CCAMLR

Commission for the Conservation of Antarctic Marine Living Resources
Commission pour la conservation de la faune et la flore marines de l'Antarctique
Комиссия по сохранению морских живых ресурсов Антарктики
Comisión para la Conservación de los Recursos Vivos Marinos Antárticos

WG-EMM-2022/15

19 June 2022

Original: English

WG-EMM

Icefish spawning aggregation in the southern Weddell Sea

K. Teschke, R. Konijnenberg, S. Hain, P. Brtnik and T. Brey

EN

Icefish spawning aggregation in the southern Weddell Sea

K. Teschke, R. Konijnenberg, S. Hain, P. Brtnik, and T. Brey

Background

During the Continental Shelf Multidisciplinary Flux Study (COSMUS) expedition from February to March 2021 aboard RV *Polarstern* (expedition ID: PS124) (Hellmer & Holtappels, 2021), a large spawning aggregation of notothenioid icefish (*Neopagetopsis ionah*, Nybelin 1947) was discovered in the southern Weddell Sea. The CCAMLR community was informed of this discovery by Germany in COMM CIRC 22/10 and SC CIRC 22/08 earlier this year (17 January 2022). Purser et al. (2022) report on the spawning aggregation in *Current Biology*.

Here we provide detailed information on the active fish nest aggregation and on additional icefish nesting sites observed in the Filchner Trough area (Knust & Schröder, 2014; Schröder, 2016; Riginella et al., 2021; Purser et al., 2022; Purser et al., in review).

Data

All seabed photographs and acoustic data collected during the RV *Polarstern* cruise PS124 using the Ocean Floor Observation and Bathymetry System (OFOBS) are available via the PANGAEA data repository (Purser et al., in review). The full specifications of the OFOBS can be found in Purser et al. (2019).

There are two PANGAEA umbrella links: one for all seabed images taken in the area of the active fish nest aggregation (Purser et al., 2021a; https://doi.pangaea.de/10.1594/PANGAEA.932827), and one for images of additional survey sites nearby in the southern Weddell Sea (Purser et al., 2021b; https://doi.pangaea.de/10.1594/PANGAEA.936205). The PANGAEA link for each individual OFOBS deployment is given under "Dataset listed in this publication series" at the end of the respective website. Acoustic data for all deployments can also be obtained from PANGAEA, with the raw side scan data available at: https://doi.pangaea.de/10.1594/PANGAEA.939322 (Hehemann et al., 2021a) and the forward facing acoustic camera data at: https://doi.pangaea.de/10.1594/PANGAEA.939341 (Purser et al., 2021c). In addition, seafloor topographic maps derived from the side scan sonar data are available at: https://doi.pangaea.de/10.1594/PANGAEA.939087 (Hehemann et al., 2021b).

Findings

The PS124 OFOBS survey sites with observations of active fish nests were located in the southern Weddell Sea near the Filchner Trough (see Figure 1). In total, four towed OFOBS surveys were conducted here where still images were taken every 20 seconds: the initial discovery of the spawning aggregation was made during dive PS124_21-7, and another three dives were then used to characterise and quantify the fish nests over an area of 45,614 m² (PS124_63-1, 67-1, 101-1) (Table 1). A total of 2,608 still images (taken by a high-resolution photo camera) for this area were analysed. Of the total 16,160 nests counted therein, 12,020 nests (74%) were actively used, i.e. contained either a fish and eggs or just eggs without the presence of a nesting fish. The total abundance of active fish nests was 0.26 nests/m². In nests containing eggs, an average of 1,735 eggs (standard deviation = +/- 433) were present.

The three dives conducted for the purpose of nest quantification cut across an area of 240 km². This area has a homogeneous environmental envelope in terms of bottom temperature (modified Warm Deep Water), depth, and topographic features such as slope, angle, and aspect. Based on this, Purser et al. (2022) considered it likely that these 240 km² of southern Weddell Sea seafloor are colonised by actively nesting fish at densities comparable to those observed directly along the crosscutting OFOBS transects. This resulted in an estimate of approx. 60 million active nests and an associated fish biomass of > 60,000 tonnes for across 240-km² area.

