Annual Report for 2022

Winter Ringed Seal Density within Beaufort Sea Oil and Gas Project Areas

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Executive Summary

In Alaska, ringed seals (*Pusa hispida*) are an important subsistence resource to coastal Alaska Natives, and important prey for polar bears (*Ursus maritimus*). Ringed seals create and maintain breathing holes through solid landfast sea ice up to 2 m thick allowing them to use habitat both on (hauling out for resting, basking, and molting) and under (access to fish and invertebrate prey) sea ice during the winter. Ringed seals also use subnivean lairs built in snow drifts on top of sea ice and within pressure ridges for resting and pupping. Ringed seals were listed as threatened under the U.S. Endangered Species Act in 2012 because predicted declines in sea ice and snow accumulation over the next century were expected to greatly reduce their numbers. In the Beaufort Sea, ringed seal use of landfast ice in winter and early spring overlaps with oil and gas activities (e.g., ice road and gravel island construction, and seismic and drilling operations). Ringed seals spend most of their time underwater and in lairs and are generally not visible from the ice surface, thus determining how many seals may be affected by oil and gas activities is difficult, but necessary, for attaining permits to conduct these activities. In May 2022, we used two trained wildlife-detection dogs to survey an area in Prudhoe Bay, near Northstar Island, that was previously studied in 1983. During this survey we found 61 ringed seal structures (47 breathing holes and 14 lairs) in an 88.2 km^2 area; a density of 0.68 structures/km^2. Fewer structures were identified in 1983 (43; 16 breathing holes and 27 lairs) in a 96.8 km^2 area; a density of 0.44 structures/km^2. Snow depths at lairs were similar between studies and averaged 76.9 cm (range 45–120 cm) in 2022 compared to 78.7 cm (range 45–130 cm) in 1983. Lairs (12 of 14) were instrumented with temperature sensors, light sensors, and cameras to record lair use. Temperature sensors detected 11 haul-out bouts in four lairs, however photographs revealed extensive use of access holes for resting without hauling out and with minimal and brief increases in lair temperature. Breathing holes were found in water as shallow as 2 m and active structures were found within 19.5 m of facilities and within an active ice road. Two different basking seals were observed to stay on the ice during the close passage of a hovercraft. This area will be surveyed again in 2023 for further comparison.

Introduction

Ringed seals (*Pusa hispida*) are an important subsistence resource to coastal Alaska Natives and important prey for polar bears (*Ursus maritimus*). In winter, ringed seals create and maintain holes through solid landfast ice up to 2 m thick allowing them to breathe, use habitat on the ice (Smith and Stirling 1975), and forage on fish (mostly Arctic cod, *Boreogadus saida)* and invertebrates (mostly crustaceans) (Crawford et al. 2015) under the ice. Ringed seals also use lairs, built in snow drifts on top of the sea ice and within pressure ridges in sea ice, for resting and pupping (Smith and Stirling 1975). Ringed seals were listed as threatened under the U.S. Endangered Species Act in 2012 (USFWS 2012) because predicted declines in sea ice and snow accumulation over the next century were expected to greatly reduce their abundance. Although ringed seals range widely in summer when the Pacific Arctic is predominately ice free, ringed seals have small ranges in landfast ice in winter and early spring (Kelly et al. 2010) that overlap with oil and gas activities (e.g., ice road and gravel island construction, and seismic and drilling operations) in the Beaufort Sea. Ringed seals are generally not visible at the ice surface (either under snow or under ice) and thus determining how many seals may be affected by oil and gas activities is difficult but important for attaining permits to conduct industry activities.

Objectives for this study include determining the current density and habitat use of ringed seals in the nearshore Beaufort Sea in the North Slope oil and gas area. Previous studies conducted in this area during the 1980s (Kelly et al. 1986, 1990) will allow us to assess if changes in density have occurred and whether they may be associated with climate change.

Goals and Objectives

Overall Objective: The overall objective of this study is to document ringed seal distribution, density, and habitat use within the landfast ice zone of the nearshore Beaufort Sea that includes BOEM's Beaufort Sea Planning Area and existing North Slope oil and gas facilities to be used for informing and developing mitigation measures to minimize disturbance from industry activities.

Objective 1: Analyze nearshore ice use by ringed seals by locating and documenting status of wintering seals and their structures to develop avoidance strategies where ringed seal habitat overlaps with North Slope oil and gas activities.

Objective 2: Utilize novel survey technology to expand capabilities to facilitate research on the habitat of ringed seals to improve understanding of ringed seal movements.

Objective 3: Identify winter and spring seasonal movement patterns of adult ringed seals with an emphasis on detecting subnivean lair use in landfast ice in areas bounded by NPR-A, ANWR, and BOEM's Beaufort Sea Planning Area.

Objective 4: Document ringed seal habitat use areas and local foraging behavior by classifying foraging locations and determine if oil and gas development activities create movement barriers for ringed seals to access prey.

Objective 5: Evaluate and compare the efficiencies of the proposed survey technologies with existing methods used to detect ringed seals, their breathing holes, and lairs.

Methods

Coordination

Meetings, communication, and training. The Principal Investigator, Lori Quakenbush and Alaska Department of Fish and Game (ADFG) staff attend Ice Seal Committee meetings, community meetings, professional conferences, and communicate with BOEM, the North Slope Borough (NSB), and Hilcorp to discuss research needs and required training for working in the oil and gas project area.

Dog Searches

Two wildlife detection dogs, trained to find seal structures by scent, were used to search the study area in May 2022. Dogs are trained to run ahead of a handler on a snowmachine into a quartering head wind (Fig. 1). When they smell a seal structure they divert from the course and run to the structure. Each dog can work separately, or they can work together.

Figure 1. Wildlife detection dogs running in front of snowmachines searching for seal structures.

Seal Structures

Seal structures include breathing holes, haul-out lairs, and pupping lairs (Fig. 2). Any of these structures can be used for basking if the seal comes out of the structure to bask on top of the snow (Fig. 3). When a structure was found its location was recorded using GPS, it was measured, and the structure number was written on a wooden stake placed nearby. Water depth at each structure was also measured and recorded. Depending on the type of structure and its status it may have received instruments (e.g., temperature probe, light sensor, and motion-activated camera).

