MNF Voyage Summary

Voyage #:	**IN2021_V01**		
Voyage title:	Quantifying krill abundance for krill monitoring and management off the Australian Antarctic Territory (TEMPO Voyage)		
Mobilisation:	Hobart, Thursday-Friday, 21-22 January 2021		
Depart:	Hobart, 1400 Friday, 29 January 2021		
Return:	Hobart, 0800 Wednesday, 24 March 2021		
Demobilisation:	Hobart, Wednesday-Thursday, 24-25 March 2021		
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Principal Investigators:	AAD Co-Investigators on proposal: • Rob King (Alternate Chief Scientist) • Karen Westwood (Project Manager) • Natalie Kelly • Martin Cox • Louise Emmerson • Colin Southwell • Mike Double • Elanor Bell • Bruce Deagle (now CSIRO, Hobart) • Brian Miller • Dirk Welsford • Simon Wotherspoon • Phoebe Lewis (PhD Student) External Co-Investigators on proposal: • Andreas Klocker (University of Tasmania, Australia) • Daniel Zitterbart (Woods Hole Oceanographic Institution, USA) • Guoping Zhu (Shanghai Ocean University, China)		
Project name:	TEMPO: Trends in Euphausiids off Mawson, Predators, and Oceanography		

Objectives and brief narrative of voyage

The primary objective of this voyage is to ensure the orderly development of the krill fishery in waters off Australia's Antarctic Territory. This will be achieved by updating the biomass estimate of Antarctic krill, enabling a revision of the catch limit within CCAMLR Division 58.4.2-East in the Indian Ocean (IO) sector of the Southern Ocean. Commercial krill fishing in the IO sector recommenced in 2016/17 after a 25 year hiatus. The current krill catch limit in the region is based on surveys conducted 14 years ago. There has been no regular ecosystem monitoring to assess how the system may have changed since then. There is an urgent need to:

- update the krill precautionary catch limit
- collect data to assist in the design of small-scale management units,
- to develop a tractable long-term krill monitoring program for the region; and
- deployment (primary) and recovery (secondary) of AAD passive acoustic whale moorings.

Scientific objectives

The primary objective of this voyage is to ensure the orderly development of the krill fishery in waters off Australia's Antarctic Territory. This will be achieved by updating the biomass estimate of Antarctic krill, enabling a revision of the catch limit within CCAMLR Division 58.4.2-East in the Indian Ocean (IO) sector of the Southern Ocean. Commercial krill fishing in the IO sector recommenced in 2016/17 after a 25 year hiatus. The current krill catch limit in the region is based on surveys conducted 14 years ago. There has been no regular ecosystem monitoring to assess how the system may have changed since then. There is an urgent need to:

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- deployment (primary) and recovery (secondary) of AAD passive acoustic whale moorings.

Our conceptual understanding of krill life history has been largely based on research within the epipelagic zone (surface to ~250m). However, recent observations indicate that krill can exist down to the abyssal zone. To understand the distribution and contribution of deep-sea krill to overall krill biomass, we will use lowered instruments and moorings to obtain full-depth vertical profiles of krill density. We will also study krill behaviour at the scale of; a) the individual, b) swarms, and c) groups of swarms, using advanced fisheries acoustic instrumentation on RV *Investigator*.

The survey design consists of ship-based acoustic line-transects to estimate krill biomass, coupled with observations of krill dependent species (*i.e.* seabirds and marine mammals). This will enable increased understanding of interactions between predators and krill biomass distributions.

The specific aims of this project are to:

1. Estimate the biomass of krill, a key parameter for updating the precautionary catch limit for the krill fishery in waters off Australia's Antarctic Territory.

2. Understand the relationship between krill density and distribution, in particular the form, number, and spatial arrangement of swarms.

3. Relate krill distribution and density to the distribution and activity of air-breathing krill predators including seabirds and marine mammals.

4. Track the movement of krill swarms in relation to the local current field in order to evaluate inter-swarm connectivity.
5. Understand the distribution and contribution of deep-sea krill to overall krill biomass and its dynamics in the region.
6. Improve our understanding of the connectivity of krill populations, and the overlap between krill and predators, in order to design a tractable long-term monitoring plan and spatial management (small-scale management unit) of the krill fishery.
7. Oceanographic and biological (plankton) sampling to understand the habitat environment.

Voyage objectives

The science teams to achieve our voyage objectives are:

- Krill Biology
- Acoustics
- Predator Observations
- Biological Oceanography
- Genetics

Krill Biology (Team Leader – Rob King)

The krill biology team are the largest group on the voyage and will be undertaking a diverse array of activities. These include;

- Routine trawls
- Target Trawls
- Growth studies using IGR tanks
- Rearing of krill larvae in Kreisel tanks
- CTD mounted krill camera and krill light trap
- Deployment of three KOMBI moorings
- CPR tows during transit

Routine Trawls

Regular trawls will be conducted along each transect line to quantify krill abundance and other zooplankton species. We will undertake 8-9 routine trawls per transect (200 m to the surface) using the Rectangular Midwater Trawl, with tandem nets having an effective mouth area of 8 m^2 and 1 m^2 (RMT 8+1), respectively. Routine trawls will always be undertaken at designated locations, even when there is nothing significant detected on the echosounders. Genetic surface seawater samples will also be taken for cross-reference (see below). The ship will return to the main transect line once trawling has been completed. In all, we expect to undertake approximately 50 routine trawls.

Target Trawls, Krill Growth and Rearing

Target trawls for krill will be utilised to support the acoustics work (see below) and to collect live krill for experimentation. Trawls will be conducted using the RMT 8+1 where swarms are seen on the echosounders and will take approximately 1 hour. To support the acoustics work, the length, volume, sex and maturity stage of krill will be recorded to determine swarm composition. For

experimentation, live krill will be incubated in Instantaneous Growth Rate (IGR) tanks (provided by the AAD) to measure growth rates over time immediately after capture. Krill moults from IGR experiments will also be frozen for genetic analysis of krill microbiomes at a later date (see below). We will also spawn krill and rear larvae using Kreisel tanks in the temperature-controlled laboratory. It is anticipated that 50 to 60 target trawls will occur during the voyage. The ship will return to the main transect line once trawling has been completed.

CTD Krill Camera and Krill Light Trap

Most krill studies focus on the epipelagic zone (surface to ~250m), but recent observations indicate that they can also exist within the abyssal zone. We will utilise a deep sea camera and krill light trap to observe krill at the ocean floor and to attempt to collect live specimens. The krill light trap will be attached to the 36 bottle CTD rosette, replacing approx. 5 Niskin bottles, and operated on all full-depth CTD casts (71 full-depth casts). The CTD will need to be lowered to within 3 to 5 m off the ocean floor, with simultaneous camera and light trapping commencing and lasting a total of 5 minutes before CTD ascent (further details provided below). Vertical profiles of current fields will be derived from the lowered ADCP which is also mounted on the CTD. A self-contained Simrad WBAT echosounder may also be attached to the rosette to gain a vertical distribution of krill, but this will be decided at a later date.

KOMBI Moorings

Three Krill Observational Mooring for Benthic Investigation (KOMBI) moorings will be deployed to the sea floor during the voyage. They will each have a deep-sea camera and echosounder to record temporal variation in krill presence over a period of a year; both near the sea floor and within the adjacent 250 m of the water column above. Their dimensions are 1145 x 1145 x 1300 mm. We aim to deploy a mooring in each of the following regions; shallow shelf, shelf break, and canyon. The moorings will not need to be retrieved until a later voyage in the following year. To determine the best locations for KOMBI deployments we will utilise the bathy multibeams to gain high resolution maps of the sea floor. The maximum depth for KOMBI mooring deployment is 1500 m. The minimum depth is around 350 m to reduce the chance of damage from iceberg keel impacts.

CPR Tows

Continuous Plankton Recorder (CPR) tows will be undertaken on transit to and from our survey area, as part of an ongoing monitoring program to assess krill and zooplankton sensitivities to climate change. The CPR is towed about 100 m astern of the ship, with each tow covering 450 nm. The CPR will be deployed and retrieved a number of times during transit. The ship will need to be slowed for a few minutes during deployment/retrieval. Once the gear has been deployed/retrieved safely the ship may then continue at normal speed.

Acoustics (Team Leader – Martin Cox)

General

The EK80 echosounder will be used continuously on transect to identify krill swarms in real time using CCAMLR-approved algorithms, and to determine overall krill distribution and abundance within the survey area. To validate algorithms and data, krill length frequency distributions will be obtained through target trawls (see above). It is absolutely vital that the EK80 undergoes a cold-water calibration during the voyage to ensure the data is accurate.

Krill swarms will also be tracked using the ME70 multibeam echosounder and the SH90 sonar. The large 140° swath of the ME70 will enable the observation of smaller krill swarms that would typically be missed by the narrow (7°) beam width of the EK80. The three-dimensional view of krill provided by the ME70, will be merged with the two dimensional view of the EK80 in near real time using Echoview. This will enable the observation of krill swarm dynamics at the scale of 10s of metres, and allow determination of swarm density, structure, and vertical distribution. All acoustic systems will be synchronized to avoid interference.

To ensure effective krill results for the voyage, the following must occur: 1) keep a consistent electronic log, 2) carry out a test of ADCP interference (required frequencies of 75 and 150 kHz) with the EK80 sounder, and 3) during all north-south transect work, turn off the bathy multibeams (all of them). On north-south transects, the only acoustics equipment that should be run are the EK80, the ME70 and SH90 sometimes, the ADCP if it doesn't interfere with the EK80, plus whatever the bridge needs for safe navigation. In the event that the ADCP interferes with the EK80, it is vital that ADCP measurements are still taken e.g. at the start/end of trawls, as well as at CTD sites. Please note that we intend to use the bathy multibeams when locating ideal sites for the KOMBI moorings. The bathy multibeams may also be used as necessary when transiting between north-south transects.

Swarm Studies

At selected locations where significant krill swarms are detected, we will thoroughly map the swarm in three dimensions (using the ME70), then re-trace the ship's path over the swarm to see if there has been any effect on the swarm's structure – e.g. due to ship avoidance. The velocity of each swarm will be estimated by subtracting both the local current field observed using the hull mounted ADCPs, and the ship's movements, from ME70 derived swarm velocities. As per above, If the ADCP interferes with krill acoustics, we will swap to the ADCP at the end of the swarm study to gain measurements. A CTD may also be conducted at the end of the swarm study to characterise the water column and to take genetics samples (see below). Up to 50 hours of ship time has been allocated for swarm studies.

Free-Floating Camera (Swarm Study Camera)

A free-floating camera will also be deployed during some swarm studies and target trawls. Whilst the ME70 provides information about krill swarms on the "super-organism" level, it does not tell us about the behaviour of individual krill. The free-floating camera will allow computation of the three dimensional space of individual krill through use of a stereoscopic system. It is enclosed within a 500 x 500 x 1500 mm self-contained frame (no ships systems required) that will be deployed off the back of the trawl deck. A self-contained echosounder (Simrad WBAT operating at 70 and 333 kHz) and various buoys will also be attached. The free-floating camera does require retrieval and will have had sufficient time in the water by the time the ship turns around to re-trace its path to go back and pick it up. The best method of retrieval requires discussion – e.g. a grappling gun and mooring rope windlass. It is intended that some type of locating system (e.g. radar reflector or AIS beacon) will be attached to one of the buoys in addition to a satellite positioning system, to enable the ship to easily re-locate the system in the event that a visual fix is unable to be made. The number of times that the free-floating camera will be deployed during the voyage is unknown and will largely depend on how rapidly the deployment/retrieval process is able to be undertaken and the remaining time available.

Predator Observations (Team Leader – Nat Kelly)

Sighting surveys of predators (mainly flying seabirds and whales, but also penguins and seals where possible) will be conducted along all survey transect lines. Conventional distance sampling methods will be utilised to estimate the distribution and abundance of marine mammals and penguins (if observed); and a snap-shot sampling method will be used for seabirds, where an observer spends 5 minutes each hour of transect time counting birds around the vessel. All work will be conducted using two observation boxes installed on Deck 05. Both will contain big-eye binoculars with high magnification to increase the accuracy of identifications (this is vital to the quality of the observation data as the survey allows no time for the vessel to divert off course to confirm species identification or group size estimates). All sighting effort and environmental data will be recorded in a database (entered on a laptop, to be located on the bridge) and linked to the vessel's track. Predator observers will work 30 to 60 minute shifts (length of shift will be weather dependent) in the observation boxes and be rotated throughout the day during daylight hours (approx. 0600-2000 local time). Observations will only to be undertaken during good observing weather, (*i.e.* ≤ Beaufort sea state 5, zero or minor fog). There will be one data entry person located on the bridge; the remainder of the observers on shift will be located on Deck 05. At least one desk will be required in the data processing lab for analyses.

Sonobuoys will also be deployed at regular intervals during the voyage to acoustically detect whales from long distances (potentially over hundreds of kilometres). The sonobuoys provide usable data in calm as well as rough seas (up to Beaufort sea state 7) and can be deployed from the deck whilst underway without slowing the ship. The sonobuoys will be deployed in passing mode every 30 nm (the vessel will not close in on detections to confirm species or group sizes) and will have their signals recorded at a listening station (on the Observation Deck). The analyses of the sonobuoy data will not be conducted during the voyage. Therefore, the only requirement once a sonobuoy has been deployed is for someone to check that it is transmitting and that the computer is recording the signals (approximately 10 minutes work). The person then returns to their normal duties. We intend to deploy approximately 200 sonobuoys during the voyage.

Biological Oceanography (Team Leader – Karen Westwood)

We will undertake 71 full-depth and 11 shallow CTD casts (to 1500 m) during the voyage (total = 82 casts). All casts will be conducted on transect with depths ranging from 200 to 4607 m. The water collected in Niskin bottles will be used for hydrochemistry measurements (dissolved oxygen, salinity, nitrate, phosphate, silicate), CO_2 measurements (dissolved inorganic carbon, alkalinity), phytoplankton (HPLC pigments, light microscopy), and genetics (see next section) analyses. Hydrochemistry measurements will be used to determine sources of Antarctic bottom water, to examine exchanges between the Indian and Pacific Oceans, to define fronts (Southern Boundary, sACCF), and to define mixed layers within surface waters. HPLC pigment data and phytoplankton light microscopy data will provide quantification of food sources and food quality for krill within the survey area. An underway Fluorescence Induction and Relaxation (FIRe) will also be installed in the underway seawater laboratory to map the photosynthetic efficiency of phytoplankton.

The biological oceanography team will also contribute to two international programs through deployment of a) biogeochemical Argo floats (BCG Argo Program, https://biogeochemical-argo.org/, 3 floats), and b) surface drifters (NOAA Global Drifter Program, https://www.aoml.noaa.gov/phod/gdp/, 5 to 10 drifters). All deployments will occur immediately

following routine CTDs when the ship has recommenced transit. Additional particulate organic carbon measurements are required from Niskin bottles at CTD stations where BGC Argo floats are deployed. CTD casts to 2250m will be conducted post-BCG Argo float deployment for salinity (required) drift checks and nitrate and oxygen (desired).

Genetics (Team Leader – Leonie Suter)

The genetics team will sample for environmental DNA (eDNA) throughout the voyage. The samples will be analysed using targeted krill markers, group specific markers (e.g. mammal specific markers for detection of whales and seals) and broad metazoan specific markers to detect community composition. Results will contribute to horizontal and vertical krill distribution and abundance estimates, krill predator interactions and krill swarm composition.

We will undertake the following during the voyage:

- Seawater sampling at all CTD stations (5 L samples), from the surface to near bottom. Krill detection will be validated against CTD krill camera and krill light trap data (see above). The samples will be filtered on board and the filters immediately frozen for later genetic analyses.
- CTDs at some swarm study sites where possible (time-dependent) – to examine eDNA shed by krill (faeces, moults, etc) beneath krill swarms. No hydrochemistry measurements will be required at these sites.
- Surface seawater sampling via the underway seawater line at routine trawl sites – to compare eDNA detection of krill with traditional trawls.
- Surface seawater sampling at a small number of target trawl sites, as the ship moves away from the swarm – to assess how far the krill eDNA signal spreads horizontally from a swarm.
- During transit from Hobart to the survey area and on return, we will sample surface seawater for long-term eDNA biomonitoring.
- A number of krill moults from IGR experiments (see above) will also be sampled and frozen – for later genetic analyses of bacterial communities associated with krill (microbiome).

Results

Planning and execution of this huge campaign under extreme uncertainties during COVID Pandemic was a real challenge. With a great support and understanding by MNF and ASP we were able to tick all the boxes for our ticket items of our ambitious science project.

Overall survey design

The survey consisted of six acoustic line-transects to estimate krill biomass and to observe swarm behaviour across ecological and density gradients within the survey area south of 62°S and between 55° and 80° E. A single fine-scale ‘krill box’ acoustic and net survey were also conducted off the Mawson coast (~ 63° 20.52’ S 66° 25.8’E) to examine prey-field condition for predators at the spatial scale of ~10s of km (comprised of eight transects, each 35 nm in length with an inter-transect spacing of 5.2 nm). This area is a site with an established long-term monitoring program for penguins and flying seabirds.

In the main (large-scale) survey, all six transects coincide with the most easterly six transects surveyed during BROKE-West. The ‘krill box’ was in a similar location to previous small-scale surveys that examined krill dynamics and its relation to land-based predators.

Objective 1. Estimate biomass of krill, a key parameter for updating the precautionary catch limit for krill fishery in waters off a portion of Australia's Antarctic Territory.

and

Objective 2. Understand the relationship between krill density and distribution, in particular the form and number, and spatial arrangement of swarms.

Routine and targeted trawls were conducted using the Rectangular Mid-water Trawl (RMT) 8+1 net to collect biological information on krill including quantification of krill and other zooplankton, verification of the acoustic targets, and conducting live experiments (Table 1, Figure 1).

Summary statistic	**Number**
41 routine trawls conducted to sample zooplankton diversity	41 routine trawls
18 target trawls conducted to collect live Antarctic krill	18 target trawls
11 IGR experiments conducted with 3168 krill individuals jarred and 540 that moulted.	3168 krill individuals
500,000 krill eggs collected from ~80 gravid females from target trawls.	~500,000 krill eggs collected
4,000 early-stage larvae successfully maintained during voyage for use in AAD krill aquarium	>4,000 larval krill returned to AAD

Table 1. Krill biology and ecology survey summary stats

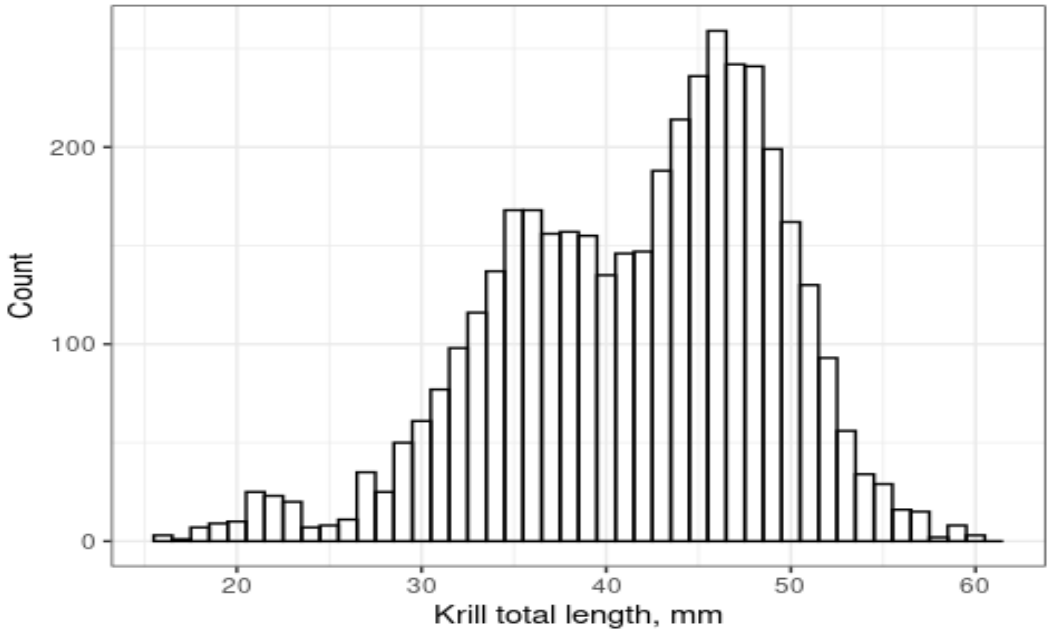


Figure 1. Length frequency distribution of krill combined from all hauls.