Table 1: Summary of OFOBS deployments made during PS124 within the *Neopagetopsis ionah* spawning aggregation. Date and start and end position coordinates are given, in addition to the number of still images analyzed for each deployment. Seabed images taken in the area of the active fish nest aggregation are available at: https://doi.pangaea.de/10.1594/PANGAEA.932827.

Station ID	Date	Lat Start	Long Start	Lat End	Long End	Depth (m)	n images analyed	Total area (m²)
PS124_63-1	27.02.2021	74°50.909'S	030°56.969'W	74°53.412'S	030°30.966'W	534-477	899	17,800
PS124_67-1	27.02.2021	74°43.837'S	031°24.087'W	74°51.513'S	030°26.118'W	588-468	1,248	19,729
PS124_101-1	11.03.2021	74°53.368'S	030°45.606'W	74°51.349'S	030°41.046'W	509-497	461	80,85
TOTAL							2,608	45,614

During the three OFOBS deployments, a flight height of 3 - 4m above the seabed was maintained.
The area covered per image was generally > 10 m² and < 30 m².

Several additional OFOBS dives were conducted within the Filchner Trough area, most of them at depths comparable to the active nesting area but at distances of up to 300 km (Figure 2). These surveys were made across the Filchner Trough sill to the west, the flat Filchner Shelf plateau to the west and the east, southward along the Trough's eastern slope, and on the continental slope north-west of the Filchner Trough (Figure 2). Similarly high densities of fish nests, though all inactive, were observed during three of these survey transects (stations 26-7, 30-7, 72-8). Occasional nests were also detected at Station 54-1 and 37-6. In addition, at Station 8-1, 16-8, 78-8, and 107-5 fish nest structures seemed to be present on the seafloor occasionally, though these could not be properly identified from the camera data. No *N. ionah* nests were imaged during any other OFOBS deployments conducted during research expedition PS124 elsewhere in the southern Weddell Sea.

