Polar and Cold Regions Research
Journal Homepage: https://journals.explorerpress.com/pcrr

Research Article

At-Sea Distribution of Seabirds and Marine Mammals in the Unexplored Southern Weddell Sea, Antarctica

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KEYWORDS

seabirds & marine mammals at-sea distribution
geographical heterogeneities
Weddell Sea
S. georgia, S. Sandwich
S Shetlands islands
antarctic continent

ABSTRACT

Background: In the frame of our long-term study in polar seas, the at-sea distribution of "top predators" – seabirds and marine mammals – was studied in the Weddell Sea area, both the well-covered northern one (sub-antarctic Scotia Sea) as well as in the almost unexplored southern and central ones. Method was our usual transect counts lasting 30 min. each, without width limitation. **Results and conclusions:** Species richness was low, dominated by only a few species, reflecting low diversity. Birds, seals and to some extend whales showed a heterogeneous distribution. They were concentrated in a few "hotspots" on the "continental" shelf and –slope, of South Georgia, South Sandwich and South Shetland (Elephant) islands, and off the Peninsula. Species showed important differences in distribution probably reflecting differences in the food web. In open waters off the shelf, species showed low densities, both in the northern and southern areas. In the case of seabirds, moreover, they were partially over-estimated by the presence of long-distance followers, probably by one order of magnitude. The absence of gentoo penguin might reflect a change in geographical distribution.

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ARTICLE INFO
Received: 27 January 2026 | Revised: 13 February 2026 | Accepted: 18 February 2026 | Published Online: 25 February 2026
DOI: https://doi.org/10.65773/pcrr.2.1.114

1. Introduction

Our study of the at-sea distribution of the marine "top predators" in polar seas consists in a synecological approach providing information on the functioning of the whole ecosystem. The number of species can reflect biodiversity, while the number of individuals can indicate productivity (prey abundance). Species richness is generally low in polar seas – approximately 30 bird species – with high heterogeneity in distribution. The activity of the Laboratory for Polar Ecology (PolE) team started with a pioneering return expedition from Belgium to Greenland in 1973 [1] and was followed by many others in both polar areas. In the context of our long-term study of the at-sea distribution of seabirds and marine mammals in polar seas, we had the opportunity to cover an almost unexplored area of the southern Weddell Sea.

2. Method

An observer of the PolE team (CJ) participated in a cruise on a small tourist ship (90 m long, 80 passengers), into the Scotia and Weddell seas, from Ushuaia, Argentina, to the Antarctic continent, from 12 February to 9 March 2025. The vessel was not an icebreaker, but ice strengthened, and so it avoided areas of heavy sea ice cover. Seabirds and marine mammals were counted by line transect methodology, on a continuous basis, visibility conditions allowing. Continuous transects were broken into 30 min segments without width limitation. Data were collected from one side and in front of the bridge in function of light conditions, 9 m above the sea-Ievel and were facilitated by using 10X40B binoculars when necessary. As a consequence of the low numbers of individuals in polar areas, the counting methodology had to be adapted, not following the "compulsory" method of 10 min transect counts with a width limitation of 300 m adapted for areas with very high local abundance such as the northern Atlantic Ocean - besides there exists no compulsory methodology in any science. In order to compare with data from previous expeditions by the same team and same methodology, mean values were used to correct for the number of counts instead of medians – even if the distribution is far from normal with median values of zero, but for the sum of all birds equal to seven.

3. Results and Discussion

3.1. Tallies of Birds and Mammals

The cruise and its 357 30 min transect counts basically covered the northern and the almost unexplored southern areas of the Weddell Sea (Figure 1), as compared with the radar-registered ships for decennia (Figure 2). The southwestern portion of the Weddell Sea had to be avoided due to heavy ice coverage (Figure 3). In total, 30 seabirds, five pinnipeds and eight cetaceans were encountered, dominated by a few species, typical of polar seas (Table 1). Some hotspots on the continental plateau and –slope presumably reflected high food availability, the reasons for which are not known. High concentrations were observed mainly in four areas, off S. Georgia, S. Sandwich and S. Shetland (Elephant) islands and the Peninsula and to a lower extend off the antarctic continent (Figure 4). Species distributions tended to be heterogeneous (Figure 5). For instance, 564 fulmars were counted sitting on ice floes or on water next to ice floes in seven counts in the same area off the Peninsula and Elephant Island (Photo 1), out of the total of 940 for the whole cruise. The most abundant species, antarctic prion and blue petrel, were observed in very large flocks flying back to their breeding colonies and thus do not reflect food web generated concentrations.