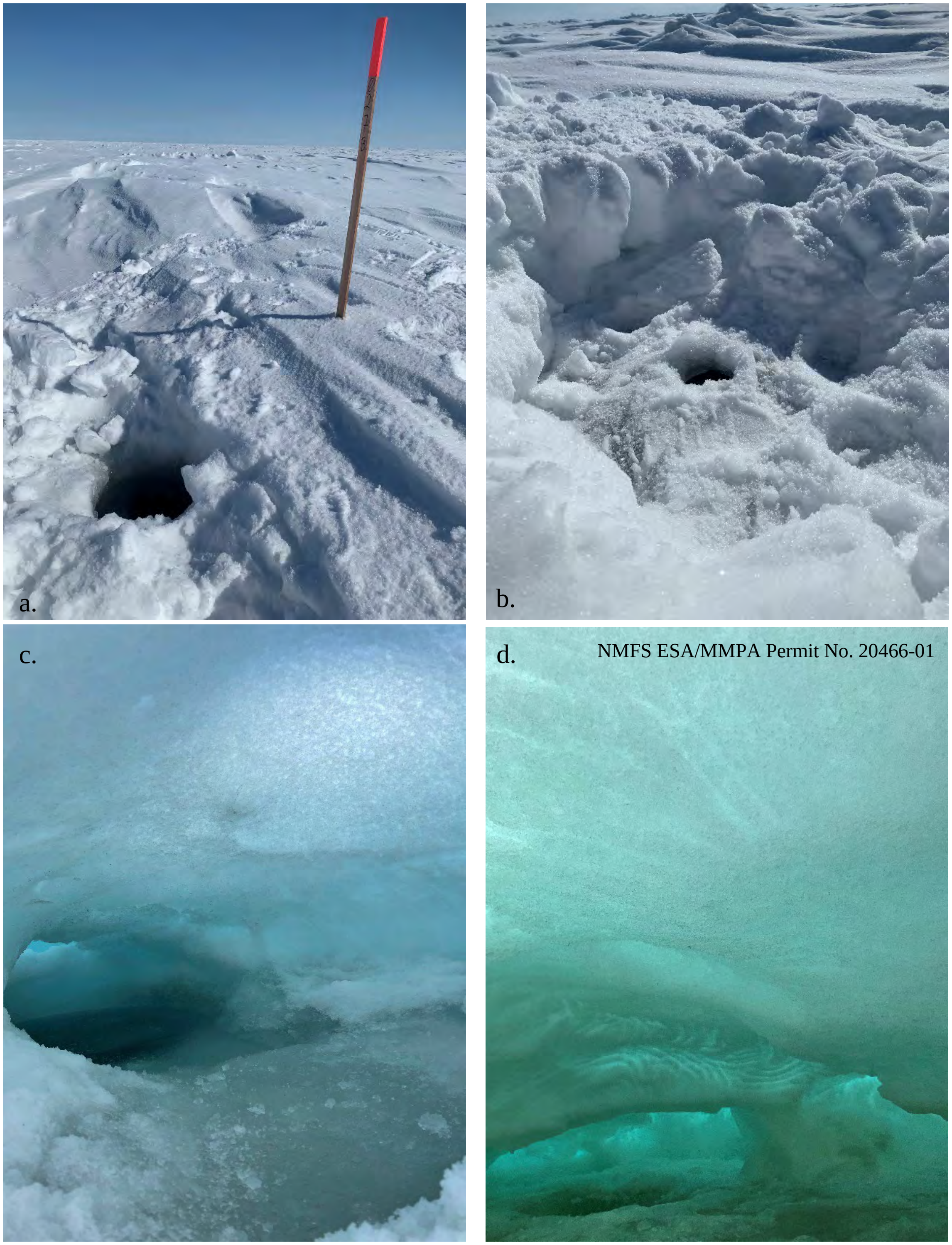


Figure 2. Seal structures included breathing holes open at the snow surface (a), and beneath the snow (b); haul-out lairs built in snow drifts on top of sea ice and within pressure ridges (c); and pupping lairs (d). Pupping lairs are haul-out lairs with evidence of a pup: small tunnels and chambers, shed lanugo (i.e., natal hair), and small seal claw scratch marks (d).

Figure 3. A ringed seal hauled out at a breathing hole in Prudhoe Bay, Alaska in May 2022.

Temperature Probes. Temperature probes manufactured by Onset™ (Bourne, MA, USA) were used to simultaneously record the temperature inside and outside of a lair (Fig. 4). An increase and subsequent decrease of inside temperature was used to identify when a seal hauled out in a lair.

Light Sensors. Light sensors manufactured by Onset™ were used to record when light levels changed in a lair (Fig. 4). An increase in light level could indicate when a seal dug out of a lair to bask or when a predator entered the lair.

Motion Activated Cameras. Motion activated cameras manufactured by Stealth Cam™ (Irving, TX, USA) were placed inside each lair pointed toward the access hole to photograph seals hauling out and seals breathing at the hole without hauling out (Fig. 4).

Figure 4. Instruments deployed in seal lairs (from left to right: camera, temperature sensor (black wire protruding through ceiling), and light sensor).

Weather Station. Meteorological data are available at the Seawater Treatment Plant (STP), which is within our study area, however the station is on the top of a six-story building on top of a causeway and the wind speed, wind direction, and temperature could be quite different than on the sea ice in our study area. Therefore, we deployed a meteorological (MET) station, manufactured by Onset™, on the sea ice in our study area (Fig. 5).

Figure 5. Meteorological (MET) station deployed on the sea ice in our study area (a). Data were downloaded from the MET station onto a laptop computer weekly (b).

Mapping

We produced maps of the locations of seal structures for analysis and reports for BOEM, Bureau of Land Management (BLM), Hilcorp Alaska LLC, and NSB. ArcGIS version 10.8 (ESRI 2020) was used for all mapping.

