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Marine Mammals Sightings at High Latitudes in the Barents Sea, the Northeastern Arctic

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Abstract

The Barents Sea, an important area for marine mammals, has changed due to climatic factors and increasing human activities. Information on the distribution of marine mammals and monitoring of areas of their high occurrence are essential for understanding population dynamics and informing conservation efforts. Survey data for occurrence of marine mammals were collected in the Barents Sea in the vicinity of the Svalbard Archipelago over 17 days in July, 2022 during the second multidisciplinary Turkish scientific Arctic expedition onboard the PolarXplorer. In total, 42 sightings of 6 cetacean species, 11 sightings of 4 pinniped species, and 2 sightings of polar bears (*Ursus maritimus*) were recorded during 110 hours of dedicated observation effort. White-beaked dolphins were sighted more often than the other cetacean species ($\chi 2=30$, $P<0.05$). The walrus was the most sighted species of pinnipeds. The encounter rate was 2.2 groups/100 nm for toothed whales, and 0.48-1.09 groups/100 nm for baleen whales. The sighted marine mammals mostly stayed as single individuals or pairs, while walruses were observed in groups of up to 120 individuals. Photo-identification data were collected and 35 humpback whale individuals were identified in the Arctic feeding area between 69.593973°N and 81.463930°N latitude; 5.443173°E and 36.833474°E longitude. Four individuals matched the existing records in the Happywhale catalogue. Our study contributes to the knowledge of occurrence and migration patterns of marine mammals in the Arctic region under rapid climate-mediated change.

Introduction

The Arctic region has undergone changes in sea-ice conditions due to intensive impact of global warming (Meredith et al., 2019). There are hydrological and ecological changes in the habitats of marine mammals, which are primarily characterised by ice loss, increased sea temperatures and primary production (e.g. Moore et al., 2019). Marine mammals' responce to the warming and sea-ice loss is reflected in shifts of species distribution (Hamilton et al., 2015; Bengtsson et al., 2022). The human activity, such as cargo transport, oil and gas activities and tourism, have a profound impact in the region (Pörtner et al., 2019). This emphasises the need for systematic monitoring of the occurrence, distribution and habitat use of marine mammals in the Arctic.

The marine mammals around the High Arctic Svalbard archipelago have been influenced by various ecological and cultural factors (Arlov, 1994). Historical hunting in the Arctic has significantly affected the distribution and abundance of marine mammals. Some whale species were nearly driven to extinction due to large-scale commercial whaling that began in the early 1600s (e.g Hacquebord, 1999). Although many whale species are now recovering, there are knowledge gaps of current trends in their abundance, distribution and habitat use. In the 18th century, the discovery of

abundant harp seal population near Jan Mayen led to seal hunting become an importnant local industry, the commercial hunt for harp seals in the northwest remains the largest for any population in the World (DFO, 2000; Lavigne, 2009).

The Barents Sea is regularly used by around 24 marine mammal species, including cetaceans, pinnipeds and polar bears (Stiansen and Filin, 2007). The number of cetacean species recorded in the Barents Sea has varied over time (Stiansen and Filin, 2007; Kovacs et al., 2009); the most recent study based on a decade of ship-based surveys from 2010 to 2019 reported 16 species (Mishin, 2021). Beluga whale (*Delphinaterus leucas*) and the polar bear (*Ursus maritimus*) are endemic Arctic species and occur in the Barents Sea all year around (Kovacs et al., 2009; Aars et al., 2017). The waters along Svalbard are important for various seasonal visitors, including fin whales (*Balaenoptera physalus*), minke whales (*Balaenoptera acutorostrata*) and humpback whales (*Megaptera novaeangliae*), which stay in the Greenland and the Barents Seas during summer and autumn (Kovacs et al., 2009; Storrie et al., 2018). Small cetaceans such as white-beaked dolphins (*Lagenorhynchus albirostris*) and harbour porpoises (*Phocoena phocoena*) are found in this region (Kovacs et al., 2009). This area also plays a key role for three endemic pinniped species: the Arctic ringed seal (*Pusa hispida*), the bearded seal (*Erignathus barbatus*) and the Atlantic walrus (*Odobenus rosmarus rosmarus*), which reside near the sea ice (Smith and Lydersen, 1991; Kovacs, 2009; Hamilton et al., 2015, 2021). The harp seal (*Pagophilus groenlandicus*) is found in open, ice-free waters of the region, where they follow capelin, a major prey source (Lavigne, 2009).

