ANTARCTIC KRILL AND ECOSYSTEM MONITORING SURVEY OFF THE SOUTH ORKNEY ISLANDS IN 2024

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Summary (English):

Environmental monitoring along 5 set transects off South Orkney Islands in the Southern Ocean have been carried out annually (since 2011) by the Institute of Marine Research, Norway. Hydro-acoustic as well as net derived data are used to calculate biomass of Antarctic krill (*Euphausia superba*) but also to assess spatial distribution and demographic composition of krill and other macrozooplankton and fish taxa. Systematic sighting data of cetaceans, penguins and pinnipeds are registered along the transects during daylight hours. Acquisition of data from the deployment of sensors that have been anchored to the seabed since previos year is also part of the procedyre. During this survey, trials were made to develop a method for extracting krill total body length frequency data by processing images from a custom build stereo camera that was attached inside the trawl. Using a custom-trained machine learning model, detection of krill segments shall be used to construct three-dimensional images that form the basis for the automated length measurements, and this will be validated against manually measured sub-samples of krill taken from each haul. The standard procedure for calculating biomass from acoustic data depends on input of representative length measurement variables from the same area and time period. This is part of a development process of automating krill biomass monitoring, which will form an important element of a data feedback management system regulating commercial fisheries. During this survey we also tested possibilities for satellite tagging whales in order to be able to study migration patterns and foraging behavior. Herein we report on the survey activities from 2024 and present preliminary results.

Summary (Norwegian):

Miljøovervaking langs fem linje-transekt ved Sør-Orknøyane i Sørishavet har blitt utført årleg sidan 2011 av Havforskingsinstituttet. Hydroakustiske data og data frå trålfangst blir brukte til å kalkulere biomasse av antarktisk kril (Euphausia superba) og for kartlegging av romleg fordeling og demografisk samansetjing av kril samt andre makrodyreplankton- og fiskearter. Systematiske observasjonsdata av kval, pingvinar og sel blir registrerte langs transekta. Innhenting av data frå utplasserte sensorar forankra til havbotnen er ein del av prosedyrane.

Under dette toktet blei det også gjennomført forsøk for å utvikle ein metode som bereknar kroppslengda av kril frå bilde tatt med eit spesialtilpassa stereokamera som blir festa inne i trålen. Ved hjelp av ein maskinlæringsmodell skal deteksjon av krilsegment brukast til å konstruere tredimensjonale bilde som dannar grunnlaget for dei automatiserte lengdemålingane, og dette vil bli validert mot manuelt målte delprøver av kril tatt frå kvart trålhal. Standard prosedyre for berekning av biomasse frå akustiske data avheng av input av representative lengdemålsvariablar frå same område og tidsperiode. Dette er ein del av ein utviklingsprosess for automatisering av krilbiomasseovervaking som vil utgjere eit viktig element i eit Feedback Management-system, som skal regulere det kommersielle fiskeriet. Vi testa også moglegheiter for satellittmerking av kval for å kunne studere migrasjonsmønster og beiteåtferd. Her rapporterer vi om undersøkingsaktivitetane frå 2024 og presenterer førebelse resultat.

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1 - Introduction and background

The Antarctic krill (*Euphausia superba*) fishery started in the early 1970s and peaked in the late 1980s with catches up to 500,000 tons per year, by USSR and Japanese vessels operating in several areas of the Southern Ocean (Figure 1). The fishing for Antarctic krill is currently concentrated within the Southwest Atlantic sector of the Southern Ocean (Commission on the Conservation of Antarctic Marine Living Resources (CCAMLR) subareas 48.1, 48.2, 48.3 and 48.4 (see fig 4)). A fixed precautionary annual catch limit for this sector was set to 620,000 tons (termed the 'trigger level') by CCAMLR in 1991 (CCAMLR Conservation Measure 51–01).

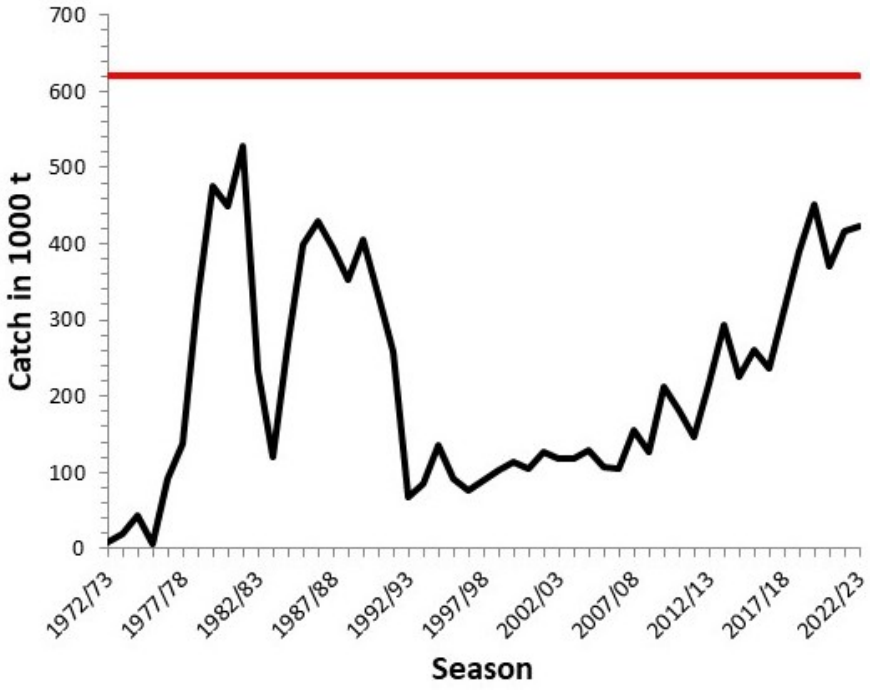


Figure 1. Annual total reported catch of Antarctic krill for the Southern Ocean (black line), the red line denotes the precautionary catch level (trigger level) set at 620 000 tonns in 1991 for the subareas 48.1-48.2.

From the total krill catch in the 2022/23 season, of 424 200 tons, 36% was taken in subarea 48.1, 44% in subarea 48.2, 20% in subarea 48.3 and 0 in subarea 48.4 (Figure 2).

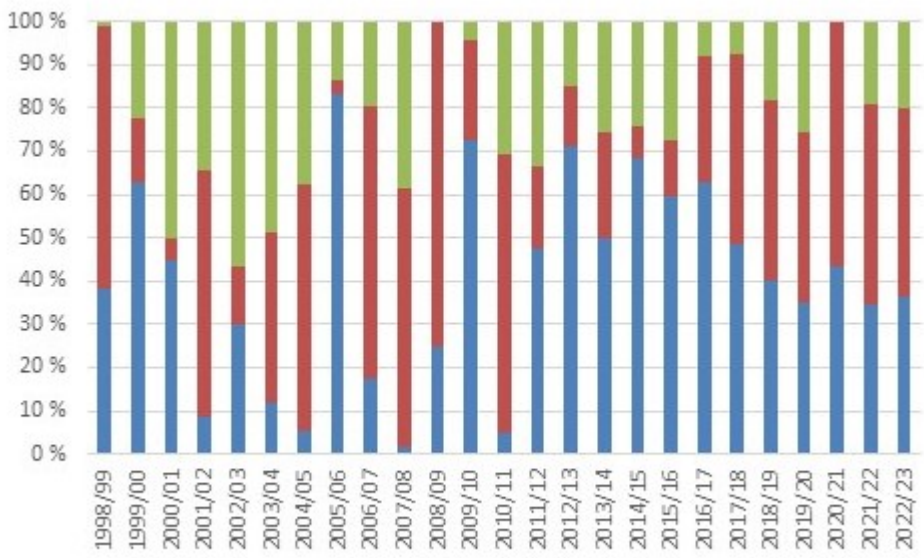


Figure 2. Proportional historical distribution of the total reported catch of Antarctic krill in the three subareas 48.1-48.3 (48.1=blue, 48,2=red, 48.3=green).

The overall catch proportion during the 2022/23 fishing season taken by the Norwegian krill industry represented 67%, the Chinese vessels caught 17%, South Korea 8%, Chile 4%, and Ukraine 3% (Figure 3).

