RV *Investigator* Voyage Plan

Voyage #:	**IN2019_V01**		
Voyage title:	The availability of Antarctic krill to large predators and their role in biogeochemical recycling in the Southern Ocean		
Mobilisation:	Hobart, Thursday, 17 and Friday, 18 January 2019		
Depart:	Hobart, Saturday, 19 January 2019		
Return:	Hobart, Tuesday, 5 March 2019		
Demobilisation:	Hobart, Wednesday, 6 March 2019		
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Chief Scientist:	Michael Double		
Affiliation:	Australian Antarctic Division	Contact details:	Mike.Double@aad.gov.au
Principal Investigators:	**AAD Co-Investigators on proposal** Elanor Bell (**Alternate Chief Scientist**) Virginia Andrews-Goff Martin Cox William de la Mare Natalie Kelly Jessica Melbourne-Thomas Brian Miller So Kawaguchi Karen Westwood **External Co-Investigators on proposal** Stephen Nicol – IMAS, AU (**Chief Scientist** on original proposal) Guy Williams – ACE-CRC, AU Bonnie Laverock – Auckland University of Technology, NZ Justin Seymour – University of Technology Sydney, AU Ari Friedlaender – Duke University, US Helena Herr – University of Veterinary Medicine, Hannover, DE Ken Findlay – Cape Peninsula University of Technology, SA Miguel Iñiguez Bessega – Fundación Cethus, AR Elanor Miller – Research Scientist, AU		

Scientific objectives

Antarctic krill (*Euphausia superba*) is the primary prey for many squid, fish, bird, and mammal species but the factors that influence the distribution, density, form and behaviour of krill are not well understood. Equally it is not known how the characteristics of krill swarms affect the availability of krill to foraging predators.

To determine whether krill swarm characteristics influence predator distribution and behaviour this project will use the latest active acoustic multibeam technology to describe the density, distribution, and fine-scale 3D structure of krill swarms both within the vicinity of Antarctic blue whales and in control locations that are demonstrably distant from these specialist and extreme krill predators. Antarctic blue whales facilitate this study because their locations can be tracked in real-time from many hundreds of kilometres using passive acoustic technology explicitly developed to detect these whales' loud, low frequency calls. Within whale aggregations the movement and foraging behaviour of blue whales will be described using tracking technologies.

In addition, this project will facilitate the first field-based investigation of the controversial theory of iron-fertilisation by whales. Through measurements of the abundance and speciation of whale faecal iron we will establish whether iron concentrations are higher within aggregations of feeding whales than within krill-only aggregations or than in adjacent areas. We will also determine whether whale faeces stimulates local production, alters phytoplankton community structure and growth, and its influence on nutrient cycling, nitrogen-fixation and biogenic climate gas production and the timescale of any effect.

This project could not only profoundly influence our view of the role of whales in the Antarctic ecosystem but will describe the potential dependencies of predators on krill in a form that may be limited in space and time. This information will inform the development of management systems for expanding Antarctic krill fisheries.

Voyage objectives

We will operate south of 60°S, northward of the ice edge, and between 140°E and 175°W. The specific study area/s within these boundaries will be determined by the locations of vocalising Antarctic blue whales, krill and sea-ice. The survey design is therefore adaptive in that sites will be chosen in real-time on the voyage according to available information. At the commencement of the voyage we will head straight to the closest group of vocalising Antarctic blue whales (ABWs) within our operational area. Vocalising ABWs are able to be detected through sonobuoys (see below) hundreds of kilometres away. When whales are found we will undertake a series of activities at that site. We will then commence a series of line transects in the same region and remain within the same area for the rest of the voyage. The study is therefore on a mesoscale and we do not aim to cover our entire operational area.

