five bearded seals, 12 seals (we could not identify species), and one unknown mammal (large and bright hotspot in the FLIR video but unidentified in the DSLR photograph) (Fig. 2, Table 2). Most of our observations occurred in western and central Norwegian Bay, and Baumann Fiord. Western and central Norwegian Bay had the highest marine mammal diversity, including polar bears, walrus, narwhal, and ringed and bearded seals. Eastern Norwegian Bay and Eureka Sound, Greely Fiord, and Bay Fiord had few to no marine mammal observations. The Baumann Fiord observations were mostly seals in open water; we were unable to identify species as most of the body was submerged in water. Our visual observers detected 27 animals (Table 2), and the FLIR detected an additional 45 animals (Table 3, Fig. 3, Fig. 4). The FLIR was particularly helpful for detecting marine mammals on sea ice in western and central Norwegian Bay (Fig. 2C), and visual observation was best for detecting seals swimming in open water, as in Baumann Fiord (Fig. 2B).

INFRARED DETECTION AT SEAL BREATHING HOLES

The FLIR video provided efficient detection of animals by using the body heat which we were able to confirm from the DSLR photograph. Interestingly, we observed two cases of the FLIR detecting hotspots, and the corresponding DSLR photograph presented a seal breathing hole (Fig. 5). The FLIR and DSLR cameras were mounted where the FLIR was placed in the forward mount (towards the nose of the aircraft), and the DSLR was placed behind it (towards the tail of the aircraft) within the aircraft's open port in the belly. As such, the FLIR recorded video slightly before the DSLR took photographs. We speculate that the seals quickly retreated to the water via their breathing hole before the DSLR took its 2-second interval photographs, and/or the infrared detected the face of the seal, which we are unable to identify in the photographs given resolution limitations. Further, when observing the photographs corresponding with the FLIR's hotspots, the holes appeared to have ice markings surrounding them, suggesting maintenance by a seal. Thus, we recorded the putative observation of a seal (Table 3, denoted by *).

ENVIRONMENTAL CONDITIONS

The weather conditions were mostly low-moderate wind and clear skies throughout our survey. We encountered low to high sea ice concentration. Sea ice was most abundant in central and western Norwegian Bay, scattered in moderate density in southern and northern Norwegian Bay, and scattered throughout Baumann and Eureka Sound (Fig. 6). New sea ice was forming throughout the study area, most prominently in Bay Fiord. Additionally, we encountered calm seas (0-3 Beaufort Sea State), 0-100% cloud cover (ceiling above 305 m), and no precipitation. The survey was clear of fog except for ~ 3 minutes of low-moderate fog on the transect line NB_03.

OTHER WILDLIFE OBSERVATIONS

We opportunistically observed one muskox, four polar bears, one bearded seal, and ~50 beluga whales off-transect during our aerial survey (Table 4).

CONCLUSION

The 2022 aerial survey in Norwegian Bay and the fiords of central and southern Ellesmere Island, NU, provided insight on summer distribution of marine mammals. Overall, we recorded 72 marine mammal observations from the FLIR and visual observer (duplicates removed) that included narwhals, polar bears, ringed seals, bearded seals, walrus, and unidentified seal species with most observations occurring in western and central Norwegian Bay. We also observed ~50 beluga whales south of the survey area, off of southwestern Devon Island.

Our results from Eureka Sound, Greely Fiord, Bay Fiord, and western Norwegian Bay serve as the first available systematic survey data for marine mammals during the open water period and were characterized by relatively few marine mammal observations. More specifically, there were 2 marine mammal sightings near Eureka, and 9 sightings in Baumann Fiord. We speculate that the relatively low number of observations may be related to the low amounts of sea ice observed in these areas.

Our observations from the central and eastern Norwegian Bay and Baumann Fiord transects serve as an update from the 2013 results from Doniol-Valcroze et al. (2020). Our transect lines also extended further westward in Norwegian Bay than Doniol-Valcroze et al. (2020). The more abundant polar bear and seal observations in this central/western Norwegian Bay area also had the most sea ice in our study area. This region may support more animals due to relatively higher productivity than in the more northern regions. Additionally, these seals are likely selecting sea ice as a physical platform to haul-out on (Lone et al. 2019), and polar bears are likely hunting ringed seals in this area (Smith 1980).

