

Summary of marine mammal aerial surveys around Ellesmere Island, Nunavut in September 2023

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SUMMARY OF MARINE MAMMAL AERIAL SURVEYS AROUND ELLESMERE
ISLAND, NUNAVUT IN SEPTEMBER 2023

by

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ABSTRACT

MacLean, R.D., Florko, K.R.N., Johnson, K.F., Ferguson, S.H., Michel, C., Thiemann, G.W., Yurkowski, D.J. 2024. Summary of marine mammal aerial surveys around Ellesmere Island, Nunavut in September 2023. Can. Tech. Rep. Fish. Aquat. Sci. 3618: vii + 20 p.

The Last Ice Area (LIA) serves as a crucial habitat for key marine mammal species, including ringed seals (*Pusa hispida*), bearded seals (*Erignathus barbatus*), narwhal (*Monodon monoceros*), Atlantic walrus (*Odobenus rosmarus rosmarus*), and polar bears (*Ursus maritimus*). In 2019, Fisheries and Oceans Canada established the Tuvaijuittuq Marine Protected Area (MPA) within the LIA to safeguard this ecologically vital Arctic region. Aerial surveys conducted in 2023 around the Canadian archipelago of Ellesmere Island, Nunavut, focused on Norwegian Bay, Archer Fiord, the Canadian side of Nares Strait, and fiords southwest of Ellesmere Island, mostly south of Tuvaijuittuq MPA to quantify, identify, and understand marine mammal habitat usage. A de Havilland Twin Otter aircraft equipped with infrared and DSLR cameras flew transects at an altitude of 1000 ft and a speed of 110 knots, covering 3307 km over six days in early September.

Infrared analysis identified 25 animals including 22 ringed seals and 3 walruses, as well as 2 breathing holes. Narwhals ($n = 26$) were visually observed in Archer Fiord, consistent with previous surveys. Additionally, observations outside transects included hundreds of birds and harp seals near Grise Fiord, a walrus colony in Walrus Fiord, polar bears near Devon Noranda, a wolf along the shore of Baumann Fiord, and groups of muskox near the Eureka weather station. Aerial surveys, initiated in 2018, continue to annually document marine mammal occurrences in the LIA, contributing to the understanding and conservation of this critical High-Arctic region.

RÉSUMÉ

MacLean, R.D., Florko, K.R.N., Johnson, K.F., Ferguson, S.H., Michel, C., Thiemann, G.W., Yurkowski, D.J. 2024. Summary of marine mammal aerial surveys around Ellesmere Island, Nunavut in September 2023. Can. Tech. Rep. Fish. Aquat. Sci. 3618 : vii + 20 p.

La dernière zone de glace sert d'habitat essentiel pour d'importantes espèces de mammifères marins, comme le phoque annelé (*Pusa hispida*), le phoque barbu (*Erignathus barbatus*), le narval (*Monodon monoceros*), le morse de l'Atlantique (*Odobenus rosmarus rosmarus*) et l'ours polaire (*Ursus maritimus*). En 2019, Pêches et Océans Canada a créé la zone de protection marine (ZPM) de Tuvaijuittuq dans la dernière zone de glace afin de préserver cette région arctique vitale sur le plan écologique. Les relevés aériens réalisés en 2023 autour de l'archipel canadien de l'île d'Ellesmere, au Nunavut, se sont concentrés sur la baie Norwegian, le fjord Archer, le côté canadien du détroit de Nares et les fjords au sud-ouest de l'île d'Ellesmere, principalement au sud de la ZPM de Tuvaijuittuq afin que l'on puisse quantifier, définir et comprendre l'utilisation de l'habitat par les mammifères marins. Un avion Twin Otter de De Havilland équipé de caméras infrarouges et d'appareils reflex mono-objectifs numériques a effectué des transects à une altitude de 1 000 pieds et à une vitesse de 110 nœuds, parcourant 3 307 km en six jours au début du mois de septembre.

L'analyse infrarouge a permis d'identifier 25 animaux, dont 22 phoques annelés et 3 morses, ainsi que 2 trous d'air. On a observé visuellement des narvals (n = 26) dans le fjord Archer, ce qui correspond aux relevés précédents. En outre, les observations effectuées en dehors des transects comprenaient des centaines d'oiseaux et de phoques du Groenland près du fjord Grise, une colonie de morses dans le fjord Walrus, des ours polaires près de Devon Noranda, un loup le long du fjord Baumann et des groupes de bœufs musqués près de la station météorologique Eureka. Les relevés aériens, entrepris en 2018, continuent de documenter chaque année les occurrences de mammifères marins dans la dernière zone de glace, contribuant ainsi à la compréhension et à la conservation de cette région essentielle de l'Extrême-Arctique.

INTRODUCTION

The Last Ice Area (LIA) in the High Arctic is predicted to host the last year-round sea ice in the Arctic, providing a potential refuge for ice-dependent species (DFO, 2020). In 2019, Fisheries and Oceans Canada designated the Tuvaijuittuq Marine Protected Area (MPA) by Ministerial Order under the *Oceans Act* within the LIA to conserve and protect this ecologically important region of the Arctic (*Order Designating the Tuvaijuittuq Marine Protected Area*, 2019). Tuvaijuittuq MPA is located along the north of the Canadian archipelago of Ellesmere Island, Nunavut (Figure 1) and is characterized by prevalent multi-year sea ice, as well as land-fast and pack-ice throughout the region (Charette et al., 2020).

The year-round sea ice in and around the MPA provides habitat for several keystone marine mammal species including ringed seals (*Pusa hispida*), bearded seals (*Erignathus barbatus*), narwhal (*Monodon monoceros*), Atlantic walrus (*Odobenus rosmarus rosmarus*), and polar bears (*Ursus maritimus*) (Charette et al., 2020). Beyond anecdotal evidence of marine mammals reported by explorers in the late 1800s and early 1900s (e.g., Greely, 1886; Peary, 1910), there is limited available knowledge about occurrences of these species within the LIA (Florko et al., 2023). Aerial surveys within the Tuvaijuittuq MPA and surrounding area have been conducted annually since 2018 to document the detection and occurrences of marine mammals (e.g. Yurkowski et al., 2019, Carlyle et al., 2021, Florko et al., 2021, 2023). These surveys aim to fill knowledge gaps identified in the Canadian Science Advisory Secretariat report for Tuvaijuittuq MPA by exploring the habitat use of marine mammals in the LIA (DFO, 2020).

To date, aerial marine mammal surveys in the region have documented several hundred animal observations around Ellesmere Island, Nunavut. Novel observations of both narwhal and walrus over 100 kilometers north of their previously established ranges have been recorded, indicating that the full importance of this region for marine mammal species is still unknown (Carlyle et al., 2021; Yurkowski et al., 2019). The objectives of the 2023 survey were to 1) observe Arctic marine mammal species around Ellesmere Island, Nunavut, and 2) detect marine mammals from the air by means of aerial images using a Digital Single-Lens Reflex (DSLR) camera and infrared video using a Forward Looking Infrared (FLIR) camera (Florko et al., 2023).