Safety

We purchase safety equipment and trained participants in its use. Safety equipment includes personal satellite-linked locator beacons (InReach™), and GPS units. A daily safety plan is made with a shore-base prior to each trip onto the sea ice. Our crew checks in with the base if any changes in the daily plan occur and closes the safety plan upon return.

Results

Coordination

Meetings, communication, and training. We communicated with Hilcorp Alaska LLC (Hilcorp) regarding housing, meals, and safety training to work in the Prudhoe Bay area. We completed training provided by the North Slope Training Cooperative (NSTC) and Alaska Safety Alliance and wildlife and environmental training provided by Hilcorp to operate unescorted in the Prudhoe Bay area. We also completed firearms safety and proficiency training conducted by the ADFG to carry firearms for polar bear protection. Prior to field work, we informed the Ice Seal Committee, the Alaska Eskimo Whaling Commission, and the North Slope Borough about this project. We presented preliminary findings of our field season to BOEM, BLM, Hilcorp, and NSB in June. Activities for the first year of this study between September 2021 and September 2022 are summarized in Table 1.

Table 1. Project history from September 2021 through September 2022.

Month	Year	Event
September	2021	Received grant award.
October		Post award meeting with BOEM. Submitted post award meeting summary to BOEM. Submitted application to NMFS for new seal research permit to replace #20466.
November		Met with Hilcorp regarding project support and NSTC safety training.
December		Met with Hilcorp Wildlife Support Staff to register for training.
January	2022	Submitted Quarterly Report to BOEM. NSTC training.
February		ADFG firearms training and proficiency testing in Anchorage Researched and purchased instruments; temperature sensors, light sensors, and motion detection cameras.
March		Procured field supplies.
April		Submitted and received an updated Animal Care and Use Committee Assurance of Animal Care protocol (ADFG ACUC #0027-2022-40). Met with Hilcorp to plan fieldwork logistics. Submitted Fieldwork Plan and Quarterly Report to BOEM. Met with NMFS permit office regarding new seal research permit.
May		Conducted fieldwork.
June		Preliminary field report to BOEM, BLM, Hilcorp, and NSB (Appendix A) Presented preliminary results to Hilcorp in online meeting.
July-August		Submitted Quarterly Report to BOEM. Responded to questions from NMFS regarding research permit application. Submitted and received an extension for our current ice seal research permit #20466-01. This will extend our permit for a year or until the new permit is issued.
September		Prepared annual report to BOEM.

Website. A webpage on the State of Alaska, Division of Wildlife Conservation website will be created for this project.
http://www.adfg.alaska.gov/index.cfm?adfg=marinemammalprogram.icesealresearch

Dog Searches
Dog searches occurred on 12 days in May and covered an 88.2 km^2 area in which 61 ringed seal structures were found, resulting in a seal structure density of 0.68 structures/km^2 (Fig. 6). Survey routes averaged 13 km/day (range: 4–23.5) and covered a total of 157 km. Wind direction and speed measured at our MET station was variable during the searches. Wind speed ranged from 0 to 30.8 km/hr and east-northeast (76°) and west-southwest (253°) winds were the predominant wind directions.

Seal Structures
Information for all seal structures found is included in Appendix B. Except for one lair (052H22), only breathing holes were used for basking during our study period (Table 2). Hole diameter, snow depth, and water depth were generally greater for haul-out lairs than for breathing holes (Table 2).

Table 2. Summary of all structures by structure type.

Structure type	N (n used for basking)	Hole diameter: (mean and range) in cm	Snow depth: (mean and range) in cm	Water T (mean and range) in °C	Water depth mean and range (m)
Breathing holes	47 (23)	37.0 (13–52)	40.8 (7–125)	-2.3 (-2.6– -2.0)	6.4 (2–11)
Haul-out lair	13 (1)	43.5 (35–50)	77 (45–120)	-2.2 (-2.6– -2.1)	7.9 (2.5–11)
Pupping lair	1 (0)	*	75	*	*