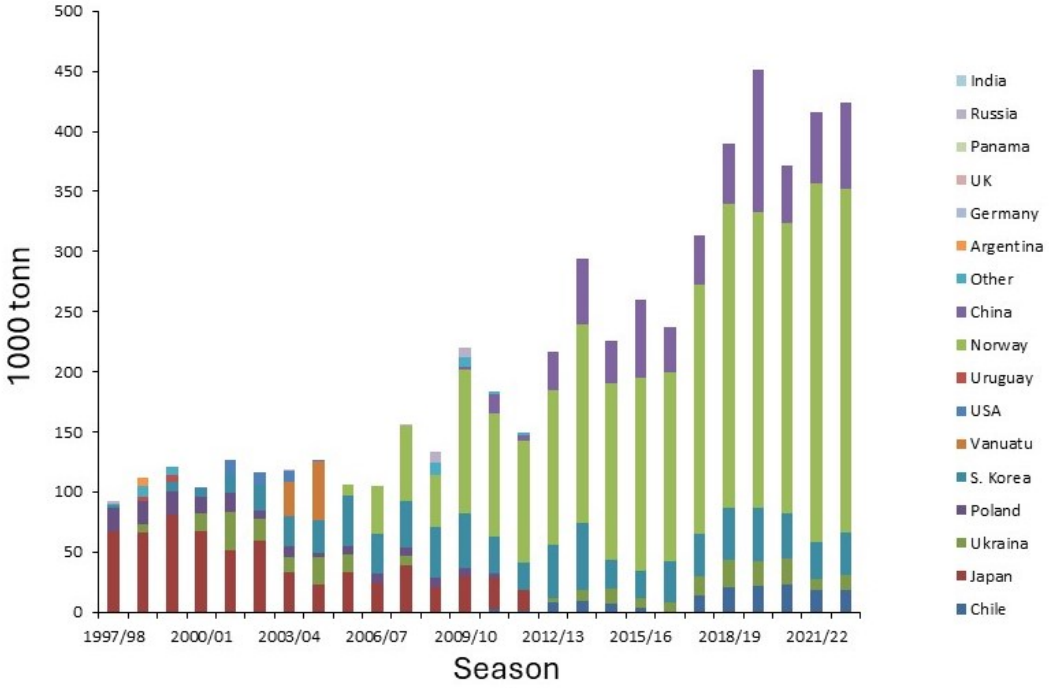


Figure 3. Annual total catch per flag state in the CCAMLR subareas 48.1, 48.2, 48.3 and 48.4, since 1997/98 to 2022/23 (data source: CCAMLR.org)

Two large-scaled acoustic trawl surveys have been executed in the Southwest Atlanticsector of the Southern Ocean (subarea 48.1-48.4), calculating a total biomass of krill in these fishing areas to be 62.6 Mt in 2019 (Krafft

et al., 2021), which was similar to the synoptic survey in 2000 (60.3 Mt; CCAMLR, 2010). Regular monitoring on meso-scale of krill distribution and demographic composition in these fishing areas, have been carried out by the US Antarctic Marine Living Resources program (AMLR) since 1996 (Reiss et al., 2008, 2017), in the Bransfield Strait and Elephant Island area (subarea 48.1). During recent years also Chinese and Korean vessels survey these same AMLR transects (Yu et al., 2019; Krafft et al., 2021; Wang et al., 2021). Previously these surveys were made during the austral summertime but presently also during the austral winter. The British Antarctic Survey run an annual acoustic survey off the South Georgia Islands ("Western core-box" subarea 48.3, since 1997 (Fielding et al., 2014)) during the summer season.

A Norwegian fishing company offered to carry out an annual krill monitoring survey commencing in 2011, for as long as they have commercial activity in the Southern Ocean (Jensen et al. 2010). Through discussions in CCAMLR WG-EMM (Working Group on Ecosystem Monitoring and Management) in 2010, it was agreed that the survey could be carried out in the CCAMLR statistical Subarea 48.2 according to similar standards as the annual scientific surveys undertaken in 48.1 and 48.3 and that the surveys should be executed with scientists from the Institute of Marine Research, Norway. The three surveys could form an integrated monitoring effort extending across the Scotia Sea (Figure 4), linking three of the areas with highest concentrations of krill and highest fishing activity. The results will help evaluate and develop the management of the krill fishery (Hill et al., 2016).

The first annual survey was carried out in January/February 2011 using the FV 'Saga Sea' (Aker Biomarine ASA). The results and study design from this survey was presented at the CCAMLR WG-EMM in 2011. The original survey design (suggested during WG-EMM 2010) consisted of six parallel north-south bound transects extending 100 nmi. During this first survey season it was recognized a need to extend the monitoring effort covering the waters over the shelf edge, north of the South Orkney archipelago, where most krill in this region traditionally aggregate. During the WG-EMM meeting in 2011 it was agreed to extend the survey transects 20 nmi northwards and to omit the westernmost transect line from the 2011 survey. Before the survey in 2014, it was also agreed to extend the transect lines further to the south to cover the northern part of the Marine Protected Area south of the South Orkney Islands, and the design has since remained unchanged.

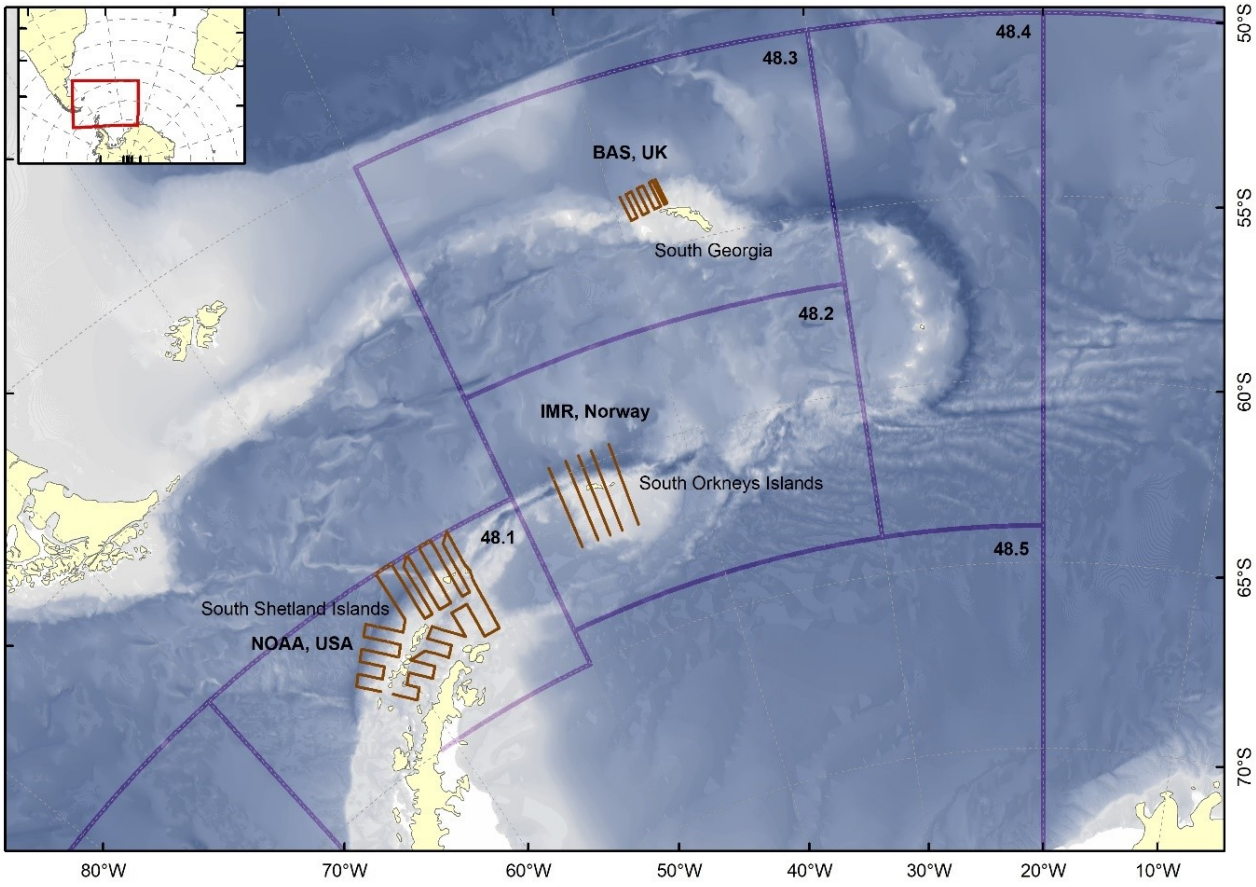


Figure 4. Annual total catch per flag state in the CCAMLR subareas 48.1, 48.2, 48.3 and 48.4, since 1997/98 to 2022/23 (data source: CCAMLR.org)

Results and activities from these annual South Orkney surveys are reported to WG EMM (*e.g.* Krafft et al., 2018b, Skaret et al., 2019) and are published in the primary literature (*e.g.* Krafft et al 2018a, 2019, Skaret et al. 2023). This report presents the survey activities from the 2024 season off the South Orkney Islands including results from acoustic recordings, taxonomic sorting of trawl catches and krill predator sighting data collected during daylight hours along the transects. Given available funding and survey ship time, implementation of various projects in addition to the prioritized core activities is possible some survey years as presented in this report.