Photo 1. Flocks of fulmars sitting on, or close to, medium ice floes

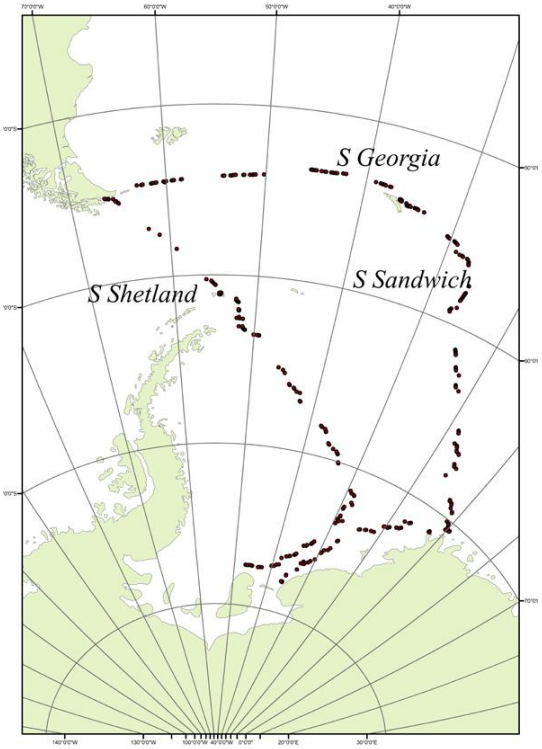


Figure 1. Position of the seabirds and marine mammals 30 min line transect counts in the Weddell Sea, February-March 2025.

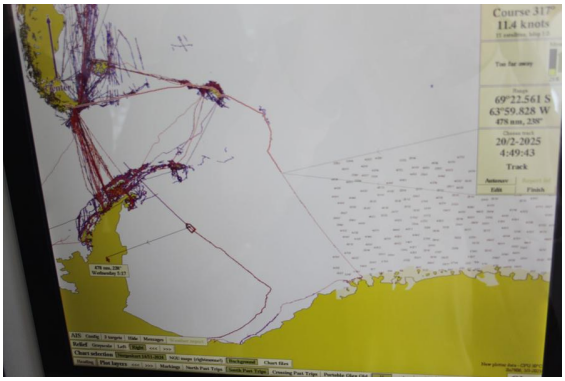


Figure 2. Route of this cruise (thin line) compared with the radar-registered ships in the area (colours).

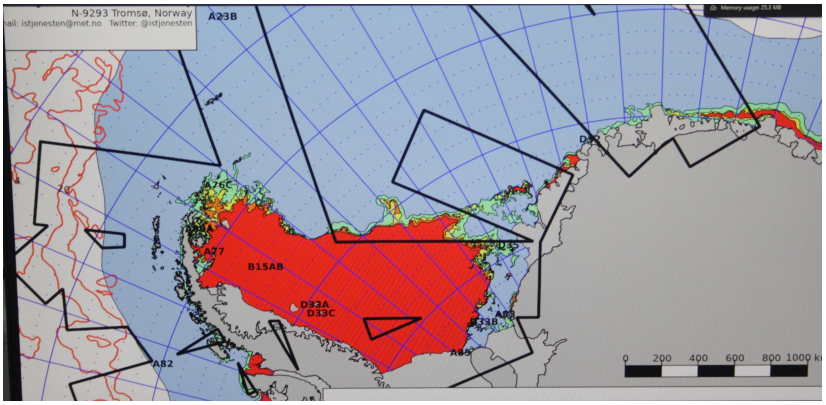


Figure 3. Heavy ice coverage in the SW Weddell Sea (red).