The FLIR detected more marine mammals than our visual observer and DSLR photographs, and was a complimentary tool to photographs which were used to confirm the presence, identify species, and count the number of animals. While the FLIR was useful in detecting animals, the higher number of marine mammals detected in central/western Norwegian Bay may have been due to better detection from the infrared on sea ice (full body detected) rather than in the open water (only head detected, as in the case of seals). Additionally, the effective and timely detection of seals retreating to breathing holes before the DSLR photographs were taken highlights the usefulness of the FLIR, and that the presence of the plane caused these seals to retreat to their breathing holes. Further consideration into the biases of the background substrate (i.e., sea ice or open water) would provide useful insight and perhaps correction factors if using these data to understand the environmental conditions associated with the observations.

Our study was primarily adjacent to Tuvaijuittuq Marine Protected Area, but the relatively few marine mammal observations within open waters of Eureka Sound (within Tuvaijuittuq Marine Protected Area) were in contrast with the numerous marine mammals observed in the open waters of Archer Fiord on northeast Ellesmere Island (eastern edge of Tuvaijuittuq Marine Protected Area; Carlyle et al. 2021) in 2019. Future work exploring the environmental conditions (e.g., chlorophyll-a, sea surface temperature, etc.) associated with these marine mammal observations could help explain the prey availability (Bluhm and Gradinger 2008) and other drivers of marine mammal distribution and abundance throughout these areas surrounding Ellesmere Island. Further, relating observations to environmental conditions could help predict summer habitat use for marine mammals at the northern extent of their range. These insights would help support the CORE objectives of understanding the importance of the Tuvaijuittuq area in Arctic marine ecosystems.

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Table 1. Summary of survey flight times and transects flown. Flight start and end times are in central daylight savings time (CDT).

Date	**Start time (CST)**	**End time (CST)**	**Duration (hr)**	**Transects**
22-08-25	09:01	13:18	4.28	NB_09, NB_08
22-08-25	14:19	18:18	3.98	NB_07, NB_06
22-08-26	09:07	13:20	4.22	NB_05, NB_04, NB_03
22-08-26	14:16	17:30	3.25	BF_09, BF_05, BF_04n, WEF_05
22-08-26	18:27	21:40	3.22	WEF_08, BF_01, BF_02, WEF_10
22-08-27	12:40	17:15	4.58	NB_09 (redo), NB_10, BF_03n, BF_03s, BF_04s
22-08-28	09:21	13:54	4.55	ERK_01
22-08-28	14:49	17:41	2.86	ERK_02, ERK_03

Table 2. Marine mammal visual observations during the 25 to 28 August 2022 aerial survey.

Date	**Time**	**Species**	**Count**	**Latitude**	**Longitude**
22-08-25	16:07	narwhal	12	77.36	-92.20
22-08-26	10:19	polar bear	1	77.14	-95.03
22-08-26	10:53	bearded seal	1	77.19	-90.33
22-08-26	11:59	bearded seal	1	76.99	-93.17
22-08-26	12:34	bearded seal	1	76.83	-91.36
22-08-26	15:13	polar bear	1	78.09	-87.09
22-08-26	15:16	seal	2	78.07	-87.01
22-08-26	16:34	seal	1	78.07	-85.16
22-08-26	19:20	seal	1	78.05	-82.59
22-08-26	19:22	seal	1	78.00	-82.67
22-08-26	19:25	seal	3	77.91	-82.72
22-08-27	14:26	ringed seal	1	77.85	-95.09
22-08-27	15:13	narwhal	1	78.08	-91.48

date = YY-MM-DD, time = central daylight savings time (CDT), latitude = decimal degrees north, longitude = decimal degrees west.

Table 3. Marine mammal observations from infrared video detection during the 25 to 28 August 2022 aerial survey.