A successful cold-water calibration of the EK80 echosounder was undertaken at the start of the first survey transect (southern end of T1) on the 13th of February at 65° 31.47 S; 55° 02.99 E.

Acoustic survey data were collected on six north-south transects (T1-T6; 2826 km) and eight transects in the small-scale Mawson krill box at the southern end of transects T2 and T3 (M1-M8;

502 km) (Figure 2). All planned acoustic transects encountered ice at the south end and were shortened. The Mawson krill box transects were pre-emptively shifted north to avoid this, but ice movement still resulted in the southern ends being truncated.

Across the survey 18 target trawls were performed to confirm the species composition of acoustic marks.

When sufficient krill were caught (10-50 individuals), their sound speed and density were measured which will provide improved model target strength estimates for the krill observed in the region.

On survey transects additional acoustic equipment was either turned off (the bathymetric multibeam systems and ADCPs) or synchronised with the EK80 system to eliminate crosstalk or interference to the quantitative use of the echosounders. All EK80 echosounder data files, sound speed profiles, and catch data were transferred ashore (to AAD) in near real-time for krill biomass estimation.

All neccesary data were successfully collected but krill biomass will not be finalised until the survey, processing, and results are finally assessed by the CAMLR Scientific Committee in October 2021.

We successfully estimated biomass of krill for the region, and this was supported as best available krill estimate for the region by CCAMLR 's working group on Acoustic Survey and Analysis Method (WG-ASAM), and expected to be endorsed by the CCAMLR Scientific Committee annual meeting later this year to form the basis for updating CCAMLR's Conservation Measure for krill fishery for the region.

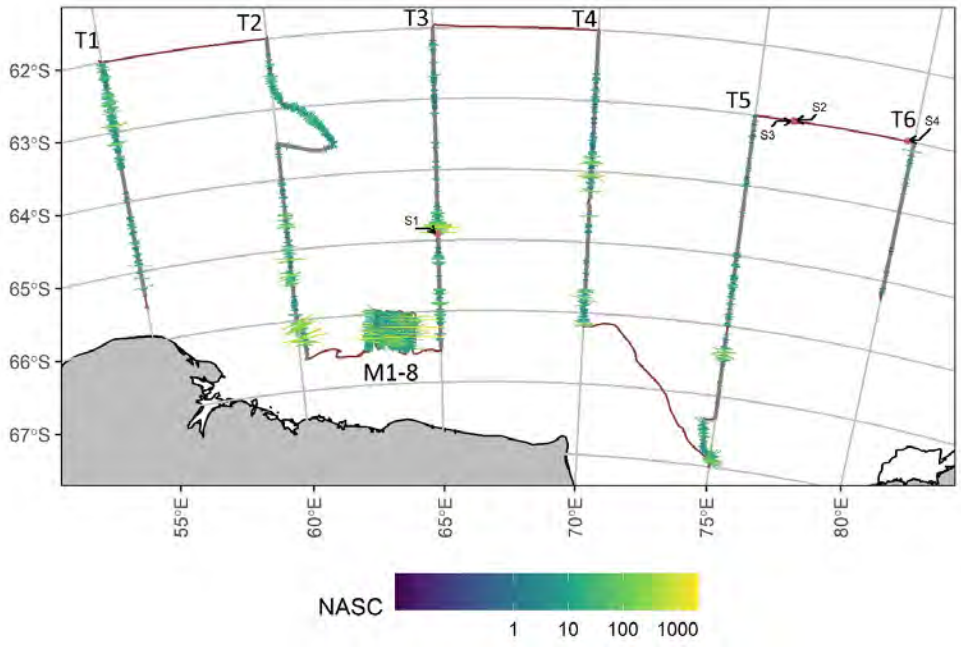


Figure 2. Distribution of Nautical Area Scattering Coefficients (NASC, m2 mni-2) from Antarctic krill observed on the survey transects. Transect names and the location of the swarm studies (S1-4) are also shown. Vessel path is shown by the red line.

Objective 3. Relate krill distribution and density to the distribution and activity of air-breathing krill predators including seabirds and marine mammals.

Cetacean observation:

A team of four cetacean observers undertook line transect distance sampling from an observation deck forward of and just below the bridge, with an average eye-height of ~18.4 m. The observers maintained line transect search effort during daylight hours, with a sea state ≤ 6, and with reasonable visibility. Observations were undertaken with both naked-eye and 7x50 binoculars, aided by 25 x 150 'big-eyes' binoculars for species and group size estimation. Observations of groups of animals consisted of estimates of radial distance (mostly derived from reticle binoculars) and angle from the vessel's heading, in addition to species, group size and composition, and group behaviour. Some informal effort was undertaken during marginal weather conditions, or when the vessel slowed for other sampling; informal effort was undertaken both on the bridge (average eye height of 20.7m) and on the observation deck. Two observers each searched a given side of the trackline, and a third, situated on the bridge, recorded effort and sightings.

A total of 2309 km of line transect distance sampling effort for cetaceans was achieved within the TEMPO survey area (see Figure 3), in addition to 838 km of informal sighting effort, yielding 479 sightings of approximately 1363 animals (see Table 2 and Figure 4). The most prevalent species observed was humpback whales, followed by fin whales; this includes ~80 humpback and fin whales observed in the vicinity of a large krill swarm between Transects 5 and 6.

Difar sonobuoys were deployed regularly along-track in order to record and detect the presence of vocalising animals. A total of 251 sonobuoys were deployed, with 199 of these functioning properly (Figure 5). These data were not analysed during the voyage.

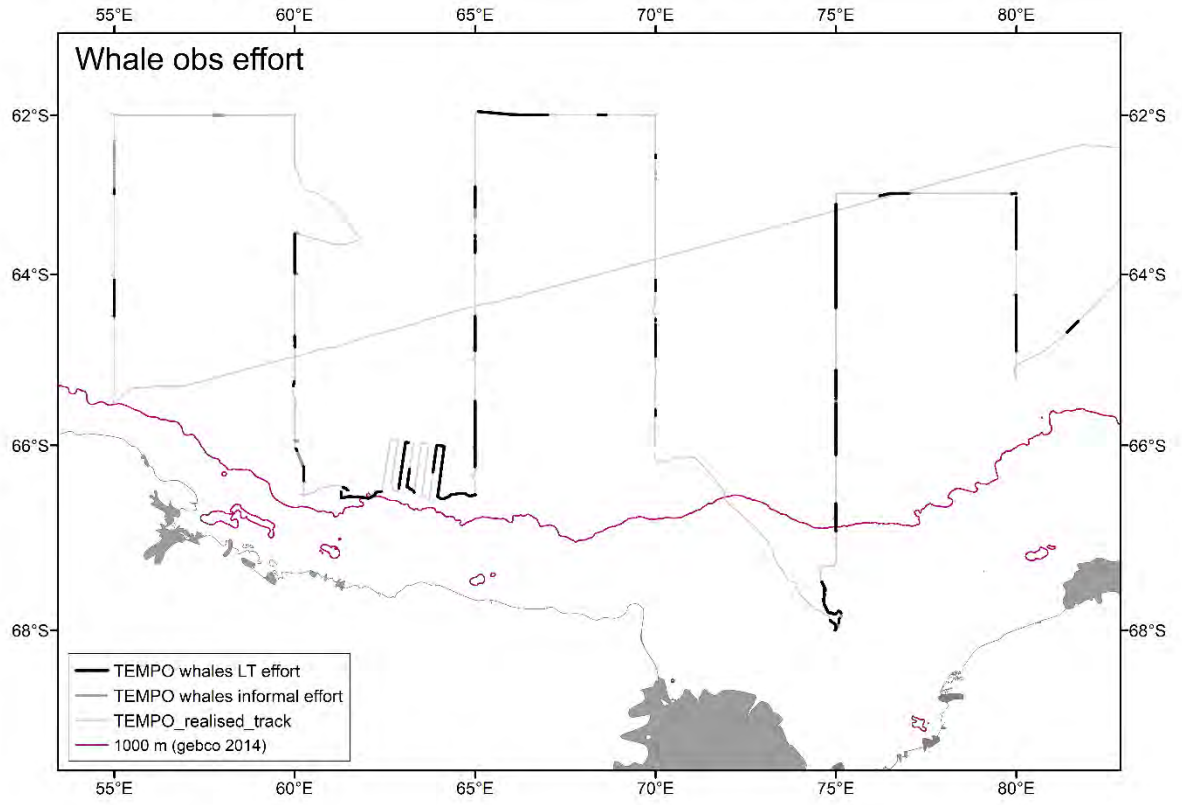


Figure 3 Distribution of line transect distance sampling effort (LT) undertaken by a team of marine mammal observers within the TEMPO survey area; the realised trackline is also shown, in addition to the 1000 m bathymetric contour, roughly indicating the location of the shelf-break.

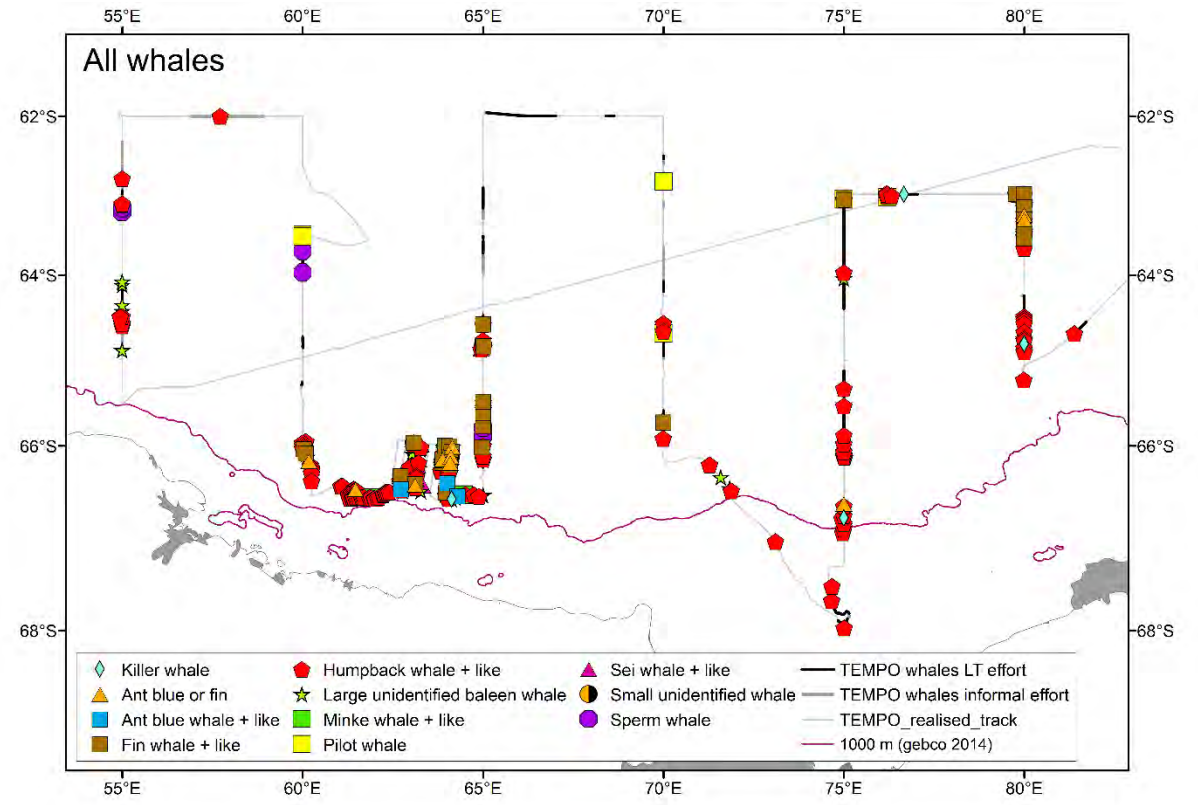


Figure 4 Distribution of cetacean sightings of various species undertaken during TEMPO. See Appendix 1 for more details on species groups.

Species	Sightings	Total animals
Antarctic Blue whale	1	2
Like Antarctic blue	1	1
Like blue whale	1	1
Fin whale	22	80
Like fin whale	16	37
Fin or blue	10	14
Humpback whale	175	395
Like humpback whale	40	65
Sei whale	15	32
Like sei whale	16	38
Antarctic minke whale	2	3
Like minke whale	1	1
Sperm whale	5	7
Like sperm whale	1	1

Species	Sightings	Total animals
Killer whale	6	35
Unid small whale	1	1
Unid large baleen	134	224
Unid whale	8	9
Unid large whale	8	8
Ziphiidae	1	2
Pilot whale	8	257
Cruciger dolphin	6	148
Southern Bottlenose whale	1	2
Total	479	1363

Table 2 Number of sightings of given species of cetaceans recorded during TEMPO voyage

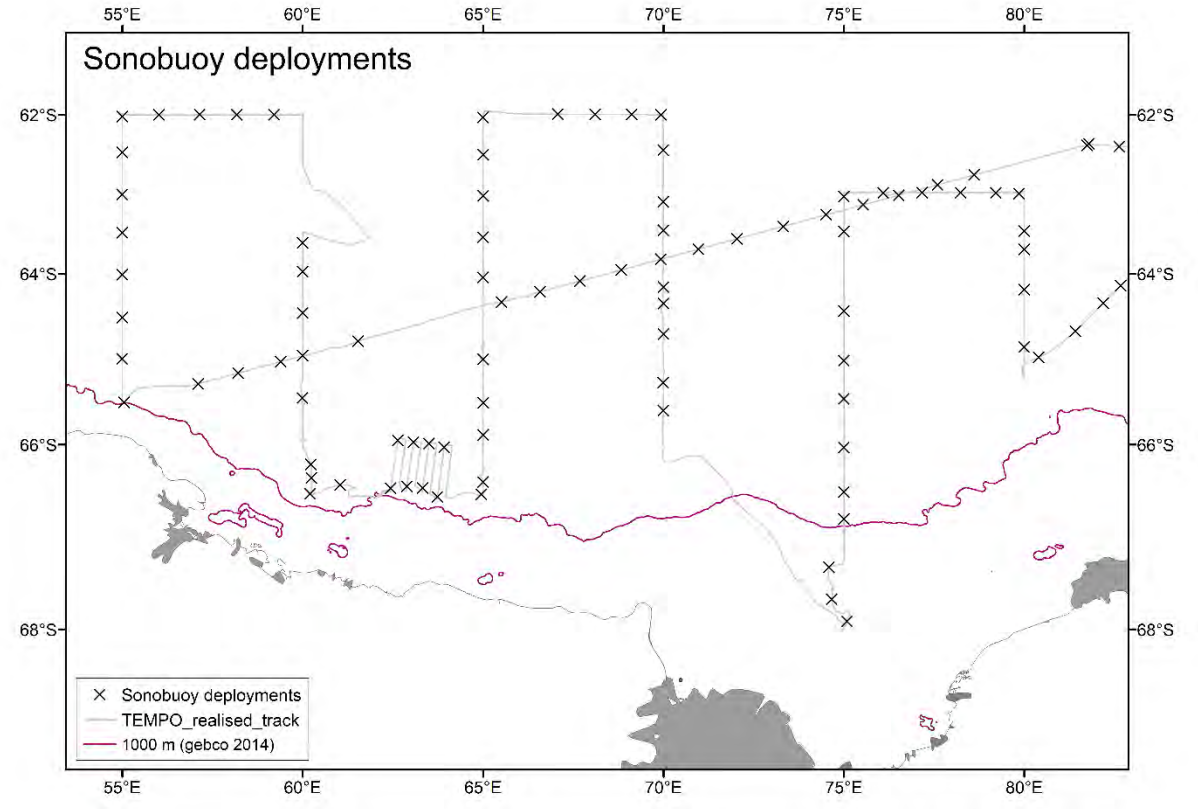


Figure 5 Location of successful Difar sonobuoys deployed during throughout the TEMPO voyage.

At-sea seabird observations:

Two seabird observers undertook observations from an enclosed observation deck above the bridge of the RV *Investigator* (approx. eye height of 24.3m), on the observation deck with the whale observers (approx. eye height of 18.4m) and astern on the same level as the observation deck.

Observing was undertaking during daylight hours, and during fair-excellent sighting conditions. Formal observing for seabirds was suspended when the vessel stopped/slowed for other sampling operations. During searching effort, one seabird observer scanned for seabirds and the other logged observations (via radio) in the enclosed observation above the bridge. Seabird searching effort was undertaken with naked-eye and with 10 x 42 binoculars. Observers searched in a 300 m quadrat on one side of the vessel (specific side could change, as was convenient). A number of different seabird observation processes were trialled during the TEMPO voyage, including continuous observations and a snapshot approach with distance sampling (which aims to minimise bias introduced by flying seabirds), and observations astern to try to account for 'followers'; it is hoped these trials will help guide development in the near future of methods for at-sea surveys for seabirds in East Antarctica.

Seabird observers achieved sighting effort along 3853 km of trackline, over 126 hrs, both within the TEMPO survey area, and along the transit home. Along track effort achieved by the seabird observers is given in Figure 6.