* = not measured

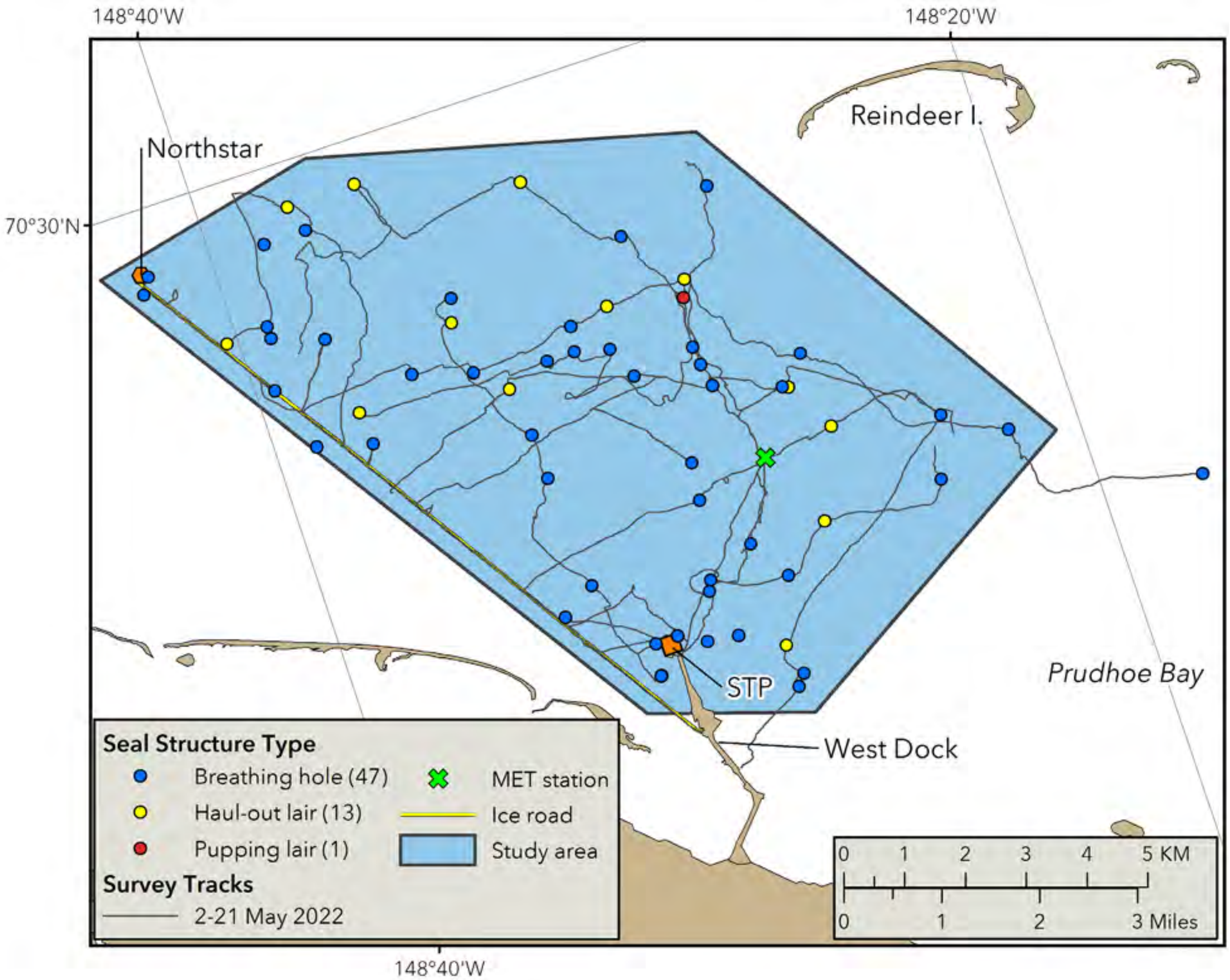
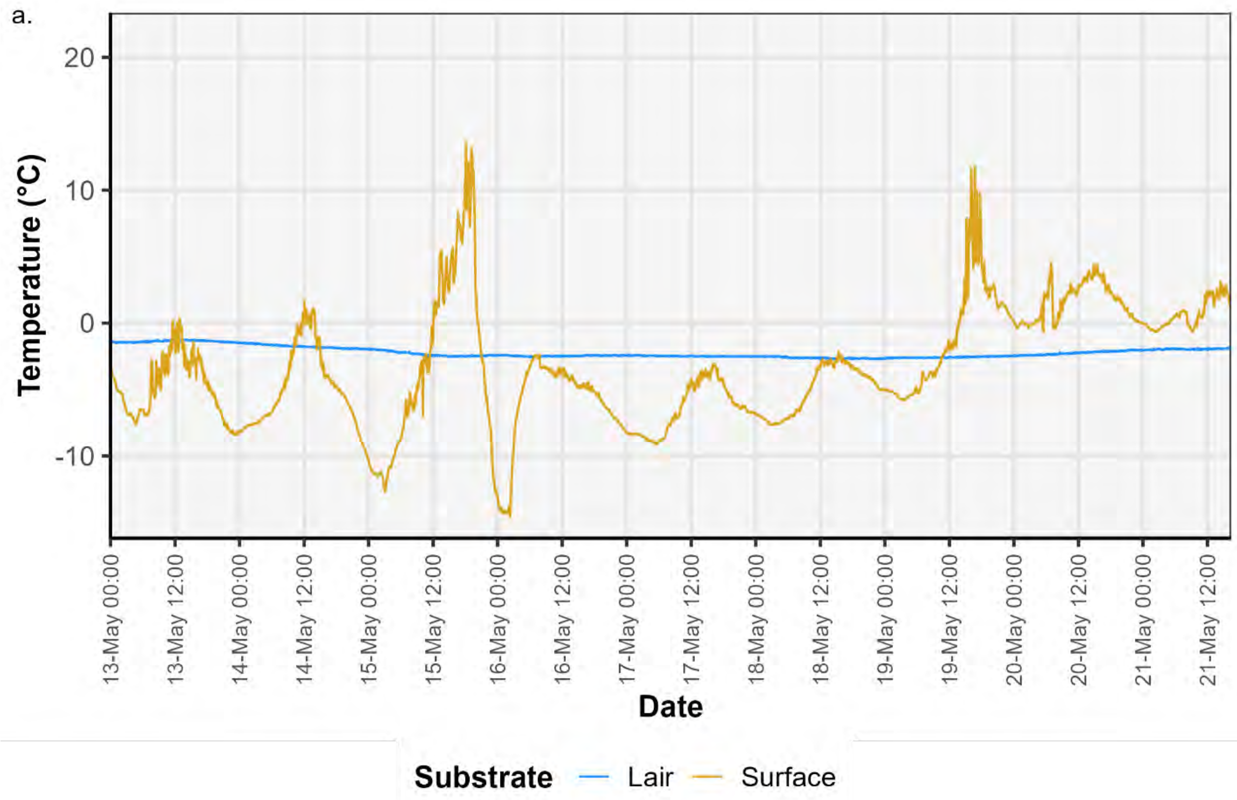


Figure 6. Map of ringed seal winter density study area boundary in the Beaufort Sea Planning Area with locations and type of 61 seal structures and routes taken by dogs to find the structures in May 2022.

