# THE MARINE BIODIVERSITY OF THE POLAR SEAS IN FISHBASE AND SEALIFEBASE*

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## Abstract

The polar seas are generally ice-covered waters with highly seasonal weather conditions, temperature, formation and extent of sea ice. To date, more than 8,000 marine species are estimated to occur in these waters (5,782 – Arctic; >8,200 – Antarctic). A collaboration with the Alfred-Wegener-Institut resulted in a preliminary list of marine species in the polar seas (7,710 species), collated from published documentation and made available via FishBase and SeaLifeBase. This list includes 533 species of bony fishes, 10 sharks, 17 rays, 208 vertebrates (whales, dolphins and sea birds), and at least 6,816 invertebrates and 114 plant species. This report includes the polar sea species list, their marine ecoregions, and an overview of available data on ecology, life history, and population dynamics.

## Introduction

The polar seas are divided between the northern (Arctic) and southern (Antarctic) hemispheres. The Arctic, defined as latitudes from 66.5° of the equator, from the high Arctic to the sub Arctic parts of Canada, Greenland and Faroe Islands, Finland, Iceland, Norway, Russia, Sweden, and the United States, including associated marine areas (AMAP 2018), covering an area of about 14 million km$_2$ in winter and 7 million km$_2$ in summer (Thomas and Dieckmann 2010). The Antarctic "*extends south of the Polar Front to the coasts of the Antarctic continent*" with a total area of ~34.8 million km$_2$ (Griffiths 2010). These areas have a variety of habitats for marine species such as sea ice, hot vents, colds seeps, and continental shelves that can reach depths of more than 5,000 m (Griffiths 2010; Michel 2013). The threats facing the Arctic and Antartic are numerous (Bennet et al. 2015) and to meet them, a good knowledge of their biodiversity is essential.

A project that aims to improve the coverage of the marine biodiversity of the polar seas in FishBase and SeaLifeBase was initiated through funding from the Alfred-Wegener-Institut (AWI). An inventory of available information on marine species in the polar seas was started in January 2018. This document reports on the progress of this project for the period January 2018-September 2019, with work highlights for the third quarter of 2019.

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## Materials and Methods

Data were acquired from an extensive repository of scientific literature notably from *Antarctic Science*, *Journal of Ichthyology*, *Polar Biology*, Google Scholar, Google Books, and Web of Science were searched using keywords such as "polar sea", "polar marine biodiversity", "Arctic", and "Antarctic" among others. References were also searched and grouped based on the composition of the circumpolar Arctic (i.e., Arctic General, Barents Sea, Beaufort Sea, Chukchi Sea, East Siberian Sea, Greenland Sea, Iceland Sea, Kara Sea, Laptev Sea, Northern Bering Sea, Norwegian Sea, Northwest Atlantic-Greenland, and White Sea), and the Antarctic. As of September 2019, about 765 references were provided by partners (e.g., Dr Todd Miller from NOAA, Dr Thomas Brey from AWI, Dr Wolf Arntz, FishBase and SeaLifeBase teams) on distribution, trophic ecology, abundance, life history, trophic ecology, and reproduction of species occurring in the polar seas.

Taxonomic data were validated against the World Register of Marine Species (WoRMs; www.marinespecies.org) and Catalogue of Life (CoL; www.catalogueoflife.org). Specific data on non-fish species were extracted and encoded into SeaLifeBase (www.sealifebase.org), a FishBase-like global biodiversity database on marine metazoans (except fish) of the world, while specific data on fish species were encoded in FishBase (www.fishbase.org), the global biodiversity information system on fishes of the world. These two global information systems work hand in hand to provide comprehensive data coverage on polar species for which data can be obtained.