Date	FLIR video ID	FLIR video time stamp	DSLR photograph ID	Species	Count	Latitude	Longitude
22-08-25	14	00_00_37_387	20220825_25mm_018952	ringed seal	1	77.72	-90.82
22-08-25	14	00_16_14_435	20220825_25mm_019289	ringed seal	1	77.71	-93.06
22-08-25	14	00_16_18_258	20220825_25mm_019291	ringed seal	4	77.71	-93.06
22-08-25	18	00_09_26_924	20220825_25mm_021587	ringed seal	1	77.35	-92.71
22-08-25	18	00_13_31_666	20220825_25mm_021705	ringed seal	1	77.35	-93.28
22-08-25	18	00_13_25_278	20220825_25mm_021702	ringed seal	1	77.35	-93.26
22-08-26	21	00_01_32_375	20220826_35mm_023018	polar bear	1	77.16	-93.43
22-08-26	21	00_03_17_936	20220826_35mm_023070	ringed seal	1	77.17	-93.19
22-08-26	21	00_03_42_764	20220826_35mm_023082	ringed seal	1	77.17	-93.13
22-08-26	21	00_09_06_883	20220826_35mm_023243	ringed seal	2	77.18	-92.37
22-08-26	21	00_14_13_857	20220826_35mm_023392	ringed seal	1	77.18	-91.65
22-08-26	22	00_01_01_188	20220826_35mm_023657	bearded seal	1	77.19	-90.40
22-08-26	22	00_01_15_983	20220826_35mm_023664	ringed seal	1	77.19	-90.36
22-08-26	22	00_03_25_175	20220826_35mm_023729	ringed seal	1	77.19	-90.05
22-08-26	22	00_03_37_590	20220826_35mm_023735	ringed seal	2	77.19	-90.02
22-08-26	22	00_20_06_415	20220826_35mm_024225	ringed seal	1	77.18	-87.70

22-08-26	23	00_17_00_660	20220826_35mm_024841	ringed seal	1	77.01	-91.07
22-08-26	24	00_09_21_702	20220826_35mm_025274	ringed seal	1	76.99	-93.03
22-08-26	25	00_09_22_118	20220826_35mm_025899	bearded seal	1	76.82	-92.20
22-08-26	25	00_10_29_694	20220826_35mm_025931	ringed seal	2	76.82	-92.05
22-08-26	25	00_11_37_704	20220826_35mm_025965	ringed seal	3	76.82	-91.89
22-08-26	25	00_11_51_696	20220826_35mm_025972	ringed seal	1	76.82	-91.86
22-08-26	26	00_01_05_571	20220826_35mm_026119	ringed seal	1	76.83	-91.18
22-08-26	30	00_05_53_944	20220826_35mm_027489	ringed seal	1	77.79	-85.59
22-08-26	30	00_06_03_752	20220826_35mm_027494	ringed seal	1	77.79	-85.58
22-08-26	30	00_06_11_958	20220826_35mm_027498	ringed seal	1	77.80	-85.57
22-08-27	35	00_25_52_361	20220827_35mm_030757	seal*	2	77.90	-91.12
22-08-27	35	00_28_52_935	20220827_35mm_030845	unknown	1	77.90	-91.56
22-08-27	35	00_33_42_298	20220827_35mm_030987	ringed seal	1	77.89	-92.27
22-08-27	36	00_14_53_891	20220827_35mm_031532	ringed seal	1	77.85	-95.06
22-08-27	36	00_17_15_231	20220827_35mm_031600	polar bear	1	77.85	-95.41
22-08-27	37	00_02_29_797	20220827_35mm_031917	walrus	1	78.04	-94.67
22-08-27	38	00_18_41_597	20220827_35mm_033263	seal	1	78.08	-87.67
22-08-27	39	00_00_12_818	20220827_35mm_033365	seal*	1	77.59	-84.90

22-08-28	44	00_03_56_954	20220828_35mm_035412	polar bear	1	79.21	-84.51
22-08-28	47	00_18_31_194	20220828_35mm_038039	ringed seal	1	79.99	-82.50

date = YY-MM-DD, time = central daylight savings time (CDT), latitude = decimal degrees north, longitude = decimal degrees west; * = breathing hole.

Table 4. Visual observations of off-transect wildlife during the aerial survey from 25 to 28 August 2022.

Date	Time	Species	Count	Latitude	Longitude	Comments
22-08-26	11:16	muskox	1	76.92	-89.18	Between NB_03 and NB_04 on land at east end of transects
22-08-26	14:16	polar bear	3	76.53	-93.21	Observed 100 m north of the Devon Noranda airstrip after takeoff
22-08-27	12:03	polar bear	1	76.46	-93.33	Observed 1 km south of the Devon Noranda airstrip before landing
22-08-27	12:02	bearded seal	1	76.42	-93.34	Observed 2 km of the Devon Noranda airstrip before landing
22-08-27	18:03	beluga whale	~50	76.33	-93.30	Observed 5 km south of the Devon Noranda airstrip after takeoff