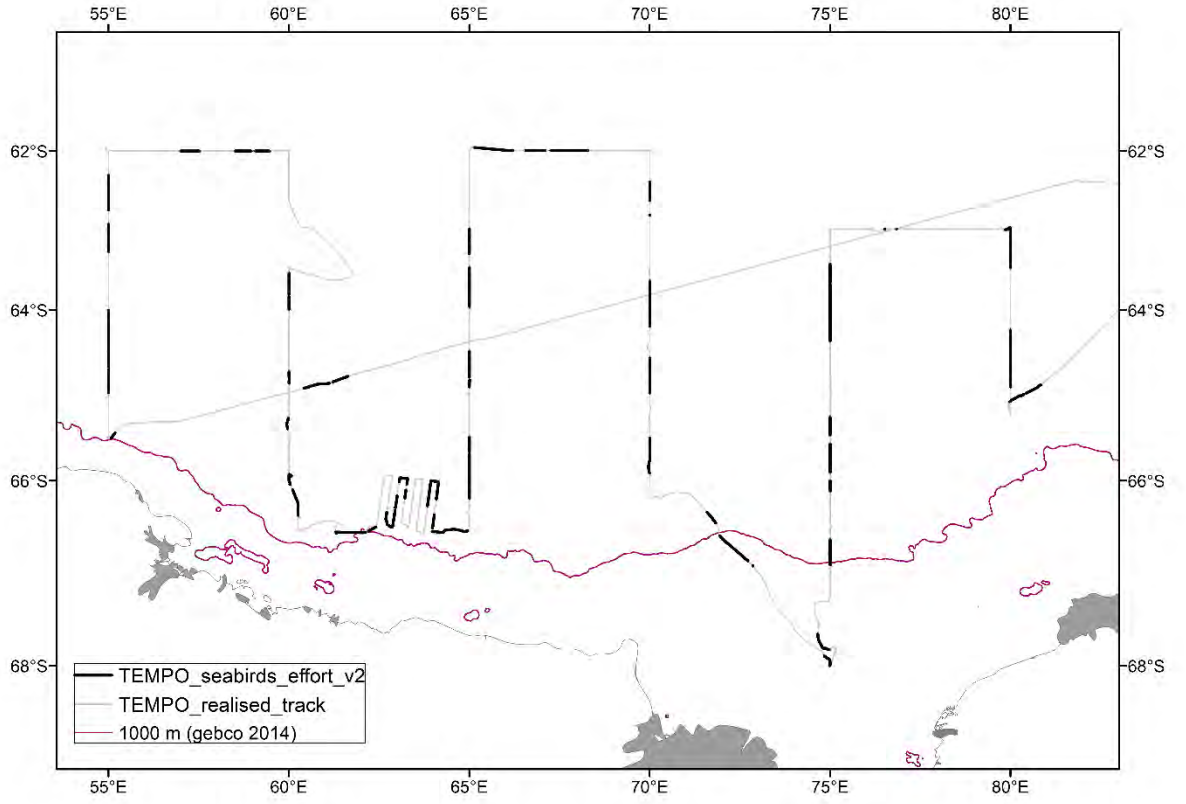


Figure 6 Distribution of along-track sighting effort achieved by seabird observers within the TEMPO survey area.

Objective 4. Track the movement of krill swarms in relation to the local current field in order to evaluate inter-swarm connectivity.

Four swarm studies were carried out during the voyage, one on a layer of krill and the others on large krill swarms (Figure 7). These swarms were mapped in 3D by conducting a detailed transect over the swarms using multi-beam echosounder ME70 to understand the entire structure of the swarm. Directions of the movement of the swarms and its velocities were monitored by tracking their movements from outside the swarm Sonar SH90.

The dimension of the largest swarm observed was 3.2km long and 300m wide, which falls under a category of superswarm. We observed 60 humpback whales and 23 fin whales within the 2 km range of the vessel when we were conducting the swarm survey.

Schooling behaviour at individual level within these swarms were also observed using the 3D video cameras and echosounder system (Swarm Study Camera System). Approximately 60 hours of video footage was collected for analysis. Preliminary observations show that the krill swarms fell into two broad categories – tight swarms under predator attack, and looser swarms on the move.

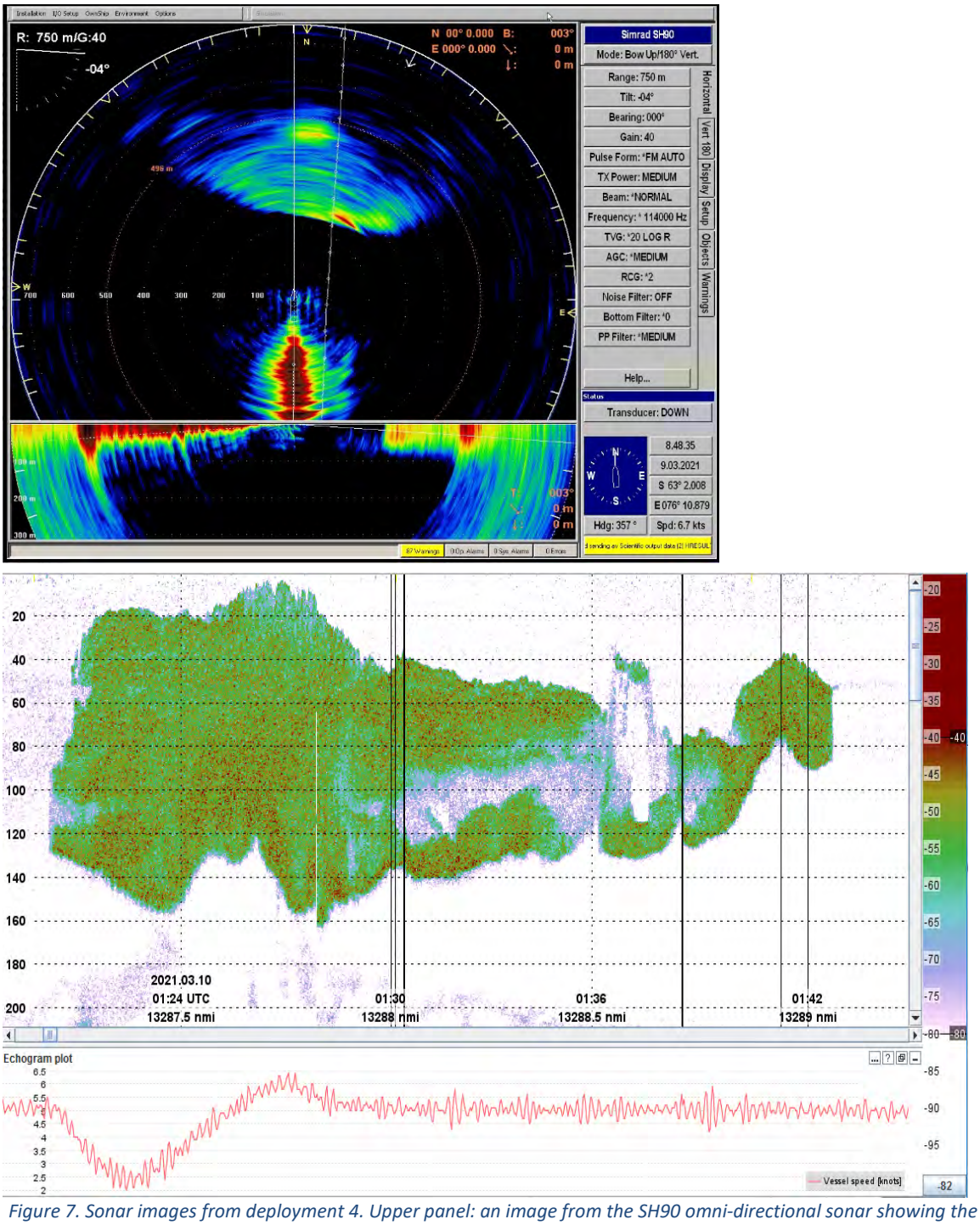


Figure 7. Sonar images from deployment 4. Upper panel: an image from the SH90 omni-directional sonar showing the krill swarm ahead of the vessel (green/blue region) as well as the S3 frame (small red mark) just inside the swarm. Lower panel: an echogram of the krill swarm, approximately 3.2 km in length. The S3 frame was deployed at the point where the upper boundary of the swarm was most shallow.

Objective 5. Obtain full depth vertical profiles of krill density to understand the distribution and contribution of deep-sea krill to the overall krill biomass and its dynamics in the region.

The objective of the Deep-CTD camera was to attract benthic krill and record their presence as well as record the nature of the sea floor habitat. Two video files were created from each CTD dip. These video files were examined during the voyage and interesting or important timestamps and events were recorded in a paper logbook.

The light trap had been deployed a total of 52 times and on its 50th deployment it successfully trapped 170 live krill at 380m depth. The trapped krill were sampled sampled for morphometrics, body condition and stable isotope analysis.

Krill Observational Moorings for Benthic Investigation (KOMBI) were deployed at a range of different seabeds, where they'll record krill at depths of up to 1500 metres over the next year or so, including when covered by ice during winter, giving completely new information (Table 3). These three are autonomous sea floor landers that are primarily intended to determine the importance of the benthic habitat for krill over an entire year. They are equipped with a biological echosounder and ADCP current meter looking upwards from the sea floor with a range of 300 metres for the ADCP and 400 m range for the echosounder 70-120 KHz. In addition, a video camera and lighting system records three minutes of video of the adjacent sea floor habitat every 5 hours. The lander also includes a CTD and a passive acoustics marine mammal recording system. To determine the best locations of the KOMBI deployments, the sea floor mapping multibeam echosounder was utilised to map high resolution bathymetry of the sea floor.

KOMBI #	Date (UTC)	Region	Latitude	Longitude	Depth (m)
001	21/02/2021	Mawson	66° S	62° E	800
002	21/02/2021	Mawson	66° S	62° E	1500
003	6/03/2021	Davis	66° S	75° E	400

Table 3. Approximate resting positions of the three deployed KOMBI landers

Objective 6. Improve our understanding of the connectivity of the krill population, and overlap between krill and predators, in order to design a tractable long-term monitoring plan and spatial management (small-scale management unit) of the krill fishery.

TEMPO Voyage successfully estimated krill biomass with a view to updating the precautionary catch limit for krill (Objective 1). Krill biomass, population, and its dynamics was studied at multiple scales (Objective 2 and 4). This will be linked to results of air-breathing predator observation (Objective 3) to help understanding of processes that relate to their interaction with the preyfield. These information will allow the design of a shorter (i.e., one- to two-week long), more tractable and sustainable krill monitoring program, critical to further understand the regional krill dynamics and predator-krill interactions. This monitoring program will provide assessments on year-to-year variation of the East Antarctic krill ecosystem for CCAMLR, ensuring harvesting is carried out in a sustainable manner into the future.

Objective 7. Oceanographic and biological (plankton) sampling in order to understand the habitat environment.

A total of 187 deployments were conducted during the voyage by the biological oceanography team together with the MNF. This included the deployment of 66 oceanographic CTDs (Figure 8) within the TEMPO survey region (including at 3 KOMBI sites and 1 Krill Swarm Study Process site); 3 Biogeochemical Argo float deployments; 9 core Argo floats; 5 NOAA Drifters and 104 eXpendable BathyThermographs (XBTs) (Table 4).

All CTD casts were conducted on transect/inter-transect transit with depths ranging from 300 to 4413 m. Of the 66 CTDs undertaken 51 were full depth to the seafloor and 15 casts were shallow depth casts to 1500m (n=10), 2250m (n=3 x BGC Argo sites) or 30m/300m (n=2 casts @ 1 x krill swarm study site).

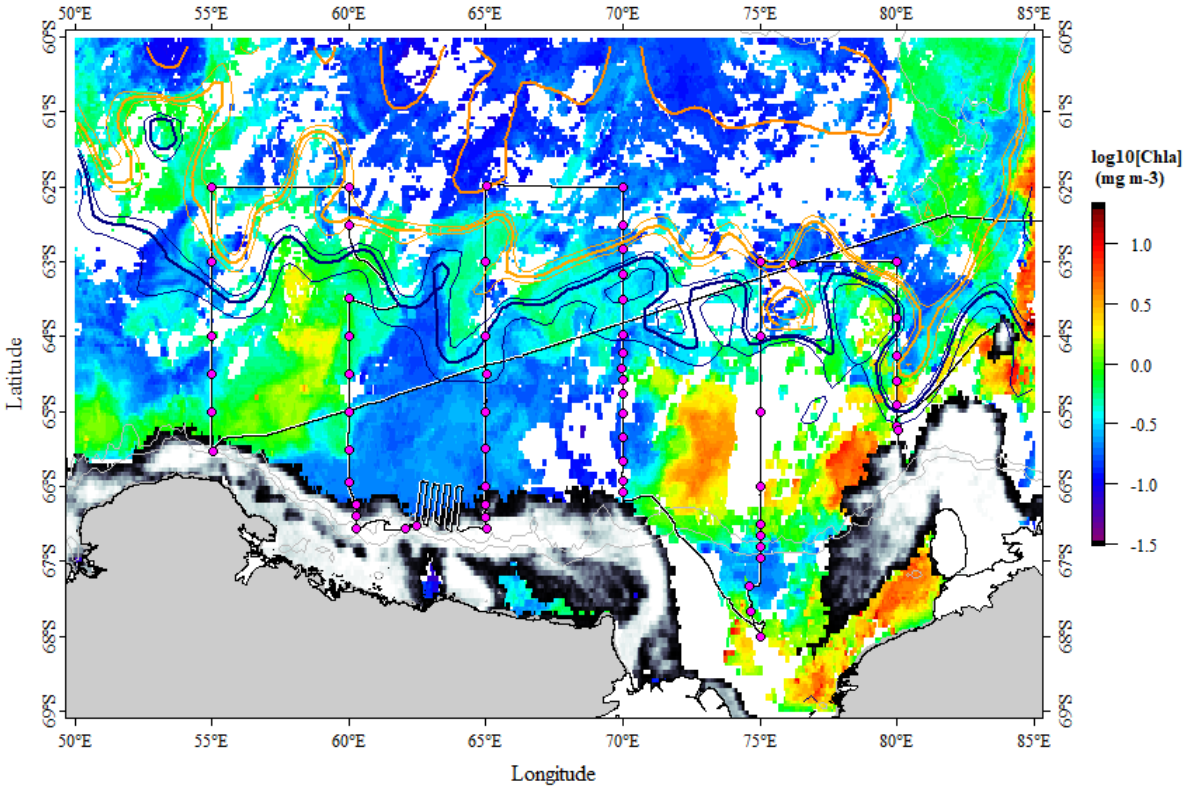


Figure 8. TEMPO voyage track (black) and location of 66 CTD stations (magenta) mapped against a background display of real time satellite data. Colour scale shows 4km resolution ocean colour indicative of surface phytoplankton (composite image 16 Feb – 5 Mar) with 3.125km sea ice concentration data shown in grayscale (image 6 Mar; darker indicates lower concentration). Streamlines depict satellite altimetry data (absolute dynamic topography) highlighting the vicinity of the Southern Boundary (navy) and the southern (SACCF-S; light orange) branch of the Southern ACC Front on 7 Mar.

Event/parameter	# Stations	# Samples	Storage	Analysis
CTD casts (n=66)				
Dissolved oxygen	65	1151	NA	On voyage
Salinity	65	1130	NA	On voyage
Nutrients	65	1208	NA	On voyage
DIC	50	522	Room temperature	CSIRO
Total alkalinity	27	288	Room temperature	CSIRO
HPLC	50	300	-135°C Nitrogen dewar	AAD
Lugols	50	100	Room temperature	AAD
POC	3	29	-80°C freezer	IMAS/CSIRO
Neodymium	1	2	4°C refrigeration	IMAS
Total		*4730*		
Routine underway sampling	# Days	# Samples	Storage	Analysis
HPLC	25	117	-135°C Nitrogen dewar	AAD
Lugols	25	24	Room temperature	AAD
Coccolithophores	25	49	Air dried	AAD
FIRe	53	Continuous	NA	IMAS
Carbon Plus (SOTS)	1	17	Frozen / stored	CSIRO
Total		*207*		
Float and drifter deployments	# Deployments			Organisation
BGC Argo floats	3			AAPP/IMOS
Core Argo floats	9			MNF/CSIRO
NOAA drifters	5			NOAA
XBT	104			MNF
Total	*121*			

Table 4. Biological oceanography sample summary during the TEMPO voyage in2021_v01.

Voyage narrative

RV *Investigator* departed from Hobart on 29 January 2021. Gear testing (RMT) was conducted on the 30th of January.

CPR tows and Sonobuoy deployment every 30 nm commenced from 30 January. Visual surveys for marine mammals and birds commenced training effort around 5 February 2021, on proper survey effort on 14 February (i.e., southern end of Transect 1), and continued throughout the voyage period during daylight hours, and during fair-good sighting conditions.

Recovery and deployment of Whales Buoy (i.e., passive acoustics mooring) was conducted 10 Feb (62° 23'S 81° 48'E), and trial CTD down to 3000m with deep CTD-camera was conducted on 6 Feb. (61° 14'S 105° 08'E)

Cold water acoustic calibration of EK80 was conducted on the 13 February (65° 31.47'S 55° 02.99'E) just prior to the commencement of the first acoustic transect.

RV *Investigator* was in the survey area from 13 Feb to 11 Mar where six broad scale systematic transects, and small scale active acoustic surveys, were conducted.

The southern-most point of each major transect line was dictated by the location of the sea ice edge (RV *Investigator* is 1C ice class). Northern ends of transects ended at the northern boundary of Division 58.4.2 East for transects 1-4 (62°S) or beyond for transects 5 and 6 (63°S) where the northern boundary is 64S. The Mawson krill box transects (M1-M8; 502km) between the end of transects T2 and T3 were pre-emptively shifted for the southern ends to approximately end at the ice edge.

Return transit commenced on the 12 March, and the ship returned to Hobart on the 24 March.

Outreach, education and communications activities

The TEMPO Voyage was very active in media and outreach and successfully raised the profile of the voyage and the importance of Southern Ocean Ecosystem studies both nationally and internationally through various media (see table below). Our outreach also included promoting the importance of gendar balance and diversity in workplace through demonstrating how the gendar balanced TEMPO science team worked together and generated excellent science. TEMPO voyage also took part in an educational event, Australian National Maritime Museum's Women in Science event, through live video link between the RV I*nvestigator* and inspired the next generation female scientists https://www.sea.museum/learn/school-excursions/special-programs/women-in-science.

Media engagements:

Print/Online	**TV**	**Radio**	**Web Blog/News Series**
7 News.com The Mercury x 3 Mirage News x 6 MSN National Tribune x 6 The West Australian x 2 ABC News x 2 The Market Herald Xinhua News PS News x 2 ABC Evenings	7 News ABC News Channel 10 Win News ABC News 24 NHK Japan	ABC Melbourne x 3 ABC Evenings ABC Hobart News ABC Northern Tas ABC Hobart Drive x 2	Australian Antarctic Program News x 4 https://www.antarctica.gov.au/news/2021/thanks-a-krillion-antarctic-voyage-delivers-breakthrough-research/ AAPP TEMPO Voyage Blog x 10 https://aappartnership.org.au/tempo/ CSIRO Scope x 1 https://blog.csiro.au/studying-antarctic-krill/ Pew Trust News article x 4 https://www.pewtrusts.org/en/research-and-analysis/articles/2021/04/30/scientists-deploy-new-technology-to-determine-krill-activity-on-east-antarctic-seafloor

Summary

The TEMPO Voyage was a multidisciplinary survey for the eastern sector of Division 58.4.2. The voyage successfully estimated biomass of krill for the region, and this was supported as best available krill estimate for the region by CCAMLR 's working group on Acoustic Survey and Analysis Method (WG-ASAM), and expected to be endorsed by the CCAMLR Scientific Committee annual meeting later this year to form the basis for updating CCAMLR's Conservation Measure for krill fishery for the region.