## Results and Discussion

A total of 975 references were used in FishBase (n=151) and SeaLifeBase (n=824) to assign fish and other marine metazoans to the polar seas. Figure 1 summarizes the types of references used with mainly 50%-59% from peer-reviewed journals; 46% of the references for fish came from book and book chapters, while the other sources for non-fish were from reports (13%), internet sources (11%), book/book chapters (11%), and the remaining (6%) from theses, database, compilations, and proceedings. This indicates the availability of references based on relevance on the World Wide Web, i.e., books for fishes, and journals for non-fish species. Eight references composed of regional checklists and books accounted for 75% of the 573 fish species recorded in FishBase, i.e., Andriyashev et al. (1995; 38%), Coad (2018; 32%), Miller (1993; 32%), Neilsen et al. (1992; 26%), Coad (1995; 24%), Quast et al. (1972; 21%) and Robins et al. (1991; 18%) covering more than 100 species per reference. Other references covered 10 to 100 fish species (30%), and the rest covered less than 10 species (65%). In SeaLifeBase, 95% of the 6,449 metazoan (non-fish) species were accounted for by three online databases validated by experts, i.e., Bisby et al. (2005; 55%), WoRMs (40%), and Rosenberg (2009; 18%), suggesting a good taxonomic quality of our compilation. Geographic validation was accounted for by references covering 10 to 920 species (241 references), and the rest with only 1-9 species per reference (580 references).

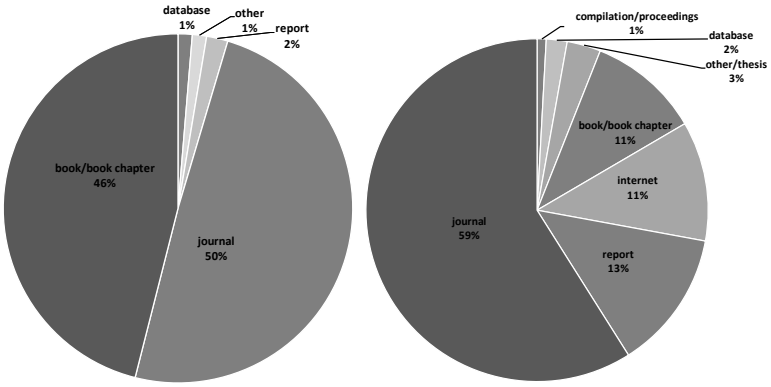



**Figure 1**. Left panel: Types of references (n=151) so far used in FishBase (for fish species; n=572) to assign species to the polar seas. Right panel: Types of references used (n=824) in SeaLifeBase (for non-fish metazoans; n=7138) to assign species to the polar seas. Data from September 2019 versions of FishBase (www.fishbase.org) and SeaLifeBase (www.sealifebase.org).

These statistics include the work done for the ongoing effort which started in January 2018 with an initial count of 6,105 marine species (fish–522; non-fish–5,583) assigned to the Polar Regions, using 697 references. Figure 2 shows the current status of references done and being processed from the pool of literature provided by partners (765 references). As of September 2019, 20% (79 SeaLifeBase; 74 FishBase; 1 Both) were fully exhausted, 7% (41 SeaLifeBase; 6 FishBase; 4 Both) ongoing (i.e., used for distribution but processing is ongoing for other information, i.e., ecology, abundance, life history, and population dynamics), and the remaining 73% (210 SeaLifeBase; 343 FishBase; 8 Both) are still to be processed (see Appendix A for the detailed count of references per topic in each area).

In 21 months of encoding, 1,555 non-fish marine metazoans were added to SeaLifeBase, while 50 fish species were added to FishBase, which increased FishBase and SeaLifeBase coverage to 7,710 marine species (fish–572; non-fish–7,138) assigned to the polar seas and thus available for species list queries[1]. Based on estimates from the literature, Acanthocephala (23), Chaetognatha (23), and Ctenophora (16), Foraminifera (252), Gastrotricha (8), Hemichordata (10), Mollusca (1,715), Platyhelminthes (132), Sipuncula (21) probably have the most complete coverage in SeaLifeBase (Figure 3). Polar sea fish species coverage (Pisces–572) in FishBase are nearly complete (Figure 3). Other taxonomic groups are largely incomplete, while some do not have available estimates.

There are also 36 marine ecoregions in the polar seas, and through this work, a total of 5,615 marine species (fish–243; non-fish–5372) were assigned to these ecoregions (see Appendix B).

This project increased the data coverage of both databases, see Table 1.