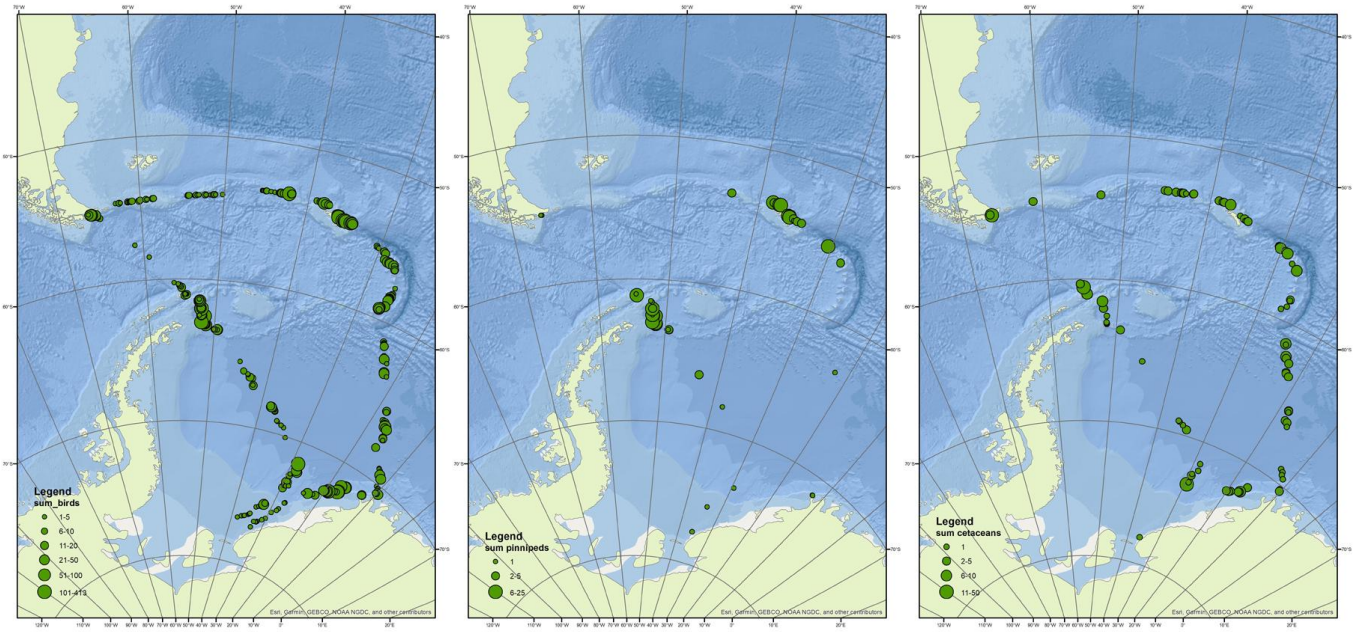


Figure 4. Sum of the observations of all seabirds (a), all pinnipeds (b) and all cetaceans (c); numbers per count.

Hotspots were embedded in empty zones (many counts had no detection). High counts in open waters otherwise having low bird numbers often involved species that tend to follow vessels, causing an overestimation of density, probably by one order of magnitude: e.g. giant petrel, black-browed albatross, pintado (Cape), snow and antarctic petrels. Two areas stood out: a northern one that included the islands and Peninsula, north of S Sandwich Islands and the Peninsula, and a southern one that was partially covered with medium ice floes and many icebergs..

Among the most abundant penguin species were emperor and Adélie, which were mostly seen on old icebergs and ice floes. Other bird species were clearly bound to the island coasts. We note that numbers of emperors were artificially higher, owing to attraction by tens around the stationary ship, being curious and attracted by people walking on the ice or by Zodiac boats and divers close to the ice floes (Photo 2). All hotspots were situated around coasts above the continental shelf and –slope (depths of 300 to 400 m).

Table 1. Seabirds ary and marine mammals encountered at sea in the Weddell Sea, February-March 2025.