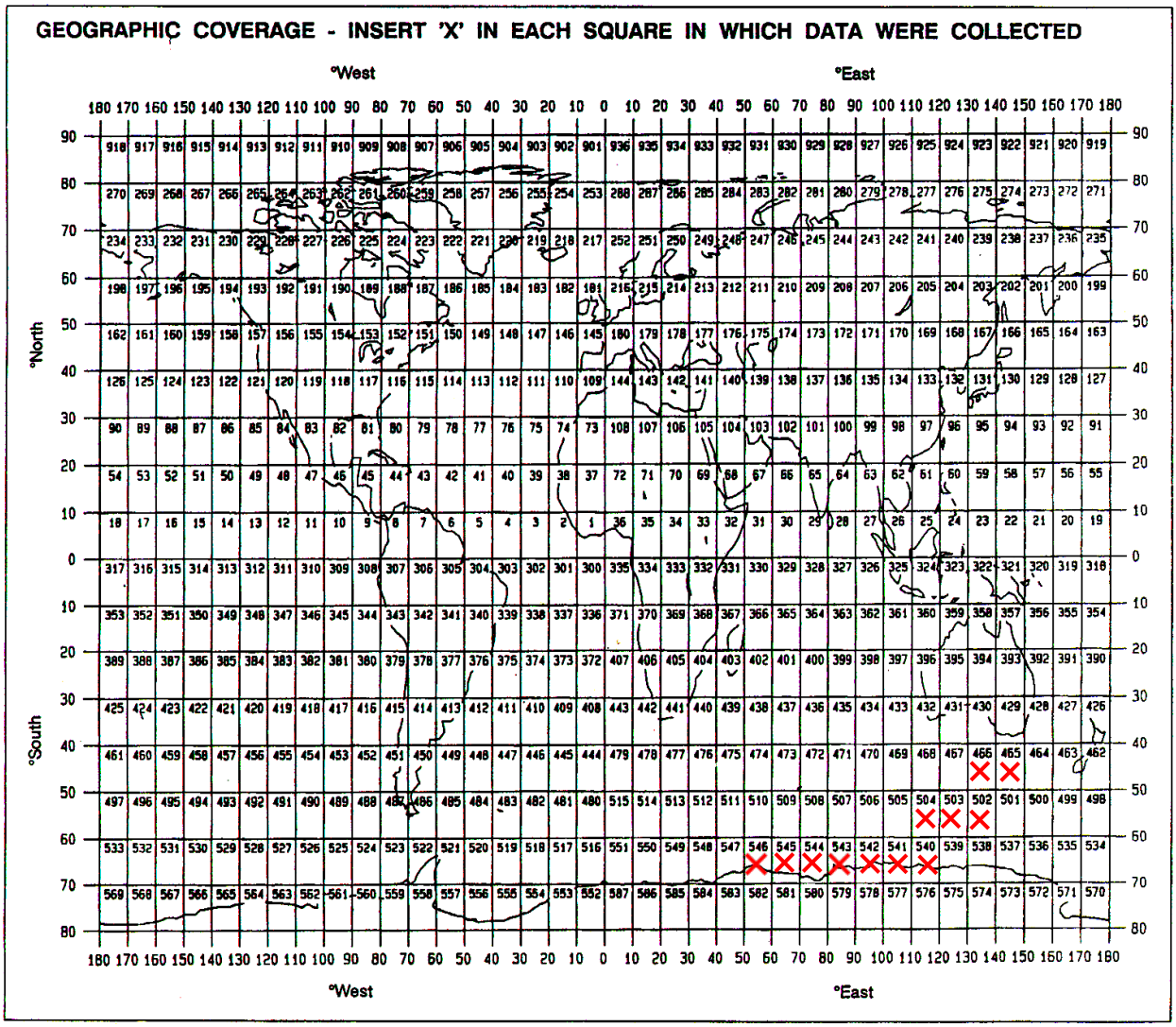
Along with acoustic survey we conducted net sampling, deployed swarm study system, deep-sea camera and light trap, deployed autonomous observatories (KOMBI Moorings) on the seafloor that will record the behaviour of krill throughout a full year to understand the dynamics and use of habitat in the surface layer as well as at seafloor.

Comprehensive oceanographic and biological (plankton) sampling were also conducted to understand the habitat environment for krill and predators, and observation of the predators was undertaken throughout the voyage to improve our understanding on their abundance and distribution in relation to distribution of krill in the region.

The information gathered from the voyage forms the basis of designing a tractable and sustainable long-term monitoring plan and to evaluate spatial management of the krill fishery.

TEMPO survey area was an uncharted territory for the RV Investigator in terms of endurance and weather/sea condition, and this was an invaluable experience for us all to plan for future voyages in the similar area/condition.

Marsden Squares



Moorings, bottom-mounted gear and drifting systems

ID	Date	APPROXIMATE POSITION (as degrees, decimal minutes)						DATA TYPE	DESCRIPTION
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2	30/01/2021 11:13	46	40.45	S	143	13.17	E	B26	Sonobuoy 4 : hydrophone sensor to collected directional passive acoustic data
3	30/01/2021 14:01	47	2.08	S	142	44.20	E	B26	Sonobuoy 5 : hydrophone sensor to collected directional passive acoustic data
4	30/01/2021 16:53	47	23.68	S	142	14.72	E	B26	Sonobuoy 6 : hydrophone sensor to collected directional passive acoustic data
5	30/01/2021 19:44	47	44.97	S	141	45.09	E	B26	Sonobuoy 7 : hydrophone sensor to collected directional passive acoustic data
6	30/01/2021 22:17	48	4.03	S	141	18.07	E	B26	Sonobuoy 8 : hydrophone sensor to collected directional passive acoustic data
7	31/01/2021 1:32	48	28.77	S	140	42.24	E	B26	Sonobuoy 9 : hydrophone sensor to collected directional passive acoustic data
8	31/01/2021 4:41	48	50.00	S	140	10.82	E	B26	Sonobuoy 10 : hydrophone sensor to collected directional passive acoustic data
9	31/01/2021 17:59	50	22.69	S	137	45.36	E	B26	Sonobuoy 11 : hydrophone sensor to collected directional passive acoustic data
10	31/01/2021 20:49	50	42.26	S	137	12.78	E	B26	Sonobuoy 12 : hydrophone sensor to collected directional passive acoustic data

ID	Date	APPROXIMATE POSITION (as degrees, decimal minutes)						DATA TYPE	DESCRIPTION
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		deg	min	N/S	deg	min	E/W		
11	31/01/2021 23:37	51	0.91	S	136	41.05	E	B26	Sonobuoy 13 : hydrophone sensor to collected directional passive acoustic data
12	1/02/2021 2:32	51	20.11	S	136	7.70	E	B26	Sonobuoy 14 : hydrophone sensor to collected directional passive acoustic data
13	1/02/2021 5:26	51	39.64	S	135	32.96	E	B26	Sonobuoy 15 : hydrophone sensor to collected directional passive acoustic data
14	1/02/2021 16:15	52	45.23	S	133	30.11	E	B26	Sonobuoy 16 : hydrophone sensor to collected directional passive acoustic data
15	1/02/2021 19:07	53	3.39	S	132	54.22	E	B26	Sonobuoy 17 : hydrophone sensor to collected directional passive acoustic data
16	1/02/2021 22:05	53	22.33	S	132	15.88	E	B26	Sonobuoy 18 : hydrophone sensor to collected directional passive acoustic data
17	2/02/2021 0:50	53	40.78	S	131	37.54	E	B26	Sonobuoy 20 : hydrophone sensor to collected directional passive acoustic data
18	3/02/2021 12:46	56	11.80	S	124	32.11	E	B26	Sonobuoy 21 : hydrophone sensor to collected directional passive acoustic data
19	3/02/2021 17:02	56	37.70	S	123	35.18	E	B26	Sonobuoy 22 : hydrophone sensor to collected directional passive acoustic data
20	4/02/2021 4:09	57	42.22	S	121	2.54	E	B26	Sonobuoy 24 : hydrophone sensor to collected directional passive acoustic data
21	4/02/2021 6:54	57	59.28	S	120	18.57	E	B26	Sonobuoy 25 : hydrophone sensor to collected directional passive acoustic data

ID	Date	APPROXIMATE POSITION (as degrees, decimal minutes)						DATA TYPE	DESCRIPTION
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23	4/02/2021 13:16	58	29.79	S	118	32.20	E	B26	Sonobuoy 28 : hydrophone sensor to collected directional passive acoustic data
24	5/02/2021 13:05	59	45.82	S	112	55.57	E	B26	Sonobuoy 29 : hydrophone sensor to collected directional passive acoustic data
25	5/02/2021 16:10	59	59.47	S	112	1.80	E	B26	Sonobuoy 30 : hydrophone sensor to collected directional passive acoustic data
26	5/02/2021 19:06	60	13.43	S	111	6.89	E	B26	Sonobuoy 31 : hydrophone sensor to collected directional passive acoustic data
27	5/02/2021 21:57	60	26.35	S	110	12.07	E	B26	Sonobuoy 32 : hydrophone sensor to collected directional passive acoustic data
28	6/02/2021 0:57	60	35.30	S	109	12.03	E	B26	Sonobuoy 33 : hydrophone sensor to collected directional passive acoustic data
29	6/02/2021 3:50	60	43.50	S	108	18.45	E	B26	Sonobuoy 34 : hydrophone sensor to collected directional passive acoustic data
30	6/02/2021 6:33	60	53.09	S	107	22.30	E	B26	Sonobuoy 35 : hydrophone sensor to collected directional passive acoustic data
31	6/02/2021 10:20	61	6.02	S	106	2.34	E	B26	Sonobuoy 37 : hydrophone sensor to collected directional passive acoustic data
32	6/02/2021 12:51	61	13.50	S	105	10.34	E	B26	Sonobuoy 38 : hydrophone sensor to collected directional passive acoustic data

ID	Date	APPROXIMATE POSITION (as degrees, decimal minutes)						DATA TYPE	DESCRIPTION
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34	7/02/2021 2:33	61	37.20	S	102	3.80	E	B26	Sonobuoy 44 : hydrophone sensor to collected directional passive acoustic data
35	7/02/2021 5:26	61	44.33	S	101	0.26	E	B26	Sonobuoy 46 : hydrophone sensor to collected directional passive acoustic data
36	7/02/2021 8:39	61	51.33	S	99	57.04	E	B26	Sonobuoy 47 : hydrophone sensor to collected directional passive acoustic data
37	7/02/2021 11:29	61	56.52	S	98	53.29	E	B26	Sonobuoy 49 : hydrophone sensor to collected directional passive acoustic data
38	7/02/2021 14:08	62	1.62	S	97	51.91	E	B26	Sonobuoy 50 : hydrophone sensor to collected directional passive acoustic data
39	7/02/2021 18:10	62	8.15	S	96	46.35	E	B26	Sonobuoy 51 : hydrophone sensor to collected directional passive acoustic data
40	7/02/2021 21:43	62	14.02	S	95	47.12	E	B26	Sonobuoy 53 : hydrophone sensor to collected directional passive acoustic data
41	8/02/2021 0:31	62	14.80	S	94	42.59	E	B26	Sonobuoy 54 : hydrophone sensor to collected directional passive acoustic data
42	8/02/2021 3:33	62	18.29	S	93	38.76	E	B26	Sonobuoy 55 : hydrophone sensor to collected directional passive acoustic data
43	8/02/2021 6:18	62	20.95	S	92	38.45	E	B26	Sonobuoy 56 : hydrophone sensor to collected directional passive acoustic data

ID	Date	APPROXIMATE POSITION (as degrees, decimal minutes)						DATA TYPE	DESCRIPTION
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45	8/02/2021 9:07	62	25.91	S	91	34.56	E	B26	Sonobuoy 58 : hydrophone sensor to collected directional passive acoustic data
46	8/02/2021 12:44	62	26.23	S	90	20.11	E	B26	Sonobuoy 60: hydrophone sensor to collected directional passive acoustic data
47	8/02/2021 15:42	62	26.92	S	89	18.79	E	B26	Sonobuoy 61 : hydrophone sensor to collected directional passive acoustic data
48	9/02/2021 0:01	62	28.24	S	87	9.65	E	B26	Sonobuoy 63 : hydrophone sensor to collected directional passive acoustic data
49	9/02/2021 2:37	62	28.46	S	86	6.91	E	B26	Sonobuoy 65 : hydrophone sensor to collected directional passive acoustic data
50	9/02/2021 5:36	62	27.53	S	84	58.13	E	B26	Sonobuoy 66 : hydrophone sensor to collected directional passive acoustic data
51	9/02/2021 8:16	62	27.07	S	83	54.98	E	B26	Sonobuoy 68 : hydrophone sensor to collected directional passive acoustic data
52	9/02/2021 11:29	62	24.79	S	82	38.15	E	B26	Sonobuoy 69 : hydrophone sensor to collected directional passive acoustic data
53	9/02/2021 14:58	62	22.72	S	81	47.38	E	B26	Sonobuoy 70 : hydrophone sensor to collected directional passive acoustic data
54	9/02/2021 23:48	62	23.74	S	81	44.34	E	B26	Sonobuoy 71 : hydrophone sensor to collected directional passive acoustic data

ID	Date	APPROXIMATE POSITION (as degrees, decimal minutes)						DATA TYPE	DESCRIPTION
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55	10/02/2021 5:34	62	39.08	S	79	36.60	E	B26	Sonobuoy 73 : hydrophone sensor to collected directional passive acoustic data
56	10/02/2021 8:18	62	46.45	S	78	36.89	E	B26	Sonobuoy 74: hydrophone sensor to collected directional passive acoustic data
57	10/02/2021 11:03	62	54.01	S	77	35.39	E	B26	Sonobuoy 75 : hydrophone sensor to collected directional passive acoustic data
58	10/02/2021 13:52	63	1.85	S	76	31.31	E	B26	Sonobuoy 76 : hydrophone sensor to collected directional passive acoustic data
59	10/02/2021 16:32	63	9.08	S	75	31.97	E	B26	Sonobuoy 77 : hydrophone sensor to collected directional passive acoustic data
60	10/02/2021 21:10	63	16.55	S	74	30.35	E	B26	Sonobuoy 78 : hydrophone sensor to collected directional passive acoustic data
61	11/02/2021 0:59	63	25.16	S	73	19.14	E	B26	Sonobuoy 79 : hydrophone sensor to collected directional passive acoustic data
62	11/02/2021 4:22	63	34.37	S	72	2.36	E	B26	Sonobuoy 80 : hydrophone sensor to collected directional passive acoustic data
63	11/02/2021 7:06	63	42.05	S	70	58.15	E	B26	Sonobuoy 81 : hydrophone sensor to collected directional passive acoustic data
64	11/02/2021 9:42	63	49.48	S	69	55.68	E	B26	Sonobuoy 82 : hydrophone sensor to collected directional passive acoustic data
65	11/02/2021 12:24	63	57.09	S	68	51.44	E	B26	Sonobuoy 83 : hydrophone sensor to collected directional passive acoustic data

ID	Date	APPROXIMATE POSITION (as degrees, decimal minutes)						DATA TYPE	DESCRIPTION
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		deg	min	N/S	deg	min	E/W		
66	11/02/2021 12:29	63	57.31	S	68	49.61	E	B26	Sonobuoy 84 : hydrophone sensor to collected directional passive acoustic data
67	11/02/2021 15:28	64	5.38	S	67	41.10	E	B26	Sonobuoy 85 : hydrophone sensor to collected directional passive acoustic data
68	11/02/2021 18:59	64	13.20	S	66	34.45	E	B26	Sonobuoy 86 : hydrophone sensor to collected directional passive acoustic data
69	11/02/2021 22:56	64	20.54	S	65	30.59	E	B26	Sonobuoy 87 : hydrophone sensor to collected directional passive acoustic data
70	12/02/2021 1:37	64	26.80	S	64	26.29	E	B26	Sonobuoy 88 : hydrophone sensor to collected directional passive acoustic data
71	12/02/2021 4:57	64	37.06	S	63	8.69	E	B26	Sonobuoy 91 : hydrophone sensor to collected directional passive acoustic data
72	12/02/2021 8:47	64	48.62	S	61	32.33	E	B26	Sonobuoy 92 : hydrophone sensor to collected directional passive acoustic data
73	12/02/2021 11:25	64	55.94	S	60	26.88	E	B26	Sonobuoy 93 : hydrophone sensor to collected directional passive acoustic data
74	12/02/2021 13:57	65	2.88	S	59	25.53	E	B26	Sonobuoy 94 : hydrophone sensor to collected directional passive acoustic data
75	12/02/2021 16:51	65	10.88	S	58	12.90	E	B26	Sonobuoy 94.1 : hydrophone sensor to collected directional passive acoustic data
76	12/02/2021 19:35	65	18.42	S	57	6.00	E	B26	Sonobuoy 95 : hydrophone sensor to collected directional passive acoustic data

ID	Date	APPROXIMATE POSITION (as degrees, decimal minutes)						DATA TYPE	DESCRIPTION
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		deg	min	N/S	deg	min	E/W		
77	12/02/2021 23:46	65	20.60	S	55	48.75	E	B26	Sonobuoy 96 : hydrophone sensor to collected directional passive acoustic data
78	13/02/2021 4:59	65	31.37	S	55	3.19	E	B26	Sonobuoy 97 : hydrophone sensor to collected directional passive acoustic data
79	13/02/2021 19:46	65	2.03	S	55	0.00	E	B26	Sonobuoy 98 : hydrophone sensor to collected directional passive acoustic data
80	14/02/2021 5:15	64	31.73	S	55	0.00	E	B26	Sonobuoy 99 : hydrophone sensor to collected directional passive acoustic data
81	14/02/2021 14:27	64	0.70	S	55	0.00	E	B26	Sonobuoy 100 : hydrophone sensor to collected directional passive acoustic data
82	15/02/2021 0:47	63	29.73	S	54	59.99	E	B26	Sonobuoy 101 : hydrophone sensor to collected directional passive acoustic data
83	15/02/2021 4:24	63	1.20	S	55	0.00	E	B26	Sonobuoy 102 : hydrophone sensor to collected directional passive acoustic data
84	15/02/2021 12:05	62	29.11	S	55	0.00	E	B26	Sonobuoy 103 : hydrophone sensor to collected directional passive acoustic data
85	15/02/2021 15:36	62	1.54	S	55	0.00	E	B26	Sonobuoy 104 : hydrophone sensor to collected directional passive acoustic data
86	15/02/2021 23:09	62	0.00	S	56	1.00	E	B26	Sonobuoy 105 : hydrophone sensor to collected directional passive acoustic data
87	16/02/2021 2:48	62	0.00	S	57	8.58	E	B26	Sonobuoy 107 : hydrophone sensor to collected directional passive acoustic data

ID	Date	APPROXIMATE POSITION (as degrees, decimal minutes)						DATA TYPE	DESCRIPTION
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		deg	min	N/S	deg	min	E/W		
88	16/02/2021 6:05	62	0.00	S	58	10.50	E	B26	Sonobuoy 108 : hydrophone sensor to collected directional passive acoustic data
89	16/02/2021 9:26	62	0.00	S	59	12.46	E	B26	Sonobuoy 109 : hydrophone sensor to collected directional passive acoustic data
90	16/02/2021 12:01	61	59.98	S	59	57.19	E	B26	Sonobuoy 110 : hydrophone sensor to collected directional passive acoustic data
91	18/02/2021 5:42	63	29.88	S	60	0.11	E	B26	Sonobuoy 111 : hydrophone sensor to collected directional passive acoustic data
92	18/02/2021 6:35	63	37.32	S	60	0.00	E	B26	Sonobuoy 113 : hydrophone sensor to collected directional passive acoustic data
93	18/02/2021 9:04	63	58.43	S	60	0.00	E	B26	Sonobuoy 114 : hydrophone sensor to collected directional passive acoustic data
94	18/02/2021 18:09	64	28.54	S	60	0.00	E	B26	Sonobuoy 115 : hydrophone sensor to collected directional passive acoustic data
95	19/02/2021 4:44	64	58.58	S	60	0.00	E	B26	Sonobuoy 116 : hydrophone sensor to collected directional passive acoustic data
96	19/02/2021 13:10	65	28.26	S	59	59.65	E	B26	Sonobuoy 117 : hydrophone sensor to collected directional passive acoustic data
97	20/02/2021 8:00	66	13.44	S	60	13.43	E	B26	Sonobuoy 118 : hydrophone sensor to collected directional passive acoustic data
98	20/02/2021 12:39	66	22.49	S	60	15.00	E	B26	Sonobuoy 119 : hydrophone sensor to collected directional passive acoustic data

