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Research Article

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Low Abundance and Biodiversity of Top Predators -Seabirds and Marine Mammals- in High Arctic Seas

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Abstract

This article concerns the comparison of data collected in different high Arctic seas by the same team, mainly same platform (from the bridge of icebreaking RV Poarstern), and thus the same methodology. Drastic differences were noted, from high numbers in the Bering Strait and Chukchi Sea on the one hand, and Fram Strait and Barents Sea on the other. In contrast, abundance, mainly of seabirds, was very low in the Arctic Basin. Most numerous bird species varied in different areas, mainly fulmar, kittiwake, Brünnich's guillemot and locally ivory gull. Biodiversity was low, as reflected by low numbers of species, a few of them representing the vast majority in numbers of individuals: between 85% and 95% of the total. Cetaceans were close to absent from the High Arctic Ocean, the Wandel Sea off North Greenland and the shallow seas along the North-East Passage; pinnipeds and polar bear were tallied on the Outer Marginal Zone OMIZ, basically absent in the Closed Pack Ice Zone CPI.

Keywords: Seabird and Marine Mammal At-Sea Distribution, High Arctic Ocean

Introduction

Polar areas, both austral and boreal, are known for their low biodiversity and biomass in comparison e.g. with tropical ones. In the case of the at-sea distribution of top predators-seabirds and marine mammals-this was illustrated along long latitudinal transects in the Atlantic Ocean [1]. Major geographical were detected in high Arctic seas; in order to allow comparison all data are presented here as mean values per 30 minute transect count.

Material and Methods

Our methodology consists of 30 minutes transect counts from the bridge 18 m above sea level by one observer, without width limitation, light and visibility allowing during transects in four hours' watches. It was discussed and described in more detail previously in various papers.

The aim of seabird watcher's members of the "Seabird Group" is to express data as density, in order to allow for extrapolating and comparing data. This is why a historical "compulsory" method was developed, limiting counts to ten minutes and to a width of 300 m. This method works well in areas with very high seabird density as the northern North Sea, but is problematic in polar areas with very low density. Moreover, it must be considered a good routine method, all observers applying the same technic. But there exists nothing like compulsory methods in science, even if results are always influenced by the sampling methods, from bacteria, zooplankton, fish, to seabirds and marine mammals.

Among the factors that make extrapolating into densities meaningless are

- The fact that many seabirds are actually followers even if not detected as such. This became obvious in areas where ships are very rare. In Antarctica, we did not encounter any ship for weeks, and the same group of seabirds was following us for days and days. One usually includes followers once a count, leading to an over estimation by orders of magnitude. More perversely, the "usual" method of 10 min counts would also include followers once a count! Such data should obviously not be expressed as reliable densities;
- The fact that many seabirds are observed during the breeding season flying to and from their colonies, mainly when feeding chicks on the nest. Such data represent a flux and should obviously not be included in distribution maps nor expressed as densities;
- The fact that more and more hotspots of seabirds, cetaceans and seals were recently detected at seasonal peaks, mainly in autumn. Such seasonally- influenced data should obviously not be expressed as mean densities. This last aspect will be developed and discussed in some detail later on in this chapter. As a more realistic alternative, we concluded thus that results should be presented raw form (numbers per count) without any calculation as density nor correction for behaviors such as diving periods for birds and whales, nor hauling-out daily rhythm of seals, and especially not for animals not observed but believed to be present in the area.

Results

Data were collected during five main expeditions.

During an expedition in the high Arctic Ocean, most numerous bird species were fulmar *Fulmarus glacialis*, kittiwake *Rissa tridactyla*, and Brünnich's guillemot *Uria lomvia*, representing 90% of the recorded individuals (Table 1, Fig. 1). Number of bird species was low: between 3 and 13. Geographical differences were marked, both as number of species as numbers of individuals (close to zero off Canada, many counts showing no contact at all, high in the Barents Sea). Cetaceans were absent and pinnipeds represented by few harp seals [2].