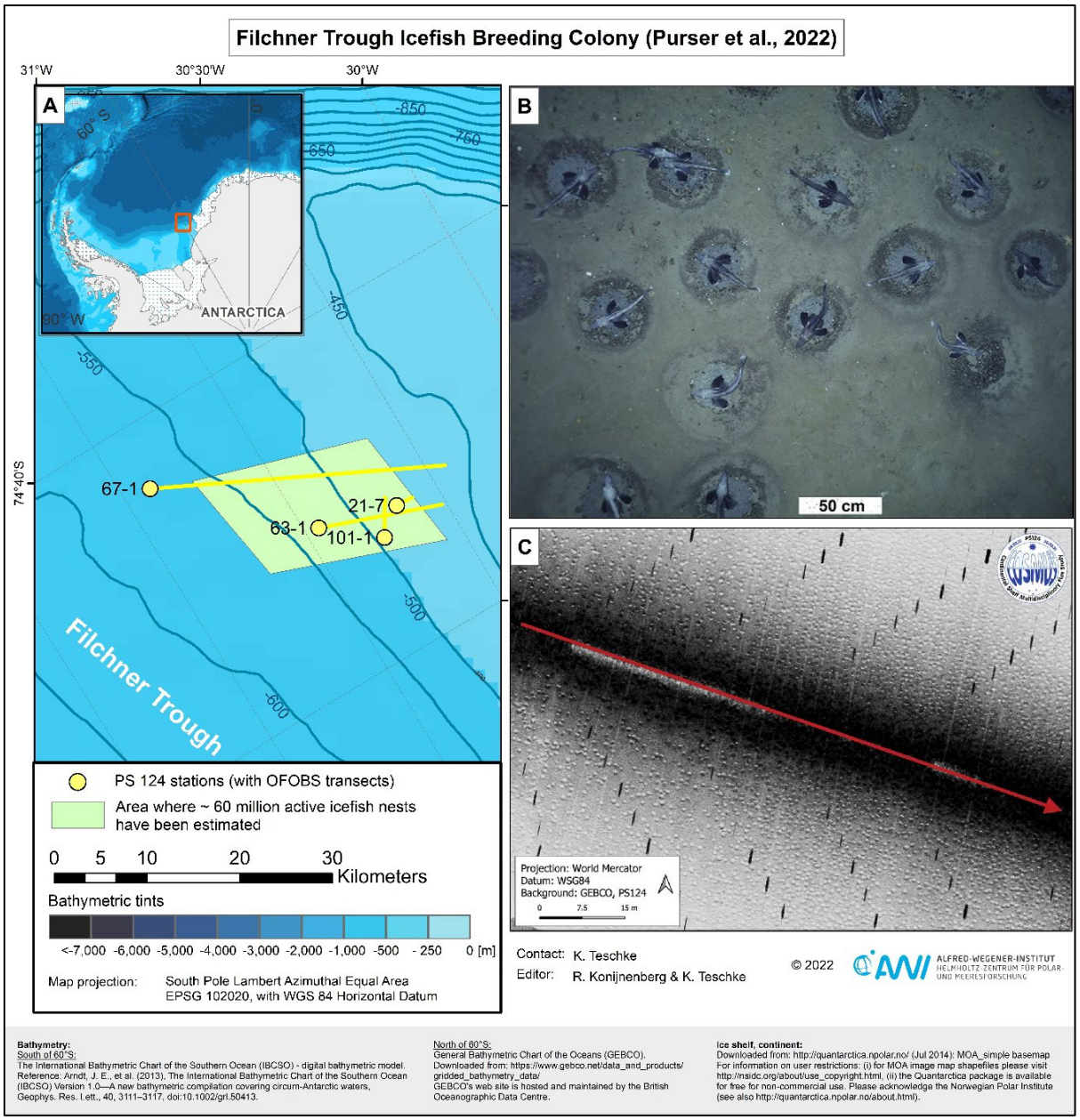

Figure 1: (A) Study site in the Filchner Trough area, southern Weddell Sea (overview map), and the area (green box) within which the *Neopagetopsis ionah* spawning aggregation was observed at an average density of 0.26 active fish nests/m²; (B) Dense array of active fish nests; (C) High frequency side scan sonar data; the seafloor is wholly covered with actively nesting ice fish. The images (B, C) were downloaded from Purser et al. (2022). All seabed images and acoustic data taken in the area of the active fish nest aggregation are available from PANGAEA (Purser et al., 2021a; Hehemann et al., 2021a; Purser et al., 2021c).