2 - Material and Methods

2.1 - Survey design, area, and vessel

The Cargo vessel “Antarctic Provider” (Aker Biomarine AS) departed Montevideo, Uruguay, on the 22. January. On the 22. February the survey ended by reaching port in Montevideo. The survey design covers 60 360 km2 of the waters around the South Orkney Islands and includes five parallel transects extending from the northernmost waypoints at 59.67°S and southernmost waypoint at 62.00°S. Longitudes for transects 1 through 5 are at 44°W, 45°W, 45.75°W, 46.5°W and 47.5° W, respectively.

In addition, a small Shelf edge stratum at 2368 km2 was covered with a denser transect grid. The Shelf edge stratum covers the locations with the highest historical krill catches. The acoustic sampling effort is higher than in the main strata, but otherwise, the design is the same (Figure 5).

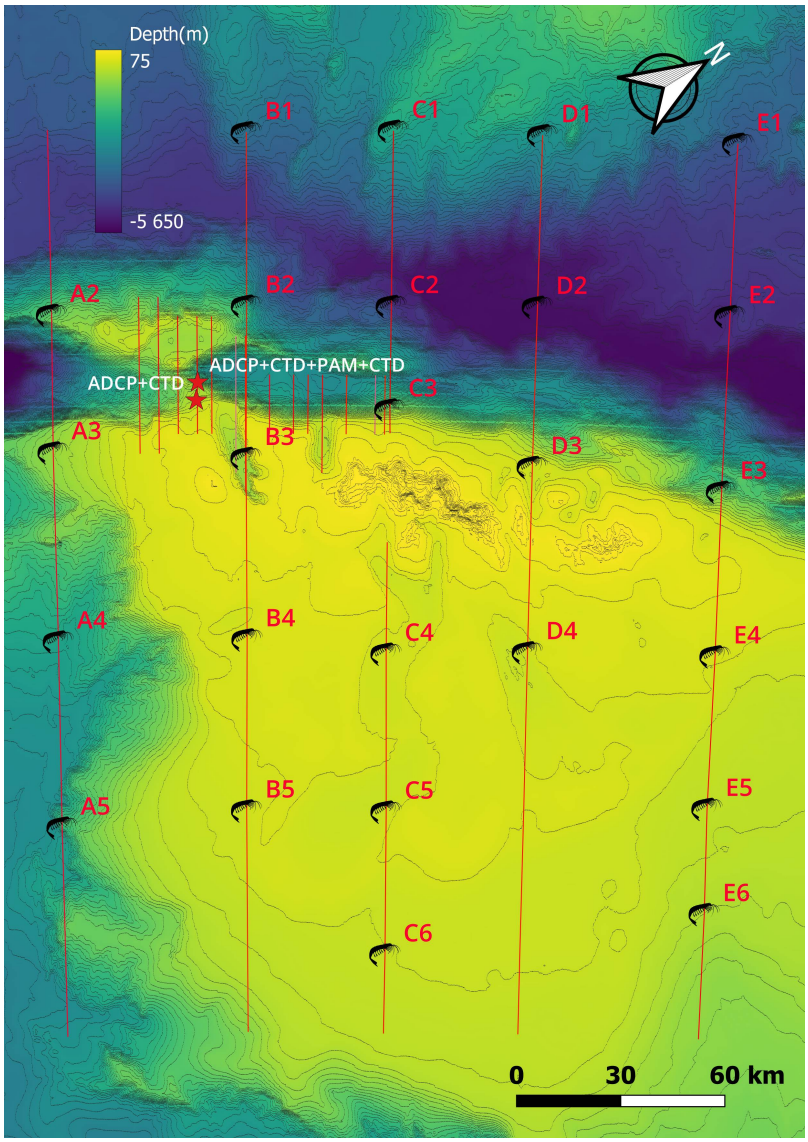


Figure 5. Summary of the 2024 krill monitoring survey lines covered with the 26 trawl stations (Ax to Ex) carried out. Two mooring rigs were deployed as denoted by the red stars; for further details see also Appendix.

Acoustic data collection

2.1.1 - Vessel mounted echosounders

During the survey ‘Antarctic Provider’ was equipped with Simrad EK80, 18 kHz and EK60 echo sounders operating at 38, 70, 120 and 200 kHz.

The echosounders were calibrated while at anchor off Signy Island using the standard sphere calibration method (Foote et al., 1987). The echo sounder was operating with a ping interval at or close to 1 per second. Nominal vessel speed during surveying is 10 knots and could be kept during most of the survey. Acoustic data were collected down to 600 m on all five frequencies. Other transceiver settings are specified in Table 1.

Table 1. Specification of transceiver settings on ‘Antarctic Provider’ applied during the 2024 survey.

Transducer type	**ES 18**	**ES38-7**	**ES70-7C**	**ES120-7C**	**ES200-7C**
Transmit power (W)	1600	2000	750	250	2000
Pulse duration (ms)	1.024	1.024	1.024	1.024	1.024
Absorption coefficient (dB Km^{-1})	3.48	10.21	17.89	25.83	39.85
Sound speed (ms^{-1})	1452	1452	1452	1452	1452
Sample distance (m)	0.186	0.0348	0.186	0.186	0.186
Two-way beam angle (dB)	-17	-20.7	-20.7	-20.7	-20.7
Sv Transducer gain (dB)	21.07	26.99	26.62	26.56	25.97
SA-correction	-0.47	-0.12	-0.33	-0.36	-0.33

Acoustic moorings

2.1.1.1 - Mooring recovery from the survey deployments in 2023

Mooring 1: Aural hydrophone, ASL and CTD at S 60° 21.917 and W 046° 33.365

Mooring 2: two NorTek Signature 55 combined echo sounder and Acoustic Doppler Current Profiler (ADCP), with one pointing upwards and the other downwards, and two CTDs were deployed at S 60° 17.56576 and W 045° 46.21143 in 2023. The release unit did not function. Planning to resque this rig in 2025 by fishing after it using a rope.

Mooring 3: Nortec Signature 100 and a CTD at S 60° 21.90475 and W 046° 45.16915.

Mooring 4: Signature 100 and a CTD at S 60° 19.11244 and W 046° 44.90525.

2.1.1.2 - Mooring re-deployment

Mooring 1: Nortek Signature 100, CTD at S 60°21.900 and W 046°45.320W (Appendix 1)

Mooring 2: Nortek Signature 100, 2 CTDs at S 60°19.110 and W46°44.887 (Appendix 2)

2.2 - Acoustic data analyses

Discrimination of targets

In this work, we applied the standard swarm-based technique for krill discrimination on 120 kHz data using an Echoview work template, which includes noise removal filters, a swarm detection filter and an integration module (CCAMLR, 2017). Swarm detection was implemented using the Large Scale Survey System (LSSS) computer program (Korneliussen et al., 2016).

Target strength prediction

The NASC were converted to biomass density (g m-2) using the SDWBApackage2010 (Conti and Demer, 2006; SG-ASAM 2010; Calise and Skaret, 2011) according to the CCAMLR protocol. The model was parameterized according to Table 1, or if nothing else specified according to Calise and Skaret (2011).

The predicted target strengths were used to calculate weighted conversion factors (CF) from NASC-values to biomass density

$$CF = \left[\sum f_i \cdot W(TL_i)\right] / \left[\sum f_i \cdot \sigma(TL_i)\right]$$

where f is the frequency of a specific length group (i) and W(TL) is weight at total length, which was calculated following Hewitt et al. (2004):

$$W(g) = 2.236 \cdot 10^{-3} \cdot TL^{3.314}$$

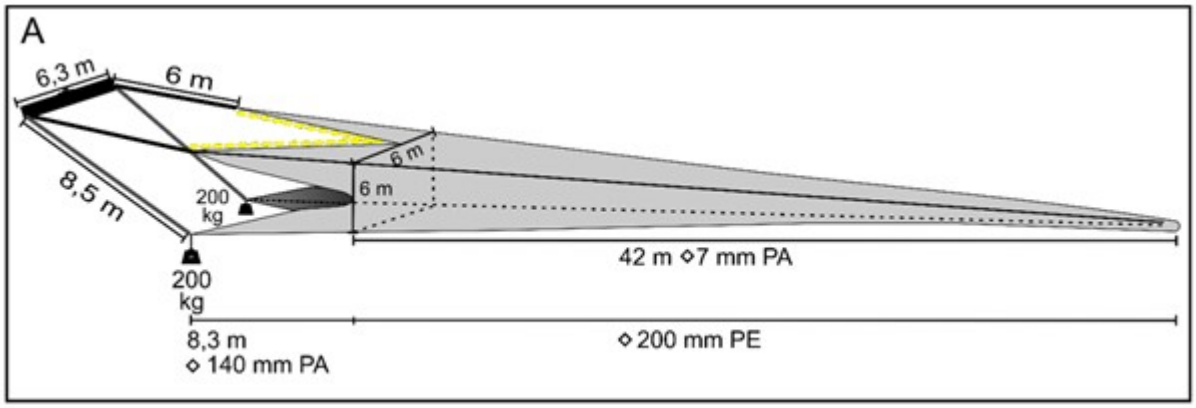
σ(TL) is the backscattering cross-section at a specific total length and was calculated using the full SDWBA model.