Note: see Devon Noranda airstrip location on Fig. 1

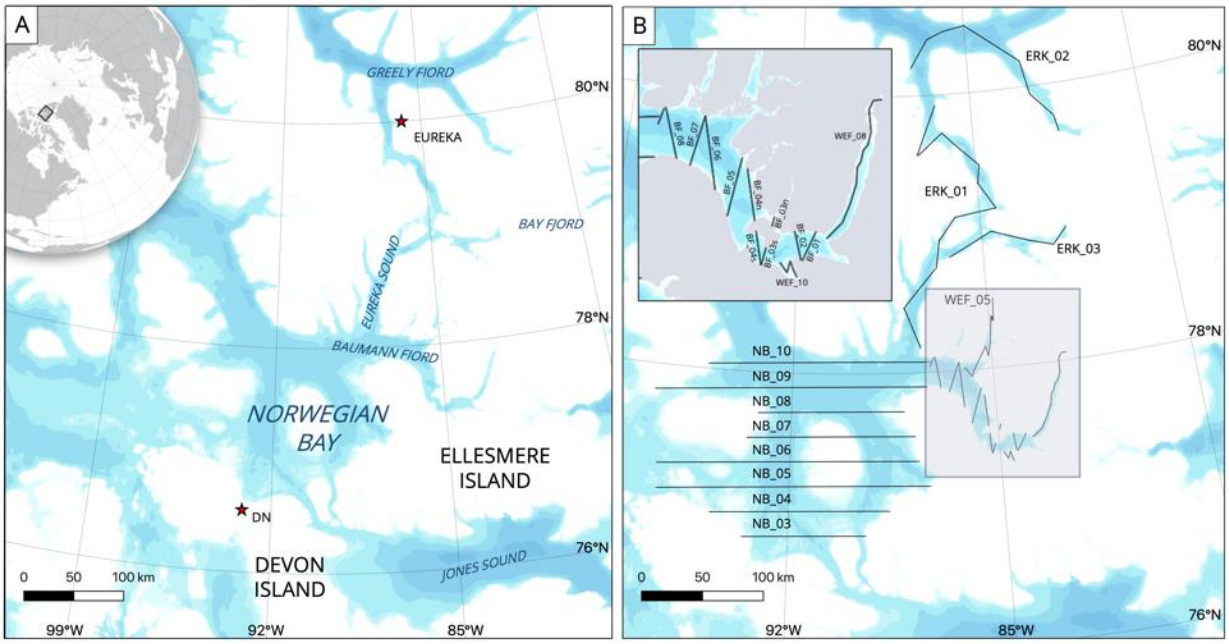

Figure 1. Map of the (A) study area and (B) transect lines surveyed. The transect lines were named by Carlyle et al. (unpub data) according to the region covered; NB = Norwegian Bay, BF = Baumann Fiord, ERK = Eureka, and WEF = western Ellesmere Island Fiords. DN = Devon Noranda airstrip

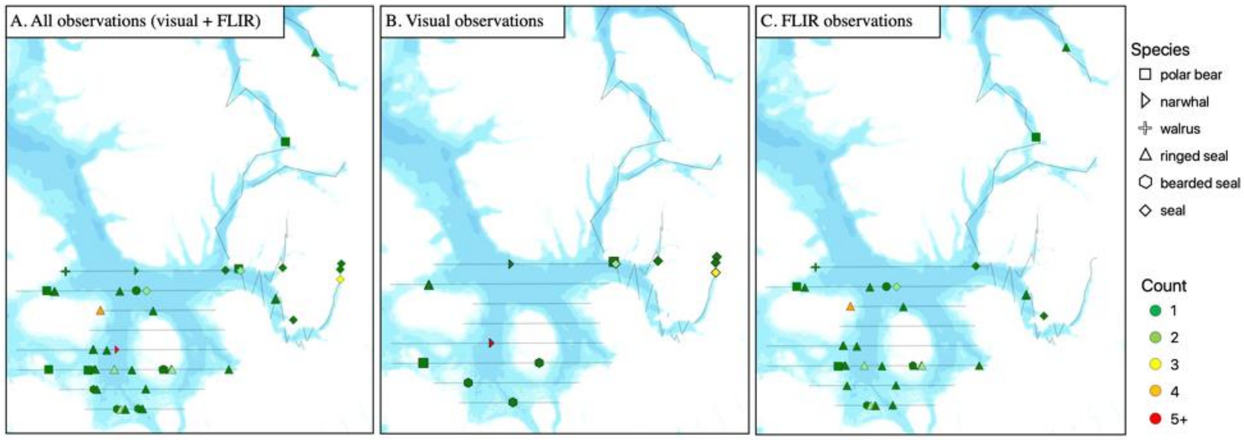

Figure 2. Map of A) all observations of marine mammals from both visual and infrared video detection, B) visual detection, and C) infrared detection during aerial surveys from 25 to 28 August 2022. FLIR = forward-looking infrared. Symbols and colours represent species and abundance of animals observed, respectively.