Systematic surveys to examine the occurrence and distribution of marine mammals in the Arctic are difficult for logistical as well as financial reasons. The obstacles are caused by various factors, which range from large expances of sea-ice and long periods of low light (up to six months a year) to dispersed nature of many marine mammals. Still, reliable data on the marine mammals species can be collected via photo-identification (photo-ID), which is non-invasive and cost-effective method to obtain data by identifying individual cetaceans from unique marks on their fins, flukes and bodies (Hammond et al., 1990). Photo-ID has been used to get a range of information, such as critical habitats, migration corridors, and abundance (Katona and Beard, 1990; Campos-Cuellar et al., 2023). The movements and residency patterns of marine mammals in the Arctic region can be tracked with relative ease (e.g. Peres dos Santos et al., 2022), as they have long lifespan, large body size, and unique fur/fin/flukes patterns and individually distinct marks.

In July of 2022, the second multidisciplinary Turkish scientific Arctic expedition was conducted onboard the icebreaker PolarXplorer. The main goal of this study was to examine the occurrence of marine mammals on the route from Norway to Svalbard and to identify the individuals of the species observed through photographs. For this remote region of Norway, we aimed to estimate the number of sightings, encounter rates and group sizes of observed cetacean species (Mysticeti and Odontoceti) and pinnipeds (Phocidae and Odobenidae) as well as polar bears during the study period. In addition, we provide photo-identification data for humpback whales, including sighting locations, sighting span, to contribute to studies of their habitat preferences and movement patterns.

Materials and Methods

Data Collection

The cruise onboard the PolarXplorer was conducted between 6 and 23 July 2022 in the Barents Sea. The length of the route, which encircled northern Norway and Svalbard, was 1,890 nm (3,500 km; Figure 1). The area covered by the study borders latitudes 69.593973°N to 81.463930°N and longitudes 5.443173°E and 36.833474°E.

Data collection on occurrence and photo-ID data of marine mammals was conducted by a trained observer. The observations were carried out from the bridge of the ship, located 14 metres above the sea level. The observations usually lasted from 07:00 to 20:00. Each observation session lasted between 30 min and two hours depending on weather conditions. A break of 15-30 min was taken between two consecutive observations to have time for the observer's rest, change batteries and camera memory cards (if necessary). Data on location and environmental parameters, such as sea state, wind, precipitation, were recorded every thirty minutes. Species of marine mammals were identified using naked eyes and/or 16×50 binoculars. The observations of marine mammals were mostly focused on 180 degrees forward and lateral arc around the ship; the observer also regularly obtained photo-identification information from other members of the team scanning the back of the ship for marine mammals. The observer was equipped with Canon R5 and R6 Mii cameras with Canon RF100-500mm telephoto lenses.

Once an individual or a group of marine mammals were sighted, the date and time of the sighting, group size (minimum, maximum and best estimate of the count), the presence or the absence of calves and the general behaviour were recorded.

Data Analysis

All the statistical analysis was performed using the statistical software R (version 4.4.0). A chi-square goodness of fit test was performed to determine whether there was significant difference in the number of sightings for the observed species. QGIS (version 3.34.1) was used to map the route of the vessel and the sightings of marine mammal species. The group