2.2.1 - Estimation of biomass

Based on the average biomass density for each nautical mile, a weighted biomass density for each transect line could be calculated and the sampling variance from the averages of each transect line according to Jolly and Hampton (1990).

2.3 - Biological sampling

The survey design included trawl stations spaced ~20–25 nautical miles apart along the set parallel north-south oriented transect lines (Figure 5). The standard survey trawl used was 42 m long, with a 36 m2 mouth opening, constructed of 7 mm (stretched) diamond shaped meshes from mouth to rear, or a 3 mm light opening (Figure 6). The trawl was towed using a 6 m wide steel beam with 200 kg weights at each lower wing tip and 1500 kg attached to the beam to ensure fast deployment to depth and the best possible geometric stability of the trawl during sampling.



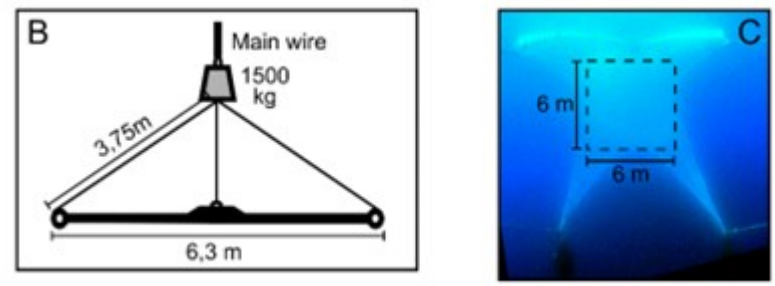


Figure 6. The survey trawl with a 7 mm meshed inner net made of polyamide (PA) 140 mm meshed PA net in the mouth, and 200 mm meshed outer support net in polyethylene (PE) (A). Steel beam with rigging (B) and underwater image captured during towing showing the mouth opening (C). See also Figure 2. In Krafft et al.2018.

At each station the trawl was lowered vertically from surface to ~200 m depth (or ~20 m above bottom if the water was < 200 m) and then hauled in at 1.5 - 2.0 knots (includes both vessel and wire speed). When landed on the trawl deck, the cod end was opened, and catch was removed. Thereby the towing rig was hung from a crane and flushed on deck to wash out biological remains stuck in the net. The macro zooplankton and micronekton were sorted, identified to species or to the nearest possible taxonomic group, and weighed. For E. superba, the length of individual krill was measured (± 1 mm) from the anterior margin of the eye to the tip of telson excluding the setae, according to the “Discovery method” used in Marr (1962). Sex and maturity stages of E. superba were determined on fresh material using the classification methods outlined by Makorov and Denys (1981). In brief, juveniles are classified due to their lack of visible sexual characteristics. Males were divided into three sub adult stages: MIIA1, MIIA2 and MIIA3 and two adult stages: MIIIA and MIIIB, females were divided into one sub adult stage: FIIA and five adult stages: FIIIA, FIIIB, FIIIC, FIIID and FIIIE (see Krafft et al. 2015 for further details).

2.4 - Hydrographical sampling

A Seabird CTD sensor was mounted in an open metal frame for protection and welded on the trawl beam to obtain profiles of temperature and salinity during the trawl hauls.

2.5 - Marine mammal observations

Marine mammal observations were carried out by a dedicated observer during daylight hours, whenever visibility was sufficient. The observer was located on the bridge and continuously scanned the starboard forward quarter (0 – 90°), binoculars were used for species identification. Angle were estimated using a drawn angle board. Distance estimation was aided by using the reticles in the binoculars that marked one milliradian per line. Together with the platform and observer height (20.3+1.7m), each reticles line from the horizon marked a known distance.

Observations were only recorded on straight sections of the vessel track with a nominal vessel speed of 10 knots. The vessel GPS track and logged effort were recorded with custom software on a windows tablet (DOI 10.5281/zenodo.10228669). For each observation the species, time, location, distance, angle, visibility and number of individuals were noted.

To describe migration patterns and foraging behaviour of humpback whales, satellite tags (SPLASH 10-373, Wildlife Computers, Redmond, Wash., U.S.A.) were deployed using an Aerial Remote Tag System (ARTS, www.restech.no) (Figure 7).



Figure 7. Satellite tagging of humpback whales using the Aerial Remote Tag System (ARTS).

2.5.1 - Pilot study using an in-trawl stereo camera for krill body length estimation

The krill body length frequency distribution data and its acoustic properties are used to convert acoustic NASC values into biomass. To provide the best overall representation of the length-frequency distribution of krill in the survey area and at the time of the survey, this can be challenging when using the standard equipment on traditional fishing vessels. Commercial nets display size selection characteristics that differ from small-meshed gear used in traditional scientific sampling, so that certain size groups can be under-represented. Changing trawling gear on board a fishing vessel is a complicated and time-consuming affair that one would rather avoid.

In this study, we developed a method for extracting body length for krill using state-of-the-art automatic image processing to analyze the video-feed from a custom built stereo camera.

The collected video data will be used for estimating the body length of the individual krill using semi-automatic image processing. Scientific methods for biomass estimation in surveys are not directly transferable to commercial fishing vessels as the methodology and data analysis will need to be automated. We therefore aimed to develop a semi-automatic tool to estimate the length-frequency distribution of krill entering a trawl during towing.

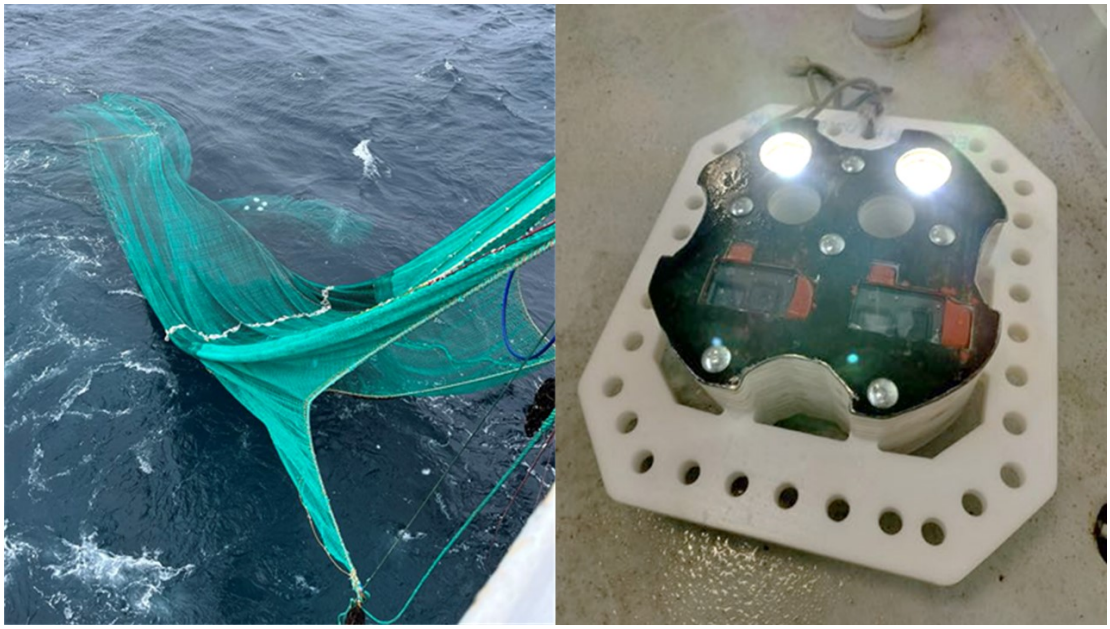


Figure 8. To the right (A): Stereo camera consisting of a specially made housing for fixating underwater lights and GoPro cameras. To the left (B): The installation of the camera in the survey trawl is visible by the added four white floats forward of the codend.