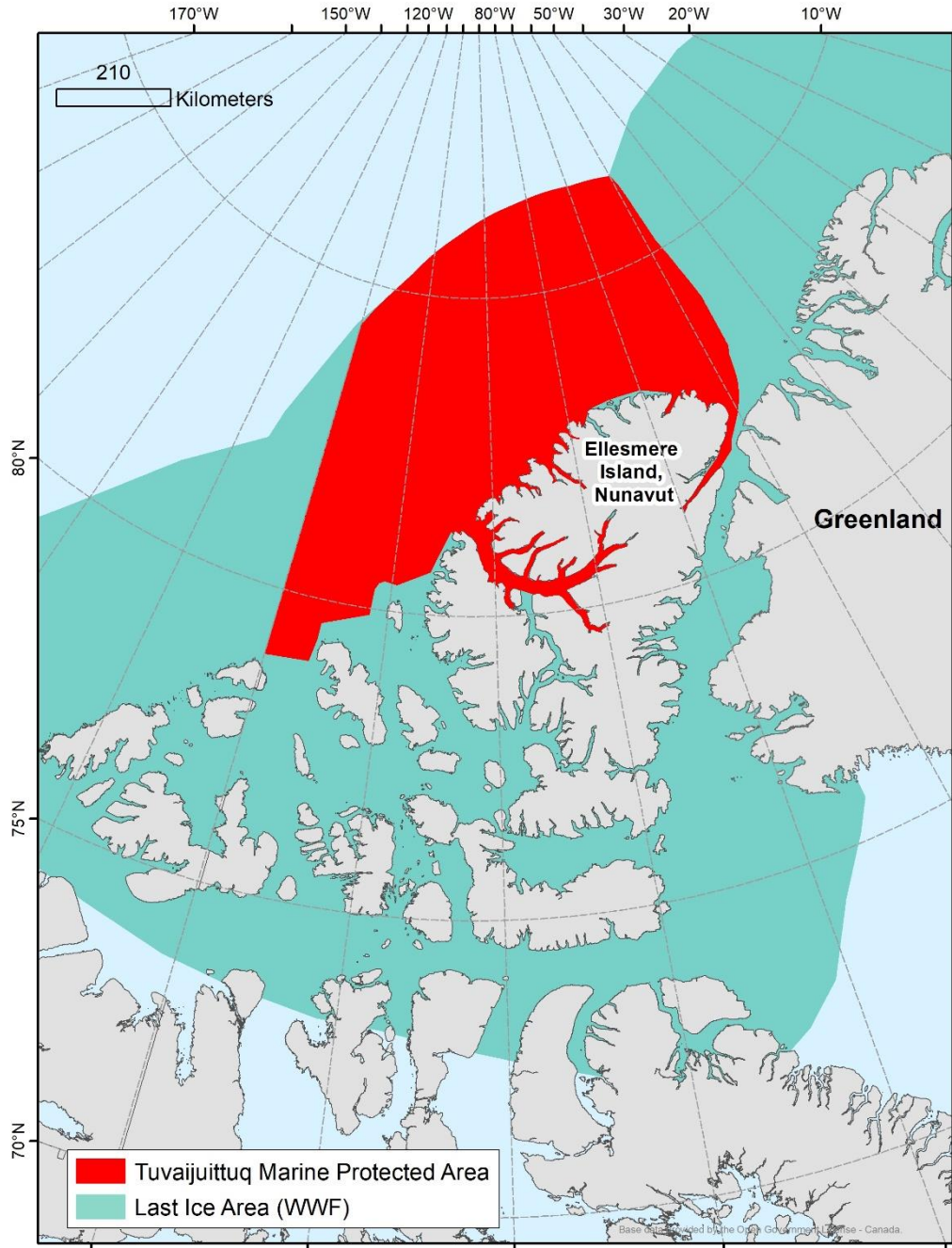


Figure 1. Tuvaijuittuq Marine Protected Area boundary within the Last Ice Area.

METHODS

STUDY AREA AND TRANSECT LINES

The aerial surveys were conducted around the Canadian archipelago of Ellesmere Island, Nunavut. The majority of transects were located south of the Tuvaijuittuq MPA where suitable sea ice habitat for ice-dependent species was likely to be present and where transects were accessible from the base in Eureka. Transects

were concentrated in Norwegian Bay, Archer Fiord, the Canadian side of Nares Strait, and the fiords in the west-southwest of Ellesmere Island (Figure 2). Specifically, we flew eight transect lines in Norwegian Bay (NB 03-10), two in Archer Fiord (AF 01-02), nine in Nares Strait (NS 01-09) two in Baumann Fiord (BF 01-02), and seven in Nansen Sound and Eureka Sound (ERK 01-07) (Figures 3-5).