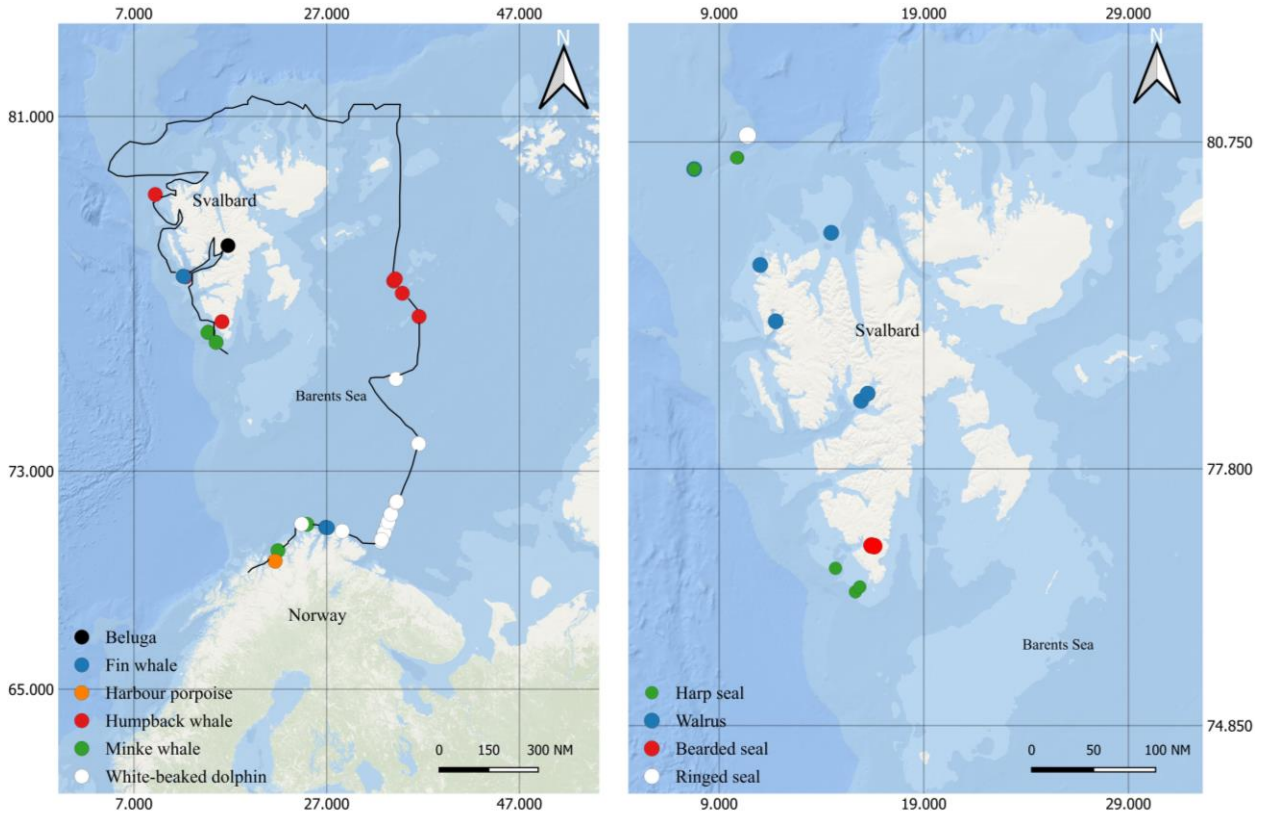

Figure 1. Sightings of cetaceans (left) and pinnipeds (right) in the Barents Sea on the route (black line) of the cruise taken by PolarXplorer between 6 and 23 July, 2022.

encounter rate was calculated as the number of sightings per 100 nm. Mean value and other statistical parameters of the group size of the cetaceans and pinnipeds were computed. The photo-identification data for marine mammals were analysed using the FastStone Image Viewer. Then, images of identified individuals were uploaded to Happywhale (www.happywhale.com), a web platform for research collaboration and citizen science, that enables data to be shared globally, ensuring cost-effective data collection, increased collaboration and access to scientific information. We explored this database to find matches between the whales identified by our team and the corresponding species recorded in the platform's dataset (Cheeseman et al., 2022). The matches were used following guidelines defined by Creative Commons licensing.

Results

Survey Effort and Sightings

During the 17-days cruise, 826 nautical miles (1,530 kilometres) of the on-effort length was covered, and 110 hours of a survey effort were spent. Marine mammals were observed on 15 out of 17 days (88% of the cruise total day count).