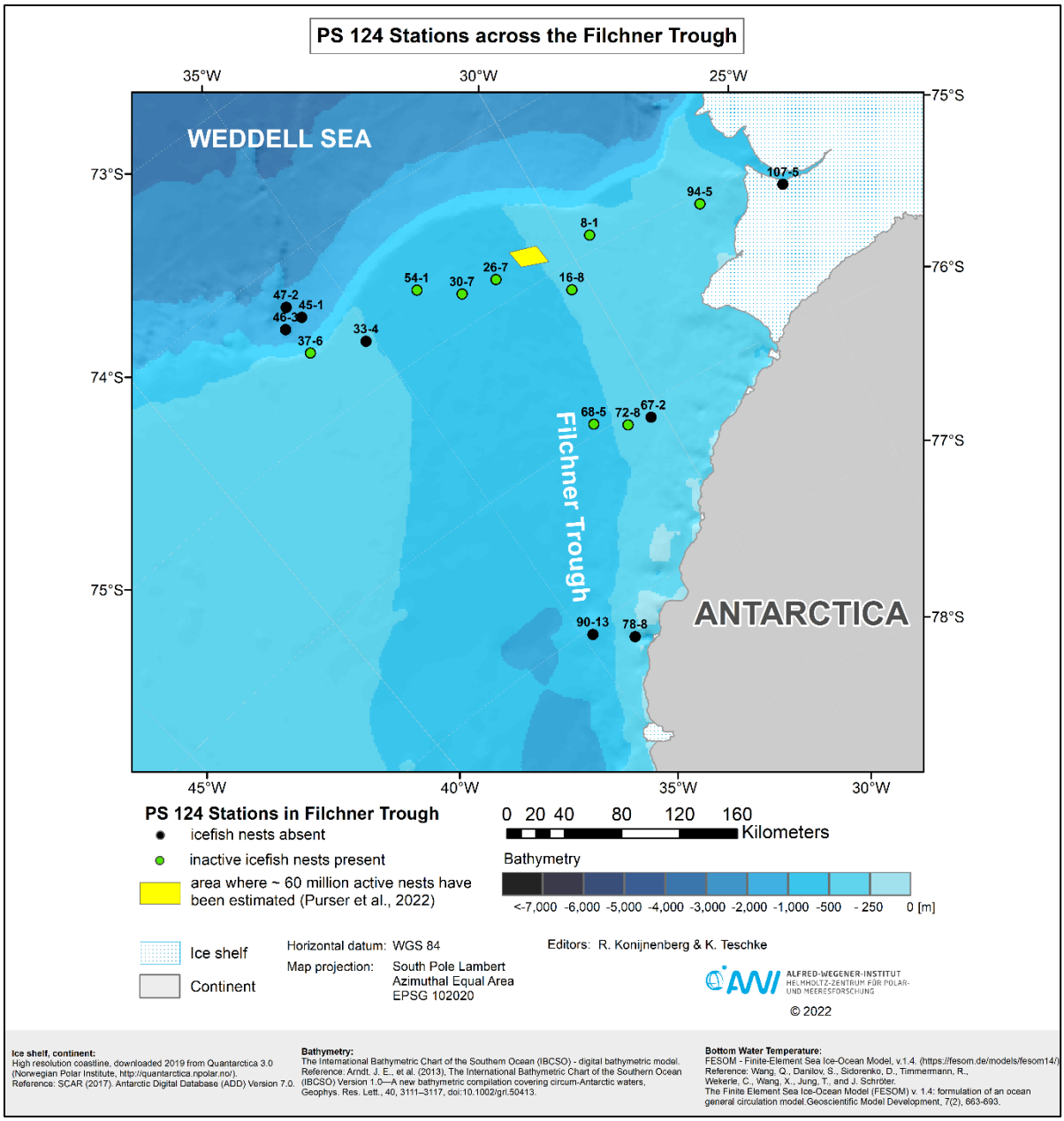

Figure 2: PS124 stations in the Filchner Trough area (southern Weddell Sea) where icefish nests were investigated using Ocean Floor Observation and Bathymetry System (OFOBS) deployments. All seabed images and acoustic data collected at these stations are available through PANGAEA (Purser et al., 2021a, b; Hehemann et al., 2021a; Purser et al., 2021c).

Additional evidence for active and inactive icefish nests had been recorded in the Filchner Trough area during previous expeditions (RV *Polarstern* PS82 and PS96) to the area during the austral summer (see Figure 3) (Knust & Schröder, 2014; Schröder, 2016; Riginella et al., 2021). Even though these studies did not investigate the spatial extent of the nests, the fact that icefish nesting sites were observed in successive years indicate that the Filchner Trough area appears to be a suitable habitat for icefish spawning.