The activities required to achieve our voyage objectives are:

- Passive Acoustics
- Whale observing, video-tracking and biopsy
- Active Acoustics
- Krill trawls
- Unmanned Aerial Systems (UASs)
- Biogeochemistry

Passive Acoustics (Team Leader – Brian Miller)

To detect, encounter and track vocalising aggregations of Antarctic blue whales (ABWs), sonobuoys will be regularly deployed throughout the entire voyage using established adaptive survey methods. Sonobuoys can provide usable data in calm and rough seas (up to Beaufort sea state 7) and can be deployed from the deck whilst underway without slowing the ship. During transit to the operational area, single sonobuoys will be deployed at 30 NM intervals with acousticians continuously monitoring for ABW calls, and making calibrated intensity and bearing measurements to estimate the distance to vocal aggregations. Within 30 NM of ABW aggregations, multiple sonobuoys may be deployed to triangulate the precise location of ABWs. Multiple sonobuoys may also be deployed during (krill) transect surveys that will subsequently occur in the study area. Upon leaving the whale aggregation, single sonobuoys will continue to be deployed at 30 NM intervals to remotely track aggregations of ABWs.

To record omni-directional acoustic data over a slightly broader area and longer time frame than is possible using sonobuoys, upon arriving at a blue whale aggregation area, an acoustic mooring will be deployed. The mooring consists of a High-frequency Acoustic Recording Package (HARP) and an autonomous Simrad Wide-Band Autonomous Transceiver (WBAT) with 70 kHz and 200 kHz transducers. This system will allow us to continuously record blue whales and ambient noise using the HARP, as well as to determine the concurrent prey field, using the different scattering characteristics of organisms at different frequencies, around the mooring using the WBAT. These data, which are more typical of those acquired during long-term passive acoustic monitoring of underwater environments, will be compared with real-time acoustic detections from sonobuoys and krill patch characteristics as determined during shipboard krill surveys (see Active Acoustics below).

Visual Observations, video-tracking and biopsy (Team Leaders – Nat Kelly, Virginia Andrews-Goff)

Observers will conduct visual observations of whales during all daylight hours to confirm the presence of acoustically tracked or non-vocalising whales. Sighting effort and environmental data will be recorded in a database and linked to the vessel track. The whale observers will use observation boxes on Level 05, and a step on the bow of the ship. They will rotate on hourly daytime shifts – up to 30 minutes each time. Observations will only be conducted during good weather.

Upon visual sightings of ABWs, the vessel will stand-off at ~1-2km and conduct a behavioural focal-follow using a photogrammetric video-tracking system. During 1-3 h of observation (to include 6-12 surfacing intervals of ABWs), accurate bearings, locations and behavioural observations will be recorded, including movements, swimming speeds, blow and diving intervals. Simultaneously, observers will estimate the relative number of ABWs and other species present. Continued sonobuoy recordings will provide simultaneous data on vocal behaviour and triangulate underwater movements of vocalising individuals (see above). Whale biopsy samples may also be collected opportunistically from the bow of the ship using a PAXARMS biopsy system (firearms).

Active Acoustics (Team Leaders – Joshua Lawrence, Martin Cox)

The EK60 scientific echosounders, the ME70 scientific multibeam and the SH90 omnidirectional sonar will be used to continuously map water column targets, primarily krill, throughout the voyage detailing swarm density, structure, and vertical distribution. The EK60 will be calibrated. A time-stamped electronic log or transcript of the ship's activities (viz., research modes and sampling events) will be kept throughout the voyage to aid in subsequent analyses of the large volumes of echosounder data.

We will use Echoview software (Echoview, Hobart, Australia) to process and combine EK60 ME70, and SH90 data into a single spatially referenced data set to allow efficient description and interpretation of patterns in krill distribution. Krill will be identified using the frequency response approach adopted by CCAMLR (2010) and krill aggregations delimited using school identification algorithms (Baranage 1992, applied in e.g. Cox et al. 2010, Cox et al. 2011). Acoustic mark identification will be validated by target trawling using an RMT 1+8 (Roe and Shale 1979).

Designed transect surveys will be conducted to directly compare patterns in krill at known distances from ABW aggregations. We will replicate the small scale night-time survey design of 8 transects, 6 NM long with a 0.75 NM transect spacing carried out previously (O'Driscoll & Double 2015), or a survey design similar to this.