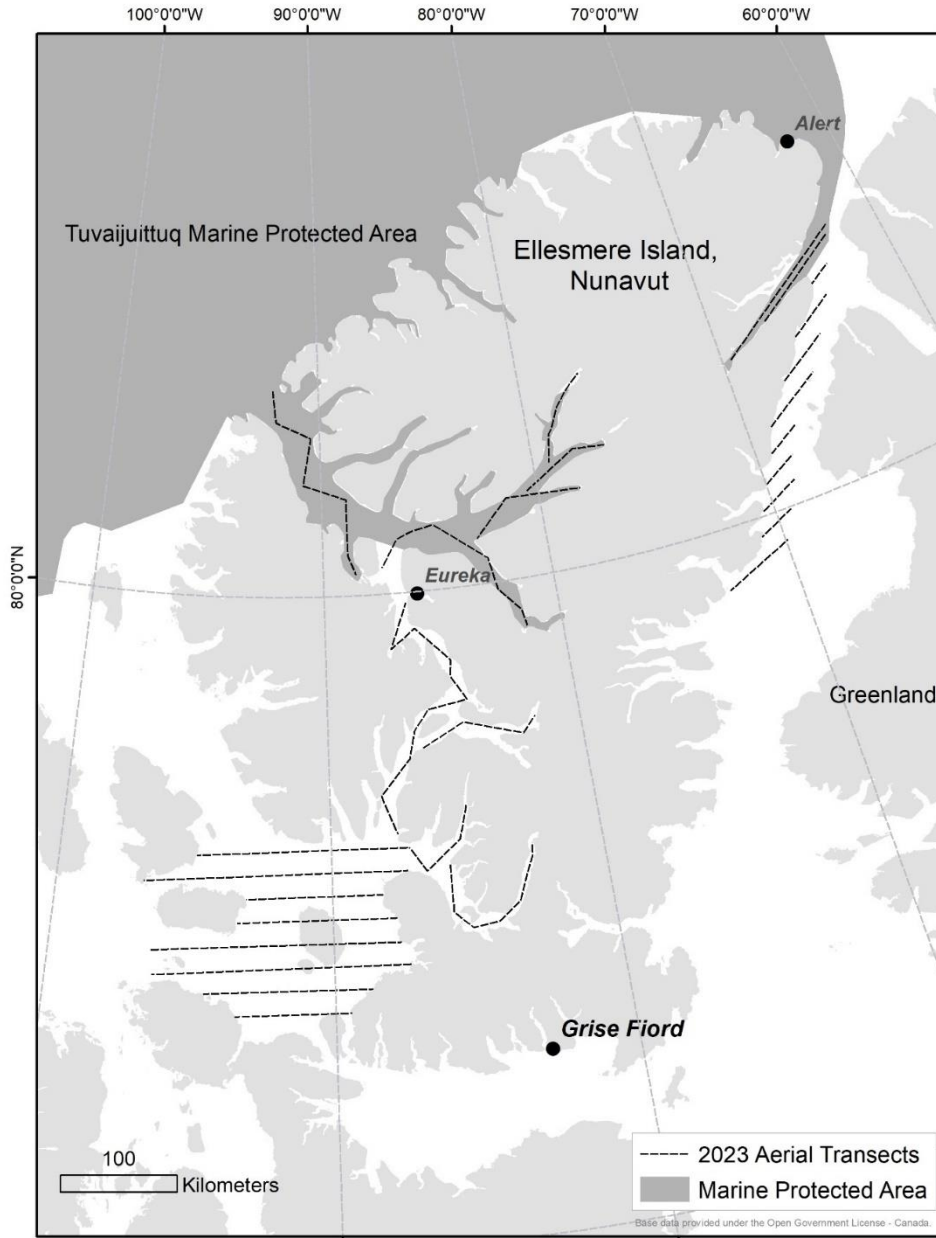


Figure 2. Aerial transect lines for the 2023 Last Ice Area aerial marine mammal surveys.

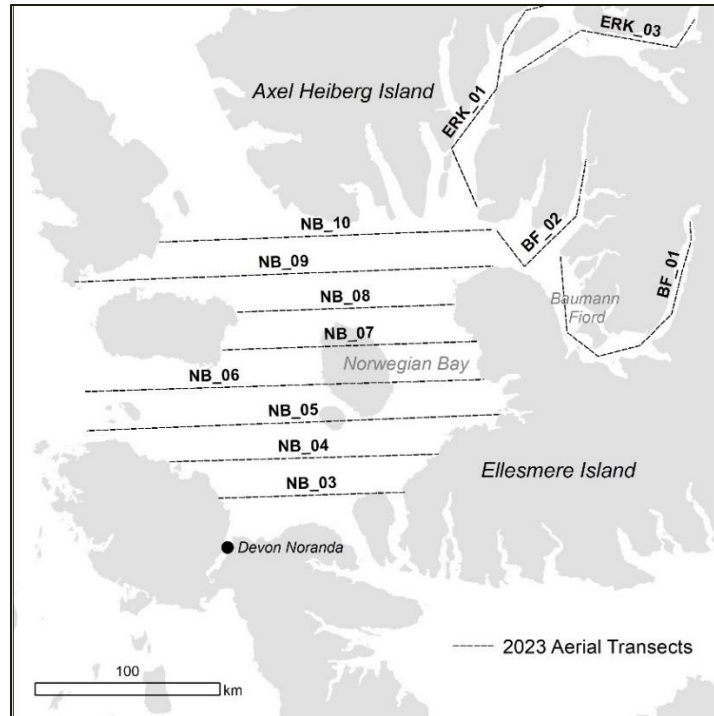


Figure 3. Norwegian Bay, Baumann Fiord, and Eureka Sound aerial transects for the 2023 Last Ice Area aerial marine mammal surveys.

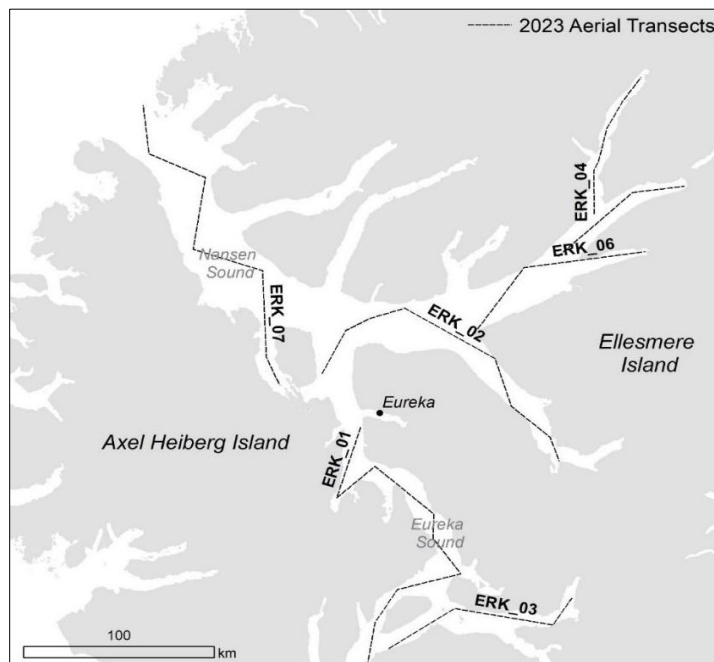


Figure 4. Nansen Sound and Eureka Sound aerial transects for the 2023 Last Ice Area aerial marine mammal surveys.

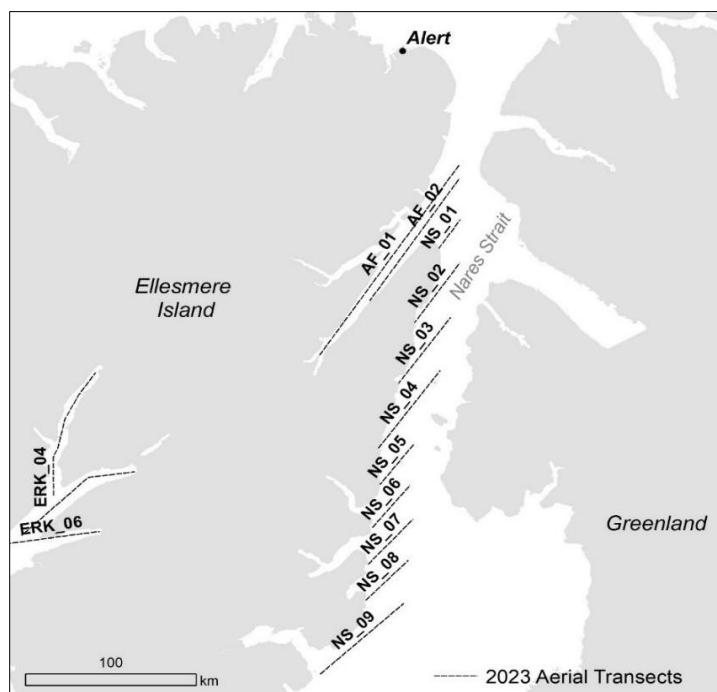


Figure 5. Archer Fiord and Nares Strait aerial transects for the 2023 Last Ice Area aerial marine mammal surveys.