The camera setup for this study consisted of two GoPro cameras in a stereo configuration and underwater flashlights all fixed within a designed housing made of Polyoxymethylene (POM) material (fig. 8A). The camera system was then installed into the standard survey trawl to record entire hauls (fig. 8B).

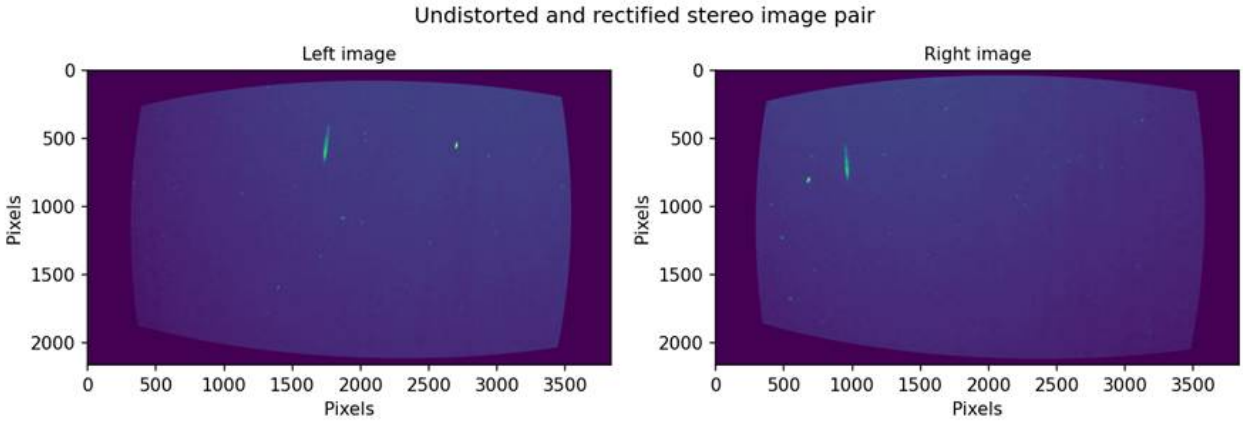


Figure 9: Example of a stereo image pair of a krill that has been pre-processed for later analysis and length estimation.

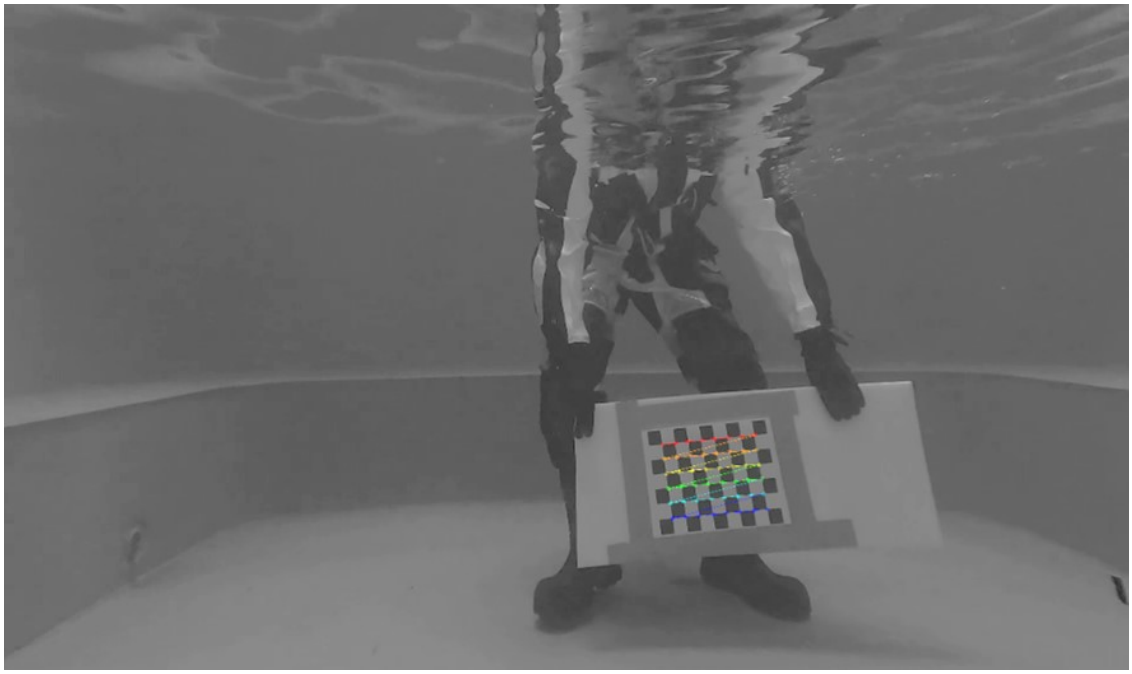


Figure 10. The stereo camera was calibrated using a checkerboard.

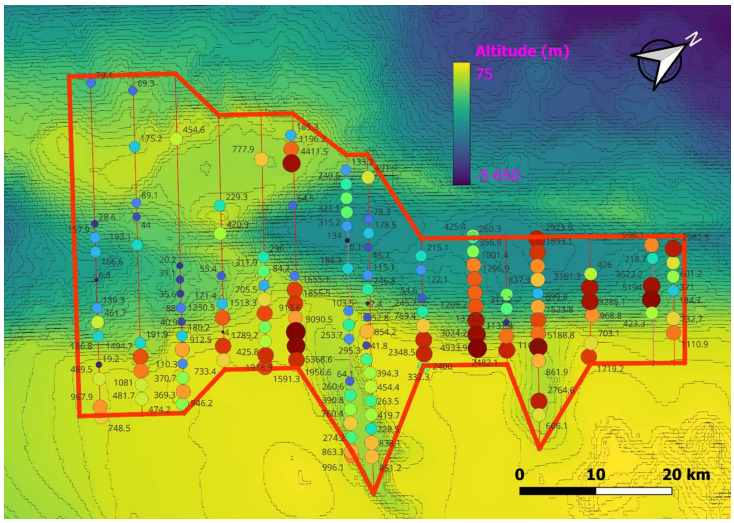
For the analysis, the video footage was synchronized, undistorted, and rectified (Figure 9) to be processed using a custom-trained machine learning model that takes in the images and detects and segments krill appearing in the footage. The synchronized footage was then used to construct three-dimensional images of krill that is the basis for length estimations using calibration parameters calculated on the vessel prior to the experimental hauls (Figure 10.). The estimated length distributions will be validated against manually measured sub-samples of the krill from each haul to evaluate the accuracy of the stereo camera measurements.

3 - Results

3.1 - Acoustic survey estimates of krill distribution and biomass

The distribution of acoustic backscatter allocated to krill is shown Figure 11. The highest NASC-values allocated to krill were observed around the shelf edge and canyons. The krill length distributions are obtained by trawl samples (Figure 14). The biomass estimates are shown in Table 2.

a) Shelf edge stratum



b) Overall stratum

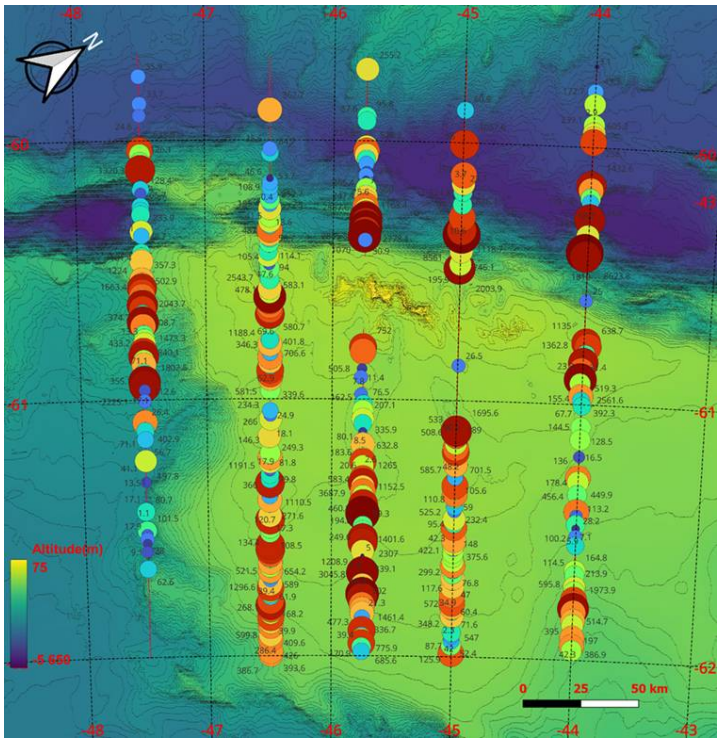


Figure 11. Distribution of Nautical Area Scattering Coefficients (NASC; m2/nmi2) allocated to E.

superba (red) and other targets (grey) from the 120 kHz recordings. Log distance is 1 nautical mile. The

symbols are not linearly scaled due to space.