	Zone*	All		Norh		South		Remark
		Total	Mean**	Total	Mean*	Total	Mean**	
Species***	Number of counts	357		195		157		
1 king penguin	Aptenodytes patagonicu	47	0.13	47	0.24	0		
2 emperor penguin	Pygoscelis papua	129	0.36	93	0.48	36	0.24	
gentoo penguin	Pygoscelis papua	0		0		0		
3 chintrap penguin	Pygoscelis antarctica	15	0.06	15	0.08	0		and 2 large colonies on Elephant Isl
4 Adélie penguin	Pygoscelis adeliae	115	0.32	33	0.17	82	0.52	
5 rockhopper penguin	Eudyptes chrysocome	6		6		6		off Ushuaia
penguin sp		51	0.14	45	0.23	6		
6 wandering albatross	Diomedea [exulans] sp	42	0.14	42	0.22	0		
7 royal albatross	Diomedea [epomorpha] epomorpha	30	0.12	27	0.14	3		
8 black-browed alb.	Thalassarche [melanophrys] melanophrys	105	0.29	104	0.53	1		
9 grey-headed albatross	Thalassarche chrysostoma	7		7		0		
10 sooty albatross	Phoebetria fusca	10	0.03	0		10		
11 light-mantled albatross	Phoebetria palpebrata	3		3		0		
12 giant petrel sp	Macronectes sp	407	1.15	358	1.84	49	0.31	both N and S species
13 antarctic petrel	Thalasoica antarctica	283	0.80	152	0.78	133	0.84	peninsula
14 pintado (Cape) petrel	Daption capense	210	0.59	195	1.00	20	0.13	
15 snow petrel	Pagodroma [nivea]	435	1.22	268	1.37	149	0.94	
16 blue petrel	Halobaena caerulea	1528	4.30	83	0.43	1445	9.15	
17 southern fulmar	Fulmarus glacialoides	941	2.65	909	4.66	33	0.21	
18 (antarctic) prion	Pachyptila (desolata)	1674	4.73	1360	7.01	314	1.99	
19 Kerguelen petrel	Pterodroma brevirostris	12	0.03	12	0.06	0		
20 soft-plumaged petrel	Pterodroma mollis	174	0.49	161	0.83	13	0.08	
21 white-chinned petrel	Procellaria aequinoctialis	198	0.56	198	1.03	0		off Ushuaia
22 sooty shearwater	Puffinus griseus	19	0.05	4	0.02	15	0.09	
23 Wilson storm-petrel	Oceanites oceanicus	319	0.89	300	1.54	19	0.12	
24 black-bellied storm-petrel	Fregetta tropica	46	0.13	41	0.21	5		mainly Peninsula
25 (georgean) diving-petrel	Pelecanoides georgicus	7		6		1		
26 south georgian shag	Phaalacocorax (atriceps) georgianus	26	0.07	25	0.13	0		
27 rock shag	Phalacrocorax magellianicus	125	0.35	125	0.64	0		off Ushuaia
28 (antarctic) tern	Sterna vittata	22	0.03	17	0.08	5		
29 (antarctic) skua	Catharacta [skua] antarctica	12	0.03	11	0.06	1		
total seabirds		**6998**	**19.6**	**4647**	**23.8**	**2340**	**14.9**	
snowy sheatbill	Chionis alba	10		9		1		terrestrial
1 (antarctic) fur seal	Arctocephalus (pusillus) doriferus	140	0.39	139	0.71	1		
2 leopard seal	Hydrurga leptonyx	7		5		2		