DATA COLLECTION

Aerial transects were flown in a de Havilland Twin Otter (DH-6) aircraft with an underbelly camera hatch at the bottom of the plane. A forward-looking infrared (Teledyne FLIR) T1020SC video camera with a 45° wide-angle lens, and two digital single-lens reflex (DSLR) NIKON D810 cameras, one with a 25 mm lens and one with a 55 mm lens, were mounted on a frame and lowered from the opening of the aircraft. The target altitude and ground speed for the transects were 1000 ft (305 m) and a speed of 110 knots (204 km/hr). The FLIR recorded video in SEQ format, at a resolution of 1024 x 768 pixels and a rate of 5 Hz. The DSLRs took photographs in JPEG format, with a resolution of 8256 x 5504 pixels at a rate of every 3 seconds for the 55mm lens camera and 6 seconds for the 25 mm lens camera (~40% overlap between photographs in sequence). The 25mm lens was rotated 90 degrees perpendicular to the transect line to accommodate the shape of the camera mount. The swath width of the 25mm lens was determined to be 292 meters due to the rotation, and the 55mm lens was determined to be approximately 199 meters. The FLIR camera had a swath width of approximately 250 meters (Florko et al., 2023). Each DSLR was synced with a Bad Elf Pro+ global positioning system (GPS) to record aircraft altitude, speed, position, and time of each photograph.

In addition to the FLIR and DSLRs, two visual observers were positioned at bubble windows on each side of the plane and recorded environmental conditions and marine

mammal sightings. Environmental metrics included sea ice cover (0-10), Beaufort Sea State (0-10 Beaufort Sea Scale), cloud cover (0-100%), fog (presence/absence), and precipitation (presence/absence). The average percent cloud cover, ice cover, and Beaufort Sea State was calculated for each transect based on the environmental conditions recorded by the observer. Marine mammal observations included species and count. The observers recorded environmental conditions at the beginning of each transect, if/when conditions changed, and when marine mammals were sighted, along with the corresponding time, later to be linked to appropriate locations (from the GPS). Visual observations were used to record the habitat characteristics along the transect, as well as to 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).

INFRARED AND AERIAL IMAGE DETECTION

Approximately 724 minutes of infrared videos were analyzed to detect bright spots indicating thermal hotspots of animal body heat using FLIR Tools software (version 6.4.18039.1003). The time of the hotspots was then compared to the aerial photo times to match up which photo corresponded to the hotspot. From the hotspots we were able to count the number of individuals and identify the species of animal observed in the DSLR photos (Figure 6).

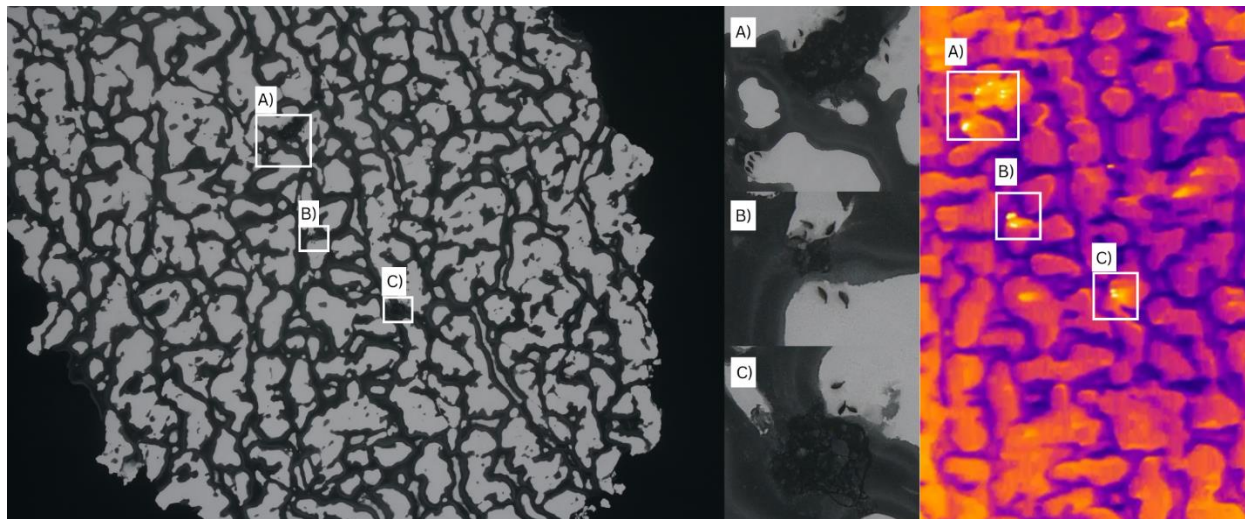


Figure 6. Example of seal detection in aerial imagery using corresponding infrared video. A), B) and C) illustrate zoomed-in views of the seals.

RESULTS

A total of 3307 km of transect lines were planned for the 2023 survey. Approximately 43 hours were spent flying for this survey from September 2nd – 9th, 2023. All planned aerial transects were surveyed, apart from roughly 35 km or 25% of transect NB_10 due to fog resulting in poor visibility. Several of the fiords surveyed were characterized by open water, which made focusing the FLIR camera difficult due to lack of contrast. However, clear DSLR photographs were captured along these transects.

OBSERVATIONS

Out of the 27 transects completed, only two had visual sightings of animals by the observers, with a total count of 29 animals for the visual observations. These transects included AF_01 (Archer Fiord) with 26 narwhal and two ringed seal sightings, and NB_09 (Norwegian Bay) with one ringed seal sighting (Table 1). There were visual observations of polar bear tracks along the AF_02 (Archer Fiord), NS_01 (Nares Strait) and NB_07 (Norwegian Bay) transects. Analysis of the infrared video identified a total of 27 animal observations including evidence of animals such as breathing holes. Based on the time of the observation identified in the infrared video, the corresponding DSLR photo at that time was cross referenced, and species were identified and counted. Based on this method, we found animals in nine of the DSLR photos. These observations included 22 ringed seals, three walruses, and two breathing holes (Table 1). There were three walruses observed in Norwegian Bay along transect NB_04 (Figure 7), 16 ringed seals observed in Bay Fiord along transect ERK_03 (Figure 8), five ringed seals observed in Archer Fiord along transect AF_01 and 1 ringed seal observed in Nares Strait along transect NS_05 (Figure 9).

Table 1. Number of observations detected in aerial images and infrared video collected along aerial transects during the 2023 Last Ice Area aerial marine mammal survey. Observations include animals and evidence of animals (i.e. breathing holes).