Table 1: Seabirds and marine mammals tallied in the high Arctic Ocean, September 2008: main species [2]
n = number of species; N = mean numbers per count

Zone*	A	B	C	D
Birds				
n	4	10	3	13
N all	0.3	17.4	< 0.3	93
N fulmar	0.1	0.04	0	49
N kittiwake	0.03	15.4	0	12
N ivory gull	0	0.9	< 0.3	1.6
N Brünnich's guillemot	0	0	0	25
Cetaceans				
n	0	0	0	0
Pinnipeds				
n	1	3	5	2
N all	0.1	0.08	0.08	0.2
N harp seal	0	0.04	0.06	0.1
Polar bear N	0	< 0.01	0	0

* A: off Canada; B: off Wrangel Isl, South of 80°N; C: North of 80°N; D: Laptev, Kara and Barents seas (see Fig 2)

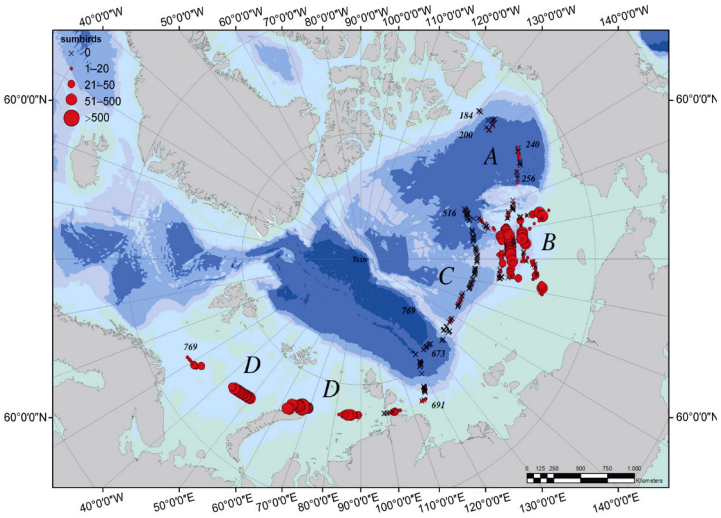

Figure 1. RV *Polarstern* expedition (*partim* north of 73°N) from 25 August to 10 October 2008: total number of seabirds per count; four zones were recognised; count numbers [2]

Along the North-East Passage off Siberia, mean bird abundance was 54 individuals per count. Main species were fulmar, kittiwake, Brünnich's guillemot, short-tailed shearwater *Puffinus tenuirostris* "overwintering" in the area after breeding in the southern hemisphere, and crested auklet *Aethia cristatellea* representing together more than 90% of the total. Important geographical differences were noted with very low abundance in the shallow East Siberian, Laptev and Kara seas, and high values in the Bering/ Chukchi seas and the Barents Sea. Differences were also qualitative, the number of bird species being varying between 9 and 15; dominating species were crested auklet in the Bering/ Chukchi seas (180 birds per count), fulmar and kittiwake in Bering/ Chukchi seas and Barents Sea (60 birds per count). Cetaceans were humpback whale *Megaptera novaeangliae*, bowhead whale *Balaena mysticetus* and white-beaked dolphin *Lagenorhynchus albirostri* in the Barents Seas, and among the pinnipeds, harp seal *Pagophilus groenlandicus* and walrus *Odobenus rosmarus* represented 97% of the total of three per count (Table 2, Fig. 2). Moreover, whales, seals and fulmars were mainly concentrated in one major hotspot [3].

Table 2: Seabirds and marine mammals tallied along the North-East Passage, August 2017: main species [3]
n = number of species; N = mean numbers per count

Zone*	A	B	C	D	E
Birds					
n	15	11	12	9	12
N all	180	33	37	23	56
N fulmar	50	0	0	7	18
N short-tailed shearwater	3	28	21	0	0
N kittiwake	16	2.5	7.4	14	18
N Brünnich's guillemot	1	0.7	2.5	0	13
N crested auklet	52	0	0	0	0
Cetaceans					
n	5	0	0	0	3
N all	0.8	0	0	0	0.8
N humpback whale	0.5	0	0	0	0.3
N bowhead whale	0	0	0	0	0.3
Pinnipeds					
n	0	2	2	2	3
N all	0	1.2	2.1	0	6
N harp seal	0	0	0	0	4
N walrus	0	1.1	1.4	0	2
Polar bear N	0	0	0.07	0	0.01