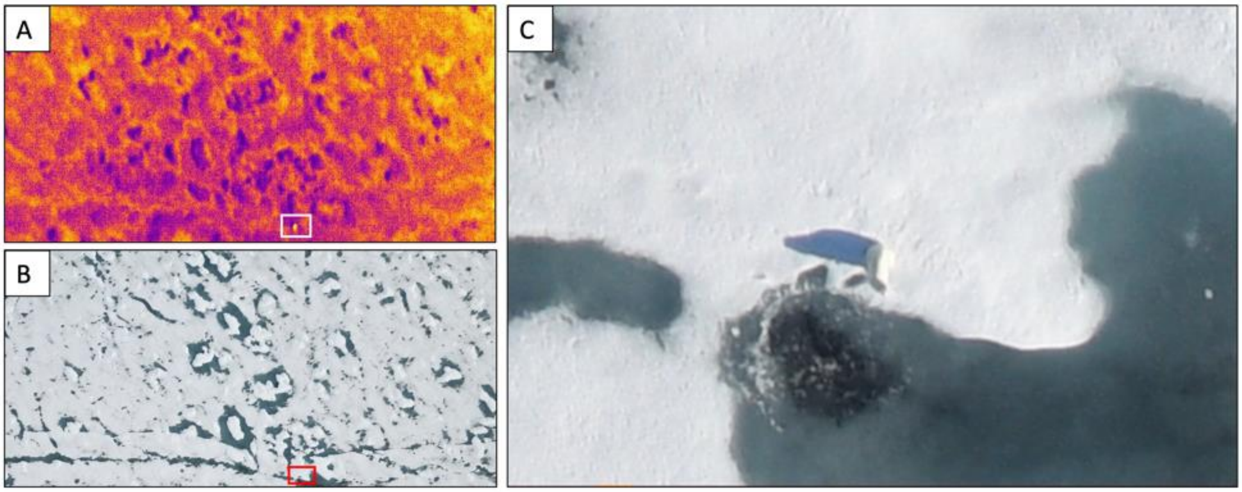

Figure 3. Example of imagery collected during aerial survey from A) FLIR, B) DSLR, and C) zoomed in (1900%) DSLR imagery of a polar bear. The white and red boxes in A and B (respectively) correspond with the view in C.