Table 2. Summary table of krill biomass estimation using the swarms method from all surveys (Skaret et al., 2023: 2011-2020, 2023: this survey). Top = Shelf edge stratum, bottom = Overall stratum

Year	Freq	Density (g/m^2)	BM (mill. t)	CV
2011				
2012				
2013				
2014				
2015	38	31.6	0.07	0.24
2016				
2017				
2018				
2019	120	217.6	0.52	0.19
2020	38	62.0	0.15	0.27
2023	120	202.9	0.48	0.23
2024	120	279.4	0.66	0.27

Year	Freq	Density (g/m^2)	BM (mill. t)	CV
2011	120	62.6	3.78	0.36
2012	120	128.8	7.77	0.35
2013	38	76.5	4.62	0.30
2014	38	28.5	1.72	0.19
2015	38	49.3	2.98	0.49
2016	120	23.2	1.40	0.29
2017	120	69.4	4.19	0.25
2018	120	27.2	1.64	0.29
2019	120	38.8	2.34	0.14
2020	38	62.6	3.78	0.36
2023	120	36.7	2.21	0.51
2024	120	80.5	4.86	0.11

3.2 - Biological sampling

A total of 25 trawl stations were successfully completed during the survey, with the largest catch weight at the northernmost stations and centered around and in the deeper part of the survey area (Figure 12). The total catch weight was dominated by salpa (58,1%) and euphausiids (33,7%) (Figure 13). Three species of euphausiids were identified: Euphasia superba, Thysanoessa macrura and Euphasia gregaria, where E.

superba was the most numerous and present at 19 stations. However, most of the catch was concentrated at station E3, which accounted for 83,0% of total sampled E. superba. T. macrura was present at 22 of the stations and together with the amphipod Themisto gaudichaudi (found at 21 stations) was the most frequent taxa occurring in the trawl samples. The rest of the biomass consisted of Cnidarians (0.97%), Teleostei (0.88%), Calanoids (0,02%), and other taxa (0,75%), of which the most occurring species and taxa were Chaetognatha spp., pteropods, polychaets, mysids, Dendrobranchiata, Calycopsis borchgrevinki and Electrona spp.

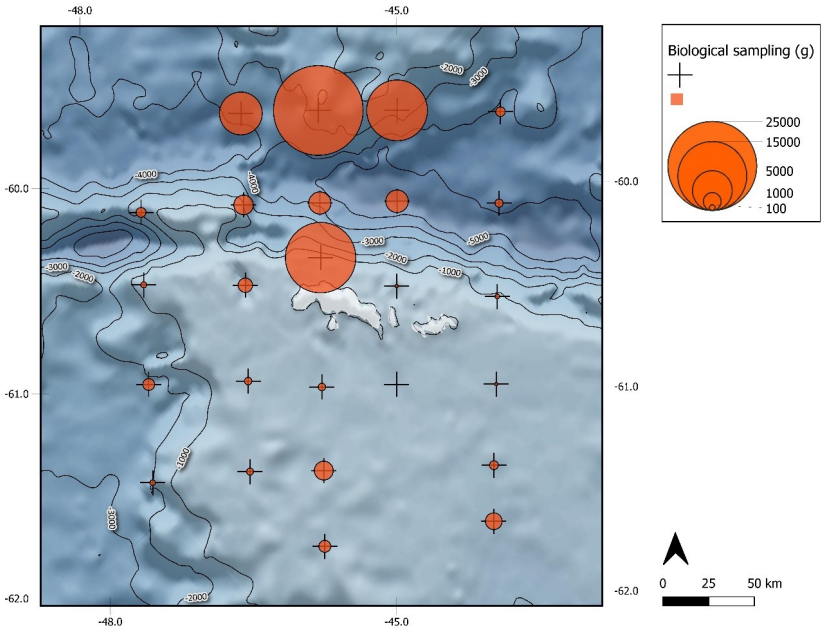


Figure 12. Total biological sampling in terms of catch weight (g).

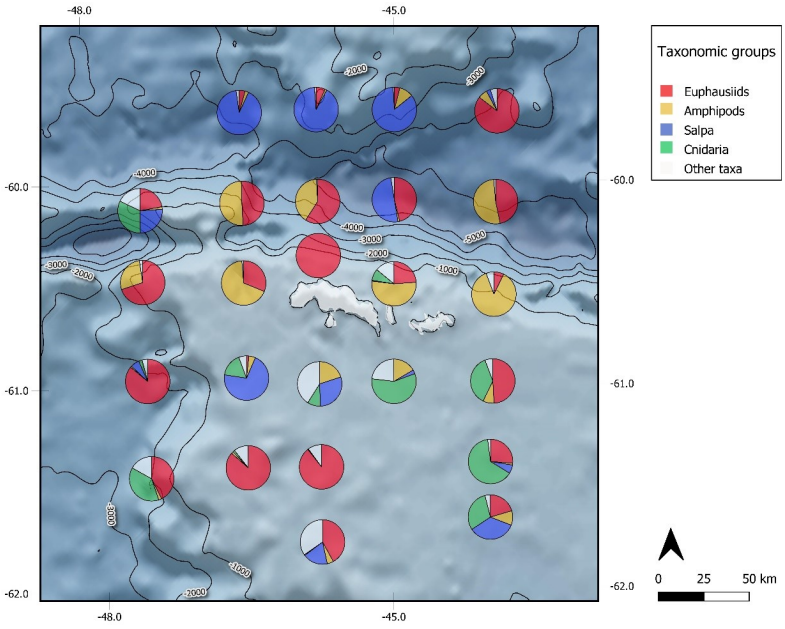


Figure 13. The most common taxonomic groups (Euphausiids, Amphipods, Salpa, Cnidaria, and other taxa) in terms of proportional catch weight at each station.

Table 3. Sexual maturation stages, number of observations, proportion (%), and mean length of E. superba.

Stage	N	Proportion	Mean ± SD
J	434	28.1	30.0 ± 3.3
FIIB	81	5.2	39.1 ± 3.8
FIIIA	35	2.2	45.0 ± 6.1
FIIIB	91	5.8	45.7 ± 5.1
FIIIC	107	6.9	47 ± 5.3
FIIID	177	11.4	52.4 ± 4.9
FIIIE	11	0.7	50.1 ± 3.0
MIIA1	19	1.2	37.7 ± 3.3
MIIA2	96	6.2	42.4 ± 3.9
MIIA3	59	3.8	46.0 ± 3.7
MIIIA	20	1.3	48.6 ± 5.2
MIIIB	416	26.9	52.1 ± 4.2
Total	1546		

The average body length of E. superba was 43.29 ± 10.0 (SD) mm, and the range was 22-60 mm (Figure 14). The demographic composition of E. superba caught in the trawl was dominated by juvenile specimens (28.1%), as well as adult males (MIIIB: 26,9%) and adult females (FIIID: 11,4%). The adult individuals were mainly found in the northernmost stations (B1, C1, C2, D2) while the earlier stages appeared in the shelf and shelf break stations such as A3, A4, C3, C5 and C6.

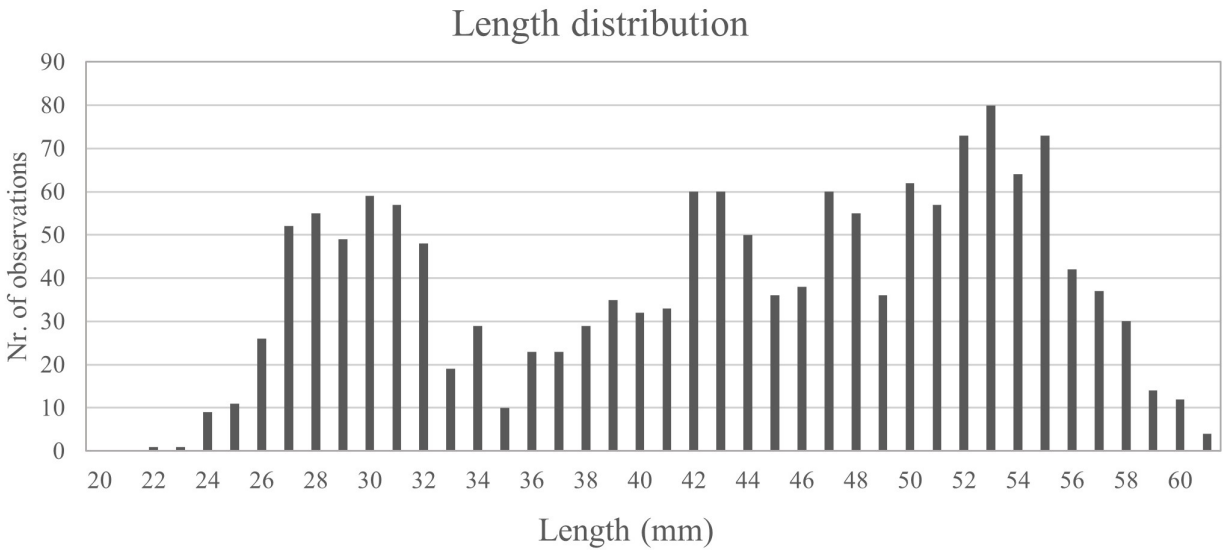


Figure 14. Length distribution of E. superba caught during the survey.