3	Weddell seal	Leptonychotes weddellii	4		2		2		
4	crabeater seal	Lobodon carcinophaga	121	0.34	120	0.61	1		
5	S elephant seal	Mirunga leonina	9		9		0		
	seal sp		21	0.07	20	0.10	1		
	total pinnipeds		**299**	**0.85**	**292**	**1.52**	**7**		
1	dolphin sp	Lagenorhynchus sp	32	0.99	32	0.16	0		probably Hourglass, 1 possible Peale's
2	long-finned pilot whale	Globicephala melas	13	0.03	9		4		
3	southern right whale	Eubalena australis	2		2		0		
4	antarctic Minke whale	Balaenoptera bonaerensis	31	0.08	6		25	0.15	
5	sei whale	Balaenoptera borealis	25	0.07	25	0.13	0		1 pod off Ushuaia
6	blue whale	Balaenoptera (musculus) intermedia	2		1		1		
7	humpback whale	Megaptera novaeangliae	47	0.13	20	0.10	27	0.17	
8	fin whale	Balaenoptera physalus	12	0.03	10	0.05	2		
	large whale sp		127	0.37	73	0.38	54	0.35	long-distance blows
	total cetaceans		**312**	**0.88**	**200**	**1.04**	**112**	**0.71**	

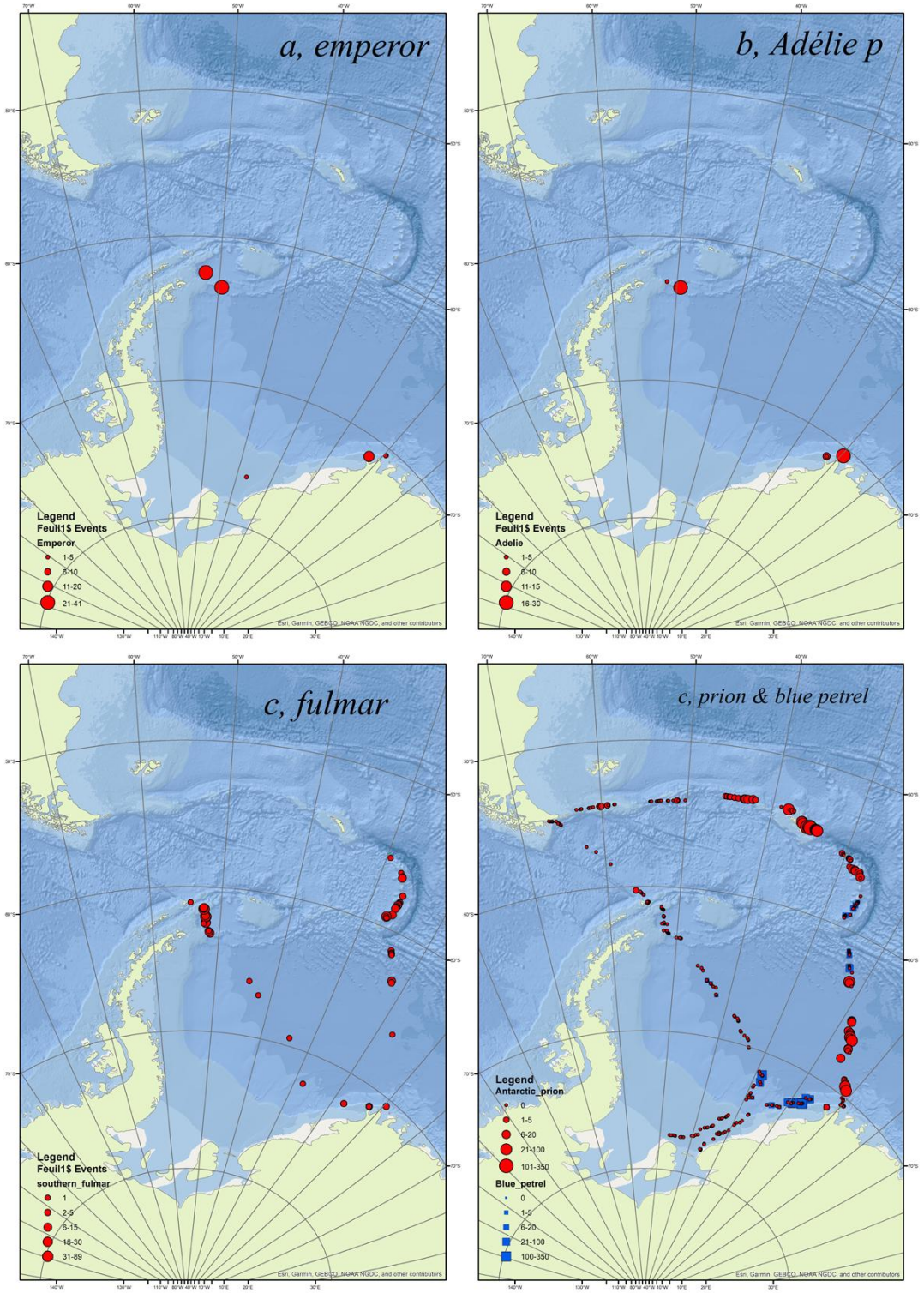
* zones: see table 1

** mean per count, when more than 10 individuals in total

*** species name in brackets: not all individuals were identified at the species level.

Photo 2. Emperor penguins attracted by the stationary ship and by people on and around pack ice, out of effort thus.

Cetaceans exhibited a distribution similar to that of seabirds, with humpback encountered somewhat widely and fin whale in the north. Among pinnipeds, the most numerous were antarctic fur seal and crabeater and Weddell seals along the coast, resting on ice floes (Table 1; Figure 5).


a, emperor
Legend
Feuil1$ Events
Emperor
1-5
6-10
11-20
21-41
b, Adélie p
Legend
Feuil1$ Events
Adelie
1-5
6-10
11-15
16-30
c, fulmar
Legend
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southern_fulmar