In the study area, six cetacean species were sighted (42 sightings); of these, three species of baleen whales (Mysticeti) and one species of toothed whales (Odontoceti) were regularly observed (Figure 1, Table 1). White-beaked dolphins (*Lagenorhynchus albirostris*) were the most observed species with 18 sightings (43%), followed by the humpback whale (*Megaptera novaeangliae*) with nine sightings (21%). The fin whale (*Balaenoptera physalus*) was sighted five times (12%) and the minke whale (*Balaenoptera acutorostrata*) was sighted four times (9.5%). Other cetaceans such as harbour porpoises (*Phocoena phocoena*) and belugas (*Delphinapterus leucas*) were sighted once over the study period. Four sightings (9.5%) belonged to unidentified cetacean species. The chi-square test confirmed the significant difference in the number of sightings for white-beaked dolphins comparing to the other cetaceans ($\chi 2=30$, $P<0.05$).

Four species of pinnipeds - harp seals, bearded seals, ringed seals and walruses - were observed during the study period. In total, 11 sightings of seals were recorded; harp seals were sighted eight times, bearded and ringed seals were sighted two and one times, respectively (Figure 1, Table 1). An exact test of goodness-of-fit did not confirm a statistically significant difference in the number of these sightings ($P= 0.09$). A total of 12 sightings of walruses were recorded (Table 1).

Four polar bears (*Ursus maritimus*) were sighted during the cruise (Table 1); one individual was spotted in the waters near North Spitsbergen (80.006439°N, 14.440328°W), and three individuals were recorded in West Spitsbergen near the Nordenskiöld Glacier (78.658221°N, 16.915086°W).

Encounter Rate and Group Size

The overall encounter rate for white-beaked dolphins was 2.2 groups per 100 nm. Group encounter rates for baleen whales were in the range between 0.48 groups/100 nm (for *B. acutorostrata*) to 1.09 groups/100 nm (for *M. novaeangliae*) (Table 1).

The group size of the humpback whale ranged from one to 60 individuals; the median value was two individuals. Fin whales and minke whales mostly stayed as single individuals or pairs (Table 1). In general, white-beaked dolphins formed groups up to 10 individuals; the mean value of the group size was 3.9 individuals (median = 3.5).

During the study period, the seals were mostly recorded as single individuals, while walruses were observed in groups of up to 120 individuals (Table 1).

Photo-Identification

Photo-identification data, which consists of 10,367 digital images, were collected in the study area. Of these, 713 images of sufficient quality were used for further identification of individuals of cetaceans, pinnipeds, and polar bears. The created photo-ID catalogue includes 35 individuals of humpback whale, eight individuals of minke whale, four individuals of fin whale, 13 slight marked individuals of white-beaked dolphin, four individuals of harp seal, two individuals (one adult and one pulp) of ringed seal, two individuals (1 presumably female) of bearded seal, 20 individuals of walrus and three polar bear individuals (Figure 2). The images are kept at www. happywhale.com under Creative Commons Attribution-NonCommercial-ShareAlike 4.0 license.

Resightings of humpback whales were documented between the Barents Sea (our data), the Greenland Sea (Happywhale platform), and the Caribbean Sea (Happywhale platform). As of October 2024, four humpback whale individuals were resighted (Figure 3, Table 2).

Two individuals of humpback whales (with ID codes H013 and H028) were recorded two times within the Greenland Sea in the vicinity of Svalbard in July, 2022. These intra-annual resightings had the distance and the duration of 55-350 km and 5 days, respectively. One more humpback whale individual (H012) was recorded across multiple years in the Caribbean Sea and the Barents Sea. The sighting span that the individual had was 4.5 years (Table 2). Another humpback whale, which is identified as H007 in our catalogue, was first observed off Desahies, Guadeloupe (Campos-Cuellar et al., 2023), and was resighted east of Svalbard in the Barents Sea.