Seal behavior in lairs

Temperature. Outside temperature fluctuates with higher day and lower night temperatures while inside of lairs temperature does not fluctuate because the sea water below provides a steady input of approximately -2°C and the snow on top insulates the lair from surface temperatures (Fig. 7a). When a seal hauls out in the lair its body temperature warms it quickly. Therefore, we can use temperature sensors inside and outside (at the snow surface) of lairs to document haul-out bouts (Kelly and Quakenbush 1990). We documented 11 haul-out bouts at four lairs. Four haul-out bouts were recorded by temperature at 039H22 between 15 and 21 May, each lasting about 12 hours (Fig. 7b). Additionally, two haul-out bouts were recorded by temperature at 026H22 between 9 and 23 May, each lasting about 12 hours, and another four haul-out bouts were recorded at 046H22 between 15 and 23 May with two lasting about 12 hours and two lasting about 6 hours. The temperature at 033H22 also increased slightly during a haul-out bout on 20 May lasting about 12 hours, however, the increase in temperature was more subtle than at other lairs. Temperature also increased, although less dramatically, in some lairs when seals used access holes for resting without hauling out (Fig. 7c).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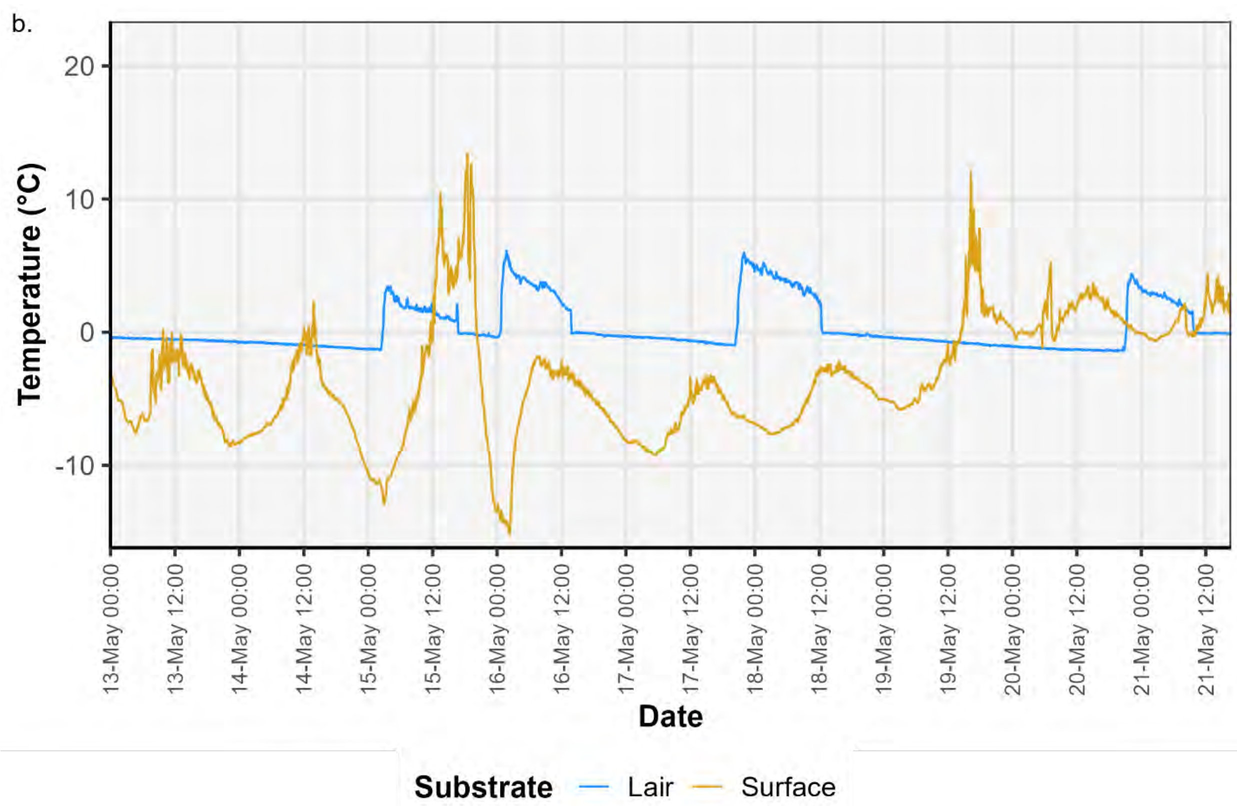
b.
Temperature (°C)
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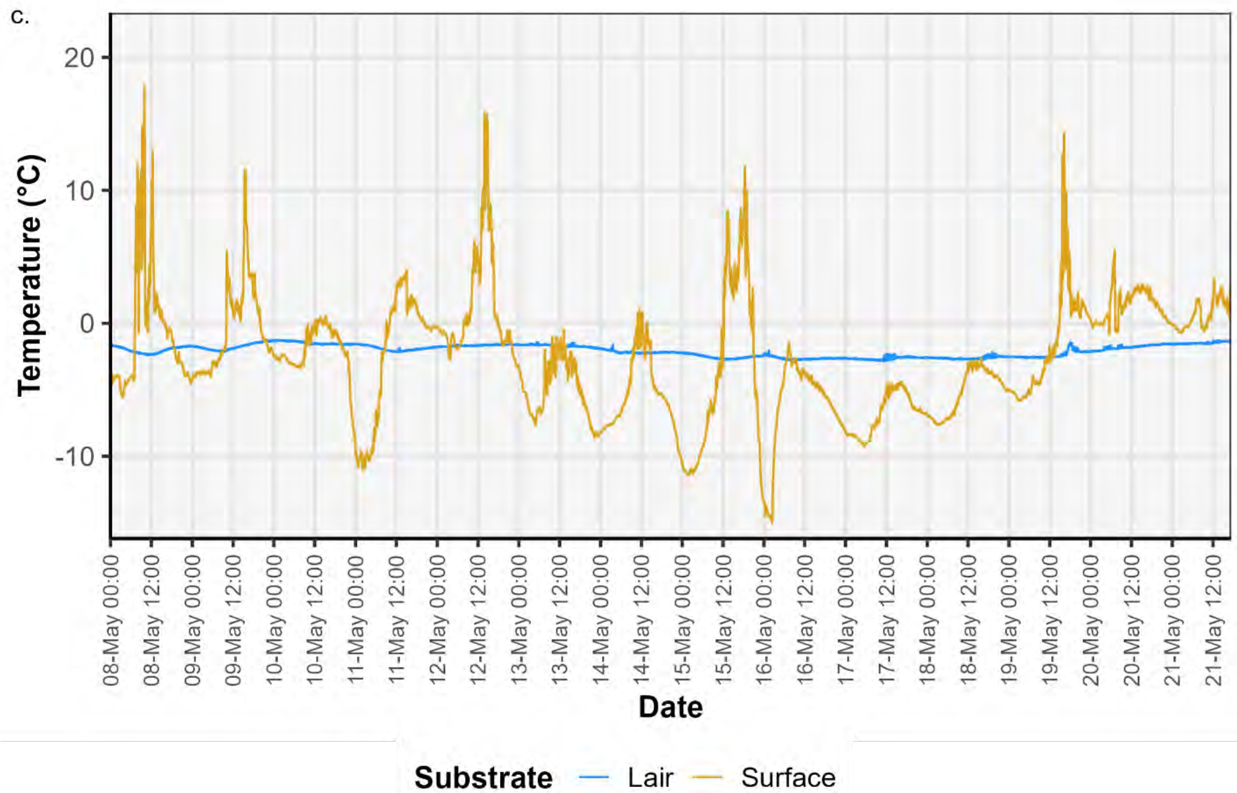