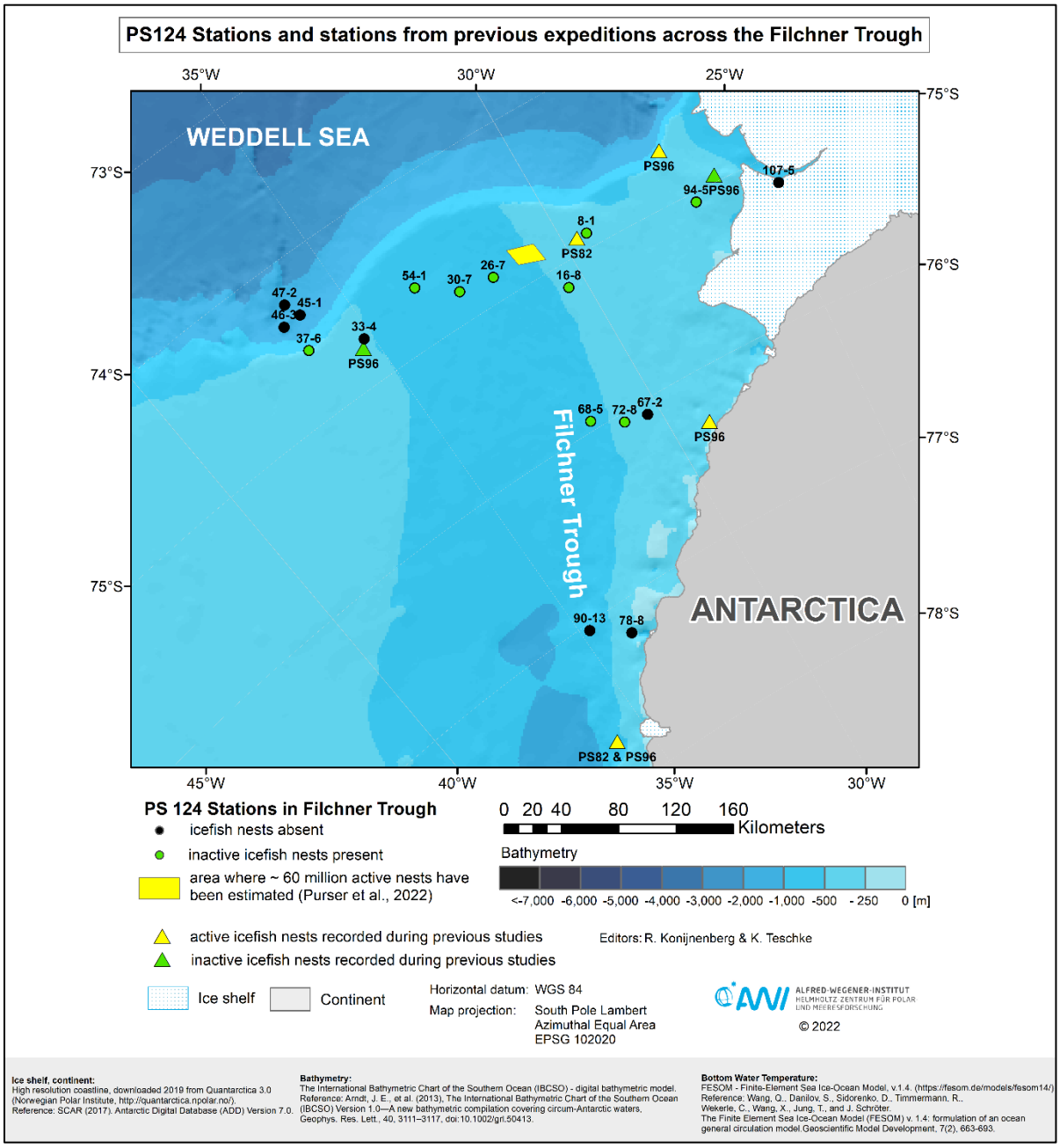

Figure 3: PS124 stations where icefish nests had been investigated and stations from previous expeditions (PS82 and PS96) where icefish nests had been found in the Filchner Trough area (southern Weddell Sea). All seabed images and acoustic data taken by Ocean Floor Observation and Bathymetry System (OFOBS) deployments at PS124 stations are available through PANGAEA (Purser et al., 2021a, b; Hehemann et al., 2021a; Purser et al., 2021c). Data from PS82 derived from Knust & Schröder (2014); all seabed images taken by Ocean Floor Observation System (OFOS) deployments during PS96 are available from PANGAEA (Piepenburg, 2016).