It is highly desirable that a cold water calibration is conducted for the EK60 echosounder. This will take up to 24 hours of ship time and needs to occur in Antarctic waters on a calm day. The ship will need to be stationary during the calibration. A sound velocity profile (temperature, salinity, pressure) will need to be measured using the CTD – 30 minutes before the calibration starts - from the surface to 10 m below the calibration sphere depth. The CTD profile data needs to be in ASCII format and accessible as soon as possible. Please note that niskin bottles do not need to be triggered during this CTD profile, with the profile taking a maximum time of 40 minutes.

Krill Trawls (Team Leader – So Kawaguchi)

Target trawls for krill will be utilized to support the active acoustic work (above), and to collect live animals for experimentation. All trawls will be conducted using a Rectangular Midwater Trawl with 1+8 nets (RMT 1+8), to be provided by the AAD. Trawls will take approximately 1 h. Live krill will be incubated in a tank (IGR tank provided by AAD) to measure growth rates over time. We will also spawn krill and rear larvae using Kreisel tanks in a temperature-controlled laboratory. It is anticipated that up to 50 trawls will occur during the voyage.

Unmanned aerial systems (UAS) operations (Team Leaders – Joshua Smith, Guy Williams)

UAS operations will be utilised to conduct whale biometrics, collect whale exhalation, monitor whale behavior, estimate biological production, and to collect faecal plumes if present. We will utilise quadcopters to undertake this work. UAS operations will take less than 2 h due to battery life and will be launched from the bow or aft main deck. For UAS operations we would like to take the ship as close as possible to whales (depending on the outcome of permit conditions) to allow visual flying rather than "beyond line of sight".

Pre-flight toolboxes will be held between relevant parties on board to determine that operations can be undertaken in safe conditions. An exclusion zone, as nominated in the UAE systems approval documentation, will be adhered to at all times. Simultaneous drone operations will be also be considered, but only after rigorous deliberations with the on board management team and the pilots to determine the safety of these operations.

Any photos taken by the drone or by those watching the operations must be compliance-checked prior to public release.

Biogeochemistry (Team Leader – Karen Westwood)

Biogeochemistry activities will be undertaken to examine iron availability, microbial production, and biogenic climate gases. For this work we will be undertaking both Conductivity Temperature Depth (CTD) and trace metal rosette (TMR) operations. We intend to undertake these operations no more than once per 24 hours during the voyage, apart from at one Process Station (see below). The maximum depth that we will sample for CTD and TMR operations is 1200m. For CTD operations we require the 24 bottle rosette. To determine the vertical structure of the water column in between CTD sites we also require the launch of two XBTs per day. This will provide a better spatial resolution of our survey area.

We also intend to undertake a Process Station on one occasion – whereby the ship re-visits the same parcel of water for up to 5 days. We intend to sample the water parcel every 24 hours, at the same time of day to avoid diurnal effects on measurements. Process Station CTDs/TMRs will be additional to our sampling requirements at other sites. We may therefore conduct two CTDs/TMRs per 24 hours over this 5 day period (rather than one). To track the same parcel of water during the Process Station we will deploy a small drogue supplied by the National Oceanic and Atmospheric Administration (NOAA, USA) as part of their drifter program (please see http://www.aoml.noaa.gov/phod/dac/gdp_drifter.php). The ship is likely to leave the immediate area of the drogue in between sampling times to conduct other activities. The drogue will therefore need to be re-found every 24 hours over the 5 days. We are able to access the GPS position of the drogue on the hour via internet. The surface buoy of the drogue is only small (30-40 cm), but will be brightly coloured with small light beacons attached for visibility to the ship. Please note that whilst we only require 1 drifter for the Process Station, we intend to deploy up to 10 drifters from the aft of the ship during the voyage in order to assist NOAA with measurements for their database. This does not require the ship to slow down, but a crew member will be required to assist in deployments. No drifters will be recovered.