* A: Bering and Chukchi seas; B: East Siberian Sea; C: Laptev Sea; D: Kara Sea; E: Barents Sea (see fig 1)

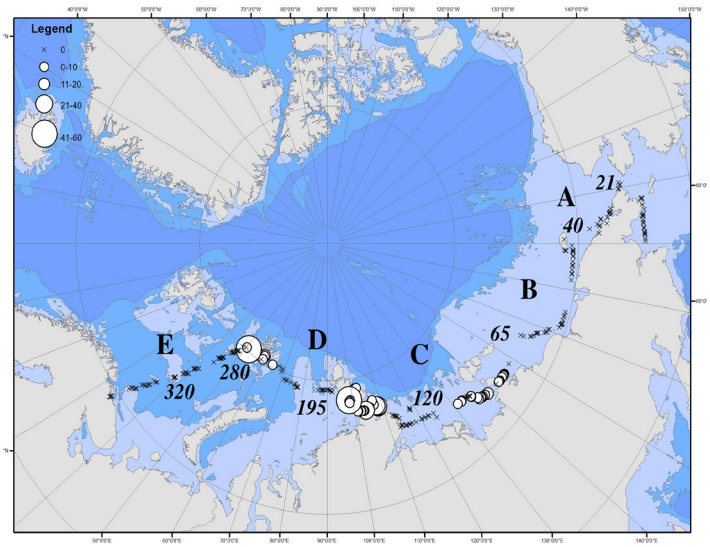

Figure 2. Expedition along the North-East Passage off Siberia, August 2017; zones, count number, ice coverage [3]

Another high Arctic expedition basically followed the ice-covered Lomonosov Bridge (Table 3, Fig. 3). Little auk *Alle alle* was the main species in the Norwegian and Greenland seas, kittiwake and ivory gull more abundant in the southern ice-free end of Lomonosov Bridge off Wrangel Island. Cetaceans were absent from the central Arctic part [4].

Table 3: Seabirds and marine mammals tallied in the ice-covered high Arctic Ocean, July-September 2014: main species [4]
n = number of species; N = mean numbers per count

Zone*	1	2	3	4
Birds				
n	7	5	4	7
N all	10	1.2	3.1	5.8
N fulmar	5	0.3	0	0.2
N kittiwake	0.6	0.25	1	5
N ivory gull	0.2	0.4	1	0.3
N little auk	2.5	0	0	0
N Brünnich's guillemot	0.6	0	0	0.2
Cetaceans				
n	2	0	0	2
N all	0.68	0	0	0.02
N fin whale	0.1	0	0	0
N white-beaked dolphin	0.6	0	0	0.02
Pinnipeds				
n	2	2	0	1
N all	0.02	< 0.01	0	0.03
N harp seal	0.01	0	0	0.03
Polar bear N	0.01	0.01	0	0

* A: Norwegian and Greenland seas, Fram Strait; 2: Lomonosov Bridge closed pack ice CPI; 3: Lomonosov Bridge end, ice-free; 4: high Arctic water (see Fig 3)