1
2-5
6-15
16-30
31-89
c, prion & blue petrel
Legend
Antarctic_prion
0
1-5
6-20
21-100
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Blue_petrel
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Esri, Garmin, GEBCO, NOAA NGDC, and other contributors

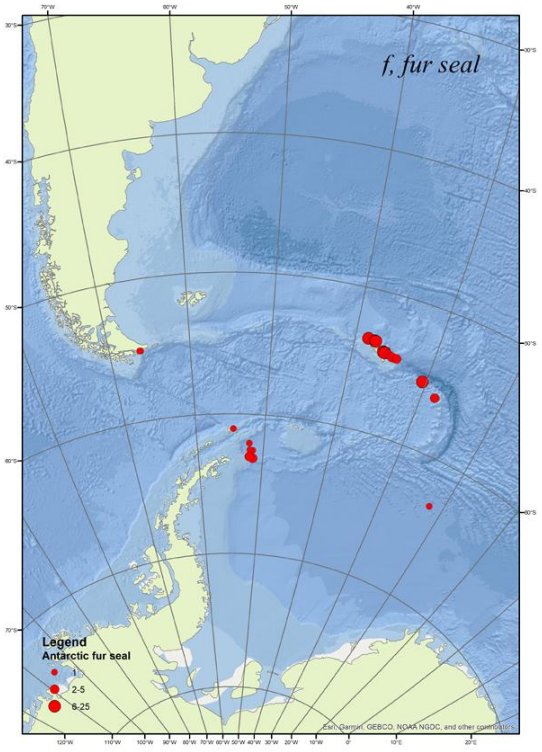

Figure 5. Detailed distribution of selected abundant species: emperor penguin (**a**), Adélie penguin (b), southern fulmar (c); giant petrel (d); blue petrel & prion (e); fur seal (f); numbers per count.

3.2. Comparison with Previous Expeditions in the Same Area

In comparison with previous expeditions of the same team in the same area, we used the data obtained in the Scotia Sea portion of this cruise and the Weddell Sea. The highest concentrations were, by far, observed around the S. Shetland Islands and Peninsula, with thousands of Adélie and chinstrap penguins, but also black-browed and grey-headed albatrosses, antarctic prions, or fur seal (Table 2).

Lower values for dolphins and penguins: possibly a seasonal effect, with the end of the breeding season and/or a different winter distribution, even if the seasons were similar: March-April 2012 and 2013. Reproducibility of data collected on successive, identical routes is known to be low – by up to one order of magnitude [2-4]. This is related to the heterogeneity of the distributions: the "hotspots" detected in both antarctic and arctic seas reflect the heterogeneities in prey abundance [5] (synthesis in [6]). No gentoo penguins were encountered, while registered at high concentrations during the previous expeditions in the same area: 0.2 and 0.4 per count (see Table 2).