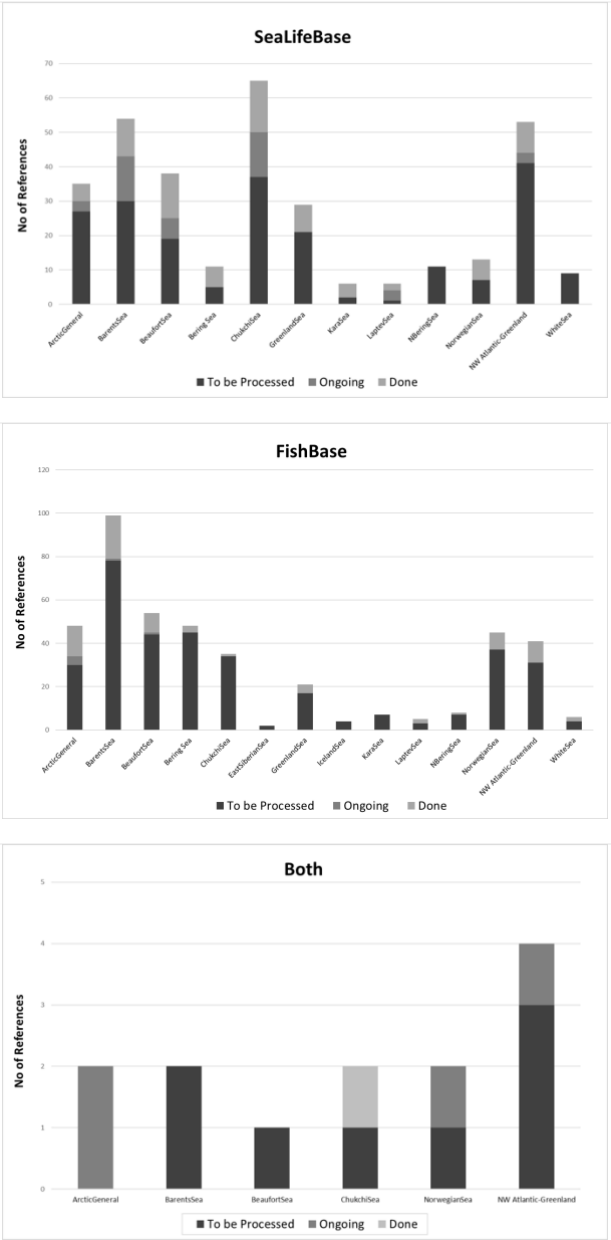
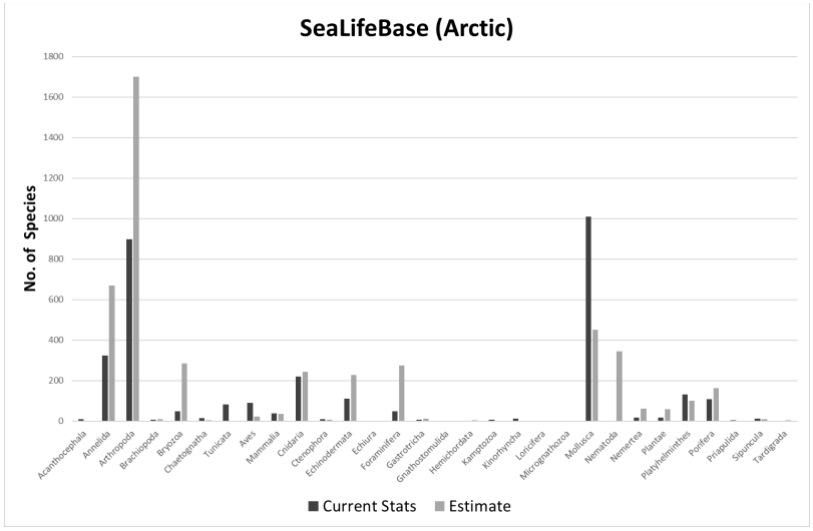
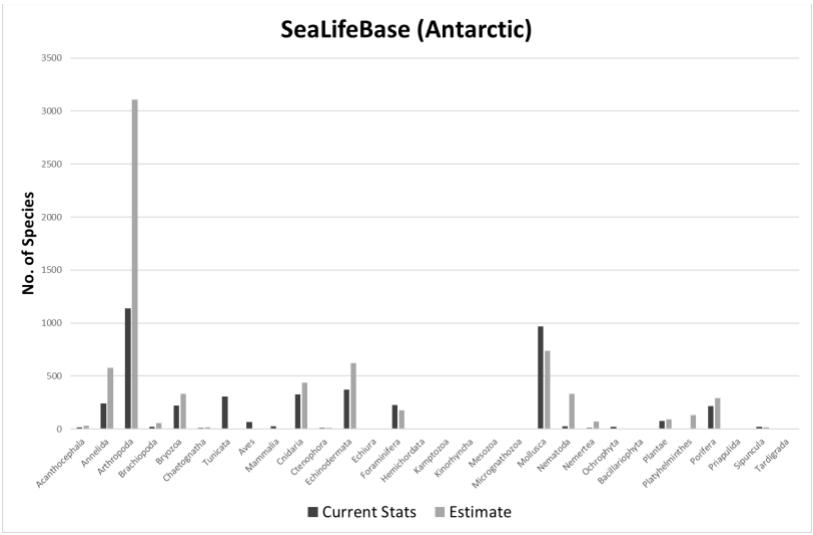