Recommendations

Continuing fieldwork

During research expedition PS124, a mooring ("WetCam-Fish", equipped with two still cameras, a CTD and a current meter), was deployed in the location 74°51.663'S, 30°48.539'W at 500-m depth in an area of particularly high active nest abundance (1.47 active nests m²) (Hellmer & Holtappels, 2021) to observe the ecology in the nesting site area over the subsequent two years. Important questions to be addressed with the "WetCam-Fish" are e.g.: (1) How often do icefish build individual nests? (2) Are nests reused in successive seasons? (3) How do adult fish behave prior to and post-hatching; do they remain with the eggs throughout the nesting cycle or forage? (4) What role and techniques are employed by predators and egg-eating fauna? (5) How is mating and spawning conducted? (Purser et al., 2022).

Future research expeditions are recommended to (i) delineate the overall spatial extent of the *N. ionah* spawning aggregation in the Filchner Trough area, (ii) further assess the environmental parameters that determine the most suitable habitat for *N. ionah* nesting, and (iii) better understand the local and potentially regional importance of this icefish nesting "metropole" for the species, surrounding ecosystems and other species (see Purser et al., 2022).

Modelling

In addition to fieldwork, we recommend a modelling approach be developed to identify suitable habitat and environmental conditions that could support nesting sites for *N. ionah* and potentially other icefish species. This habitat suitability model could then be used to identify likely areas for nesting locations in other areas.

Protection of icefish nesting areas

The extraordinary and globally unprecedented spawning colony of *N. ionah* icefish in the southern Weddell Sea might only be one example of other icefish nesting areas still to be discovered in other parts of the circum-Antarctic shelf and slope. In order to protect those important areas, we propose icefish nesting areas are to be protected through a general CCAMLR protection mechanism either by:

(i) amendments to a suitable and already existing CCAMLR Conservation Measure to include the protection of icefish nesting areas; or
(ii) the development of a new, specific Conservation Measure to protect icefish nesting areas.

The adoption and implementation of such a revised or new CM would recognize the commitment made by Members to implement the CCAMLR precautionary and ecosystem approach to fisheries management.

References

CCAMLR, Conservation Measure 22-09 (2012). Protection of registered vulnerable marine ecosystems in subareas, divisions, small-scale research units, or management areas open to bottom fishing, CCAMLR, Hobart, Australia, https://cm.ccamlr.org/sites/default/files/22-09_6.pdf.

CCAMLR-40/20 Rev. 1 (2021). Draft Conservation Measure establishing a Marine Protected Area across the Weddell Sea region. Delegations of the European Union and its Member States, Norway, Uruguay, Australia, the United Kingdom, New Zealand, the USA, Republic of Korea, India and Ukraine. CCAMLR Meeting, Hobart, Australia, 18 to 29 Oct 2021.

COMM CIRC 22/10 and SC CIRC 22/08 (2022). Icefish in the Weddell Sea – information provided by Germany to all members of the Commission and the Scientific Committee. 17 January 2022

Hehemann, L., Purser, A., Boehringer, L., Werner, E., and Wenzhöfer, F. (2021a). Side scan sonar and swath bathymetry collected along OFOBS profiles during POLARSTERN cruise PS124, Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research, Bremerhaven, *PANGAEA*, https://doi.pangaea.de/10.1594/PANGAEA.939322