ID	Date	APPROXIMATE POSITION (as degrees, decimal minutes)						DATA TYPE	DESCRIPTION
		LATITUDE			LONGITUDE				
		deg	min	N/S	deg	min	E/W		
99	20/02/2021 21:55	66	62.96	S	60	12.27	E	B26	Sonobuoy 120 : hydrophone sensor to collected directional passive acoustic data
100	21/02/2021 17:03	66	29.36	S	62	26.19	E	B26	Sonobuoy 122 : hydrophone sensor to collected directional passive acoustic data
101	21/02/2021 21:59	65	57.31	S	62	38.58	E	B26	Sonobuoy 123 : hydrophone sensor to collected directional passive acoustic data
102	22/02/2021 7:15	65	58.58	S	63	4.24	E	B26	Sonobuoy 126 : hydrophone sensor to collected directional passive acoustic data
103	22/02/2021 12:55	66	29.13	S	63	19.63	E	B26	Sonobuoy 127 : hydrophone sensor to collected directional passive acoustic data
104	22/02/2021 16:29	65	59.32	S	63	30.09	E	B26	Sonobuoy 129 : hydrophone sensor to collected directional passive acoustic data
105	22/02/2021 23:36	66	35.14	S	63	44.23	E	B26	Sonobuoy 130 : hydrophone sensor to collected directional passive acoustic data
106	23/02/2021 3:38	66	1.95	S	63	55.33	E	B26	Sonobuoy 131 : hydrophone sensor to collected directional passive acoustic data
107	23/02/2021 8:33	66	35.02	S	64	0.40	E	B26	Sonobuoy 132 : hydrophone sensor to collected directional passive acoustic data
108	23/02/2021 11:22	66	33.43	S	64	56.96	E	B26	Sonobuoy 133 : hydrophone sensor to collected directional passive acoustic data
109	23/02/2021 16:15	66	25.12	S	64	59.99	E	B26	Sonobuoy 134 : hydrophone sensor to collected directional passive acoustic data

ID	Date	APPROXIMATE POSITION (as degrees, decimal minutes)						DATA TYPE	DESCRIPTION
		LATITUDE			LONGITUDE				
		deg	min	N/S	deg	min	E/W		
110	24/02/2021 9:33	65	53.50	S	65	0.00	E	B26	Sonobuoy 136 : hydrophone sensor to collected directional passive acoustic data
111	24/02/2021 12:05	65	31.60	S	65	0.00	E	B26	Sonobuoy 137 : hydrophone sensor to collected directional passive acoustic data
112	24/02/2021 20:18	65	1.22	S	65	0.00	E	B26	Sonobuoy 138 : hydrophone sensor to collected directional passive acoustic data
113	25/02/2021 11:01	64	32.21	S	65	0.00	E	B26	Sonobuoy 139 : hydrophone sensor to collected directional passive acoustic data
114	25/02/2021 20:18	64	2.75	S	65	0.00	E	B26	Sonobuoy 140 : hydrophone sensor to collected directional passive acoustic data
115	26/02/2021 5:12	63	33.19	S	65	0.01	E	B26	Sonobuoy 141 : hydrophone sensor to collected directional passive acoustic data
116	26/02/2021 9:33	63	2.33	S	65	0.00	E	B26	Sonobuoy 142 : hydrophone sensor to collected directional passive acoustic data
117	26/02/2021 17:01	62	31.05	S	65	0.00	E	B26	Sonobuoy 143 : hydrophone sensor to collected directional passive acoustic data
118	26/02/2021 21:53	62	2.11	S	65	0.00	E	B26	Sonobuoy 144 : hydrophone sensor to collected directional passive acoustic data
119	44254.19348	61	59.54	S	66	5.10	E	B26	Sonobuoy 146 : hydrophone sensor to collected directional passive acoustic data
120	27/02/2021 7:57	61	59.66	S	67	4.51	E	B26	Sonobuoy 147 : hydrophone sensor to collected directional passive acoustic data

ID	Date	APPROXIMATE POSITION (as degrees, decimal minutes)						DATA TYPE	DESCRIPTION
		LATITUDE			LONGITUDE				
		deg	min	N/S	deg	min	E/W		
121	27/02/2021 11:18	61	59.78	S	68	6.56	E	B26	Sonobuoy 148 : hydrophone sensor to collected directional passive acoustic data
122	27/02/2021 14:36	61	59.90	S	69	7.24	E	B26	Sonobuoy 149 : hydrophone sensor to collected directional passive acoustic data
123	27/02/2021 17:26	62	0.00	S	69	55.95	E	B26	Sonobuoy 150 : hydrophone sensor to collected directional passive acoustic data
124	28/02/2021 0:47	62	27.52	S	70	0.00	E	B26	Sonobuoy 152 : hydrophone sensor to collected directional passive acoustic data
125	28/02/2021 12:11	63	6.82	S	70	0.00	E	B26	Sonobuoy 153 : hydrophone sensor to collected directional passive acoustic data
126	1/03/2021 4:11	63	55.64	S	70	0.00	E	B26	Sonobuoy 155 : hydrophone sensor to collected directional passive acoustic data
127	1/03/2021 12:25	64	9.77	S	70	0.00	E	B26	Sonobuoy 156 : hydrophone sensor to collected directional passive acoustic data
128	1/03/2021 19:11	64	21.53	S	70	0.00	E	B26	Sonobuoy 157 : hydrophone sensor to collected directional passive acoustic data
129	2/03/2021 5:35	64	43.51	S	70	0.00	E	B26	Sonobuoy 158 : hydrophone sensor to collected directional passive acoustic data
130	2/03/2021 18:16	65	17.53	S	69	59.27	E	B26	Sonobuoy 159 : hydrophone sensor to collected directional passive acoustic data
131	3/03/2021 1:32	65	36.87	S	70	0.00	E	B26	Sonobuoy 160 : hydrophone sensor to collected directional passive acoustic data

ID	Date	APPROXIMATE POSITION (as degrees, decimal minutes)						DATA TYPE	DESCRIPTION
		LATITUDE			LONGITUDE				
		deg	min	N/S	deg	min	E/W		
132	5/03/2021 8:25	67	41.06	S	74	39.82	E	B26	Sonobuoy 163 : hydrophone sensor to collected directional passive acoustic data
133	5/03/2021 13:58	67	20.86	S	74	35.26	E	B26	Sonobuoy 164 : hydrophone sensor to collected directional passive acoustic data
134	6/03/2021 4:05	66	49.40	S	75	0.00	E	B26	Sonobuoy 165 : hydrophone sensor to collected directional passive acoustic data
135	6/03/2021 14:49	66	31.91	S	75	0.00	E	B26	Sonobuoy 166 : hydrophone sensor to collected directional passive acoustic data
136	7/03/2021 1:50	66	2.07	S	75	0.00	E	B26	Sonobuoy 168 : hydrophone sensor to collected directional passive acoustic data
137	7/03/2021 10:12	65	28.82	S	75	0.00	E	B26	Sonobuoy 169 : hydrophone sensor to collected directional passive acoustic data
138	7/03/2021 13:24	65	2.18	S	75	0.01	E	B26	Sonobuoy 170 : hydrophone sensor to collected directional passive acoustic data
139	8/03/2021 0:20	64	27.18	S	75	0.00	E	B26	Sonobuoy 172 : hydrophone sensor to collected directional passive acoustic data
140	8/03/2021 3:15	64	2.07	S	75	0.00	E	B26	Sonobuoy 173 : hydrophone sensor to collected directional passive acoustic data
141	8/03/2021 10:05	63	28.95	S	75	0.00	E	B26	Sonobuoy 174 : hydrophone sensor to collected directional passive acoustic data
142	8/03/2021 13:22	63	2.68	S	75	0.00	E	B26	Sonobuoy 175 : hydrophone sensor to collected directional passive acoustic data

ID	Date	APPROXIMATE POSITION (as degrees, decimal minutes)						DATA TYPE	DESCRIPTION
		LATITUDE			LONGITUDE				
		deg	min	N/S	deg	min	E/W		
143	8/03/2021 21:13	63	0.00	S	76	5.57	E	B26	Sonobuoy 176 : hydrophone sensor to collected directional passive acoustic data
144	9/03/2021 13:32	63	0.00	S	77	10.19	E	B26	Sonobuoy 177 : hydrophone sensor to collected directional passive acoustic data
145	9/03/2021 18:00	63	0.01	S	78	14.25	E	B26	Sonobuoy 178 : hydrophone sensor to collected directional passive acoustic data
146	9/03/2021 21:10	63	0.00	S	79	12.77	E	B26	Sonobuoy 179 : hydrophone sensor to collected directional passive acoustic data
147	10/03/2021 4:43	63	0.68	S	79	51.18	E	B26	Sonobuoy 180 : hydrophone sensor to collected directional passive acoustic data
148	10/03/2021 11:32	63	28.70	S	80	0.00	E	B26	Sonobuoy 181 : hydrophone sensor to collected directional passive acoustic data
149	10/03/2021 13:07	63	42.28	S	79	59.99	E	B26	Sonobuoy 182 : hydrophone sensor to collected directional passive acoustic data
150	10/03/2021 21:38	64	11.71	S	80	0.00	E	B26	Sonobuoy 183 : hydrophone sensor to collected directional passive acoustic data
151	11/03/2021 11:12	64	52.56	S	80	0.00	E	B26	Sonobuoy 184 : hydrophone sensor to collected directional passive acoustic data
152	12/03/2021 5:54	64	59.97	S	80	24.19	E	B26	Sonobuoy 185 : hydrophone sensor to collected directional passive acoustic data
153	12/03/2021 10:27	64	41.50	S	81	24.98	E	B26	Sonobuoy 186 : hydrophone sensor to collected directional passive acoustic data

ID	Date	APPROXIMATE POSITION (as degrees, decimal minutes)						DATA TYPE	DESCRIPTION
		LATITUDE			LONGITUDE				
		deg	min	N/S	deg	min	E/W		
154	12/03/2021 13:44	64	21.39	S	82	11.49	E	B26	Sonobuoy 188 : hydrophone sensor to collected directional passive acoustic data
155	12/03/2021 16:08	64	9.01	S	82	39.64	E	B26	Sonobuoy 188.1 : hydrophone sensor to collected directional passive acoustic data
156	12/03/2021 16:11	64	8.84	S	82	40.02	E	B26	Sonobuoy 189 : hydrophone sensor to collected directional passive acoustic data
157	12/03/2021 16:14	64	8.64	S	82	40.47	E	B26	Sonobuoy 190 : hydrophone sensor to collected directional passive acoustic data
158	12/03/2021 19:06	63	57.16	S	83	11.40	E	B26	Sonobuoy 191 : hydrophone sensor to collected directional passive acoustic data
159	12/03/2021 23:43	63	44.24	S	84	8.93	E	B26	Sonobuoy 192 : hydrophone sensor to collected directional passive acoustic data
160	13/03/2021 3:00	63	39.13	S	85	10.32	E	B26	Sonobuoy 193 : hydrophone sensor to collected directional passive acoustic data
161	13/03/2021 6:52	63	33.11	S	86	19.06	E	B26	Sonobuoy 194 : hydrophone sensor to collected directional passive acoustic data
162	13/03/2021 10:22	63	27.20	S	87	27.69	E	B26	Sonobuoy 195 : hydrophone sensor to collected directional passive acoustic data
163	13/03/2021 13:45	63	21.80	S	88	32.37	E	B26	Sonobuoy 196 : hydrophone sensor to collected directional passive acoustic data
164	13/03/2021 15:58	63	18.05	S	89	13.72	E	B26	Sonobuoy 197 : hydrophone sensor to collected directional passive acoustic data

ID	Date	APPROXIMATE POSITION (as degrees, decimal minutes)						DATA TYPE	DESCRIPTION
		LATITUDE			LONGITUDE				
		deg	min	N/S	deg	min	E/W		
165	13/03/2021 19:12	63	14.43	S	90	2.88	E	B26	Sonobuoy 198 : hydrophone sensor to collected directional passive acoustic data
166	13/03/2021 22:48	63	7.71	S	91	4.83	E	B26	Sonobuoy 199 : hydrophone sensor to collected directional passive acoustic data
167	14/03/2021 2:15	63	2.80	S	92	18.21	E	B26	Sonobuoy 200 : hydrophone sensor to collected directional passive acoustic data
168	14/03/2021 4:55	62	56.79	S	93	17.66	E	B26	Sonobuoy 201 : hydrophone sensor to collected directional passive acoustic data
169	14/03/2021 9:01	62	49.43	S	94	46.34	E	B26	Sonobuoy 202 : hydrophone sensor to collected directional passive acoustic data
170	14/03/2021 9:04	62	49.34	S	94	47.32	E	B26	Sonobuoy 203 : hydrophone sensor to collected directional passive acoustic data
171	14/03/2021 12:03	62	43.24	S	95	51.60	E	B26	Sonobuoy 205 : hydrophone sensor to collected directional passive acoustic data
172	14/03/2021 15:00	62	37.33	S	96	53.18	E	B26	Sonobuoy 206 : hydrophone sensor to collected directional passive acoustic data
173	14/03/2021 16:04	62	35.85	S	97	15.11	E	B26	Sonobuoy 207 : hydrophone sensor to collected directional passive acoustic data
174	14/03/2021 19:00	62	30.54	S	98	14.91	E	B26	Sonobuoy 208 : hydrophone sensor to collected directional passive acoustic data
175	14/03/2021 22:12	62	24.80	S	99	22.19	E	B26	Sonobuoy 209 : hydrophone sensor to collected directional passive acoustic data

ID	Date	APPROXIMATE POSITION (as degrees, decimal minutes)						DATA TYPE	DESCRIPTION
		LATITUDE			LONGITUDE				
		deg	min	N/S	deg	min	E/W		
176	15/03/2021 0:56	62	18.33	S	100	22.75	E	B26	Sonobuoy 210 : hydrophone sensor to collected directional passive acoustic data
177	15/03/2021 3:36	62	11.94	S	101	22.05	E	B26	Sonobuoy 211 : hydrophone sensor to collected directional passive acoustic data
178	15/03/2021 6:42	62	4.36	S	102	27.36	E	B26	Sonobuoy 213 : hydrophone sensor to collected directional passive acoustic data
179	15/03/2021 9:39	61	56.81	S	103	27.93	E	B26	Sonobuoy 214 : hydrophone sensor to collected directional passive acoustic data
180	15/03/2021 12:34	61	48.54	S	104	30.02	E	B26	Sonobuoy 215 : hydrophone sensor to collected directional passive acoustic data
181	15/03/2021 15:07	61	41.00	S	105	23.30	E	B26	Sonobuoy 216 : hydrophone sensor to collected directional passive acoustic data
182	15/03/2021 18:18	61	30.81	S	106	31.23	E	B26	Sonobuoy 217 : hydrophone sensor to collected directional passive acoustic data
183	15/03/2021 21:12	61	20.75	S	107	33.03	E	B26	Sonobuoy 218 : hydrophone sensor to collected directional passive acoustic data
184	16/03/2021 0:02	61	10.65	S	108	33.89	E	B26	Sonobuoy 219 : hydrophone sensor to collected directional passive acoustic data
185	16/03/2021 2:47	61	0.12	S	109	32.93	E	B26	Sonobuoy 220 : hydrophone sensor to collected directional passive acoustic data
186	16/03/2021 6:04	60	48.19	S	110	36.39	E	B26	Sonobuoy 221 : hydrophone sensor to collected directional passive acoustic data

ID	Date	APPROXIMATE POSITION (as degrees, decimal minutes)						DATA TYPE	DESCRIPTION
		LATITUDE			LONGITUDE				
		deg	min	N/S	deg	min	E/W		
187	16/03/2021 9:11	60	36.51	S	111	35.38	E	B26	Sonobuoy 222 : hydrophone sensor to collected directional passive acoustic data
188	16/03/2021 21:41	59	48.91	S	115	10.30	E	B26	Sonobuoy 223 : hydrophone sensor to collected directional passive acoustic data
189	16/03/2021 21:45	59	48.69	S	115	11.22	E	B26	Sonobuoy 224 : hydrophone sensor to collected directional passive acoustic data
190	17/03/2021 0:43	59	35.77	S	116	3.79	E	B26	Sonobuoy 225 : hydrophone sensor to collected directional passive acoustic data
191	17/03/2021 4:16	59	19.64	S	117	6.64	E	B26	Sonobuoy 226 : hydrophone sensor to collected directional passive acoustic data
192	17/03/2021 6:51	59	8.04	S	117	50.10	E	B26	Sonobuoy 227 : hydrophone sensor to collected directional passive acoustic data
193	20/03/2021 5:34	53	39.91	S	134	43.22	E	B26	Sonobuoy 228 : hydrophone sensor to collected directional passive acoustic data
194	20/03/2021 8:20	53	19.42	S	135	16.33	E	B26	Sonobuoy 229 : hydrophone sensor to collected directional passive acoustic data
195	20/03/2021 11:25	52	57.67	S	135	50.61	E	B26	Sonobuoy 230 : hydrophone sensor to collected directional passive acoustic data
196	20/03/2021 14:19	52	36.57	S	136	23.11	E	B26	Sonobuoy 231 : hydrophone sensor to collected directional passive acoustic data
197	20/03/2021 17:24	52	12.30	S	136	59.59	E	B26	Sonobuoy 232 : hydrophone sensor to collected directional passive acoustic data

ID	Date	APPROXIMATE POSITION (as degrees, decimal minutes)						DATA TYPE	DESCRIPTION
		LATITUDE			LONGITUDE				
		deg	min	N/S	deg	min	E/W		
198	20/03/2021 20:55	51	44.09	S	137	40.80	E	B26	Sonobuoy 233 : hydrophone sensor to collected directional passive acoustic data
199	20/03/2021 23:43	51	24.32	S	138	8.98	E	B26	Sonobuoy 234 : hydrophone sensor to collected directional passive acoustic data
200	21/03/2021 2:31	51	3.31	S	138	38.31	E	B26	Sonobuoy 235 : hydrophone sensor to collected directional passive acoustic data
201	21/03/2021 5:51	50	39.04	S	139	11.45	E	B26	Sonobuoy 236 : hydrophone sensor to collected directional passive acoustic data
202	21/03/2021 9:52	50	10.28	S	139	49.72	E	B26	Sonobuoy 237 : hydrophone sensor to collected directional passive acoustic data
203	21/03/2021 12:45	49	50.01	S	140	16.07	E	B26	Sonobuoy 238 : hydrophone sensor to collected directional passive acoustic data
204	21/03/2021 16:57	49	19.42	S	140	54.91	E	B26	Sonobuoy 239 : hydrophone sensor to collected directional passive acoustic data
205	21/03/2021 19:57	48	57.23	S	141	22.43	E	B26	Sonobuoy 240 : hydrophone sensor to collected directional passive acoustic data
206	21/03/2021 22:58	48	34.79	S	141	49.70	E	B26	Sonobuoy 241 : hydrophone sensor to collected directional passive acoustic data
207	22/03/2021 2:00	48	12.29	S	142	16.53	E	B26	Sonobuoy 242 : hydrophone sensor to collected directional passive acoustic data
208	22/03/2021 5:14	47	49.12	S	142	43.60	E	B26	Sonobuoy 243 : hydrophone sensor to collected directional passive acoustic data