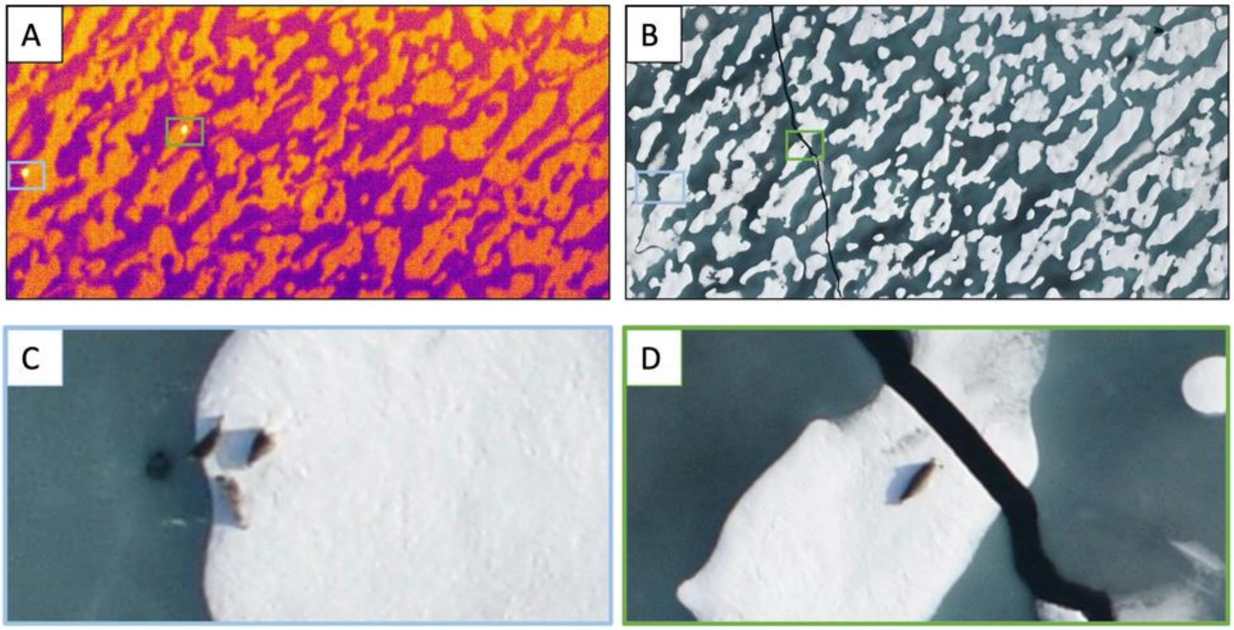

Figure 4. Example of imagery collected during aerial survey from A) FLIR, B) DSLR, and C and D) zoomed in (1900%) DSLR imagery of ringed seals. The blue and green boxes in A/B correspond with the view in C and D (respectively).

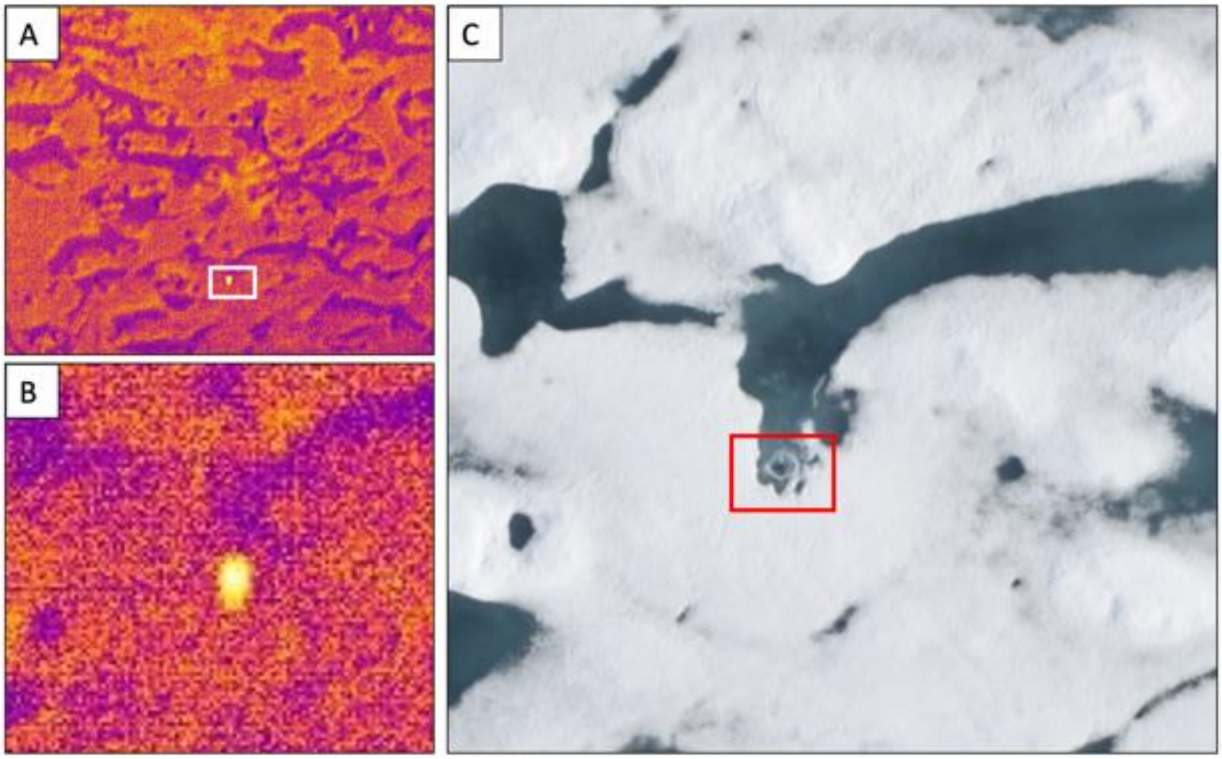

Figure 5. Example of imagery collected during aerial survey from A) FLIR, B) zoomed in FLIR, and C) zoomed in (1900%) DSLR imagery. This example shows the thermal signature of a marine mammal in the FLIR images (A and B) and a breathing hole in the DSLR image C.