**Figure 2**. Status of references (n=765) provided by partners that were used in SeaLifeBase (upper panel, n=330); FishBase (middle panel, n=423) in both databases (lower panel, n=13) as of September 2019.

1 List of species by ecosystem: 1) Antarctica: fishes (https://fishbase.ca/trophiceco/FishEcoList.php?ve_code=259), other vertebrates and invertebrates (https://www.sealifebase.ca/TrophicEco/FishEcoList.php?ve_code=259); 2) Arctic: fishes (https://fishbase.ca/trophiceco/FishEcoList.php?ve_code=1205), other vertebrates and invertebrates (https://www.sealifebase.ca/TrophicEco/FishEcoList.php?ve_code=1205); 3) All other species list queries by marine ecoregion is also available on Fishbase (https://fishbase.ca) and SeaLifeBase (https://www.sealifebase.ca).



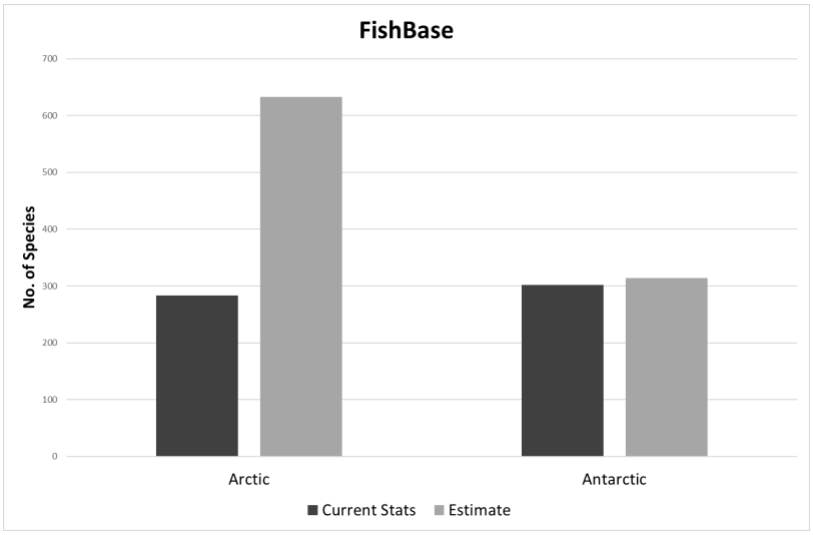




**Figure 3**. Number of species assigned to the Arctic (upper panel) and the Antarctic (middle panel) in SeaLifeBase and in FishBase (lower panel) compared with their publication estimates by species group as of September 2019.

## Third Quarter of 2019 Highlights

Aside from the continuous encoding of data from references provided by our partners, during the third quarter of 2019, focus was given to increasing common names for polar species in FishBase and SeaLifebase. Here are the details of the 2019 third quarter outputs:

1) Data on polar seas species common names increased by 4%, 326 records for 226 species using 18 references in SeaLifeBase and 17%, 167 records for 135 species using 4 references in FishBase. At present, the total count of common names for polar seas species in both databases is 9,881 (SLB–8,738 common names for 1,846 species; FB–1,143 common names for 521 species). Additional common names will be provided by our collaborator Todd Miller from NOAA. He is currently corresponding with collaborators for common names in Russian and from native (First Nation) people in the Arctic. This will be incorporated into the database in the 4th quarter report.
2) During the reporting period, the following were performed under AquaMaps:
   - Occurrence point data for non-fish species were received from GBIF; processing of occurrence cells in preparation for computing species environmental envelopes (HSPEN) for non-fishes completed; generation of probabilities of species occurrence (HSPEC) and mapped data completed. Implementation/uploading of latest maps in aquamaps.org on-going.
   - Evaluation ongoing for (1) inclusion of dissolved oxygen (bottom layer) as additional predictor of distribution for deep water species ongoing; (2) effect of observed/real dataset (Bio-ORACLE) on current/present distribution; and (3) holes in species richness maps in polar and gyre regions (current/2050). Collaborated with AWI on algorithm to detect faulty maps. These will be among the priorities for the upcoming map review and editing process, along with maps for crucial species groups (e.g., corals, highly commercial species), and species that are potential winners and losers due to climate change by year 2050.

**Table 1.** Data available for polar sea species in FishBase (www.fishbase.org) and SeaLifeBase (www.sealifebase.org) as of September 2019.

| Data | FishBase (572 sp) | SeaLifeBase (7138 sp) |
|---|---|---|
| Ecology | 422 records | 6942 records |
| Depth Range | 544 records | 3801 records |
| Distribution | 728 records | 7168 records |
| Reproduction | 241 records | 5939 records |
| Growth | 1211 records for 156 species | 1433 records for 186 species |
| Max Lengths | 721 records for 249 species | 682 records for 364 species |
| Food Items | 7104 records for 359 species | 7488 records for 519 species |
| Diet | 1031 records for 164 species | 414 records for 106 species |
| Abundance | 429 records for 124 species | 2838ords for 140 species |

3) With respect to item 1 of the contract (Provision of FishBase/SeaLifeBase/AquaMaps data through their web-based interfaces and through a mirror server at AWI web portals; notably at the Helmholtz Institute for Functional Marine Biodiversity at the University Oldenburg or HIMFB web portal, in the context of knowledge transfer to the public), this is no longer pursued as per meeting of Thomas Brey with Nina Garilao in November 2018. The AWI IT department is not yet amenable to hosting any of the mirrors. Dr. Brey received for HIFMB the physical copies of the FishBase and SeaLifeBase mirrors that are now in the August 2019 version. This is the third update for the year, the others were done in February and April.

## Conclusion and Recommendations

The results presented here indicate good progress in increasing the coverage of Polar species in FishBase and SeaLifeBase. We are keeping abreast with new literature focusing on the region using Google Alerts for new publications. The challenge is to keep up with the encoding pace as new information becomes available to assure their inclusion in FishBase and SeaLifeBase updates, notably for newly described species or revisions of known taxonomic groups, which may require the splitting of or combination of data for species undergoing such revisions. This affects the species count for polar seas as well as lists of species by taxonomic group, by country, and by ecosystems.

We note some data processing challenges when information provided by partners do not match the FishBase and SeaLifeBase database conventions (e.g., growth and length-weight data which need further processing). Some of these data may not be usable, and thus, require further data mining, e.g., for life traits. As for species assignment in marine ecoregions, a process was developed and in execution to ensure that all polar seas species are assigned to their corresponding marine ecoregion.

Finally, partnership with institutions that may have biodiversity data, and/or additional information that can contribute towards the completion of key data for the polar seas is actively pursued, with the help of current partners.

## Acknowledgements

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World Register of Marine Species (WoRMs) (2050) http://www.marinespecies.org/index.php

**Appendix A**. Number of references available per ecosystem in the polar seas per topic. Diet, growth, and reproduction (some numbers pertaining to "ongoing" studies were omitted).

SEALIFEBASE

| Ecosystem | Dist_abun_size_freq | | | Diet studies | | Growth | | Reproduction | |
|---|---|---|---|---|---|---|---|---|---|
| | Total Refs | Ongoing | Done | Total Refs | Done | Total Refs | Done | Total Refs | Done |
| Arctic General | 31 | 2 | 4 | 1 | 1 | | | | |
| Barents Sea | 44 | 11 | 6 | 6 | 4 | 3 | 1 | 1 | |
| Beaufort Sea | 24 | 6 | 4 | 8 | 5 | 6 | 2 | | |
| Bering Sea | 4 | | | 7 | 5 | | | | |
| Chukchi Sea | 48 | 12 | 4 | 13 | 4 | 3 | 1 | 1 | 1 |
| East Siberian Sea | | | | | | | | | |
| Greenland Sea | 19 | | | 3 | 2 | 6 | 1 | 1 | 1 |
| Iceland Sea | | | | | | | | | |
| Kara Sea | 7 | 4 | | | | | | | |
| Laptev Sea | 6 | 3 | 2 | | | | | | |
| NBering Sea | 9 | | | 2 | | | | | |
| Norwegian Sea | 7 | | | 2 | 2 | 3 | 3 | 1 | 1 |
| NW Atlantic-Greenland | 32 | | 2 | 14 | 6 | 6 | | 1 | 1 |
| White Sea | 9 | | | | | | | | |
| SLB | 240 | 38 | 22 | 56 | 29 | 24 | 8 | 3 | 4 |