Species/Observation	FLIR Observations	Visual Observations	Total
Ringed Seal	22	3	25
Narwhal	0	26	26
Atlantic Walrus	3	0	3
Breathing Hole	2	0	2
Total Observations	27	29	56

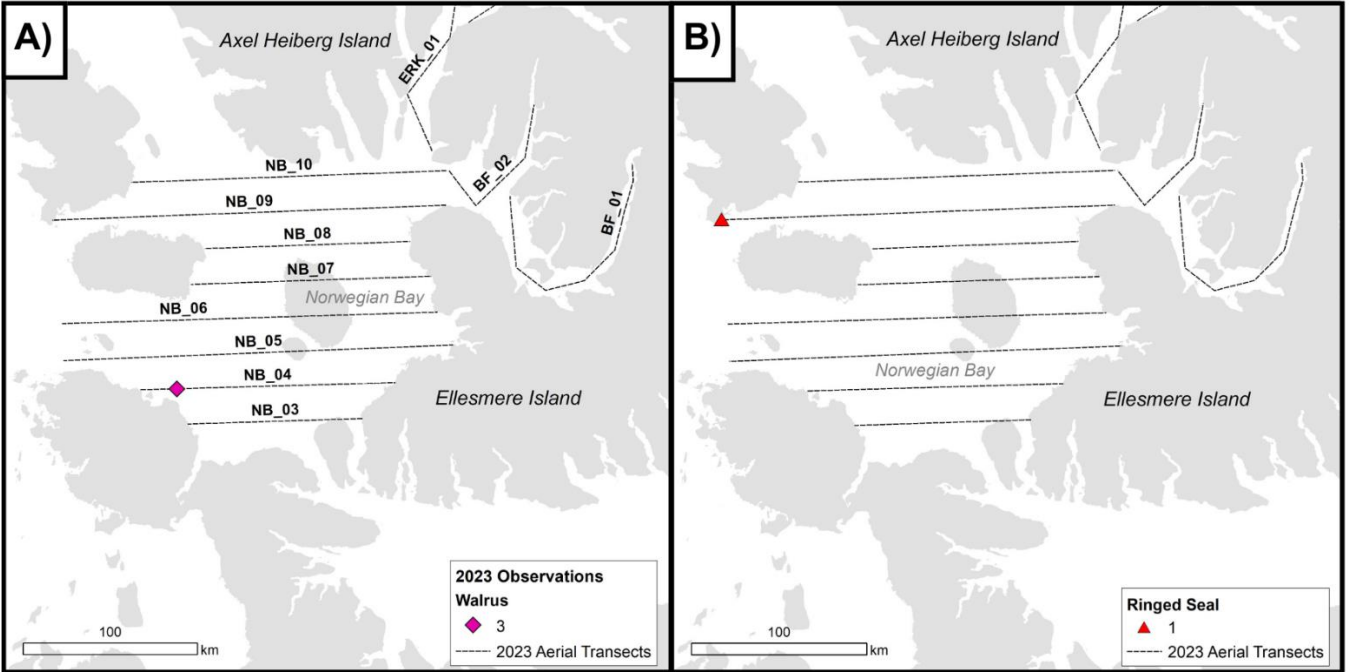


Figure 7. Animal observations detected from A) infrared and aerial imagery and B) visual observations collected in Norwegian Bay during the 2023 Last Ice Area aerial marine mammal surveys.

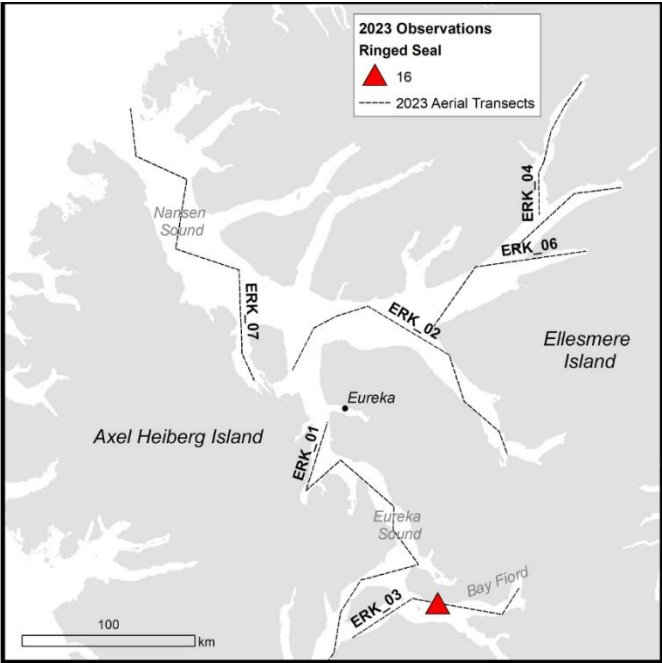


Figure 8. Animal observations detected from infrared and aerial images collected in Nansen and Eureka Sound during the 2023 Last Ice Area aerial marine mammal surveys. Note: there were no visual observations along these transects.