Discussion

This study provides description of the marine mammals found in the waters of the Barents Sea in the summer period in the frame of the 2022 Turkish Scientific Arctic Expedition. According to the our results, the cetacean and pinniped fauna may include minimum of six species of whales and dolphins, and four species of pinnipeds. Polar bears were also sighted in the Svalbard Archipelago.

Baleen whales from the Balaenopteridae family and small dolphins, specifically (*Lagenorhynchus albirostris*) were the most frequently observed species in the Barents Sea; their occurrence often overlapped during the study period.

During our cruise, the humpback whale (*Megaptera novaeangliae*) occurred north-west and south of Svalbard and the northern Barents Sea, which is in line with previous studies of their seasonal occurrence in this area. It was shown that humpback whales are commonly seen in the Norwegian and Barents Seas, as well as in the Greenland Sea during summer and autumn months (Leonard and Øien, 2020; Hamilton et al., 2021). Availability of herring, capelin, and krill, i.e. the main prey species of humpback whales in the Barents Sea (Løviknes et al., 2021), might influence whale movements and their occurrence

Table 1. Number of sightings, encounter rates (group/100 nautical miles) and group characteristics for marine mammals recorded in the Barents Sea during the cruise from 6 to 23 July, 2022

Species	No. sightings	Encounter rate	Mean group size	Max. group size
Cetaceans				
Humpback whale	9	1.09	12.5	60
Fin whale	5	0.60	2	4
Minke whale	4	0.48	3.2	10
White-beaked dolphin	18	2.20	3.9	10
Harbour porpoise	1	-	-	2
Beluga	1	-	-	60
Unidentified whale	4	-	1	1
Pinnipeds				
Harp seal	8	-	1.9	10
Bearded seal	2	-	1	1
Ringed seal	1	-	-	3
Walrus	12	-	16.5	120
Bears				
Polar bear	2	-	2	3

Figure 2. Examples of identified cetaceans (A - fin whale, B – minke whale, C – white-beaked dolphin) polar bears (D), and pinnipeds (E - bearded seal, F - ringed seal, G- harp seal, H - walrus), which were photographed during the study period.

(Leonard and Øien, 2020). The individual movements of humpback whales were inferred from the matches between our records and the Happywhale database; it was shown that these whales undertake annual migrations between high-latitude feeding grounds and low-latitude breeding sites (Katona and Beard, 1990). In the North Atlantic, the West Indies is the breeding ground for most humpback whales where they overwinter and reproduce; their highest concentrations are recorded near the coast of the Dominican Republic, and another smaller breeding population is found around the Cape Verde Islands (Mattila et al., 1994; Stevick et al., 2003; Wenzel et al., 2020). The humpback whales of the Northern hemisphere exhibit strong site fidelity to specific feeding grounds in the Gulf of Maine, eastern Canada, western Greenland, Iceland, and Norway during summer (Stevick et al., 2003,2018; Kennedy, 2013), a behavior that has been linked to long-term separation between different feeding groups of the whole population (Palsbøll et al., 1995; Valsecchi et al., 1997). In particular, humpback whale individuals from the south-eastern Caribbean population migrate to Norway and Iceland (Stevick et al., 2018), and our results are consistent with these migratory destinations. Furthermore, it is known that some whales travel more than 8,000 km to reach the northernmost feeding ground in northern Norway and the Barents Sea (Whaletrack, 2018).

In this study, minke whales were observed along the continental shelf fairly close to the land, which is consistent with observations from other sightings surveys in this area (Skern-Mauritzen et al., 2009; Storrie et al., 2018). Generally, they are associated with open-water masses without dense ice cover (Storrie et al., 2018). While the depth is not the main factor that affects the distribution of minke whales, they are often found in areas with intermediate depths (Skern-Mauritzen et al., 2009). Studies conducted by Kovacs and Lydersen (2006) and Storrie et al. (2018) showed that the northern Atlantic, in particular Norwegian and Arctic waters, is an important feeding area for minke whales in the spring/summer seasons.