A broader discussion consists in comparing data collected elsewhere in the Antarctic seas by the same team and same methodology. Concerning the number of species, data are of the same order in the different areas, reflecting similar species diversities. Densities (individuals per count) vary: less seabirds in this area, similar densities for pinnipeds, higher for cetaceans (Table 3). Such differences are considered to reflect differences in food availability and thus bio-productivity (see also [2,7-10]).

Table 2. Seabirds and marine mammals counted along the transects to S Georgia (A), S Shetlands (B) and S Sandwich islands (C) by tis team, mean number per 30 min transect count.

Transect	A	B	C
Number of counts	333	365	143
Species			
gentoo penguin	0.50	0.65	-
Adélie penguin	10.6	-	0.34
chinstrap penguin	14.3	7.81	0.06
black-browed albatross	4.23	2.01	0.45
grey-headed albatross	20.1	0.14	0.04
antarctic fulmar	231	1.94	0.73
antarctic prion	30.7	27.0	11.1
white-chinned petrel	0.31	2.56	0.57
sooty shearwater	1.33	0.18	-
giant petrel	1.43	1.66	2.04
Wilson storm-petrel	0.48	0.93	1.98
pintado (Cape) petrel	5.54	0.09	1.22
black-bellied storm-petrel	4.82	2.16	0.31
∑ **birds**	**341**	**57**	**22**
antarctic fur-seal	0.34	4.45	0.77
∑ **pinnipeds**	**0.34**	**6.25**	**0.91**
Dolphin sp	0.71	0.26	0.03
humpback whale	0.01	0.11	0.13
fin whale	0.15	0.02	0.05
∑ **cetaceans**	**0.19**	**0.50**	**1.02**

A. Return transects to S Georgie and S Shetland isl [3]
B. Return transects to S Georgia and S Sandwich isl [1]
C. To S Georgia and S Sandwich isl, this study, partim

3.3. Comparison with Other Antarctic Seas

Table 3. Summary of the seabird and marine mammal at-sea distribution in Antarctic seas: main species.

		Seabirds		Pinnipeds		Cetaceans		
Area	Number of counts	Number of species	Mean nbr per count	Number of species	Mean nbr per count	Number of species	Mean nbrper count	References
Weddell Sea pack ice	291	24	180	6	6	3	0,1	[20]
Africa - Antarctica transects	1927	27	35	7	0,4	3	0,7	[3,4]
Amundsen & Bellingshausen seas	1000	15	8	4	2,3	5	0,2	[21]
off antarctic peninsula	100	25	40	3	7	3	0,5	Joiris, unpublished
S Georgia / S Sandwich transect	365	34	57	3	7	8	0,5	[21]
S Weddell Sea (northern area)	195	29	20	5	0,9	8	0,9	Joiris & D'Hert, this study
Mean		25.7	56,7	4,7	3,9	5	0,5	

4. Conclusion

The northern area, constituting Ushuaia to S. Georgia, S. Sandwich and S. Shetland Islands/ Peninsula (subantarctic Scotia Sea and Weddell Sea), corresponds to an area with local high densities of top predators [2,11-16] and prey availability [5,17]. The concentration of birds and mammals in the Scotia-Weddell Confluence, was already described [18,19].

Numbers of species was low, with highest numbers of individuals represented by few species. The distribution of seabirds, seals and to some extend cetaceans were heterogeneous and were mainly observed above shallow areas along the coasts, corresponding to the continental slope of the islands and the continent: this is consistent with these areas generally characterized by high prey availability. The southern Weddell Sea, almost unexplored, showed in contrast very low densities in open water, among the lowest of the Antarctic seas, even if partially over-estimated by the presence of long-distance followers in low numbers, registered once per count.

Contributions

Claude R. Joiris on board and basic redaction; Diederik D'Hert maps. Data set available by Claude R. Joiris

Funding

No external funding

Conflicts of Interest

The authors don't have any conflicts of interest.

Acknowledgments

We are grateful to D. Ainley, J.-M. Valette and two anonymous reviewers who helped improve a first version of this manuscript.

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