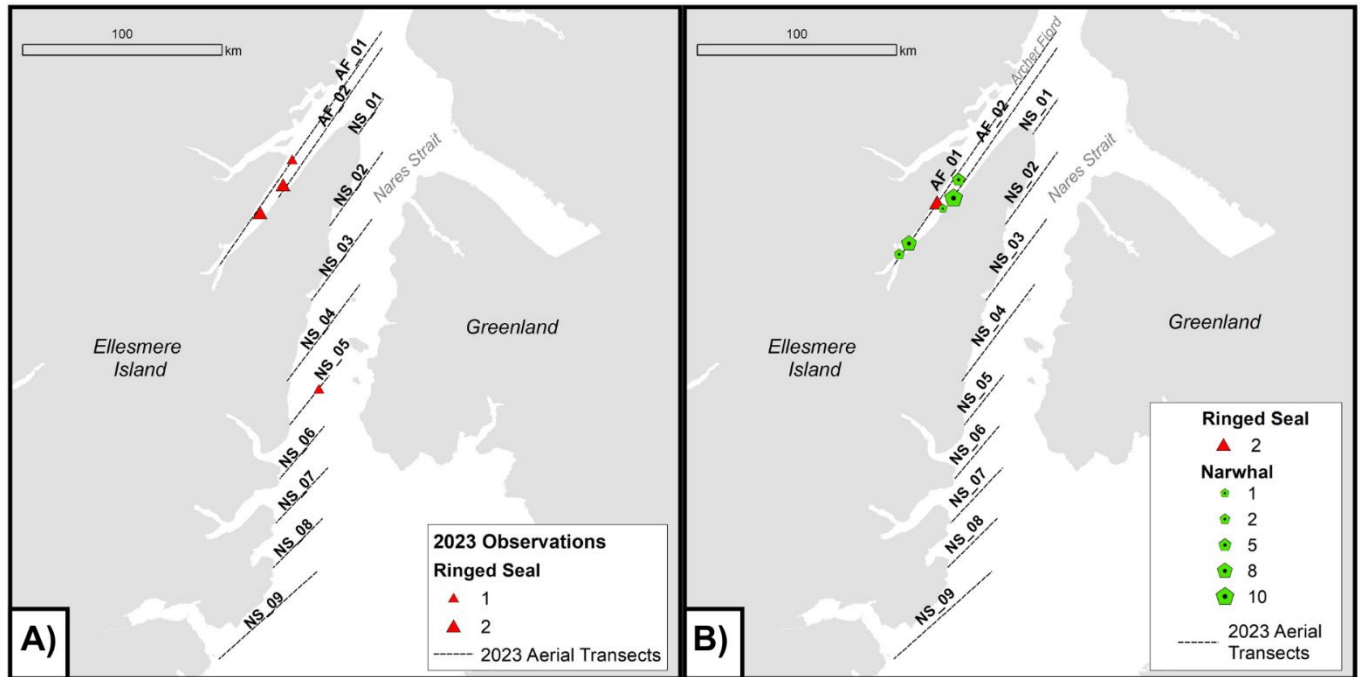


Figure 9. Animal observations detected from infrared and aerial imagery A) and visual observations B) collected in Archer Fiord and Nares Strait during the 2023 Last Ice Area aerial marine mammal surveys.

ENVIRONMENTAL CONDITIONS

The weather conditions for the survey were mostly cloudy (high ceiling) and without precipitation, except for a portion of the Norwegian Bay transects which included some rain or snow. The majority of transects had an average percent cloud cover above 20%, with several having an average cloud cover of 100% along the transects (Figure 10), although this did not interfere with our transects (except NB_10) due to the high ceiling and our target altitude of 1000 ft. The average ice cover measured on a scale from 0-10 varied across all transects; however, three of the transects had an average ice cover of 0 including BF01, BF02, and ERK04 (Figure 11). The Beaufort Sea State also varied across transects, with the majority of transects having a Beaufort Sea State below 2 (Figure 12). The MODIS satellite imagery for the survey dates was extracted from NASA worldview as shown in Figure 13. The imagery also shows the cloud cover and sea-ice conditions in the study area on the corresponding survey days.

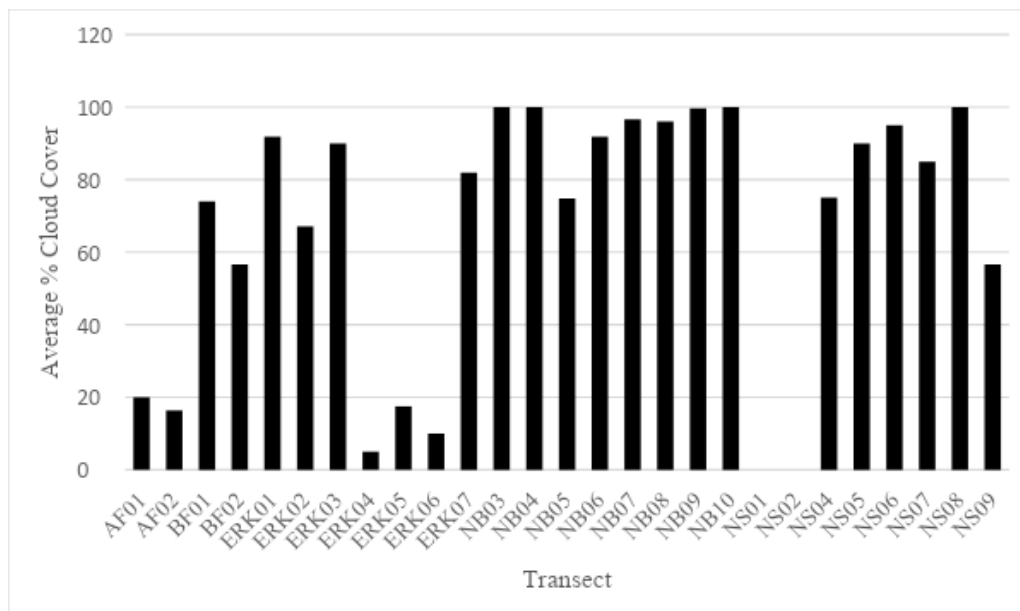


Figure 10. Average percent cloud cover for each transect surveyed during the September 2023 LIA survey.

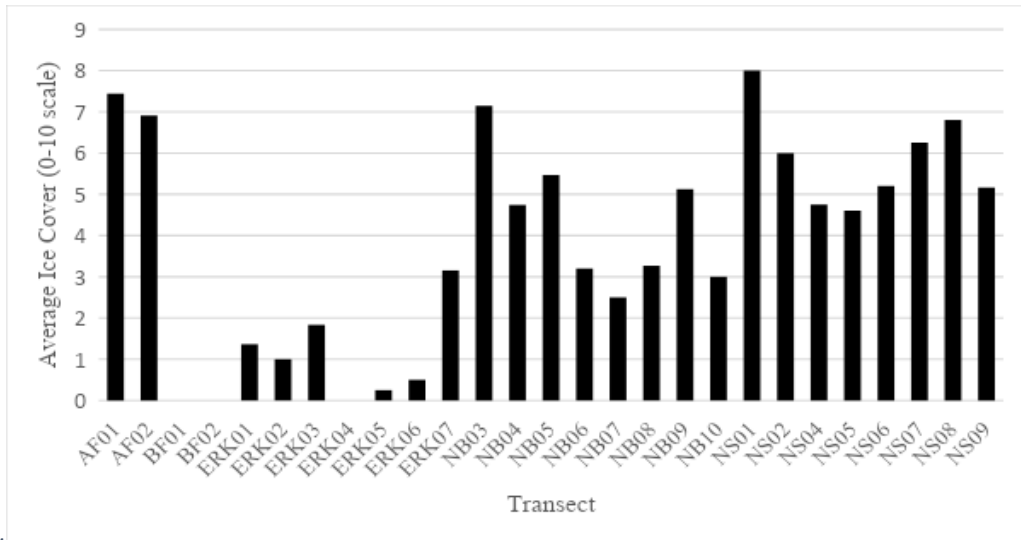


Figure 11. Average sea ice cover for each transect surveyed during the September 2023 LIA survey.