We also intend to conduct one incubation experiment during the voyage – examining the release of bioavailable iron over time and its effect on phytoplankton and bacteria. Incubations will be run for 2 weeks with regular sampling. The MNF deck incubators are required for this work.

Operational Risk Management

The AAD has proceeded with a full operational risk assessment for this voyage but it is not yet complete. However, all operations have been conducted on previous voyages. We intend to undertake daily tool-box meetings during the voyage.

Risk	Activities impacted	Contingency management
Use of firearms for whale biopsies	Injury to person	• National Firearms Safety Code and Firearms Safety Procedure provided to the MNF. • Users require Firearms licences • Gun locker with restricted access located in the Chief Scientist's cabin and ammunition stored in the Master's safe. Master only to hold keys to both of these locations.

Risk	Activities impacted	Contingency management
Use of radioisotopes	Radiation leak Working alone	Radioisotope Application Form submitted Certified personnel only Appropriate PPE
Deployment of sonobuoys (passive acoustics)	Non-functioning receiver system Non-functioning sonobuoys Loss of Antarctic blue whale location capability	Undertake sea trial to test antennas and interference Safe work instruction to be developed
Deployment and retrieval of an acoustic mooring	Injury to person Loss of mooring Loss of time series data on whales and krill	Safe work instruction to be developed
Whale observations, video-tracking	Injury to person Loss of whale data	Safe work instruction to be developed
Echosounders	Interference between instruments Instrument problems during voyage Loss of krill swarm mapping	Undertake sea trial during outward transit to test ping depths and synchronisation Regular checks of data to detect instrument problems with trouble-shooting Test echosounders in Storm Bay on departure
Trawling	Non-functional RMT Injury to person Loss of krill data and echosounder verification	Undertake sea trial to test RMT package Test RMT in Storm Bay on departure Operation as per MNF procedures Back-up communications system under development (AAD) Spare complete RMT net provided by AAD
Unmanned aerial systems	Loss of quadcopter Loss of biometrics, whale exhalant samples, iron sampling close to whales	Safe work instruction to be developed
CTD and TMR operations	Loss of rosette Loss of iron, production and DMS measurements Loss of data for Deep Argo float calibration	Operations as per MNF procedures
Deployment of drifters	Non-functioning drifter Loss of process station	Safe work instruction to be developed
Deployment of a continuous plankton recorder (CPR)	Loss of CPR unit Loss of zooplankton mapping data	Operation as per MNF procedures

Risk	Activities impacted	Contingency management
Use of hazardous chemicals	Injury to person Danger to ship (e.g. explosives/flammable)	Chemical risk assessments to be completed as required Appropriate training and PPE
Sea ice cover	Unable to access locations of Antarctic blue whales	Attempt to find alternate aggregation
Major storms	Loss of voyage time for scientific operations	Allow weather time in voyage plan
Equipment loss or failure or lack of spare parts/consumables	Variety of sampling activities	Spare equipment, parts and consumables to be packed Equipment to be tested prior to packing
Access to decks	Loss of most activities	Allow weather time in voyage plan

Media Activities

With several agencies involved, it is important that media opportunities are managed in a coordinated way.

All media products including releases and multimedia content will be agreed by both MNF and AAD.
Social media will also be managed as per an agreement all expeditioners are required to sign with MNF. All pictures/posts will be sent from the Voyage Leader to MNF and AAD.

Organisation	Activities	Timing	Responsible person
AAD	Article on voyage in Antarctic Magazine http://www.antarctica.gov.au/magazine/2016-2020/issue-35-december-2018/science/krill,-whales,-and-poo-power	Dec (completed)	Dr Wendy Pyper
AAD	Launch voyage webpage (on AMMC site) Info on aims, key people, voyage tracker, 'blog'	15 Dec	Mark Horstman
AAD MNF	Social media posts re: team gathering in Hobart and training	2 weeks before departure	Mark Horstman
AAD CSIRO MNF UTAS	Internal comms – all staff email about voyage with links to webpage and social media All agencies can share or do their own	1 week before departure	Mark Horstman
AAD MNF TasPorts	Media launch of voyage Presser on dock next to RV *Investigator* Voyage science leader – Mike Double Biogeochemist – Elanor Bell	19 Jan 2019 Day of departure	Mark Horstman Matt Marrison