ID	Date	APPROXIMATE POSITION (as degrees, decimal minutes)						DATA TYPE	DESCRIPTION
		LATITUDE			LONGITUDE				
		deg	min	N/S	deg	min	E/W		
209	22/03/2021 8:41	47	26.44	S	143	9.61	E	B26	Sonobuoy 244 : hydrophone sensor to collected directional passive acoustic data
210	22/03/2021 11:39	47	3.49	S	143	35.44	E	B26	Sonobuoy 245 : hydrophone sensor to collected directional passive acoustic data
211	22/03/2021 12:48	46	54.43	S	143	45.52	E	B26	Sonobuoy 246 : hydrophone sensor to collected directional passive acoustic data
212	22/03/2021 12:50	46	54.12	S	143	45.84	E	B26	Sonobuoy 246.1 : hydrophone sensor to collected directional passive acoustic data
213	22/03/2021 20:04	45	58.80	S	144	45.75	E	B26	Sonobuoy 247 : hydrophone sensor to collected directional passive acoustic data
214	22/03/2021 21:45	45	46.96	S	144	58.24	E	B26	Sonobuoy 248 : hydrophone sensor to collected directional passive acoustic data
215	23/03/2021 0:55	45	24.15	S	145	21.98	E	B26	Sonobuoy 249 : hydrophone sensor to collected directional passive acoustic data
216	23/03/2021 3:24	45	6.58	S	145	40.01	E	B26	Sonobuoy 250 : hydrophone sensor to collected directional passive acoustic data
217	23/03/2021 6:06	44	43.00	S	146	3.82	E	B26	Sonobuoy 251 : hydrophone sensor to collected directional passive acoustic data
218	9/02/2021 8:21	62	27.09	S	83	52.82	E	H11, D90, H13	XBT
219	13/02/2021 18:10	65	14.42	S	55	0.00	E	H11, D90, H13	XBT

ID	Date	APPROXIMATE POSITION (as degrees, decimal minutes)						DATA TYPE	DESCRIPTION
		LATITUDE			LONGITUDE				
		deg	min	N/S	deg	min	E/W		
220	14/02/2021 3:45	64	44.35	S	55	0.00	E	H11, D90, H13	XBT
221	14/02/2021 12:54	64	13.91	S	55	0.00	E	H11, D90, H13	XBT
222	15/02/2021 1:09	63	27.08	S	55	0.00	E	H11, D90, H13	XBT
223	15/02/2021 11:56	62	30.28	S	55	0.00	E	H11, D90, H13	XBT
224	16/02/2021 3:59	62	0.00	S	57	26.48	E	H11, D90, H13	XBT
225	18/02/2021 7:15	63	43.12	S	59	59.99	E	H11, D90, H13	XBT
226	18/02/2021 16:26	64	16.91	S	60	0.00	E	H11, D90, H13	XBT
227	19/02/2021 3:06	64	45.80	S	60	0.00	E	H11, D90, H13	XBT
228	19/02/2021 11:38	65	18.39	S	59	58.15	E	H11, D90, H13	XBT
229	20/02/2021 7:21	66	8.96	S	60	8.94	E	H11, D90, H13	XBT
230	20/02/2021 12:21	66	19.97	S	60	15.00	E	H11, D90, H13	XBT

ID	Date	APPROXIMATE POSITION (as degrees, decimal minutes)						DATA TYPE	DESCRIPTION
		LATITUDE			LONGITUDE				
		deg	min	N/S	deg	min	E/W		
231	20/02/2021 17:57	66	28.61	S	60	15.00	E	H11, D90, H13	XBT
232	20/02/2021 23:05	66	32.22	S	60	28.23	E	H11, D90, H13	XBT
233	20/02/2021 23:42	66	29.73	S	60	37.95	E	H11, D90, H13	XBT
234	21/02/2021 0:20	66	28.07	S	60	51.81	E	H11, D90, H13	XBT
235	21/02/2021 3:44	66	31.14	S	61	17.16	E	H11, D90, H13	XBT
236	21/02/2021 4:54	66	34.27	S	61	32.57	E	H11, D90, H13	XBT
237	21/02/2021 5:40	66	34.60	S	61	49.09	E	H11, D90, H13	XBT
238	21/02/2021 6:25	66	35.35	S	62	3.75	E	H11, D90, H13	XBT
239	23/02/2021 9:07	66	35.09	S	64	12.01	E	H11, D90, H13	XBT
240	23/02/2021 10:51	66	33.19	S	64	46.71	E	H11, D90, H13	XBT
241	23/02/2021 15:55	66	27.88	S	65	0.00	E	H11, D90, H13	XBT

ID	Date	APPROXIMATE POSITION (as degrees, decimal minutes)						DATA TYPE	DESCRIPTION
		LATITUDE			LONGITUDE				
		deg	min	N/S	deg	min	E/W		
242	24/02/2021 2:34	66	7.40	S	65	0.00	E	H11, D90, H13	XBT
243	24/02/2021 10:39	65	42.43	S	65	0.01	E	H11, D90, H13	XBT
244	24/02/2021 10:44	65	43.34	S	65	0.00	E	H11, D90, H13	XBT
245	24/02/2021 18:38	65	12.49	S	65	0.00	E	H11, D90, H13	XBT
246	24/02/2021 20:28	66	15.19	S	64	59.73	E	H11, D90, H13	XBT
247	25/02/2021 9:43	64	43.42	S	65	0.00	E	H11, D90, H13	XBT
248	25/02/2021 18:36	64	13.89	S	65	0.00	E	H11, D90, H13	XBT
249	26/02/2021 5:09	63	33.61	S	65	0.00	E	H11, D90, H13	XBT
250	26/02/2021 17:09	62	30.23	S	65	0.01	E	H11, D90, H13	XBT
251	27/02/2021 9:20	61	59.71	S	67	29.83	E	H11, D90, H13	XBT
252	27/02/2021 23:09	62	14.45	S	70	0.00	E	H11, D90, H13	XBT

ID	Date	APPROXIMATE POSITION (as degrees, decimal minutes)						DATA TYPE	DESCRIPTION
		LATITUDE			LONGITUDE				
		deg	min	N/S	deg	min	E/W		
253	1/03/2021 2:01	63	44.39	S	70	0.00	E	H11, D90, H13	XBT
254	1/03/2021 11:51	64	6.09	S	70	0.00	E	H11, D90, H13	XBT
255	2/03/2021 5:02	64	39.51	S	70	0.00	E	H11, D90, H13	XBT
256	2/03/2021 11:32	64	53.09	S	70	0.00	E	H11, D90, H13	XBT
257	2/03/2021 17:19	65	11.59	S	70	0.58	E	H11, D90, H13	XBT
258	3/03/2021 0:30	65 2	9.62	S	70	0.00	E	H11, D90, H13	XBT
259	5/03/2021 5:46	67	51.69	S	75	7.99	E	H11, D90, H13	XBT
260	5/03/2021 12:51	67	31.00	S	74	38.19	E	H11, D90, H13	XBT
261	5/03/2021 18:45	67	9.15	S	75	0.01	E	H11, D90, H13	XBT
262	6/03/2021 10:41	66	43.19	S	74	59.98	E	H11, D90, H13	XBT
263	6/03/2021 14:45	66	32.47	S	75	0.00	E	H11, D90, H13	XBT

ID	Date	APPROXIMATE POSITION (as degrees, decimal minutes)						DATA TYPE	DESCRIPTION
		LATITUDE			LONGITUDE				
		deg	min	N/S	deg	min	E/W		
264	6/03/2021 22:59	66	14.87	S	75	0.00	E	H11, D90, H13	XBT
265	7/03/2021 10:25	65	27.00	S	75	0.00	E	H11, D90, H13	XBT
266	8/03/2021 0:09	64	28.66	S	75	0.00	E	H11, D90, H13	XBT
267	8/03/2021 10:06	63	28.79	S	75	0.00	E	H11, D90, H13	XBT
268	8/03/2021 21:26	63	0.00	S	76	9.25	E	H11, D90, H13	XBT
269	9/03/2021 13:41	63	0.00	S	77	13.43	E	H11, D90, H13	XBT
270	9/03/2021 18:05	63	0.00	S	78	15.80	E	H11, D90, H13	XBT
271	9/03/2021 21:15	63	0.00	S	79	14.29	E	H11, D90, H13	XBT
272	9/03/2021 21:22	63	0.00	S	79	16.39	E	H11, D90, H13	XBT
273	10/03/2021 11:06	63	24.54	S	80	0.00	E	H11, D90, H13	XBT
274	10/03/2021 20:01	64	1.02	S	80	0.00	E	H11, D90, H13	XBT

ID	Date	APPROXIMATE POSITION (as degrees, decimal minutes)						DATA TYPE	DESCRIPTION
		LATITUDE			LONGITUDE				
		deg	min	N/S	deg	min	E/W		
275	11/03/2021 10:26	64	45.93	S	80	0.00	E	H11, D90, H13	XBT
276	11/03/2021 18:07	65	5.78	S	80	0.00	E	H11, D90, H13	XBT
277	12/03/2021 3:32	65	10.66	S	79	57.19	E	H11, D90, H13	XBT
278	12/03/2021 4:02	65	6.75	S	79	56.32	E	H11, D90, H13	XBT
279	12/03/2021 6:06	64	59.26	S	80	27.45	E	H11, D90, H13	XBT
280	12/03/2021 6:56	64	56.26	S	80	41.35	E	H11, D90, H13	XBT
281	12/03/2021 7:40	64	53.02	S	80	52.23	E	H11, D90, H13	XBT
282	12/03/2021 7:52	64	52.46	S	80	54.11	E	H11, D90, H13	XBT
283	12/03/2021 10:08	64	43.37	S	81	20.29	E	H11, D90, H13	XBT
284	12/03/2021 11:17	64	36.33	S	81	37.24	E	H11, D90, H13	XBT
285	12/03/2021 12:13	64	30.71	S	81	50.68	E	H11, D90, H13	XBT

ID	Date	APPROXIMATE POSITION (as degrees, decimal minutes)						DATA TYPE	DESCRIPTION
		LATITUDE			LONGITUDE				
		deg	min	N/S	deg	min	E/W		
286	12/03/2021 13:19	64	23.96	S	82	5.62	E	H11, D90, H13	XBT
287	12/03/2021 14:12	64	18.45	S	82	18.21	E	H11, D90, H13	XBT
288	12/03/2021 15:07	64	13.67	S	82	29.09	E	H11, D90, H13	XBT
289	12/03/2021 16:06	64	9.17	S	82	39.29	E	H11, D90, H13	XBT
290	12/03/2021 17:05	64	5.15	S	82	48.37	E	H11, D90, H13	XBT
291	12/03/2021 18:12	64	0.19	S	82	59.58	E	H11, D90, H13	XBT
292	12/03/2021 18:57	63	57.61	S	83	9.60	E	H11, D90, H13	XBT
293	12/03/2021 20:17	63	53.76	S	83	25.02	E	H11, D90, H13	XBT
294	12/03/2021 21:12	63	51.33	S	83	34.76	E	H11, D90, H13	XBT
295	12/03/2021 22:09	63	48.77	S	83	44.96	E	H11, D90, H13	XBT
296	12/03/2021 23:17	63	44.93	S	84	0.52	E	H11, D90, H13	XBT

ID	Date	APPROXIMATE POSITION (as degrees, decimal minutes)						DATA TYPE	DESCRIPTION
		LATITUDE			LONGITUDE				
		deg	min	N/S	deg	min	E/W		
297	13/03/2021 0:08	63	43.48	S	84	17.77	E	H11, D90, H13	XBT
298	13/03/2021 1:21	63	41.41	S	84	42.10	E	H11, D90, H13	XBT
299	13/03/2021 2:19	63	40.04	S	84	58.10	E	H11, D90, H13	XBT
300	13/03/2021 3:09	63	38.96	S	85	13.02	E	H11, D90, H13	XBT
301	13/03/2021 4:09	63	37.65	S	85	31.19	E	H11, D90, H13	XBT
302	13/03/2021 4:12	63	37.61	S	85	31.79	E	H11, D90, H13	XBT
303	13/03/2021 5:13	63	35.99	S	85	45.68	E	H11, D90, H13	XBT
304	13/03/2021 6:08	63	34.40	S	86	3.95	E	H11, D90, H13	XBT
305	13/03/2021 7:08	63	32.67	S	86	24.14	E	H11, D90, H13	XBT
306	13/03/2021 8:08	63	31.10	S	86	43.76	E	H11, D90, H13	XBT
307	13/03/2021 11:04	63	26.32	S	87	39.28	E	H11, D90, H13	XBT

ID	Date	APPROXIMATE POSITION (as degrees, decimal minutes)						DATA TYPE	DESCRIPTION
		LATITUDE			LONGITUDE				
		deg	min	N/S	deg	min	E/W		
308	15/03/2021 6:38	62	4.51	S	102	26.06	E	H11, D90, H13	XBT
309	15/03/2021 8:35	61	59.38	S	103	7.73	E	H11, D90, H13	XBT
310	15/03/2021 10:59	61	53.10	S	103	56.28	E	H11, D90, H13	XBT
311	15/03/2021 11:02	61	52.94	S	103	57.42	E	H11, D90, H13	XBT
312	15/03/2021 13:04	61	47.08	S	104	40.58	E	H11, D90, H13	XBT
313	15/03/2021 15:12	61	40.72	S	105	25.25	E	H11, D90, H13	XBT
314	15/03/2021 17:21	61	33.90	S	106	11.12	E	H11, D90, H13	XBT
315	15/03/2021 19:20	61	27.35	S	106	53.30	E	H11, D90, H13	XBT
316	15/03/2021 21:14	61	20.63	S	107	33.61	E	H11, D90, H13	XBT
317	16/02/2021 16:20	62	0.11	S	60	1.73	E	D06, D90	BGC-Argo_1, Hull #9168, CTD#9
318	27/02/2021 21:09	61	59.10	S	69	59.63	E	D06, D90	BGC-Argo_2, Hull #9167, CTD#32
319	8/03/2021 17:11	62	59.99	S	75	1.34	E	D06, D90	BGC-Argo_3, Hull #9166, CTD#57
320	15/02/2021 19:00	61	57.96	S	54	55.75	E	D06, D90	STD-Argo_1, Hull #9027
321	20/02/2021 1:03	65	31.60	S	60	0.00	E	D06, D90	STD-Argo_2, Hull #9039

ID	Date	APPROXIMATE POSITION (as degrees, decimal minutes)						DATA TYPE	DESCRIPTION
		LATITUDE			LONGITUDE				
		deg	min	N/S	deg	min	E/W		
322	25/02/2021 1:12	64	58.44	S	65	0.00	E	D06, D90	STD-Argo_3, Hull #9135
323	27/02/2021 14:52	61	57.35	S	65	2.15	E	D06, D90	STD-Argo_4, Hull #9033
324	3/03/2021 15:38	65	0.10	S	70	0.00	E	D06, D90	STD-Argo_5, Hull #9032
325	7/03/2021 18:37	65	1.10	S	75	3.70	E	D06, D90	STD-Argo_6, Hull #9025
326	10/03/2021 18:32	63	44.00	S	80	0.00	E	D06, D90	STD-Argo_7, Hull #8839
327	12/03/2021 6:25	65	1.50	S	80	16.70	E	D06, D90	STD-Argo_8, Hull #8850
328	13/03/2021 2:18	63	41.05	S	84	41.00	E	D06, D90	STD-Argo_9, Hull #9026
329	15/02/2021 0:45	63	29.86	S	54	59.99	E	D05, D90	NOAA_1, Hull #60718040
330	16/02/2021 3:52	62	0.00	S	57	28.89	E	D05, D90	NOAA_2, Hull #60716630
331	26/02/2021 16:14	62	36.30	S	65	0.01	E	D05, D90	NOAA_3, Hull #60717250
332	9/03/2021 14:25	63	0.00	S	77	28.45	E	D05, D90	NOAA_4, Hull #60717520
333	13/03/2021 3:36	63	38.31	S	85	21.75	E	D05, D90	NOAA_5, Hull #60718050
334	21/02/2021 15:50	66	34.00	S	62	3.70	E	H13, D01, D71, B28	KOMBI Mooring: KOMBI_001, Triangulated landing position: 66 33.963S 62 03.681E
335	21/02/2021 15:50	66	31.10	S	62	26.90	E	H13, D01, D71, B28	KOMBI Mooring: KOMBI_002, Triangulated to: 66 31.108S 62 26.942E
336	21/02/2021 15:47	66	57.20	S	75	0.30	E	H13, D01, D71, B28	KOMBI Mooring: KOMBI_003, Triangulated to: 66 57.244S 75 00.324E WD: approx. 385m
337	25/02/2021 7:05	64	52.02	S	64	59.16	E	B09, B21, B28	SS1, Swarm Study Camera System Deployed
338	9/03/2021 4:12	63	0.52	S	76	11.21	E	B09, B21, B28	SS2, Swarm Study Camera System Deployed

ID	Date	APPROXIMATE POSITION (as degrees, decimal minutes)						DATA TYPE	DESCRIPTION
		LATITUDE			LONGITUDE				
		deg	min	N/S	deg	min	E/W		
339	9/03/2021 8:34	63	1.91	S	76	10.98	E	B09, B21, B28	SS3, Swarm Study Camera System Deployed
340	10/03/2021 3:09	63	1.30	S	79	49.74	E	B09, B21, B28	SS4, Swarm Study Camera System Deployed

Summary of data and samples collected

Item Name, Identifier (e.g. serial number)	Principal Investigator	NO	UNITS	DATA TYPE	DESCRIPTION
ADCP current profiles	So Kawaguchi				Data set: ADCP. Custodian: DAP/GSM. Team: Underway data. Description: ADCP data. Data form: .raw & .png (geotagged, timestamped).
OceanPol C-Band Weather Radar Aerosol and Air Chemistry Lab Instruments Micro Rain Radar OceanRAIN disdrometer Sonic anemometer and fast temperature and humidity sensors Parsivel-2 Disdrometer CTK-25 ceilometer ToF-ACSM (Time of Flight Aerosol Chemical Speciation Monitor)	So Kawaguchi	Underway	Underway	M01 M05 M06 M71 M90	Cloud Aerosol Precipitation Radiation Interactions eXperiment (CAPRIX). Custodian: Bureau of Meteorology/MNF. Team: MNF. Description: Datasets will be combined with the existing ones to continue to build a comprehensive understanding of the relationship between ocean productivity, aerosol formation, and then link to rainfall properties and surface radiation.
Underway data	So Kawaguchi				Data set: Underway data. Custodian: MNF. Team: DAP (MNF). Description: (1) Navigation data (NAV): Latitude, Longitude, Speed, Heading, course over ground, Gyros, and Doppler Log (dual GPS instrument). (2) Thermosalinograph (TSG): Water Salinity, flow-rate, Temperature, Fluorescence, and pCO2. (3) Atmospheric (MET): Humidity, Wind speed and direction (vane and

Item Name, Identifier (e.g. serial number)	Principal Investigator	NO	UNITS	DATA TYPE	DESCRIPTION
					ultrasonic), Radiometer, Pyranometer, PAR, Air temperature, Air pressure, Optical Rain, Ozone and Trace gases (port and starboard instruments).
Gravity measurements	So Kawaguchi	98	Lines	G27	Data set:Gravity measurements. Custodian: MNF. Team: Description: Data form: .raw files.
EM122, EM710 multibeam data	So Kawaguchi	1911	Lines	G74	Data set: EM122, EM710 multibeam. Custodian: DAP/GSM. Team: Active acoustics. Description: Bathymetric multibeam data. Data form: .all files (geotagged, timestamped).
XBT data	So Kawaguchi	104	Deployments	H11, D90, H13	Data set: XBT data. Custodian: MNF. Team: GSM (MNF). Description: Temperature data XBTs. Data form: Spreadsheet.
Underway pCO2 measurements	So Kawaguchi	29	Days	H74	Data set: Underway pCO2 measurements. Custodian: Bronte Tilbrook (CSIRO O&A). Team: Biological Oceanography. Description: fugacity of carbon dioxide (fCO2) in surface seawater and atmosphere, air pressure, sea surface temperature, gas flows, wind speed,sea surface salinity, on the way in and out of survey area.
BGC Argo floats	So Kawaguchi	3	Deployments	D06, D90	Data set: BGC Argo floats. Custodian: Esizabeth Shadwick (CSIRO O&A). Team: Biological Oceanography. Description: 3 x BGC Argo deployment sites. (floats #9168-CTD#9; #9167-CTD#32; #9166-CTD#57)
Core Argo floats	So Kawaguchi	9	Deployments	D06, D90	Data set: Core Argo floats. Custodian: MNF. Team: MNF. Description: Description: 9 x Core Argo deployment sites (floats #9027, #9039, #9135, #9033, #9032, #9025, $8839, #8850 and #9026 on transit to and within TEMPO survey area.