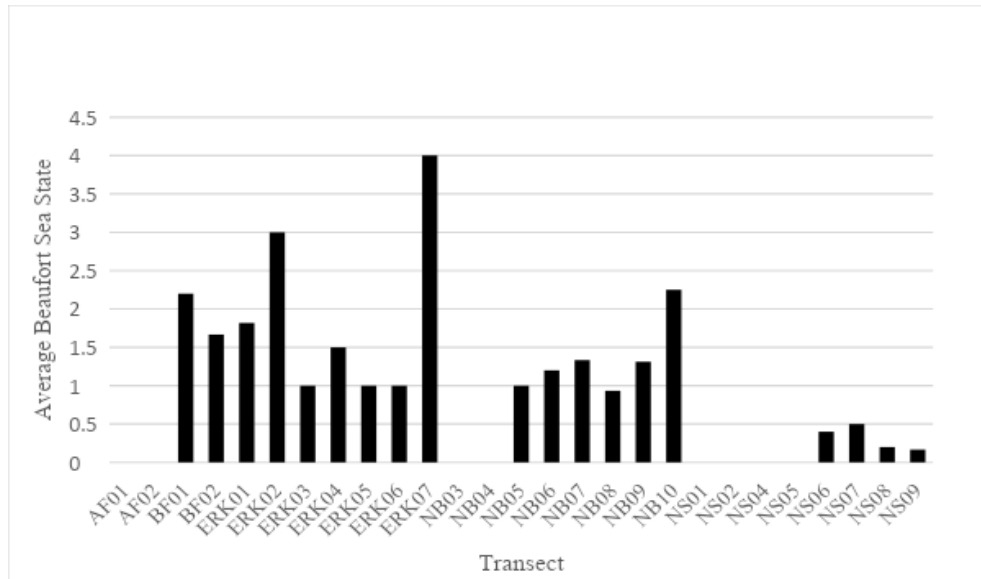


Figure 12. Average Beaufort Sea State for each transect surveyed during the September 2023 LIA survey.

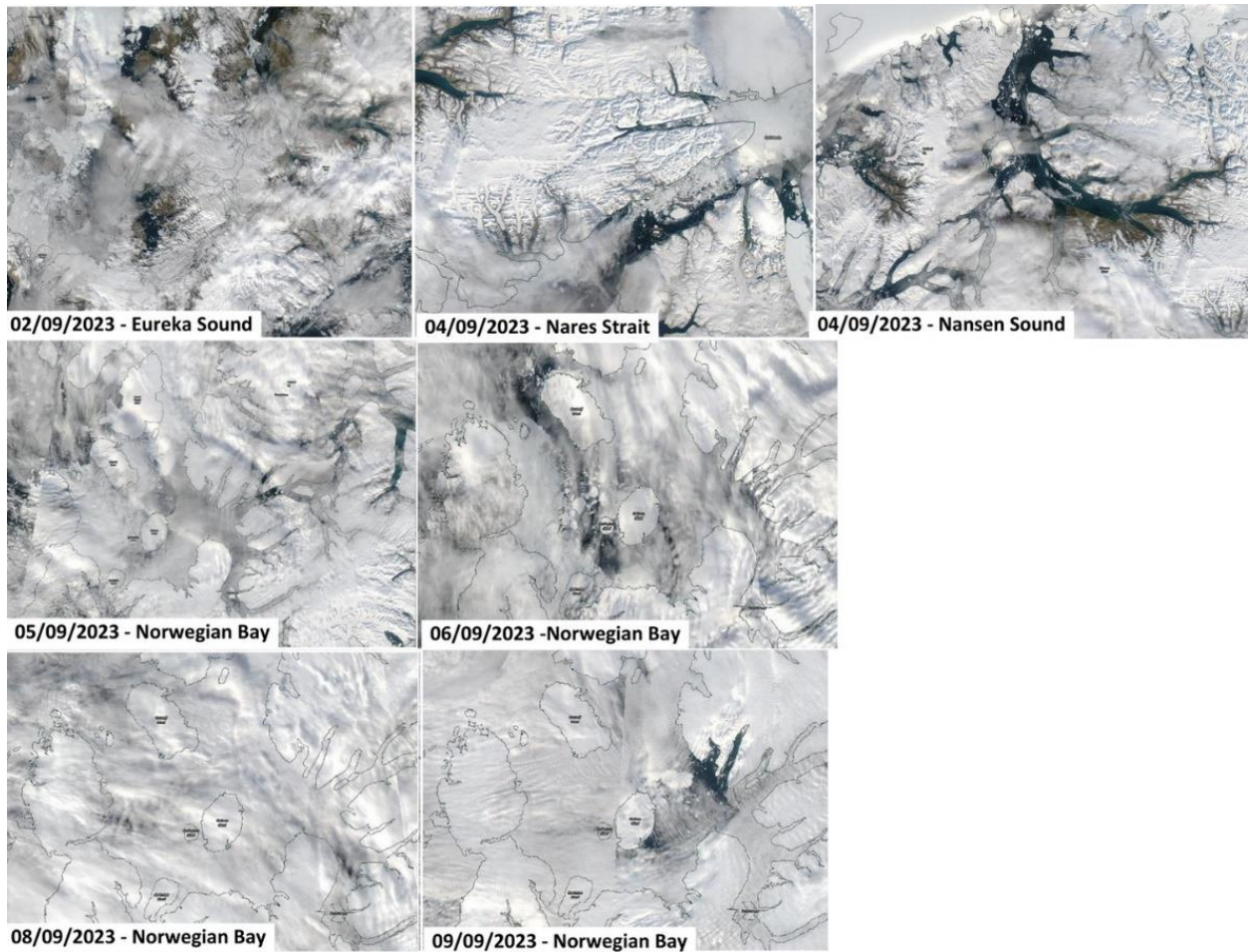


Figure 13. MODIS satellite imagery of the cloud cover and sea-ice conditions for each survey day with the corresponding area surveyed including Eureka Sound, Nares Strait, Nansen Sound, and Norwegian Bay. Images accessed from NASA Worldview (<https://go.nasa.gov/39ldDgE>).

OTHER WILDLIFE OBSERVATIONS

Opportunistic animal observations were made outside of the transects during transit to and from the survey and fueling locations. For example, on September 2nd we observed ~10 unidentifiable animals on land between the Baumann Fiord transects. These animals were white in colour and could have been wolves or caribou. On the same day we observed another wolf along Baumann Fiord. On September 5th, near the community of Grise Fiord, we observed hundreds of birds, hundreds of harp seals (Figure 14), and a narwhal amongst the harp seals. On the same day we observed a colony of ~26 Atlantic walrus in Walrus Fiord and two polar bears on land near the Devon Noranda fueling location south of Norwegian Bay. On several of the survey days we observed groups of ~3-10 muskox near the Eureka weather station.



Figure 14. DSLR photo of harp seals observed near Grise Fiord on September 5, 2023 (top) and a zoomed in view of the seals (bottom).

CONCLUSION

The 2023 LIA aerial marine mammal survey was the first to be conducted in September, providing information on the distribution of marine mammals in the LIA in the month with the most limited sea ice (Kim et al., 2023). Overall, we recorded 27 marine mammal observations from the FLIR and 29 separate visual observations that included ringed seals, narwhals and walruses. The FLIR detected roughly the same number of marine mammals as visual observations; however, these observations did not overlap. For instance, narwhals were only detected by visual observations and did not show up on infrared video or in aerial images because they were outside of the camera swath. Further manual analysis of aerial imagery to detect animals may yield a greater number of observations, since the infrared video was out of focus over open water and polar bear tracks do not show up as thermal bright spots.