Our observations of fin whales in the Barents Sea and along the west coast of Svalbard align with previous studies by Øien (2009) and Leonard and Øien (2020) who reported high abundance of this species in the region, and especially along the continental slope northward to Spitsbergen. Fin whales have been observed along the west coast of Svalbard as far north as 81.5°N; they occur in the region from March to November, with peak sightings between June and September (Storrie et al., 2018). While this species is common in deep waters, it was also found in shallow zones and areas with complex bottom relief and slopes that aggregate prey (Skov et al., 1995; Leonard and Øien, 2020). In our study, no fin whales were observed in the deepest waters distant from the shelf break, indicating preference for topographic features related to the shelf break of the Barents Sea.

White-beaked dolphins were mostly observed in the western Barents Sea, excluding the northernmost areas. However, recent studies indicated a decrease both in dolphin occurrence and abundance, that is likely correlated with reduced prey availability (Leonard and Øien, 2020; Mishin and Lukin, 2024). The observed distribution of these dolphins aligns with known distribution patterns of capelin (Dolgov et al., 2010), particularly along the shelf edge, as capelin populations shift northward (Skern-Mauritzen et al., 2009). During our observations, typical group sizes of white-beaked dolphins ranged from 1 to 10 individuals, although larger groups have been documented in the literature (Reeves et al., 1999).

Beluga whales and harbor porpoises were seen once during the cruise, although they are known to be year-round residents of the High Arctic region. They were observed in shallow waters close to the coast. The Svalbard Archipelago is a main habitat for beluga whales that have strong coastal distribution with preferences for the usage of fjords (Storrie et al., 2018). Harbour porpoise is the smallest cetacean species in the Barents Sea; it inhabits coastal waters and stays mainly as single/pair individuals (Kovacs et al., 2009). As the route of the cruise took place through the open waters from Norway to and around Svalbard, and sometimes in less suitable weather conditions, the detection of beluga whales, which spend their time in association with glacier fronts during summer (Kovacs et al., 2009), and harbor porpoises, which do not emerge prominently from the water surface (Bjørge and Tolley, 2018), could be difficult. Therefore, the lack of these species in our records could be due to technical obstacles and may not reflect their true occurrence.

During the study period, our observations of baleen whales were in line with previously recorded data in this region. However, changes in the marine ecosystems caused by climate warming may affect in the distribution ranges of cetaceans; the recent studies conducted in the Barents Sea and near the Svalbard archipelago have shown that these animals has shifted their range to fjords and coastal areas (Bengtsson et al., 2022). In the Arctic region, minke whales and humpback whales tend to spread more widely to the eastern areas (Mishin and Lukin, 2024), where they were rarely registered (Øien, 2009). Decreasing sea ice cover in the Arctic and associated increase in zooplancton, an important food source for cetaceans, are likely to lead to a shift in their range and the expansion into new habitats, as suggested by Moore et al. (2016).