Organisation	Activities	Timing	Responsible person
AAD MNF	Regular 'blog' stories for webpage, social posts and pics (where appropriate) from Voyage Science Leader on activities from ship Dropbox set up for voyage participants to leave social media contributions that are authorised for public use, and released by voyage management team	During voyage	Mark Horstman Mike Double
AAD MNF	Video and pics from BBC	Mid-voyage	Mark Horstman
AAD MNF BBC	Targeted stories and live crosses with media outlets, as opportunities arise	During voyage opportunistically	Mark Horstman
AAD MNF	Presser on docks at end of voyage Provide media outlets with edited multimedia package of highlights from BBC	5 March 2019	Mark Horstman Matt Marrison
AAD	Voyage report to the Scientific Committee of International Whaling Commission	May 2019	Mike Double
AAD and collaborating institutions	Scientific publications from voyage	2019-2020	Chief Scientist Science Team Leaders

Overall activity plan including details for first 24 hours of voyage

14th January:

- Spooling of NSF mooring line to net drum
- Installation of IGR tanks x 2 with continuous seawater flow and drainage

16th January MNF Mobilisation:

- Loading of MNF Trace metal rosette and storage container, MNF trace metal clean laboratories, MNF RadVan
- Loading of AAD RadVan
- Loading of Sonobuoy container into hold
- Loading of AAD liquid nitrogen container

17th January 2019, AAD Mobilisation Day 1:

- Connection of AAD RadVan to power and set-up of scintillation counter
- Shipping containers lifted on to the main deck to be unloaded into labs and office spaces by science participants. Containers to be removed once empty.
- Installation of yagi & omnidirectional very high frequency (VHF) antennas and cabling to work station
- Installation of video-tracking station
- Installation of Kreisel tanks in Constant Temperature laboratory
- Set-up of trace metal clean laboratory
- Set-up of MNF deck incubators

18th January 2019, AAD Mobilisation Day 2:

- Loading of AAD 10 foot RMT gear container
- Loading of net boxes containing RMT1+8 nets (x2), dimensions are 3250x650x600(h). One will be sitting in a cradle which is slightly larger
- Loading of CPR
- Acoustic modems and electronics to be attached to top bar on RMT
- Set-up RMT for net trials the following day
- Setup battery charging (lithium) locations for RMT control electronics
- Loading of drifters
- Empty cage pallets to be removed on backload
- Continued installation of equipment
- Stowage of all gear to be completed

19th January 2019, Departure at 08:00:

- Depart Hobart to Storm Bay
- RMT net trial
- Active acoustic testing (few hours) with some or all data to be transferred ashore
- AAD vessel, *Remora*, to come alongside *Investigator* at 16:30 and off board personnel (technicians for scientists)
- Depart for Transect 1
- Deploy sonobuoys as soon as practical to listen for vocalising Antarctic Blue Whales which can be detected hundreds of kilometres away. We will transit to the closest detected aggregation of ABWs within our operational area.
- CTD and TMR testing as soon as practical down to 2000 m - allow 4 hours
- CPR to be deployed at 40 °S and retrieved 450 NM later. Repeat CPR deployments/retrievals during transit to operational area as far as possible

24th January (approx.) – 27th February (approx.) 2019:

- Science survey

27th February – 5th March 2019:

- Transit to Hobart, arriving AM
- Offload live krill
- De-spool mooring line and offload

6th March 2019:

- Demobilisation

Voyage track example

As described above the exact sampling locations within our operational area will initially depend on the detection of vocalising Antarctic blue whales (ABWs) and the extent of sea-ice. The survey is therefore adaptive and based on real-time data. We aim to conduct a mesoscale survey, with the ship conducting a survey box in the region of interest once ABWs are found. We do not aim to cover our entire operational area.