Item Name, Identifier (e.g. serial number)	Principal Investigator	NO	UNITS	DATA TYPE	DESCRIPTION
NOAA drifters	So Kawaguchi	5	Deployments	D05, D90	Data set: NOAA drifters. Custodian: Karen Westwood (AAD). Team: Biological Oceanography. Description: Drifter positions, temp, hPa. Data form: Spreadsheet.
CTD Profiles	So Kawaguchi	66	Deployments	H09, H10, H11, H90, D90	Data set: CTD Profiles. Custodian: MNF. Team: Biological Oceanography. Description: Hydrochemistry mesaurements Profiles.
Dissolved oxygen (CTD casts)	So Kawaguchi	1151	Samples	H10, H21	Data set:Dissolved oxygen (CTD casts). Custodian: MNF. Team: MNF Hydrochem. Description: Analysed on voyage. Data form: Spreadsheet
Salinity (CTD casts)	So Kawaguchi	1130	Samples	H10, D90	Data set:DSalinity (CTD casts). Custodian: MNF. Team: MNF Hydrochem. Description: Analysed on voyage. Data form: Spreadsheet
Nutrients (CTD casts)	So Kawaguchi	1208	Samples	H10, H24, H25, H76, H26	Data set:Nutrients (CTD casts). Custodian: MNF. Team: MNF Hydrochem. Description: Analysed on voyage. Data form: Spreadsheet
DIC (CTD casts)	So Kawaguchi	522	Samples	H90	Data set:DIC (CTD casts). Custodian: Elizabeth Shadwick (CSIRO O&A). Team: Biological Oceanogrpahy. Description: Stored in room temperature. Data form: Sample bottles.
Total alkalinity (CTD casts)	So Kawaguchi	288	Samples	H27	Data set:Total alkalinity (CTD casts). Custodian:Elizabeth Shadwick (CSIRO O&A). Team: Biological Oceanogrpahy. Description: Stored in room temperature. Data form: Sample bottles.
HPLC (CTD casts)	So Kawaguchi	300	Samples	B01, B02	Data set: HPLC (CTD casts). Custodian:Karen Westwood (AAD). Team: Biological Oceanogrpahy. Description: Stored in -135°C Nitrogen dewar. Data form: Filter samples.

Item Name, Identifier (e.g. serial number)	Principal Investigator	NO	UNITS	DATA TYPE	DESCRIPTION
Lugols (CTD casts)	So Kawaguchi	100	Samples	B08, B09	Data set: Lugols (CTD casts). Custodian:Karen Westwood (AAD). Team: Biological Oceanogrpahy. Description: Stored in room temperature. Data form: Sample bottles.
POC (CTD casts)	So Kawaguchi	29	Samples	B71	Data set: POC (CTD casts). Custodian: Di Davies (IMAS/CSIRO). Team: Biological Oceanogrpahy. Description: Stored in -80°C freezer. Data form: Filter samples.
Neodymium (CTD casts)	So Kawaguchi	2	Samples	H90	Data set: Neodymium (CTD casts). Custodian: Matt Corkhill (IMAS). Team: Biological Oceanogrpahy. Description: Stored in 4°C refrigiration. Data form: Filter Samples
BGC Argo biological samples - particulate organic carbon (POC) - from CTD niskin bottles	So Kawaguchi	29	Samples	H10, H90	Data set:BGC Argo biological samples - particulate organic carbon (POC) - from CTD niskin bottles. Custodian: Di Davies (CSIRO O&A). Team: Biological Oceanography. Description: 3 x BGC Argo deployment sites (floats #9168, #9167 and #9166); plus 1 x krill swarm study site; all within TEMPO survey area. Data form: Samples (-86C frozen)
Environmental DNA (eDNA) CTD	So Kawaguchi	112	Samples	B21, B90	Data set:Environmental DNA Samples frm CTD casts. Custodian: Leonie Suter (AAD). Team: Biological Oceanography. Description: Water samples from niskin bottles. Data form: Samples (-86C frozen)
Environmental DNA (eDNA) Underway	So Kawaguchi	95	Samples	B21, B90	Data set:Environmental DNA Samples from underway uncontaminated seawater intake. Custodian: Leonie Suter (AAD). Team: Biological Oceanography. Description: Water samples from niskin bottles. Data form: Samples (-86C frozen)
HPLC (Underway)	So Kawaguchi	117	Samples	B01, B02	Data set: HPLC (Underway). Custodian:Karen Westwood (AAD). Team: Biological Oceanogrpahy. Description: Stored in -135°C Nitrogen dewar. Data form: Filter samples.

Item Name, Identifier (e.g. serial number)	Principal Investigator	NO	UNITS	DATA TYPE	DESCRIPTION
Lugols (Unerway)	So Kawaguchi	24	Samples	B08, B09	Data set: Lugols (Underway). Custodian:Karen Westwood (AAD). Team: Biological Oceanogrpahy. Description: Stored in room temperature. Data form: Sample bottles.
Coccolithophores (Underway)	So Kawaguchi	49	Samples	B08	Data set:Coccolithophores (Underway). Custodian:Karen Westwood (AAD). Team: Biological Oceanogrpahy. Description: Air dried. Data form: Air dried samples.
FIRe (Underway)	So Kawaguchi	53	Days	B01, B02	Data set: FIRe (Underway). Custodian: Clara Vives (UTAS). Team: Biological Oceanogrpahy. Description: Measured on voyage.
Carbon Plus (SOTS) (Underway)	So Kawaguchi	17	Samples	H90	Data set:Carbon Plus (SOTS) (Underway). Custodian:Esizabeth Shadwick (CSIRO O&A). Team: Biological Oceanogrpahy. Description: Frozen. Data form: Filter samples.
EK80 multi-frequency acoustics data	So Kawaguchi	2826	km	B28, B09, B14	Data set: EK80 raw data. Custodian: Martin Cox (AAD). Team: Acoustics. Description: Six frequency downward facing scientific echosounder data (18, 38, 70, 120, 200, 333). Data form: Geotagged, timestamped .raw files.
ME70 Acitve Acoustic data	So Kawaguchi	4852	km	B28, B09, B14	Data set: ME70 raw data. Custodian: Martin Cox (AAD). Team: Acoustics. Description: Active acoustic Multibeam data (~70-120kHz). Data form: Geotagged, timestamped .raw files.
SH90 Omnidirectional sonar data	So Kawaguchi	360	km	B09, B21, B28	Data set: SH90 Omnidirectional sonar data. Custodian: Martin Cox (AAD). Team: Acoustics. Description: Omnidirectional sonar data (111.5kHz). Data form: Geotagged, timestamped .raw files.
Swarm Studies System (S3) Acoustics	So Kawaguchi	4	Deployments	B09, B21, B28	Data set: Swarm Studies System (S3) Custldian: Martin Cox (AAD). Team: Acoustics. Description: Acoustics Data collected using the WBAT, to be used to assess the orientation and density of individual krill within the swarm. Accelerometer data will aid the interpretation of the acoustic and video data. GPS data is used to locate the frame

Item Name, Identifier (e.g. serial number)	Principal Investigator	NO	UNITS	DATA TYPE	DESCRIPTION
					upon retrieval. Data form: Acoustic .raw files, and Accelerometer .csv files.
Acoustic Properties of Zooplankton	So Kawaguchi	48	Measurements	B09, B21, B28	Data set: Acoustics Properties of Zooplankton (APOP). Custodian: Martin Cox (AAD). Team: Acoustics. Description: Acoustic time of flight through krill, density of water mixtures, weight of krill and water mixtures. Data form: Matlab-formatted files, comma-separated text files.
S3 swarm study GoPro footage	So Kawaguchi	4	Deployments	B09, B21	Data set: S3 swarm study GoPro footage. Custodian: So Kawaguchi (AAD). Team: Krill Biology. Description: Swarm behaviour - swimming speed, polarisation, orientation. Data form: GoPro video footage.
Deep Ocean Camera	So Kawaguchi	106	Video files	B18, B19, B21,	Data set: Deep Ocean Camera. Custodian: So Kawaguchi (AAD). Team: Krill Biology. Description: Deep CTD camera video clips from 53 CTD stations. Data form: MP4 and jpeg files.
KOMBI	So Kawaguchi	3	moorings	H13, D01, D71, B28	Data set: KOMBI Moorings Deployment information. Custodian: So Kawaguchi (AAD). Team: Krill Biology. Description: 3 x KOMBI deployment informaiton. Data form: Deployment information datasheet
Trawl Log (Routine and Target)	So Kawaguchi	2	Bundles	B09, B21	Data set:Trawl Log (Routine and Target). Custodian: So Kawaguchi (AAD). Team: Krill Biology. Description: Trawl logs for routine and target tows. Data form: Hardcopy and electoronic (scanned).
RMT Sample demography	So Kawaguchi	59	Deployments	B09, B21	Data set: RMT Sample demography IGR data. Custodian: So Kawaguchi (AAD). Team: Krill. Description: Krill integrated growth experiments. Data form: Hardcopy spreadsheet.

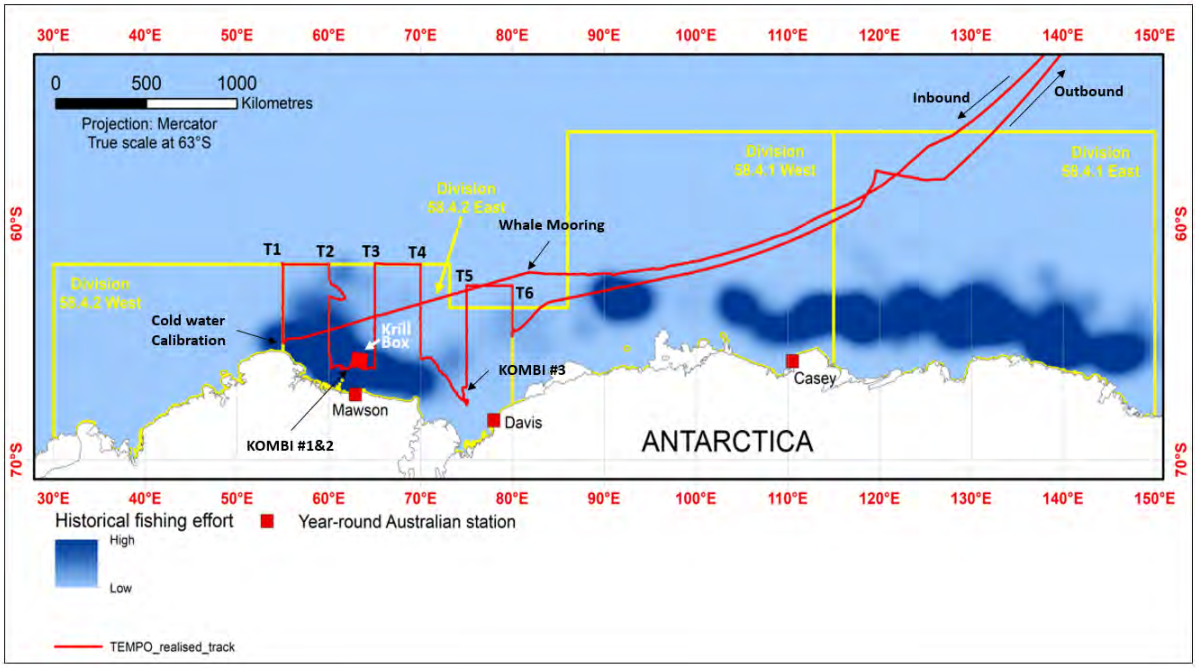
Item Name, Identifier (e.g. serial number)	Principal Investigator	NO	UNITS	DATA TYPE	DESCRIPTION
RMT-1 Samples	So Kawaguchi	116	Samples	B09, B21	Data set: RMT-1 samples. Custodian: So Kawaguchi (AAD). Team: Krill biology. Description: Preserved net samples. Data form: Seamples in jars, 10% Formalin or frozen at -86C
RMT-8 Samples	So Kawaguchi	116	Samples	B09, B21	Data set: RMT-8 samples. Custodian: So Kawaguchi (AAD). Team: Krill biology. Description: Preserved net samples. Data form: Seamples in jars, 10% Formalin or frozen at -86C
Krill Instantaneous Growth Rates (IGR)	So Kawaguchi	11	experiments	B09, B21	Data set: Krill IGR experiment samples. Custodian: So Kawaguchi (AAD). Team: Krill Biology. Description: Instantaneous Growth Rate (IGR) experiments were run on-board for 4 days following a successful krill trawl. Eleven IGR experiments were successfully run across the voyage with 540 moulted animals out of a total of 3168 individuals jarred up. . Data form: Excel spredsheet.
Krill Light Traps	So Kawaguchi	150	Individuals	B09, B21	Data set: Krill Light Trap samples. Custodian: So Kawaguchi (AAD). Team: Krill Biology. Description: The light trap was operated for 2.5 minutes at the within 5m off the bottom. The trap uses an internal light to attract krill which are then trapped by a funnel and closing door mechanism. Data form: Frozen (-86C)
Southern Ocean CPR Continuous Plankton Recorder data	So Kawaguchi	14	Tows	B09	Dataset: Southern Ocean CPR Continuous Plankton Recorder data. Custodian: John Kitchener (AAD). Team: Krill Biology. Description: CPR tows were undertaken on transit to and from our survey area. The CPR is towed about 100 m astern of the ship, with each tow covering 450 nm. Once retrieved the internal mechanisms silk roll is preserved for later analysis at the AAD. Data form: 2L Jars, fixed in 10% formalin.

Item Name, Identifier (e.g. serial number)	Principal Investigator	NO	UNITS	DATA TYPE	DESCRIPTION
Sonobuoy data	So Kawaguchi	251	Deployments	B26	Data set: Sonobuoy data. Custodian: Brian Miller (AAD). Team: Predator Observation. Description: Raw and processed data recorded from sonobuoys. Data form: Digital recordings of audio (24 bit wav files). Pamguard database (sqlite) and Pamguard binary files (see Pamguard Documentation)
Sonobuoy deployment log	So Kawaguchi	55	Days	B26	Data set: Sonobuoy deployment log. Custodian: Brian Miller (AAD). Team: Passive acoustics. Description: Sonobuoy deployment information. Data form: Hard copy spreadsheet; Pamguard database for details on binary storage formats).
Bird Observations	So Kawaguchi	3853	km	B25	Data set: Formal sighting effort undertaken by two observers to detect and count seabirds, both on the wing and on water. Sighting effort undertaken during daylight hours, and in Beaufort sea state <=6. Sightings, effort and environmental conditions recorded in a SQLite database. Custodian: Nat Kelly (AAD)
Whales observations	So Kawaguchi	3612	km	B26	Data set: Formal sighting effort undertaken by a team of four observers to detect and count cetaceans, using distance sampling methods. Sighting effort undertaken during daylight hours, and in Beaufort sea state <=6. Sightings, effort and environmental conditions recorded in a SQLite database. Custodian: Nat Kelly (AAD)
Whales Fluke Photos	So Kawaguchi	33	Images	B26	Data set: Whale identification photos. Team: Predator Observation. Description: Digital photographs. Data form: SLR digital cameras. Custodian: Kym Collins
Pinniped observation	So Kawaguchi	3612	km	B26	Data set: Whilst pinnipeds were not a specific target species, seal sightings were recorded when detected during distance sampling effort for cetaceans. Sightings, effort and environmental conditions recorded in a SQLite database. Custodian: Nat Kelly (AAD)

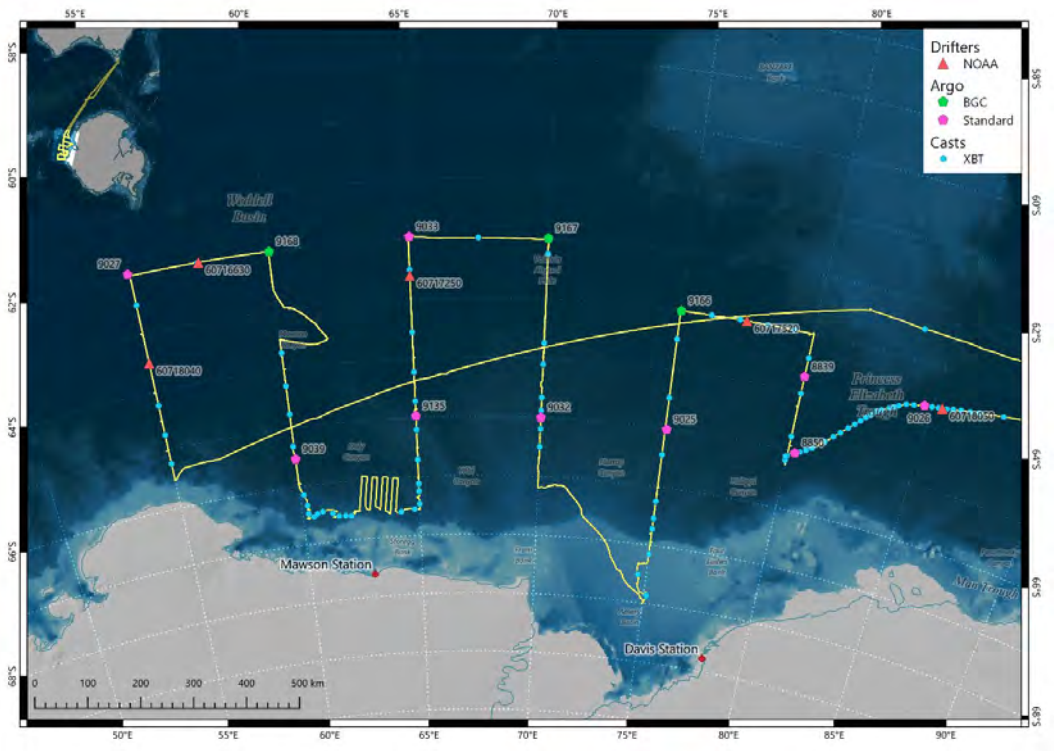
Curation Report

Relevant information is captured in the description colomn of Summary of data and samples collected table in the previous section.

Track Chart



TEMPO Voyage Track with locations of Whale Mooring, Coldwater Calibration, and KOMBI Moorings.



TEMPO voyage track (yellow) and location of BGC (n=3) and core (n=9) Argo floats, NOAA drifters (n=5) and XBT deployments (n=104). Background shows GEBCO bathymetry (Weatherall et al. 2015). Figure supplied by F. Chui (MNF/DAP).