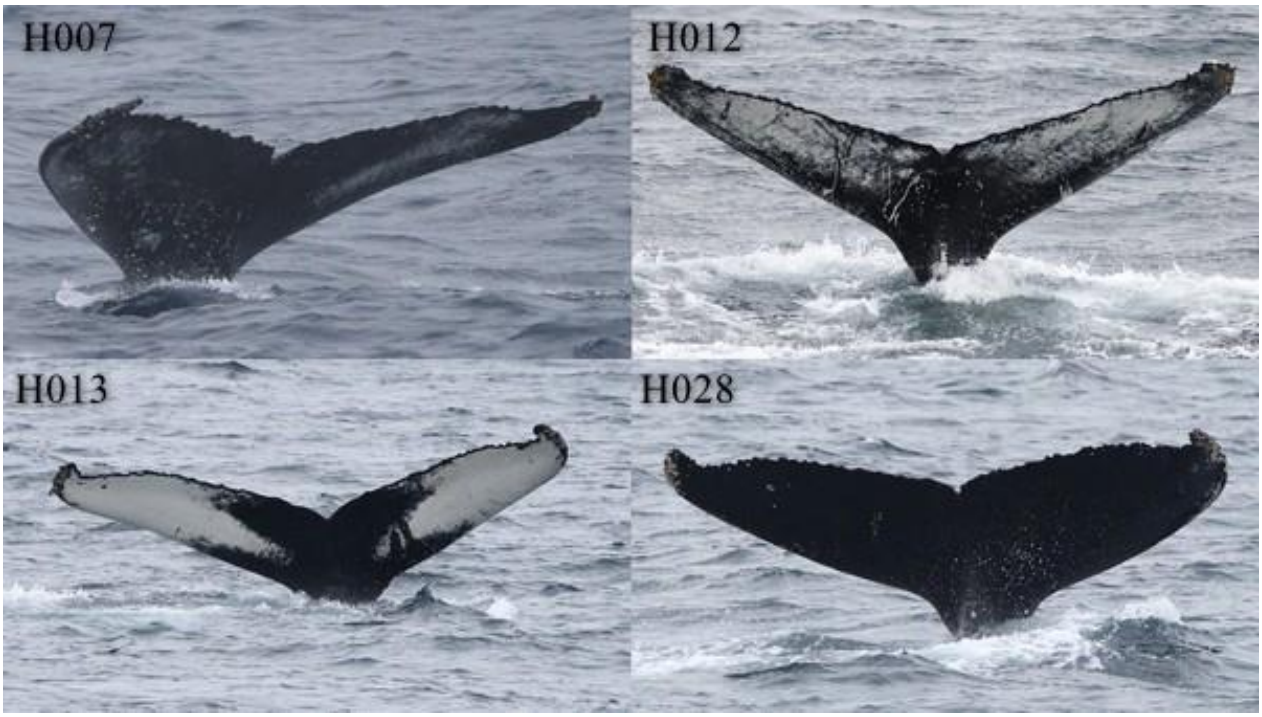

Figure 3. Individuals of humpback whales, which were resighted, photographed by M. Sözen during the cruise in July, 2022.

Table 2. Resightings of humpback whales identified by our team and the Happywhale contributors

ID	1st sighting	Next sightings	Sighting span	Contributor(s)
H007	Apr 2022, Caribbean Sea	Jul 2022, Barents Sea	80 days	Campos-Cuellar et al., 2023
H012	Feb 2018, Caribbean Sea	Jul 2022, Barents Sea	4.5 years	D. Frink, R. Burke, M. Sözen
H013	Jul 2022, Greenland Sea	Jul 2022, Greenland Sea Jul 2022, Greenland Sea	5 days	M. Sözen, J.M. Lambin
H028	Jul 2022, Greenland Sea	Jul 2022, Greenland Sea	5 days	M. Sözen, Queloz

Arctic pinnipeds such as harp, ringed and bearded seals, and the walrus, were recorded during the cruise. Walruses were the most frequently seen species, followed by harp seals, while there were few sightings of ringed and bearded seals.

During the study period, walruses were observed both in the water and hauled out on land; it suggests that the Svalbard Archipelago and its waters are used as important foraging and resting areas during the summer period. This is consistent with known walrus behavior, when they gather in shallow areas to haul out after the pupping and molting seasons, and in winter they are found offshore on drifting ice (Gjertz et al., 2001; Hamilton et al., 2015). The sightings of walruses around Spitsbergen during the study are in line with reports describing their distribution in the region. Hotspots, both for individual sightings and specific locations, are situated along the northeast coast of Greenland between 74° and 81°N, in southern and northern Svalbard, and in Russian waters between Svalbard and Franz Josef Land (Hamilton et al., 2021). The maximum group size recorded for walruses in our study (120 individuals) confirms the fact of strong social behaviour of this species, as it is known to haul-out in densely packed groups (Gjertz et al., 2001).