Hydrography

The hydrographical profiles from the survey area based on the trawl mounted CTD are shown in Figure 15. A thermocline was observed mostly around 50-60 m.

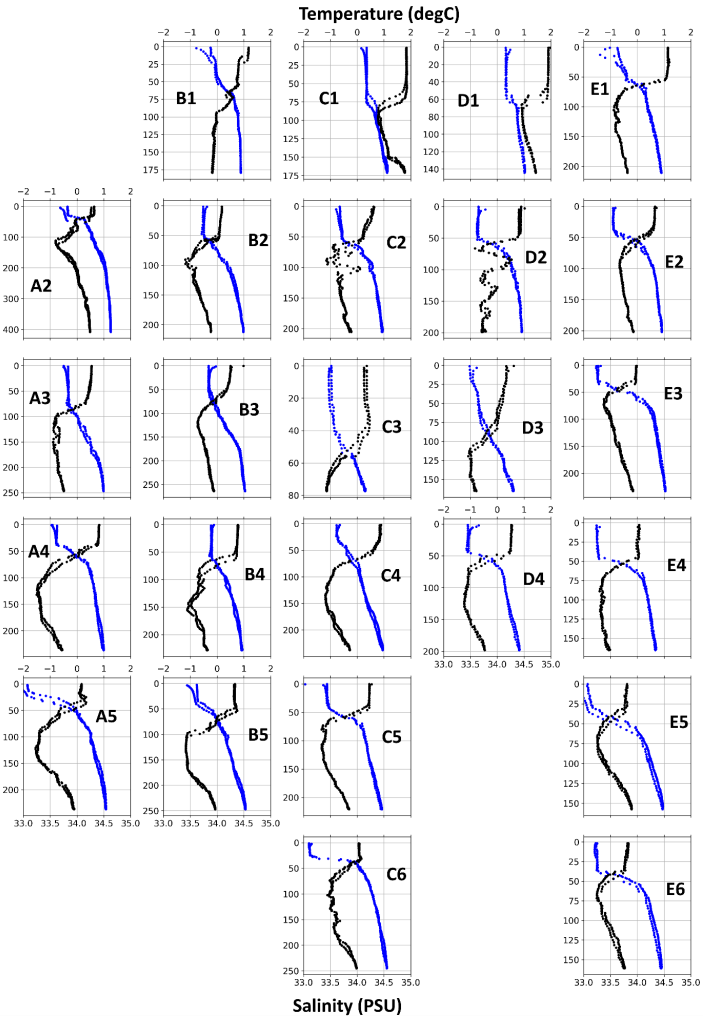


Figure 15. Hydrographical profiles from the ctd-casts with temperature in black and salinity in blue.

3.3 - Marine predator observations

The observed species were: Fin whales (Balaenoptera physalus), Antarctic fur seals (Arctocephalus gazella) and Humpback whales (Megaptera novaeangliae) and Orcas (Orcinus orca). Table 4 lists the number of individuals observed per species. The map in Figure 16 displays the location of the effort periods and observed marine mammals.

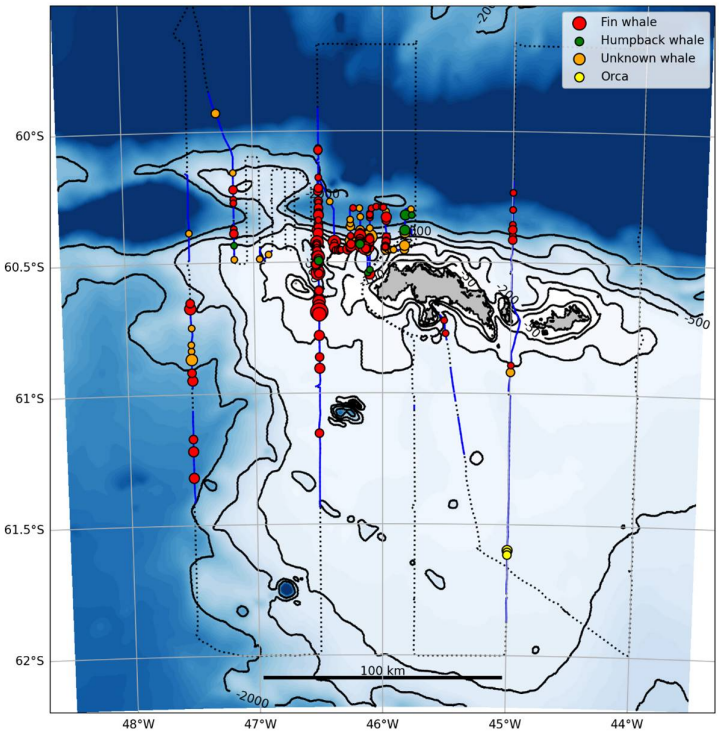


Figure 16. Map of vessel track, observations efforts and marine mammal sightings. Blue tracks mark the observation effort, black dashed line the survey track where observations were not possible.

Table 4. Summary of observerd species

Species	N
Unknown whale	98
Humpback whale	16
Antarctic furseal	27
Chinstrap penguin	218
Fin whale	256
Unknown penguin	10
Killer whale	7
Gentoo penguin	3

The satellite tracks from a female humpback whale with calf is illustrated in figure 17.

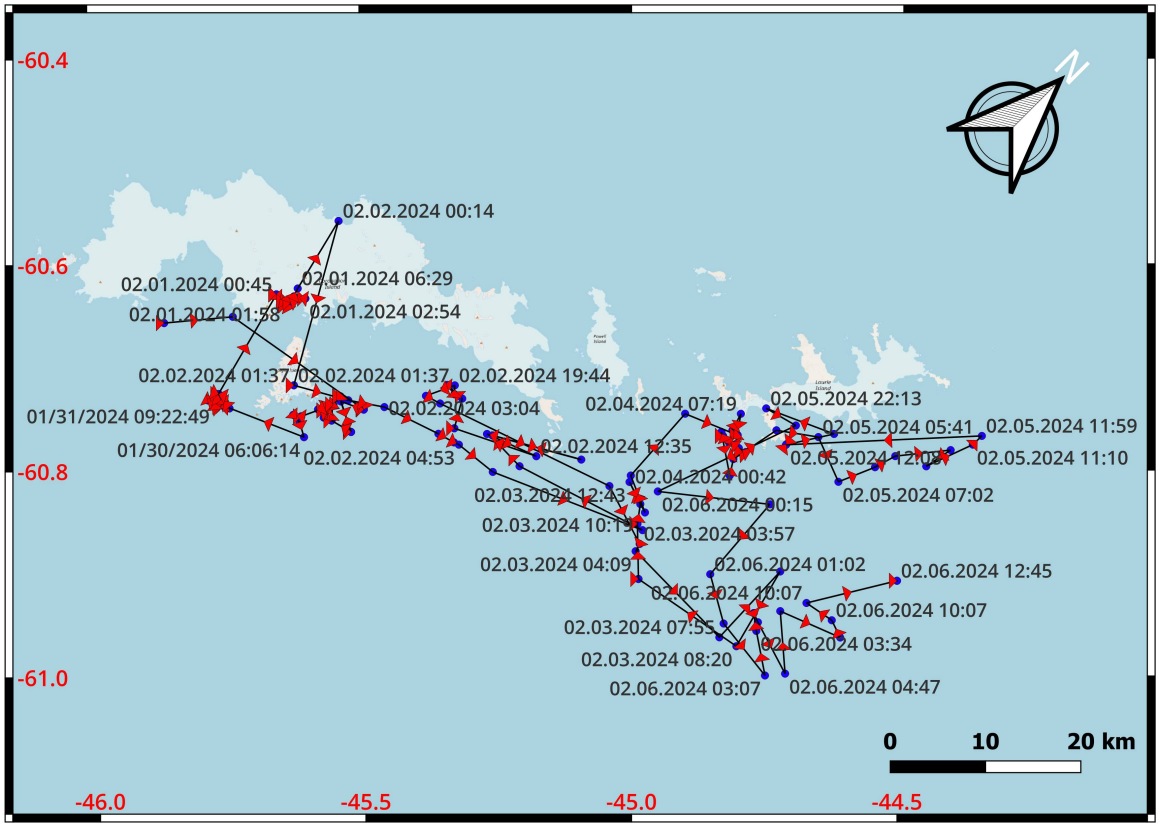


Figure 17. The satellite tracks from a Humpback whale female with calf

4 - Acknowledgements

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6 - Appendix

Appendix 1

Institute of Marine Research

Mooring record book for self registrating instruments detail

Ship/Platform:	Antarctic Provider
Location:	
Latitude:	S 60 ° 21.900
Longitude:	W 046° 45.320