Acknowledgements

This voyage was successful because of the hard work and contribution by a large number of people from Australian Antarctic Division, Marine National Facility, Institute of Marine and Antarctic Science of the University of Tasmania, the University of Sydney, and CSIRO. Special thanks to RV *Investigator* Master Mike Watson for his excellent leadership and Voyage Manager Linda Gaskell's amazing voyage management on board, and Karen Westwood's entire project management under the most challenging time. The crew of RV Investigator, MNF support staff, and the scientific party were instrumental to the success of this voyage. We are grateful to Drs Reiss and Cutter (Southwest Fisheries Centre NOAA) for kindly undertaking calibration of the three Nortek Signature 100 system for our KOMBI mooring system. We thank generous support from Pew Charitable Trust, Antarctic Science Foundation, and Australian Antarctic Partnership Program. This project was sponsored by the Australian Antarctic Division, and supported by Australian Antarctic Program Project #4512 and Marine National Facility Granted Voyage IN2021_V01.

Signature

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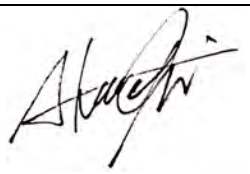
Title:	Chief Scientist
Signature:	
Date:	7 October 2021

Appendix A – CSR/ROSCOP Parameter Codes

	METEOROLOGY
M01	Upper air observations
M02	Incident radiation
M05	Occasional standard measurements
M06	Routine standard measurements
M71	Atmospheric chemistry
M90	Other meteorological measurements

	PHYSICAL OCEANOGRAPHY
H71	Surface measurements underway (T,S)
H13	Bathythermograph
H09	Water bottle stations
H10	CTD stations
H11	Subsurface measurements underway (T,S)
H72	Thermistor chain
H16	Transparency (eg transmissometer)
H17	Optics (eg underwater light levels)
H73	Geochemical tracers (eg freons)
D01	Current meters
D71	Current profiler (eg ADCP)
D03	Currents measured from ship drift
D04	GEK
D05	Surface drifters/drifting buoys

	MARINE BIOLOGY/FISHERIES
B01	Primary productivity
B02	Phytoplankton pigments (eg chlorophyll, fluorescence)
B71	Particulate organic matter (inc POC, PON)
B06	Dissolved organic matter (inc DOC)
B72	Biochemical measurements (eg lipids, amino acids)
B73	Sediment traps
B08	Phytoplankton
B09	Zooplankton
B03	Seston
B10	Neuston
B11	Nekton
B13	Eggs & larvae
B07	Pelagic bacteria/micro-organisms
B16	Benthic bacteria/micro-organisms
B17	Phytobenthos
B18	Zoobenthos
B25	Birds
B26	Mammals & reptiles
B14	Pelagic fish
B19	Demersal fish
B20	Molluscs
B21	Crustaceans

D06	Neutrally buoyant floats
D09	Sea level (incl. Bottom pressure & inverted echosounder)
D72	Instrumented wave measurements
D90	Other physical oceanographic measurements

	CHEMICAL OCEANOGRAPHY
H21	Oxygen
H74	Carbon dioxide
H33	Other dissolved gases
H22	Phosphate
H23	Total - P
H24	Nitrate
H25	Nitrite
H75	Total - N
H76	Ammonia
H26	Silicate
H27	Alkalinity
H28	PH
H30	Trace elements
H31	Radioactivity
H32	Isotopes
H90	Other chemical oceanographic measurements

B28	Acoustic reflection on marine organisms
B37	Taggings
B64	Gear research
B65	Exploratory fishing
B90	Other biological/fisheries measurements

	MARINE GEOLOGY/GEOPHYSICS
G01	Dredge
G02	Grab
G03	Core - rock
G04	Core - soft bottom
G08	Bottom photography
G71	In-situ seafloor measurement/sampling
G72	Geophysical measurements made at depth
G73	Single-beam echosounding
G74	Multi-beam echosounding
G24	Long/short range side scan sonar
G75	Single channel seismic reflection
G76	Multichannel seismic reflection
G26	Seismic refraction
G27	Gravity measurements
G28	Magnetic measurements
G90	Other geological/geophysical measurements

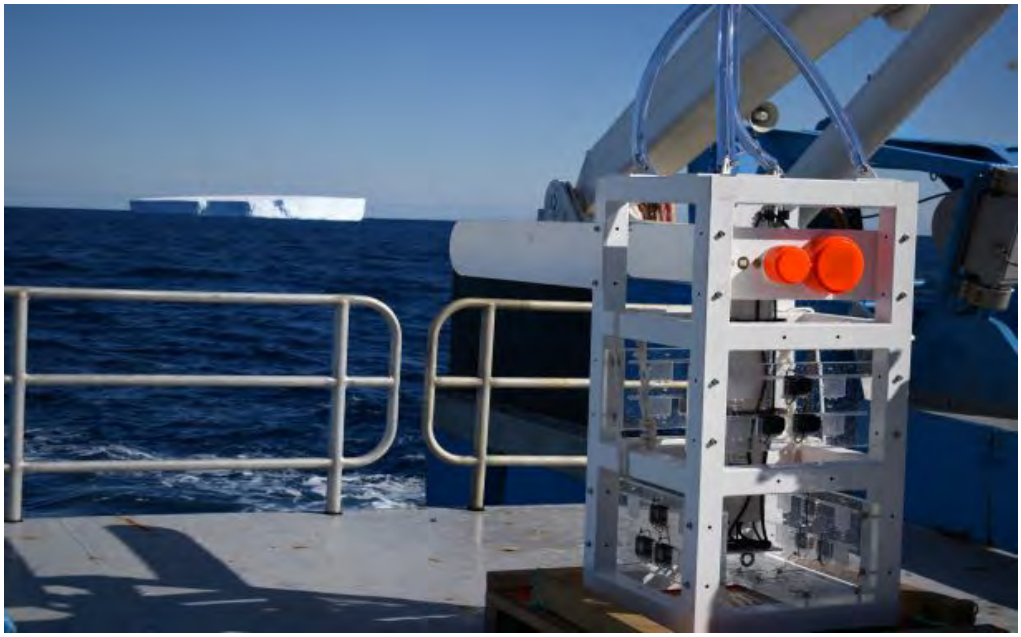
	MARINE CONTAMINANTS/POLLUTION
P01	Suspended matter
P02	Trace metals
P03	Petroleum residues
P04	Chlorinated hydrocarbons
P05	Other dissolved substances
P12	Bottom deposits
P13	Contaminants in organisms
P90	Other contaminant measurements

Appendix B – Photographs

Scientist and MNF support staff abord the RV Investigator (Photo Credit: So Kawaguchi)

Beautiful Aurora Australis were observed during the survey (Photo Credit: So Kawaguchi)

Gear officer fireing Grapple Gun to retrieve Swarm Study System (Photo Credit: So Kawaguchi)



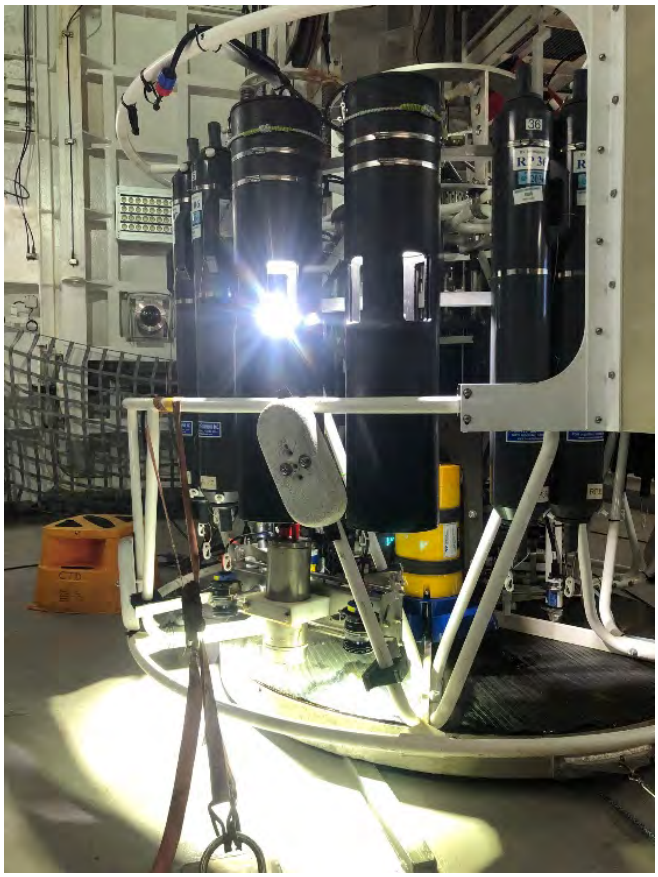
Swarm Study System waiting on trawl deck to be deployed (Photo Credit: So Kawaguchi)

Humpback whales coming to check out Swarm Study System (Photo Credit: So Kawaguchi)

Predator observation team in action on Deck 5 (Photo Credit: So Kawaguchi)

Predator observers monitoring patterns of whales call received on Sonobuoy (Photo Credit: So Kawaguchi)

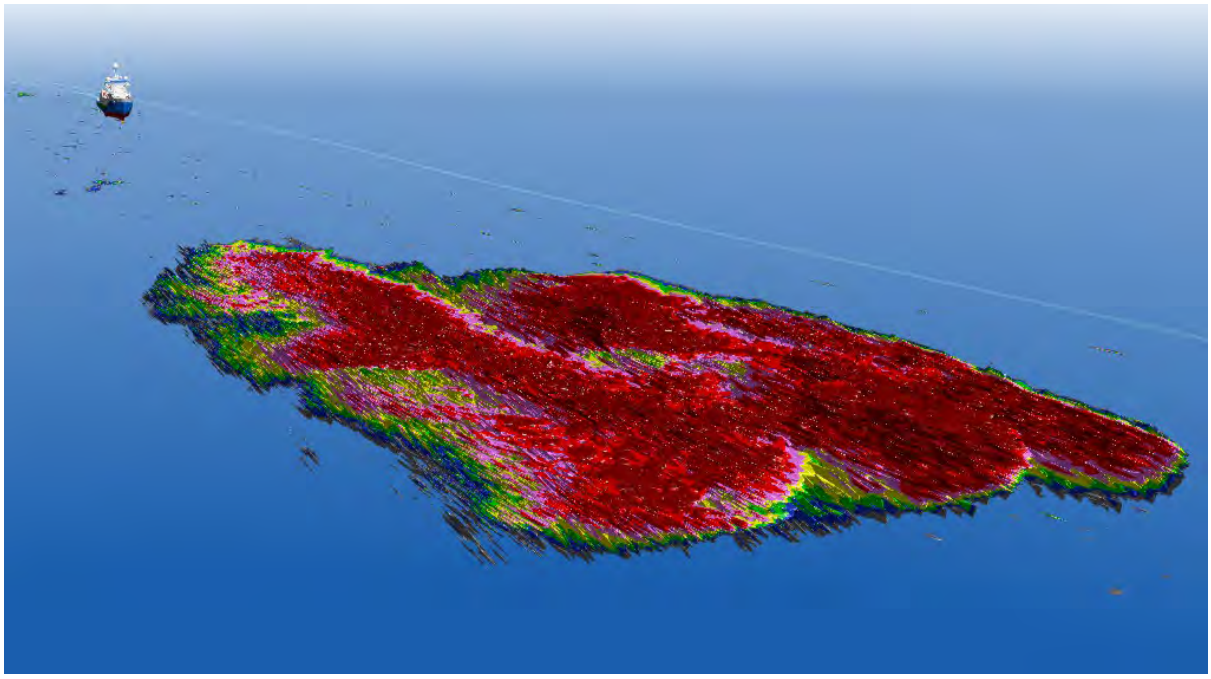
Operating RMT net from the Operations Room (Photo Credit: So Kawaguchi)



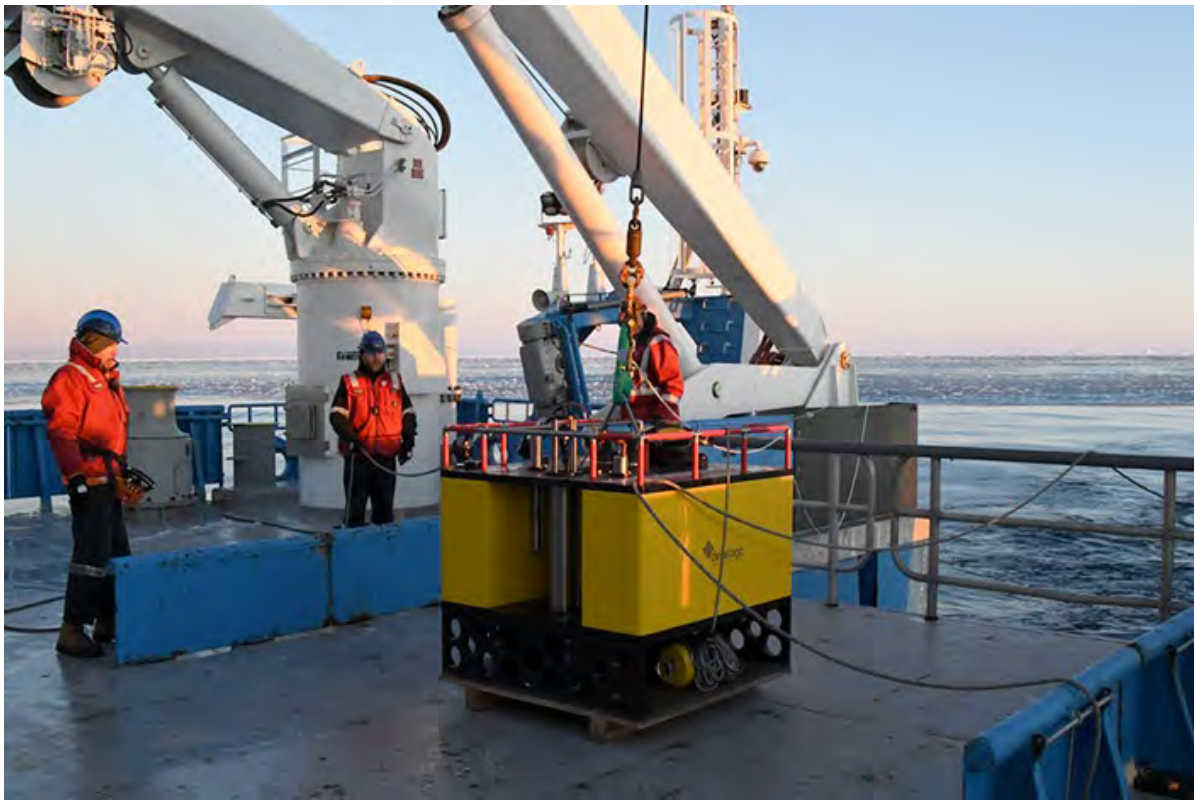
Light trap mounted on CTD Rossett (Photo Credit: So Kawaguchi)

Antarctic krill captured on Deep-Sea Camera at 1,000m seafloor (Photo Credit: AAD)

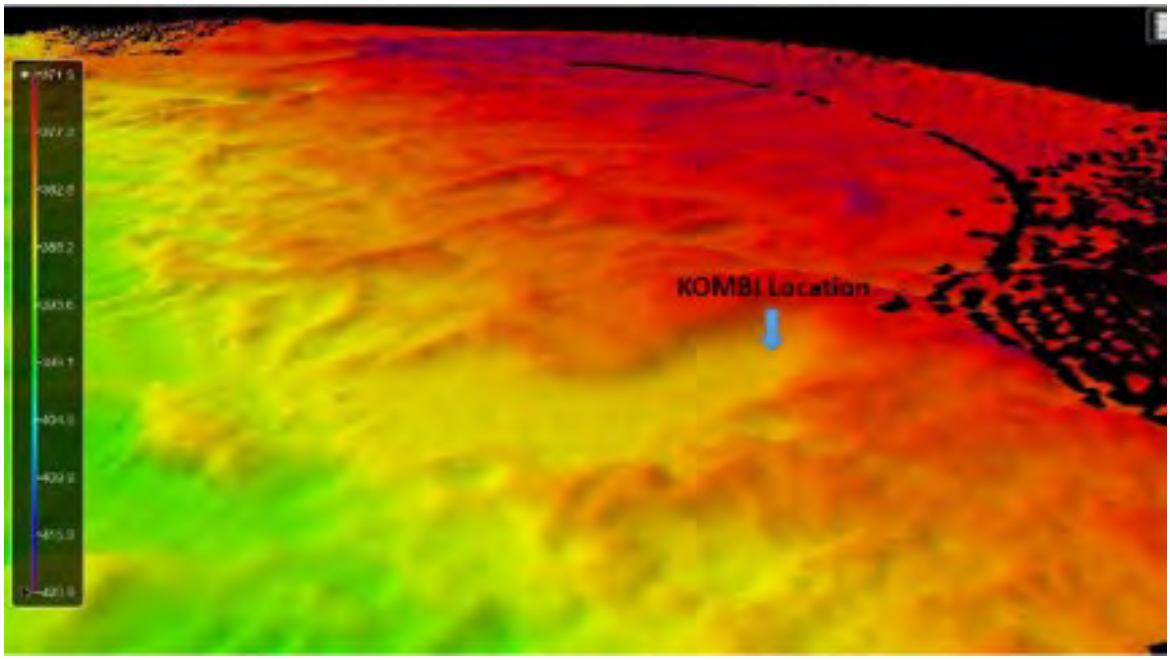
Giving direction to the Bridge from Operations room on very fine scale transects to map krill swarm (Photo Credit: So Kawaguchi)



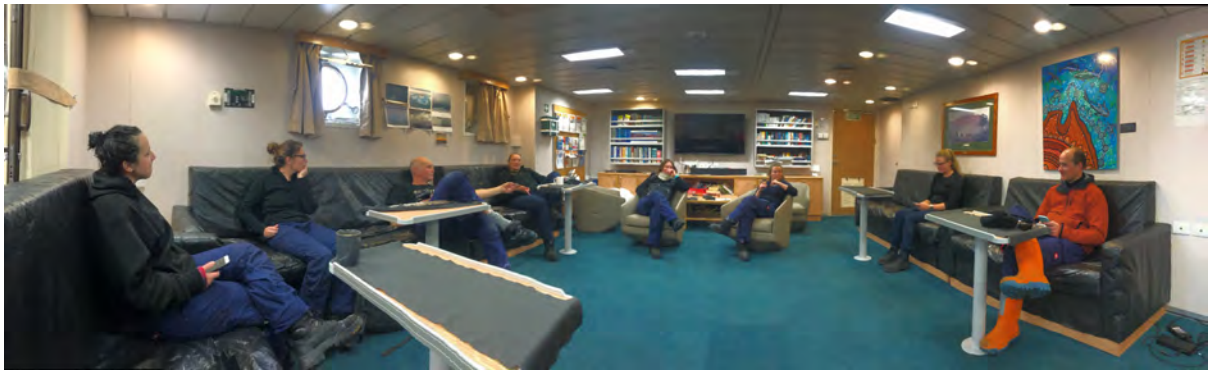
3D mapping of an Antarctic krill swarm (Credit: AAD)



KOMBI Mooring waiting to be deployed (Photo Credit: So Kawaguchi)



Botom topography of KOMBI #3 deployment location (Credit: Chris Berry)



Shift hand-over meeting (Photo Credit: So Kawaguchi)

DAP support made Satellite data interactively available real time on the ships intranet mapping system and Grafana, supporting lively scientific discussion during the Voyage (Photo Credit: So Kawaguchi)

Biological Oceanography team operating CTD (Photo Credit: So Kawaguchi)