Hehemann, L., Boehringer, L., Purser, A., Werner, E., and Wenzhöfer, F. (2021b). Seafloor bathymetric maps derived from side scan data collected along OFOBS profiles during POLARSTERN cruise PS124 to the southern Weddell Sea, Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research, Bremerhaven, *PANGAEA*, https://doi.pangaea.de/10.1594/PANGAEA.939087

Hellmer, H.H. and Holtappels, M. (2021). The Expedition PS124 of the Research Vessel POLARSTERN to the southern Weddell Sea in 2021, https://doi.org/10.48433/BzPM_0755_2021

Knust, R. and Schröder, M. (2014). The Expedition PS82 of the Research Vessel POLARSTERN to the southern Weddell Sea in 2013/2014, http://doi.org/10.2312/BzPM_0680_2014

Piepenburg, D. (2016). Seabed photographs taken along OFOS profiles during POLARSTERN cruise PS96 (ANT-XXXI/2 FROSN). Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research, Bremerhaven, *PANGAEA*, https://doi.org/10.1594/PANGAEA.862097

Purser, A., Marcon, Y., Dreutter, S., Hoge, U., Sablotny, B., Hehemann, L., Lemburg, J., Dorschel, B., Biebow, H., and Boetius, A. (2019). Ocean Floor Observation and Bathymetry System (OFOBS): A New Towed Camera/Sonar System for Deep-Sea Habitat Surveys. IEEE Journal of Oceanic Engineering 44, 87-99

Purser, A., Boehringer, L., Hehemann, L., and Wenzhöfer, F. (2021a). Ocean Floor Observation and Bathymetry System (OFOBS) images of Neopagetopsis ionah ice fish nest arrays in the Filchner Trough, Antarctica collected during the PS124 Polarstern expedition, Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research, Bremerhaven, *PANGAEA*, https://doi.pangaea.de/10.1594/PANGAEA.936205

Purser, A., Hehemann, L., Boehringer, L., Werner, E., and Wenzhöfer, F. (2021b). Ocean Floor Observation and Bathymetry System (OFOBS) seafloor images of the Weddell Sea, Antarctica collected during the PS124 Polarstern expedition, Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research, Bremerhaven, *PANGAEA*, https://doi.pangaea.de/10.1594/PANGAEA.932827

Purser, A., Hehemann, L., Boehringer, L., Werner, E., and Wenzhöfer, F. (2021c). Forward facing acoustic camera seafloor sonar data from the southern Weddell Sea, collected during POLARSTERN cruise PS124, Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research, Bremerhaven, *PANGAEA*, https://doi.pangaea.de/10.1594/PANGAEA.939341

Purser, A., Hehemann, L., Boehringer, L., Tippenhauer, S., Wege, M., Bornemann, H., Pineda-Metz, S.E.A. et al. (2022). Icefish Metropole: Vast breeding colony discovered in the southern Weddell Sea. Current Biology, https://doi.org/10.1016/j.cub.2021.12.022

Purser, A., Hehemann, L., Boehringer, L., Werner, E., Pineda-Metz, S.E.A. et al. (in review). The COSMUS Expedition: Seafloor Images and acoustic bathymetric data from the PS124 expedition to

the southern Weddell Sea, Antarctica. Earth System Science Data Discussion [preprint], https://doi.org/10.5194/essd-2021-444, 2022

Riginella, E., Pineda-Metz, S.E.A., Gerdes, D., Koschnick, N., Böhmer, A., Biebow, H., Papetti, C., Mazzoldi, C. and La Mesa, M. (2021). Parental care and demography of a spawning population of the channichthyid *Neopagetopsis ionah*, Nybelin 1947 from the Weddell Sea, Polar Biology, https://doi.org/10.1007/s00300-021-02913-5

Schröder, M. (2016). The Expedition PS96 of the Research Vessel POLARSTERN to the southern Weddell Sea in 2015/2016, http://doi.org/10.2312/BzPM_0700_2016