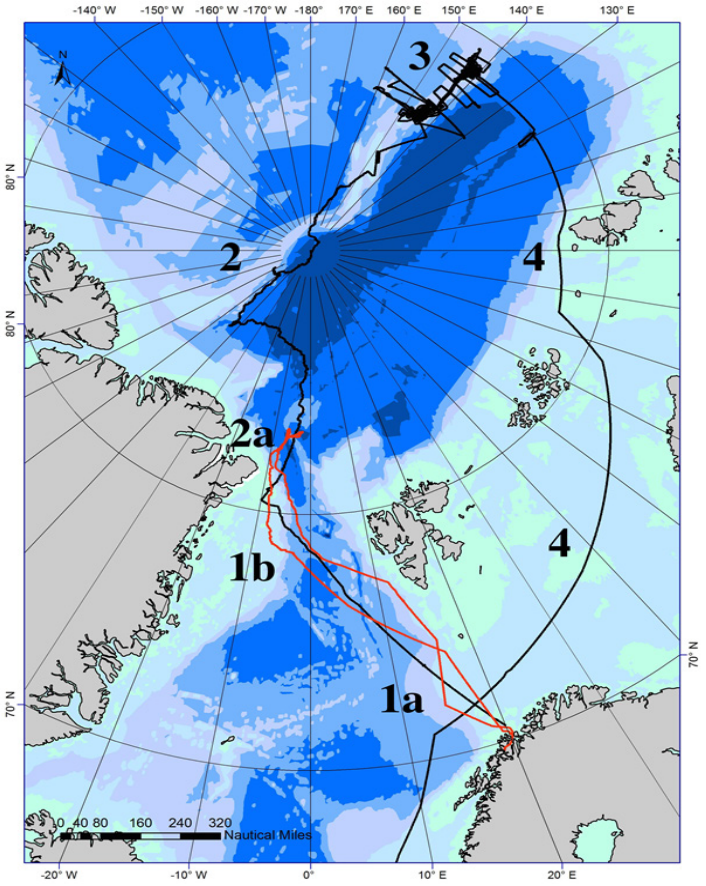

Figure 3. RV *Polastern* expeditions in the ice covered high Arctic Ocean, July- September 2014; four zones [4]

The expedition to the very poorly studied Wandel Sea (North Greenland) (Table 4, Fig. 4) showed the low abundance of kittiwake and high density of ivory gull, the main species of the coastal Wandel Sea. Cetaceans were absent in the area, and three seal species and polar bears *Ursus maritimus* present in low numbers [5].

Table 4: Seabirds and marine mammals tallied in the Norwegian, Greenland and Wandel seas, August 2018: main species [5]; n = number of species; N = mean numbers per count

Zone*	**A**	**B**	**C**
Birds			
n	18	14	7
N all	64	8.9	2.1
N fulmar	4.6	2.2	0.6
N kittiwake	1.6	0.51	0.02
N ivory gull	0	1	1.3
N puffin	35	0.5	0
N Brünnich's guillemot	0	0.1	0
Cetaceans			
n	6	4	0
N all	0.4	0.1	0
N sperm whale	0.06	0	0

N fin whale	0.02	0.01	0
N minke whale	0.06	0.01	0
N humpback whale	0	0.02	0
Pinnipeds			
n	0	4	3
N all		0.4	0.3
N harp seal		0.02	0
N ringed seal		0.05	0.02
N bearded seal		0.04	0.02
N hooded seal		0.05	0.03
Polar bear N	0	0.03	0.02

* A: Norwegian Sea; B: Greenland Sea, Fram Strait; C: Wandel Sea (see Fig. 4)

Table 5: Seabirds and marine mammals tallied around Svalbard, June - July 1991 [6]
n = number of species; N : mean numbers per count

Zone	All	North*
Birds		
n	19	13
N all	76	51
N little auk	12	21
N kittiwake	32	14
N fulmar	16	5
Cetaceans		
n	6	0
N all	0.3	0
N white-sided dolphin	0.3	0
Pinnipeds		
n	5	4
N all	1.6	0.9
N harp seal	0.7	0.2
N bearded seal	0.4	0.3
Polar bear N	**0.06**	**0.07**