One 25mm DSLR photo observation in Bay Fiord had the highest concentration of ringed seals seen in any one photo since the surveys began in 2018, with a total of 16 ringed seals. The location of this observation was in Bay Fiord, approximately 84 km south of the Nansen Sound boundary of Tuvaijuittuq MPA. The majority of transects in the 2023 survey had no observations of animals, which may be indicative of the limited sea ice habitat available in these transects. However, the number of observations of several marine mammal species in Archer Fiord is consistent with the findings of previous surveys, reinforcing the importance of this area for marine mammal biodiversity (Carlyle et al., 2021).

This survey explored transects that were not previously surveyed in preceding LIA surveys, including transects in Nansen Sound. While no animals were observed in these transects, the lack of observations, as well as the environmental conditions recorded in these fiords, provides insight into previously un-surveyed areas of the Last Ice Area.

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APPENDICES

Appendix A. Summary of daily survey flight times and transects flown during the Last Ice Area aerial marine mammal surveys in September 2023. Flight start and end times are in central daylight savings time (CDT).

Date	Take-Off	Landing	Total Daily Time (h)	Transects
2023-09-02	10:15	19:00	8.75	BF01, BF02, ERK01, ERK02, ERK07
2023-09-04	9:54	21:32	11.63	ERK06, AF01, AF02, ERK05, NS01, NS02, NS03, NS04, NS05, NS06, NS07, NS08, NS09
2023-09-05	9:38	18:30	8.87	ERK03, NB03, NB04
2023-09-06	9:35	18:30	8.92	NB05, NB06, NB07, NB08
2023-09-08	9:43	11:21	1.63	NB10
2023-09-09	13:10	16:30	3.33	NB09

Appendix B: Visual observations of marine mammals during the Last Ice Area aerial marine mammal surveys in September 2023 (date = YY-MM-DD, time = central daylight savings time (CDT)).

Date	Transect	Species	Count	Time	Note	Latitude	Longitude
2023-09-02	BF01	-	0	-	-		
2023-09-02	BF02	-	0	-	-		
2023-09-02	ERK01	-	0	-	-		
2023-09-02	ERK02	-	0	-	-		
2023-09-02	ERK07	-	0	-	-		
2023-09-04	ERK06	-	0	-	-		
2023-09-04	AF01	Narwhal	2	14:38	Swimming in a pair	81.218	-69.346
2023-09-04	AF01	Narwhal	8	14:44	Swimming in pairs	81.248	-68.970
2023-09-04	AF01	Narwhal	1	14:52	Pilot spotted	81.336	-67.700
2023-09-04	AF01	Narwhal	10	14:54	Pilot spotted	81.362	-67.301
2023-09-04	AF01	Narwhal	5	14:57	Pilot spotted	81.426	-66.966
2023-09-04	AF01	Ringed Seal	1	15:59	Lone seal on ice	81.368	-67.798
2023-09-04	AF02	Ringed Seal	1	15:59	Lone seal on ice	81.368	-67.798
2023-09-04	ERK05	-	0	-	-		
2023-09-04	AF02	-	0	-	-		
2023-09-04	NS01	-	0	-	-		
2023-09-04	NS02	-	0	-	-		
2023-09-04	NS03	-	0	-	-		
2023-09-04	NS04	-	0	-	-		
2023-09-04	NS05	-	0	-	-		

Date	Transect	Species	Count	Time	Note	Latitude	Longitude
2023-09-04	NS06	-	0	-	-		
2023-09-04	NS07	-	0	-	-		
2023-09-04	NS08	-	0	-	-		
2023-09-04	NS09	-	0	-	-		
2023-09-05	ERK03	-	0	-	-		
2023-09-05	NB03	-	0	-	-		
2023-09-05	NB04	-	0	-	-		
2023-09-06	NB05	-	0	-	-		
2023-09-06	NB06	-	0	-	-		
2023-09-06	NB07	-	0	-	-		
2023-09-06	NB08	-	0	-	-		
2023-09-08	NB10	-	1	-	-		
2023-09-09	NB09	Ringed Seal	1	14:33	Swimming	77.901	-87.769

Appendix C. Marine mammal observations from infrared video detection during the Last Ice Area aerial marine mammal survey in September 2023. Opportunistic observations were observed outside of the survey transects (date = YY-MM-DD, time = central daylight savings time (CDT), latitude = decimal degrees north, longitude = decimal degrees west).

Stratum	Transect	Detection	FLIR_file	FLIR_min	camera_1_25mm	Species	Count	Date	Lat_y	Lon_x
AF	1	FLIR	187	17.27	20230904_25mm_cam1_04860.jpg	Ringed Seal	2	9/4/2023	81.3315	-67.9664
AF	1	FLIR	187	27.4	20230904_25mm_cam1_04916.jpg	Ringed Seal	2	9/4/2023	81.405703	-67.045025
AF	1	FLIR	187	29.25	20230904_25mm_cam1_04977.jpg	Ringed Seal	1	9/4/2023	81.4923	-66.5266
NS	5	FLIR	193	2.09	20230904_25mm_cam1_05894.jpg	Ringed Seal	1	9/4/2029	80.5215	-68.2345
ERK	3	FLIR	198	7.56	20230905_25mm_cam1_06518.jpg	Unknown		9/5/2023	78.9251	-85.2454
ERK	3	FLIR	198	17.2	20230905_25mm_cam1_06610.jpg	Ringed Seal	16	9/5/2023	78.9461	-83.9771
Grise Fiord *Opportunistic		FLIR	200	4.36	20230905_25mm_cam1_07124.jpg	Harp Seal		9/5/2023	76.4451	-83.1251
Walrus Fiord *Opportunistic		FLIR	201	7.11	20230905_25mm_cam1_07327.jpg	Walrus	3	9/5/2023	76.4869	-88.6702
Walrus Fiord *Opportunistic		FLIR	201	7.16	20230905_25mm_cam1_07328.jpg	Walrus	3	9/5/2023	76.4839	-88.6741
Walrus Fiord *Opportunistic		FLIR	201	7.26	20230905_25mm_cam1_07329.jpg	Walrus	2	9/5/2023	76.4809	-88.6782

Stratum	Transect	Detection	FLIR_file	FLIR_min	camera_1_25mm	Species	Count	Date	Lat_y	Long_x
Walrus Fiord *Opportunistic		Photo	201		20230905_25mm_cam1_07330.jpg	Walrus Feces		9/5/2023	76.4780	-88.6825
NB	4	Photo	202		20230905_25mm_cam1_07925.jpg	Polar Bear Tracks		9/5/2023	76.9738	-94.5000
NB	4	FLIR	202	37.38	20230905_25mm_cam1_07872.jpg	Walrus	3	9/5/2023	76.9864	-93.7080
NB	6	FLIR	204	7.35	20230906_25mm_cam1_08306.jpg	Breathing Hole		9/6/2023	77.1731	-92.3117
NB	8	FLIR	208	8.41	20230906_25mm_cam1_09715.jpg	Breathing Hole		9/6/2024	77.7197	-91.8292