Figure 7. Temperature records from inside (blue) and outside (at the snow surface, gold) three lairs. No haul out bouts were detected in lair 038H22 (a). Increases and decreases in inside lair temperature (blue) mark the start and end of four haul out bouts in lair 039H22 (b). Small short increases in temperature mark the use of access holes for resting without hauling out in lair 022H22 (c).

Light Sensors. All light sensors recorded consistently low light penetration; none recorded an increase that would indicate the collapse of the lair roof either by predation, the seal digging out to bask, or melting of the roof due to warm outside air temperatures.

Motion Activated Cameras. Cameras in lairs documented seals hauled out and seals resting and breathing in the access hole without hauling out. We observed a minimum of 78 bouts where seals stayed in the access hole for longer than 30 minutes (average 103.5 min; range: 30–623 min), longer than would be necessary for seals to breathe. During these bouts seals were observed resting, scratching at the sea ice, and sleeping in the access hole. Additionally, cameras documented four short (<15 mins) haul-out bouts that were not documented by temperature sensors. Three lairs (007H22, 055H22, and 056H22) did not have any activity documented and although there was activity in lair 048H22, photos taken by the camera were unusable because obstructions made it impossible to decipher seal behavior. On at least one occasion we were able to document two different seals using the same lair. One seal appears to be the primary occupant, but the other seal uses the access hole on more than one occasion when the primary occupant leaves (Fig. 8).

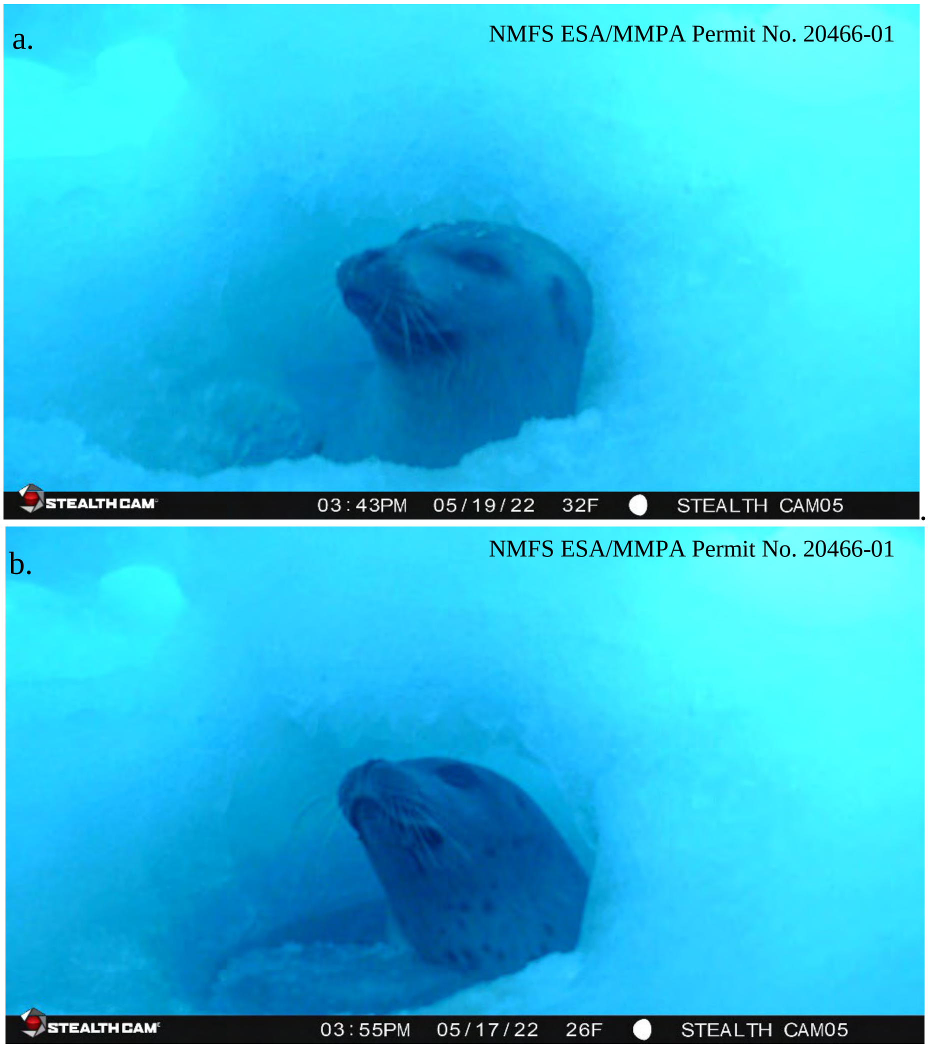

Figure 8. Stealth Cam™ photos of two different ringed seals using lair 026H22. Seal 1 was the primary occupant of this lair and spent considerable time resting in the access hole and hauling out (a). This seal is identifiable by dark coloration around the muzzle and few spots on the chest and neck. Seal 2 spent less time in the lair and is identifiable by the long dark mark on its lower left chin and by the numerous spots on the chest and neck (b).

Accomplishment of Objectives

Overall Objective: The overall objective of this study is to document ringed seal distribution, density, and habitat use within the landfast ice zone of the nearshore Beaufort Sea that includes BOEM's Beaufort Sea Planning Area and existing North Slope oil and gas facilities to be used for informing and developing mitigation measures to minimize disturbance from industry activities.