FISHBASE

| Ecosystem | Dist_abun_size_freq | | | Diet studies | | Growth | | Reproduction | |
|---|---|---|---|---|---|---|---|---|---|
| | Total Refs | Ongoing | Done | Total Refs | Done | Total Refs | Done | Total Refs | Done |
| Arctic General | 34 | 4 | 9 | 2 | | 4 | 2 | 8 | 2 |
| Barents Sea | 50 | 1 | 11 | 20 | 2 | 14 | 2 | 15 | 5 |
| Beaufort Sea | 31 | 1 | 3 | 13 | 4 | 8 | 1 | 2 | 1 |
| Bering Sea | 18 | | 2 | 10 | | 18 | | 2 | 2 |
| Chukchi Sea | 26 | | | 6 | 1 | 3 | | | |
| East Siberian Sea | 2 | | | | | | | | |
| Greenland Sea | 11 | | 1 | 7 | | | | 3 | 3 |
| Iceland Sea | 4 | | | | | | | | |
| Kara Sea | 4 | | | 2 | | 1 | | | |
| Laptev Sea | 3 | | | | | 2 | 2 | | |
| NBering Sea | 5 | | | 2 | | 1 | 1 | 1 | 1 |
| Norwegian Sea | 12 | | | 8 | | 16 | 2 | 10 | 6 |
| NW Atlantic-Greenland | 17 | | 3 | 11 | | 8 | 2 | 6 | 6 |
| White Sea | 5 | 1 | 1 | | | 1 | 1 | | |
| | 222 | 7 | 30 | 81 | 7 | 76 | 13 | 47 | 26 |

**Appendix B.** Number of species assigned to each marine ecoregion in the polar seas based on September 2019 versions of FishBase (www.fishbase.org) and SeaLifeBase (www.sealifebase.org).

| Marine Ecoregions | FishBase | SeaLifeBase |
|---|---|---|
| Amundsen/Bellingshausen Sea | 1 | 72 |
| Antarctic Peninsula | 1 | 90 |
| Baffin Bay - Davis Strait | 123 | 824 |
| Beaufort Sea - continental coast and shelf | | 907 |
| Beaufort-Amundsen-Viscount Melville-Queen Maud | | 15 |
| Bouvet Island | | 136 |
| Chukchi Sea | 35 | 619 |
| Crozet Islands | | 379 |
| East Antarctic Dronning Maud Land | | 23 |
| East Antarctic Enderby Land | | 54 |
| East Antarctic Wilkes Land | | 108 |
| East Greenland Shelf | 3 | 106 |
| East Siberian Sea | 39 | 94 |
| Heard and Macdonald Islands | | 276 |
| High Arctic Archipelago | | 21 |
| Hudson Complex | | 108 |
| Kara Sea | 35 | 158 |
| Kerguelen Islands | | 1624 |
| Lancaster Sound | | 11 |
| Laptev Sea | 44 | 485 |
| North and East Barents Sea | | 798 |
| North and East Iceland | | 31 |
| North Greenland | | 465 |
| Northern Labrador | | 11 |
| Northern Norway and Finnmark | | 118 |
| Peter the First Island | | 18 |
| Prince Edward Islands | | 238 |
| Ross Sea | 5 | 37 |
| South and West Iceland | | 45 |
| South Georgia | 2 | 481 |
| South Orkney Islands | | 823 |
| South Sandwich Islands | | 352 |
| South Shetland Islands | 2 | 672 |
| Weddell Sea | 50 | 625 |
| West Greenland Shelf | 3 | 124 |
| White Sea | 10 | 171 |