Instruments / Sensors

#	Brand	Type	Serial No.	Depth	Comments
1	Nortek	Signature 100	101122		
2	SEA-BIRD	SBE-37 IMP	20724		
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					

Bottom depth:
Outgoing date: 2024.02.12
Outgoing time (UTC):
Incoming date: Click here to enter a date.
Incoming time (UTC): XX:XX

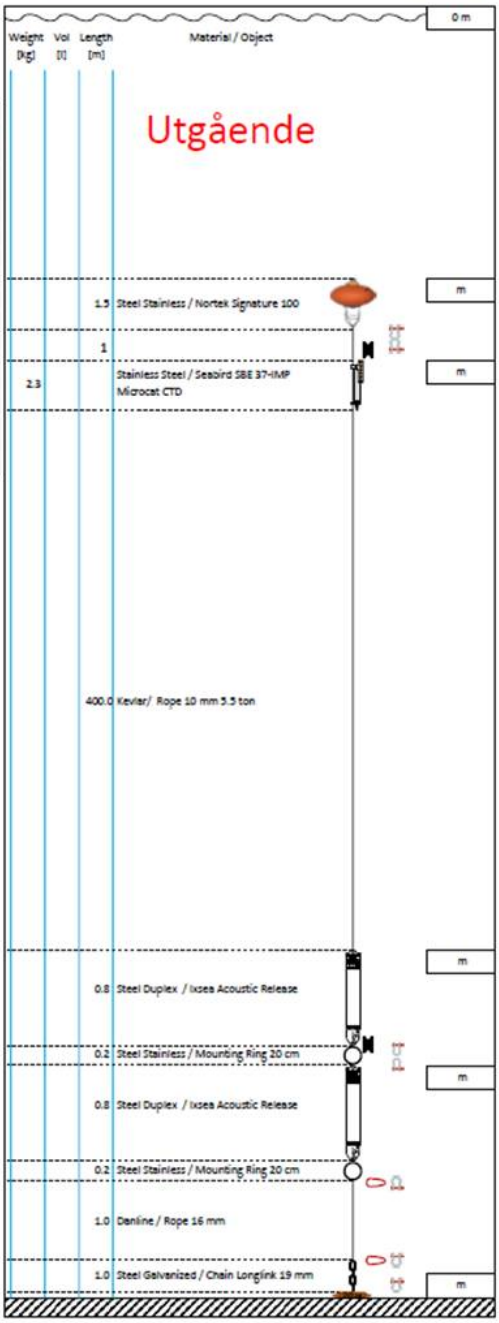
Comments:

Responsible: Guosong Zhang

~~ARGOS~~
PTTID: NA Undocumented

Acoustic release: IXBLUE OCEANO R5 (Two releases)
Up: Serial no: 2549 Range code: 2B8A Release code: 2B55
Bottom:Serial no: 22290134 Range code: 35A7 Release code: 3555

Station name: Krill 2024 Nortek SIG 100		
Color code:		
Sum weight (incl. anchor): [kg]		
Sum weight (excl. anchor): [kg]		
Sum volume: [l]		
Buoyancy (anchor on): [kg]		
Buoyancy (anchor off): [kg]		
Stainless Steel Shackle		S
Galvanized Steel Shackle		G
Stainless Steel Thimble		
Galvanized Steel Thimble		
Description	Spec	No
Shackle Stainless Steel		0
Shackle Stainless Steel	2.50	0
Shackle Galvanized Steel	0.50	0
Shackle Galvanized Steel	2.00	1
Shackle Galvanized Steel	3.25	12
Shackle Galvanized Steel	4.75	0
Shackle Galvanized Steel	6.50	0
Thimble Stainless Steel		0
Thimble Stainless Steel		0
Thimble Galvanized Steel		2
Thimble Galvanized Steel		0
Thimble Nylon		8
		0
		0
		0



Appendix 2

Institute of Marine Research

Mooring record book for self registrating instruments detail

Ship/Platform: Antarctic Provider
Location:
Latitude: 60° 19.110' S
Longitude: 46° 44.887' W

Instruments / Sensors

#	Brand	Type	Serial No.	Depth	Comments
1	Nortek	Signature 100	101135		
2	SEA-BIRD	SBE-37 IMP	20677		
3	MTE	Aural M3	MTEAU00 315LF		
4	SEA-BIRD	SBE-37 IMP	20725		
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					

Bottom depth: 912m
Outgoing date: 2024.02.12
Outgoing time (UTC): 15:30
Incoming date: Click here to enter a date.
Incoming time (UTC): XX:XX

Comments:

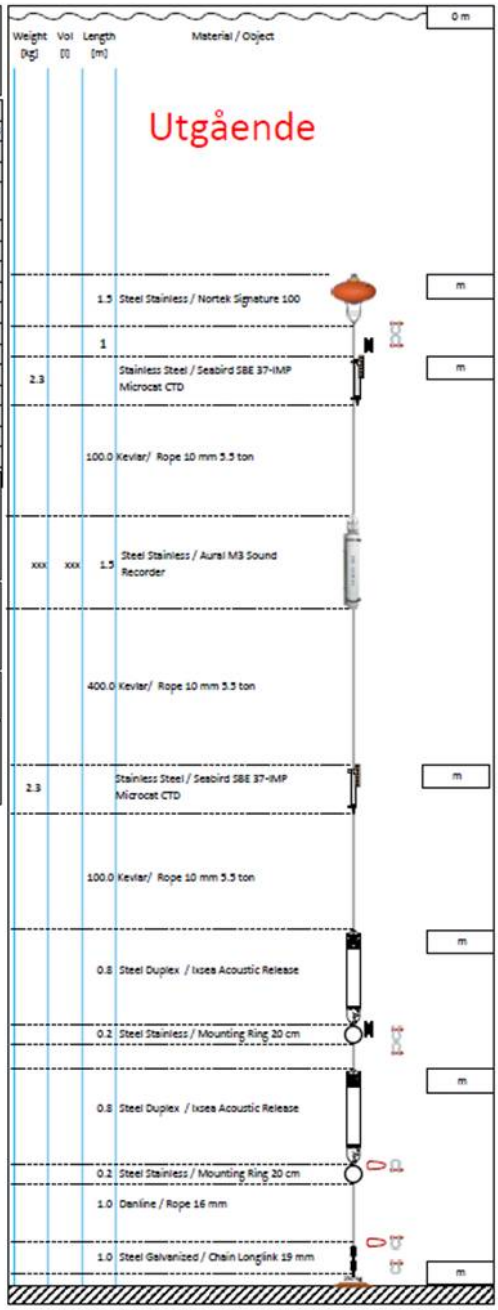
Responsible: Guosong Zhang

~~ARGOS~~
PTTID: NA Undocumented

Acoustic release: IXBLUE OCEANO R5 (Two releases)
Up: Serial no: 2418 Bottom:Serial no: 22290133
Range code: 1BD7 Range code: 35A6
Release code: 1B55 Release code: 3555

Station name: Krill 2024 Nortek SIG 100
Color code:
Sum weight (incl. anchor): [kg]
Sum weight (excl. anchor): [kg]
Sum volume: [l]
Buoyancy (anchor on): [kg]
Buoyancy (anchor off): [kg]
Stainless Steel Shackle S
Galvanized Steel Shackle G
Stainless Steel Thimble
Galvanized Steel Thimble

Description	Spec	No.
Shackle Stainless Steel		0
Shackle Stainless Steel	2.50	0
Shackle Galvanized Steel	0.50	0
Shackle Galvanized Steel	2.00	1
Shackle Galvanized Steel	3.25	12
Shackle Galvanized Steel	4.75	0
Shackle Galvanized Steel	6.50	0
Thimble Stainless Steel		0
Thimble Stainless Steel		0
Thimble Galvanized Steel		2
Thimble Galvanized Steel		0
Thimble Nylon		8
		0
		0
		0



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