* Longitudinal transect north of Svalbard, around 81°N

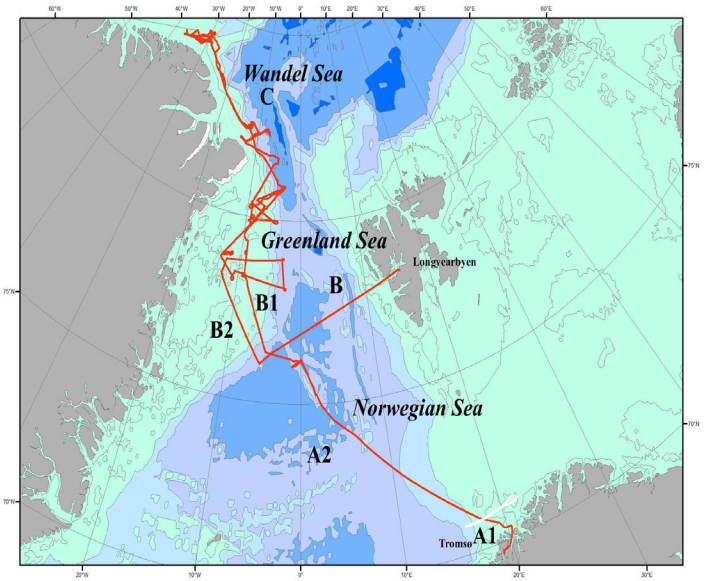

Figure 4. RV *Polarstern* expedition in the Norwegian, Greenland and Wandel seas, August 2018 [5]

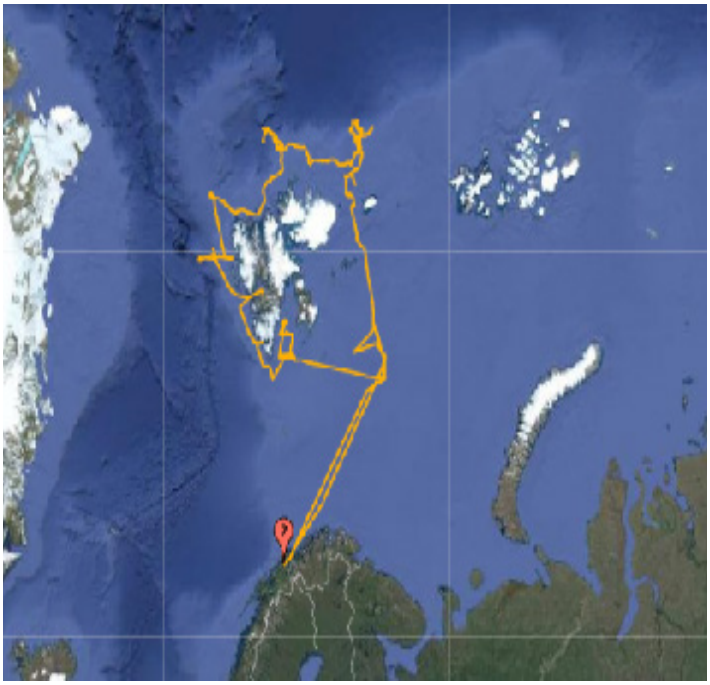

Figure 5. Polarstern expedition around Svalbard in 1991 [6]

During the second European Polarstern Study (EPOS II) around Svalbard in June-July 1991, total number of seabird was high (28500 in total, i.e. 80 per count for 19 species), including along the longitudinal transect north of Svalbard, around 81°N (50 per count, 13 species). The main species observed during the whole expedition, as well as during the northern transect, were little auk, kittiwake and fulmar – both light and dark morphs, mainly light in the transect. Cetaceans, mainly white-sided dolphin Lagenorhynchus acutus during the whole expedition, were absent in the northern transect. Harp and bearded seals were the most numerous species (0.2 and 0.3 per count in the north transect). Seals and polar bears were noted on the Marginal Ice Zone (OMIZ) all around Svalbard [6].

Discussion

Most striking differences concern seabird data: their numbers were very low in the central Arctic Ocean, including Wandel Sea. The main factor is not pack-ice as such: lowest value – including many 30 min counts without any contact – were tallied in the deep ocean (3000 m) both with (A) or without (C) important ice cover [2, 4, 5]. Polar bears and seals were concentrated in the Marginal Ice Zone (MIZ) but absent in Closed Pack Ice (CPI).

Such data reflect a very low biodiversity, taking into account the low number of species and the strong dominance of a few species. Number of species and their geographical variations basically fit the model by Huettmann *et al.* [6]. Most abundant species were also different in the different areas, an important qualitative difference. Considering the abundance of predators is reflecting prey availability, these data also reflect important differences in bio-productivity.

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