Harp seals were recorded 8 times in open water area north-west of the Svalbard Archipelago and near Sørkapp. This pattern coincides with other studies, showing that harp seals extensively use open ocean areas near the edge of the pack ice, between 75 and 80°N, for foraging in the summer and autumn (Hamilton et al., 2021). Bengtsson et al. (2021) reported that harp seals have been increasingly observed north of Svalbard and in Hinlopenstretet, likely due to the retreating summer sea ice edge and increased inflow of water from the Atlantic, which makes these areas accessible for the seals. Harp seals mainly stay in the open waters of the Barents Sea, making them inaccessible to polar bears (Smith and Stirling, 2019). As they are very social animals, they can be seen in groups of tens of individuals as in our study, and sometimes occur in groups of thousands (Bengtsson et al., 2021).

Ringed seals were observed in open water more than 100 km offshore north of Spitsbergen, suggesting their offshore movement during summer. Lydersen (1998) found out that ringed seals in Svalbard leave the fjords to feed in the Barents and Greenland Seas in the summer period and return in spring. After molting, some ringed seals move offshore to areas with 40%–80% ice coverage, while others stay near the coasts of Svalbard, particularly around glacial fronts; following such distinct patterns, seals are still offered with high food concentrations and suitable resting conditions (Freitas et al., 2008). Notably, offshore seals depart from the drifting pack-ice regions late in autumn, despite the fact that ice conditions are favorable, as they need to return to the overwintering and breeding sites in Svalbard's fjords (Freitas et al., 2008).

Unlike the ringed seals, bearded seals were observed close to land deep into Hornsund fjord on the west of Svalbard. Their distribution throughout the Arctic is driven by strong affinity to ice which serves as a resting platform. Although they can be found in deep waters up to 600 m (Lomac-MacNair et al., 2018), bearded seals typically inhabit shallower coastal waters (Hamilton et al., 2021) that are related to their shallow benthic feeding habits (Lowry et al., 1980). Both ringed and bearded seals may form small groups of several individuals (Kovacs, 2009; Lindsay et al., 2023); however, they are mostly solitary/pair animals as it was observed during the cruise.

Expected responces of highly mobile pinnipeds to changes in ice extent and its seasonal availability might effect birth rates (Chernook and Boltnev, 2008) and cause changes in harvest level (Kovacs et al., 2011). Rising sea temperatures and reduced ice cover threaten the stability of seal populations making them more vulnerable to new predators (Hamilton et al., 2017).

The sightings of polar bears were recorded around the Svaldard Archipelago, corresponding to the locations reported by Hamilton et al. (2021). Polar bears inhabit Arctic regions where the sea ice is a main habitat, hunting ground for seals, and the route between the sites for mating, breeding, and feeding (Stirling, 2002; Stirling and Derocher, 2012). The rapid sea-ice habitat loss in the Barents Sea region, with a summer season extended by approximately 20 weeks since 1979 (Laidre et al., 2015; Stern and Laidre, 2016), raises concerns about the survival of this subpopulation. As the local ecotype of the subpopulation of polar bears is likely to be several hundred individuals, increasing in the duration of summer may cause further the polar bear carrying capacity of the Archipelago (Aars et al., 2017).

Conclusion

The results presented in this paper provide valuable information on the presence of marine mammals in the Barents Sea and around the Svalbard Archipelago, even though they were collected over a short continous observation period of 17 days. The importance of our resulst is emphasised by the fact that these regions are experiencing significant changes in sea ice conditions (Moore et al., 2019). A continuous ship-based monitoring program is crucial for improving our understanding of marine mammal populations in the Arctic region. Additionally, expanding photo-identification efforts for humpback whales in the Arctic feeding areas will help to better explore their connections with breeding grounds in the Caribbean.

Ethical Statement

Ethic approval is not applicable to this study as it involves only observational research on marine mammals. These observations, including photo-identification, were carried out in accordance with

relevant guidelines and maintained a safe distance avoiding behavioral disruptions.

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Author Contribution

MS designed the study, collected data, reviewed the manuscript, and approved the final version. NU conducted data analysis, drafted and reviewed the manuscript. KV conducted photo-identification analysis and reviewed the manuscript. AY provided statistical analysis support and critical manuscript revisions.

Conflict of Interest

The authors declare that they have no known competing financial or non-financial, professional, or personal conflicts that could have appeared to influence the work reported in this paper.

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