During the 2022 spring field season we documented 61 ringed seals structures in an 88.2 km^2 area within the landfast ice zone of the nearshore Beaufort Sea that includes BOEM's Beaufort Sea Planning Area and existing North Slope oil and gas facilities. Some seal structures were found close to infrastructure (Fig. 6) and at water depths ranging from 2–11 m (Fig. 9).

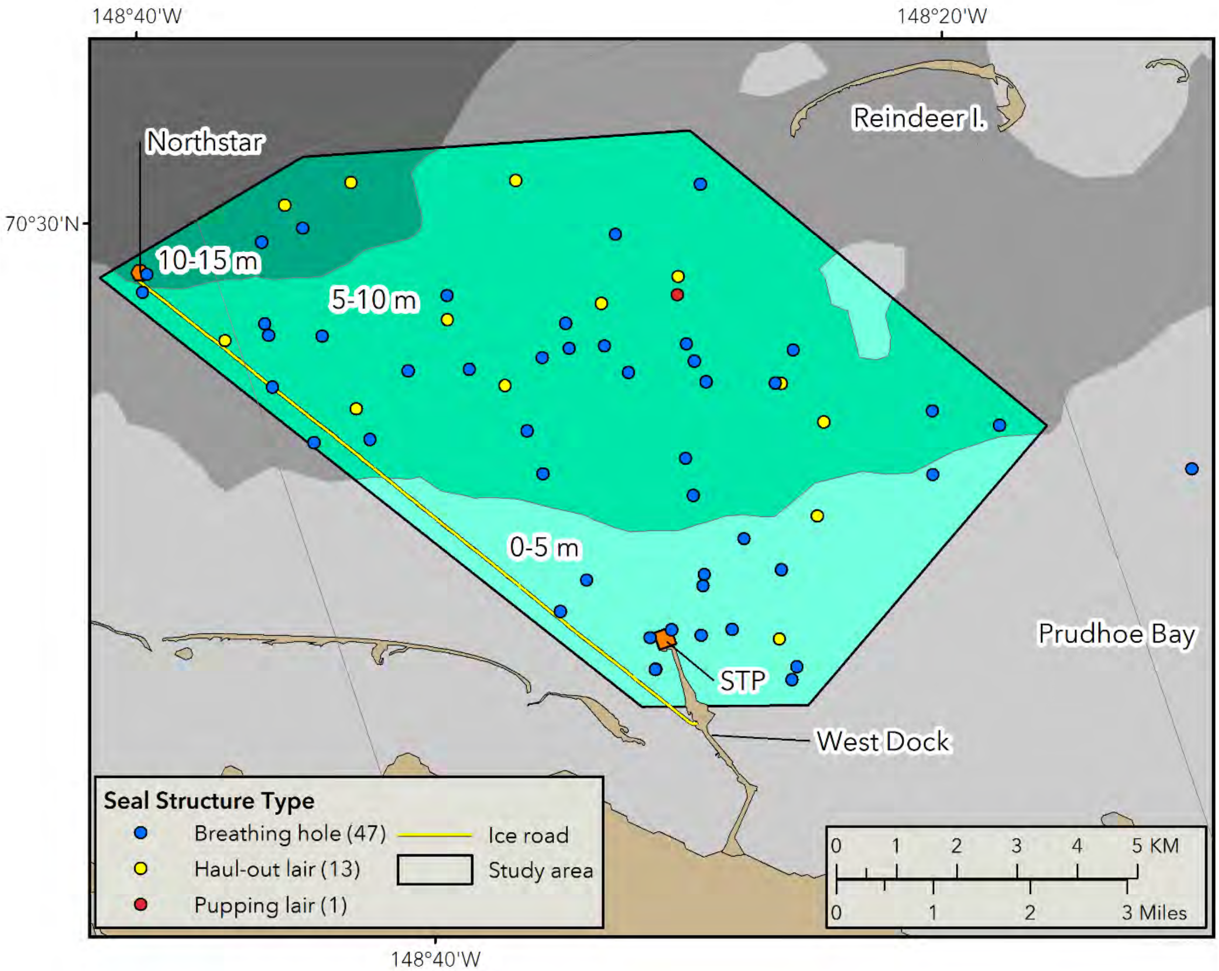

Figure 9. Locations and type of seal structures relative to water depth.

Objective 1: Analyze nearshore ice use by ringed seals by locating and documenting status of wintering seals and their structures to develop avoidance strategies where ringed seal habitat overlaps with North Slope oil and gas activities.

Ringed seal structures were common throughout the nearshore sea ice area used by North Slope oil and gas activities. Some structures were found close to infrastructure where industrial activity occurred regularly, indicating that some seals are tolerant of such activity. In addition, two different individual seals observed basking on the surface did not flush when passed by the hovercraft (Fig. 10), which is used to transport personnel and supplies to and from Northstar. Breathing holes were found in water as shallow as 2 m and active structures were found within 19.5 m of facilities and within an active ice road.

Figure 10. Hovercraft used to transport personnel and supplies between West Dock and Northstar in spring after the ice road is deemed unsafe for travel.

Objective 2: Utilize novel survey technology to expand capabilities to facilitate research on the habitat of ringed seals to improve understanding of ringed seal movements.

Although dogs have been used by indigenous hunters to find seal holes (e.g., Nelson 1969) and thus may not be considered novel, dogs are the best method available for conducting research on winter ringed seal habitat. Dogs can survey large areas in a single day (~25 km) and can detect breathing holes and lairs up to 3 km away. They can also detect old breathing holes that are frozen and no longer active. Understanding individual ringed seal movements requires satellite or VHF tracking devices placed on live-captured ringed seals. Capture efforts are expensive, time consuming, and cause disturbance to the study area, especially at the structures in which captures occur. It is unclear how capture activities influence the movements of seals within the area of interest.

The use of drones would expand our capability to study ringed seal density and habitat during the basking and snow melt season. Drones are currently not allowed by the Department of Interior due to security concerns. We were unable to fly a traditional aerial survey with a single engine airplane during the peak of basking this year due to low ceilings in late May. Having a drone and pilot on site would allow us to take advantage of brief good weather windows during basking. Getting a count of the minimum number of seals and breathing holes in the study area to compare with the number of structures found would provide useful comparisons.