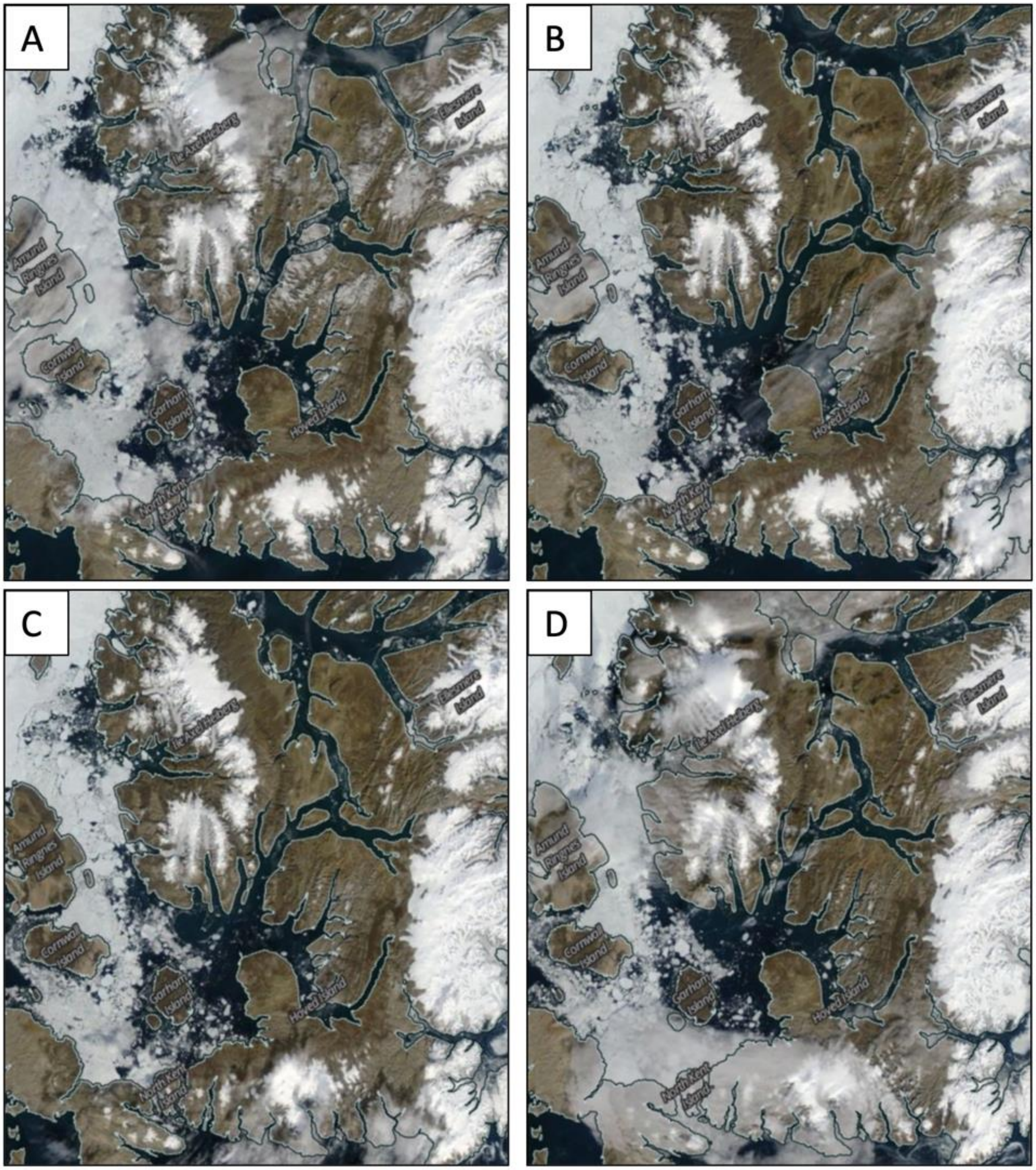

Figure 6. MODIS satellite imagery of the sea-ice conditions in Norwegian Bay, Baumann Fiord, Eureka Sound, Greely Fiord, and Bay Fiord for A) 25 August, B) 26 August, C) 27 August, and D) 28 August 2022. Images accessed from NASA Worldview (https://go.nasa.gov/39IdDgE).