Objective 3: Identify winter and spring seasonal movement patterns of adult ringed seals with an emphasis on detecting subnivean lair use in landfast ice in areas bounded by NPR-A, ANWR, and BOEM’s Beaufort Sea Planning Area.

Winter and spring are seasons when adult ringed seals move minimally in landfast ice habitats. Adults set up their breeding territories in winter and pups are born and reared in spring. Mating occurs after pupping and is followed by molting, which occurs as the snow and landfast ice are melting. This study is focused on BOEM’s Beaufort Sea Planning Area however, similar methods could be used in NPR-A and ANWR. Our current methods do not allow us to assess movement of individual seals during this period.

Objective 4: Document ringed seal habitat use areas and local foraging behavior by classifying foraging locations and determine if oil and gas development activities create movement barriers for ringed seals to access prey.

In general, ringed seals gain weight in winter and lose weight in spring during pupping, lactating, mating, and molting. As mentioned above, ringed seals in landfast ice habitats make localized movements in winter and spring because they cannot range too far from their breathing holes; in summer and fall they make long-distance movements because they are no longer restricted by breathing hole locations. During winter and spring when ringed seals are located near oil and gas development activities, they are likely foraging locally in a relatively small area probably mostly on invertebrates (amphipods). In May 2022 we often saw pelagic invertebrates floating in the seal holes (Fig. 11).

Figure 11. Pelagic invertebrates, including Gammaracanthus sp.*, found floating in a seal breathing hole. Ringed seals are known to eat* Gammarus sp.*, but not* Gammaracanthus sp.*, during winter (Crawford et al. 2015).*

Objective 5: Evaluate and compare the efficiencies of the proposed survey technologies with existing methods used to detect ringed seals, their breathing holes, and lairs.

We may be able to fly an aerial survey in late spring during basking and compare the number of structures found then to the number found in winter/spring using trained wildlife-detection dogs. If the numbers are comparable, an aerial survey conducted when most seal holes are visible could be used to estimate seal hole density. We tried to conduct a survey in late May and early June 2022 during the peak of basking, however low ceilings prevented flights. More work needs to be done to assess how seal hole density relates to seal density, however the relationship is not likely to be highly variable.

Other Activities: Although not an objective of this study, we were able to collect water samples from seal holes for Dr. Krista Longnecker, a biochemist from Woods Hole Oceanographic Institute (WHOI). Longnecker studies how bacteria change the chemistry of the ocean. As part of a NASA-funded project Longnecker, and colleagues Dr. Samuel Laney (WHOI) and Dr. Stephen Okkonen (University of Alaska Fairbanks), use the under-ice water samples to quantify bacterial consumption of dissolved organic carbon found in the near-shore environment under the sea ice. We provided 37 water samples, from 31 different seal holes for Longnecker's study. The data from these samples will improve estimates of the role of bacteria in geochemical cycling in the region.

Discussion

Dogs were effective at finding ringed seal structures in deep snow and when seals were basking on the surface when winds were sufficient (i.e., > 5 kts). When winds are calm or variable, scents do not broadcast far, and it is more difficult to located structures and distances covered from the survey track are lower.

Instruments were effective in recording weather conditions in the study area and documenting temperature, light, and behavior in lairs without disturbing seals. Temperature sensors recorded haul-out bouts with an increase in temperature. However, cameras documented that some seals spent considerable time (up to 10 hrs 23 min) resting and sleeping in lair access holes without hauling out. This behavior resulted in subtle changes in the lair temperature that went unnoticed until we reviewed consecutive photos from the cameras. This extensive use of lair access holes has not been documented before and changes what we know about ringed seal use of lairs. We did not instrument breathing holes with cameras, so we do not know if they were also used this way. We plan to include cameras on breathing holes next year to further address this behavior. If seals use breathing holes and lair access holes for resting and sleeping, the use of lairs to haul out may be less important than previously thought. Lairs are still important for pupping and pup rearing.

We were not able to accomplish an aerial survey in 2022 during peak basking or when seal holes were visible after snow melt due to low ceilings. A comparison of the number of holes counted in an aerial survey and the number found by dogs will be useful for developing ways to monitor structure and seal densities. If the numbers are comparable, it may be possible to monitor seal density by monitoring hole density using aerial survey methods.

Acknowledgments

Funding for this research was provided by BOEM (Contract No. M21AC00024) and BLM and we appreciate the support and assistance of Richard Raymond and Craig Perham. Substantial support was provided by Hilcorp Alaska LLC in the form of room, board, snowmachine maintenance, dog sitting, and gear space. We thank the Hilcorp environmental crew including Amy Peloza, Jen Dushane, Eric Van Dongen and John Blackwell and the entire Hilcorp Seawater Treatment Plant crew. Thanks to John Pulis and Chris Hall at Alaska Clean Seas for providing a snowmachine that was critical to our field work. ADFGs Division of Wildlife (Jessie Dunshie, Mark Nelson, and Ryan Adam) supported our work with a truck, and we appreciate the Department of Transportation in Deadhorse for their tire repair and tire replacement services. The ADFG Division of Sport Fish provided two snowmachines with sleds and a trailer. Specifically, Brian Collyard, Dave Stoller, and Rick Queen went above and beyond to tune up the machines and load and wrap them for a safe trip up the haul road. We appreciate the special skills of our brother-sister team of scent-detection dogs, Stout and Indigo, without which we would not have much to present in this report. Seal research was conducted under research permit #20466-01 issued to ADFG by the National Marine Fisheries Service and under an approved ADFG Animal Care and Use Protocol #0027-2022-40.

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List of Appendices

Appendix A. Field report shared with BOEM, BLM, Hilcorp, and NSB.

Appendix B. Ringed seal structures found, structure type, covariates, and instrumentation.

List of Project Presentations

Presented preliminary results to Hilcorp and answered questions during an online meeting on 22 June 2022.