The survey operational area spans the Dumont D'Urville Sea to the western Ross Sea region (Figure 1). This includes waters off Australian Antarctic Territory and New Zealand Antarctic Territory, including the Ross Dependency and the Ross Sea Region Marine Protected Area (RSRMPA). It is also within the IWC Southern Ocean Whale Sanctuary. We will be occupying CCAMLR Division 58.4.1 and Sub-Area 88.1. We will ensure that adequate permits are obtained to conduct work in these regions. Krill trawling and collection will be undertaken under permit. Liaison with CCAMLR will be required to ensure our work is complementarity with RSRMPA research and the monitoring plan.

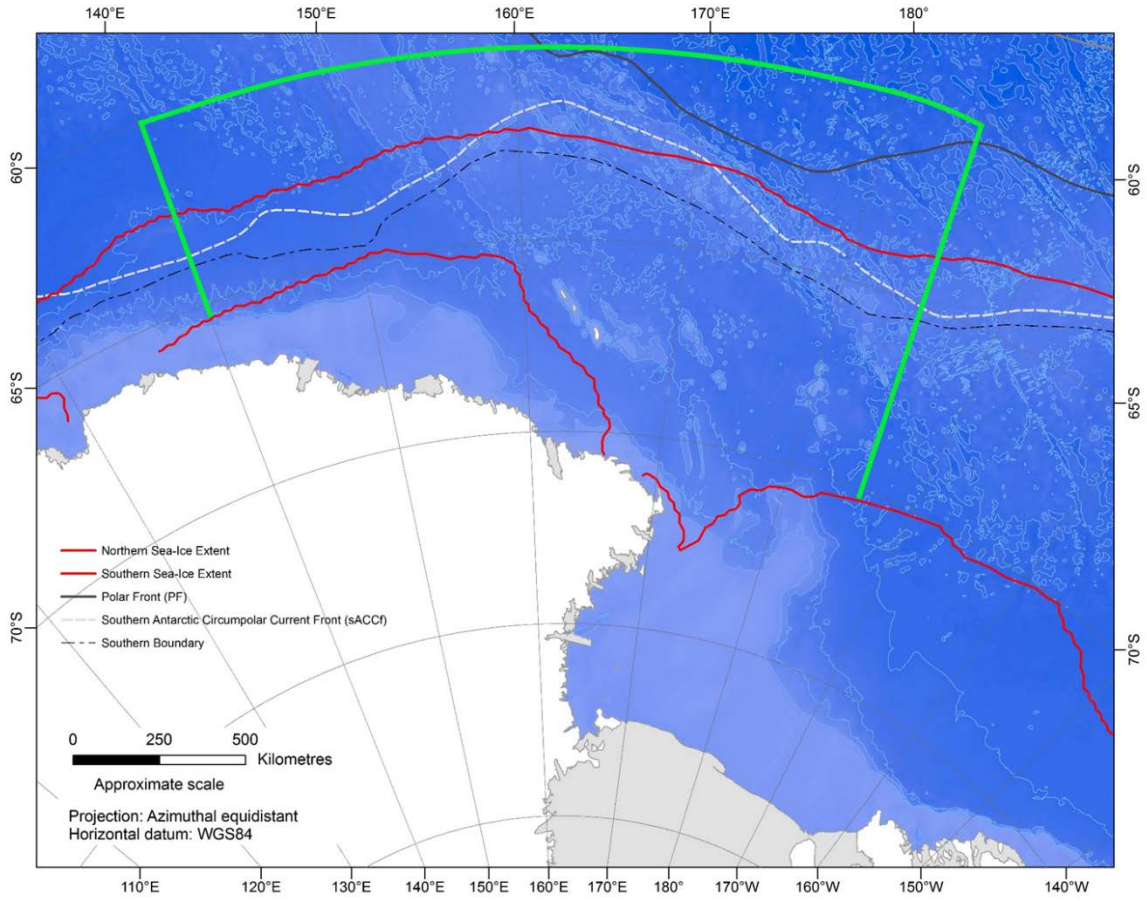
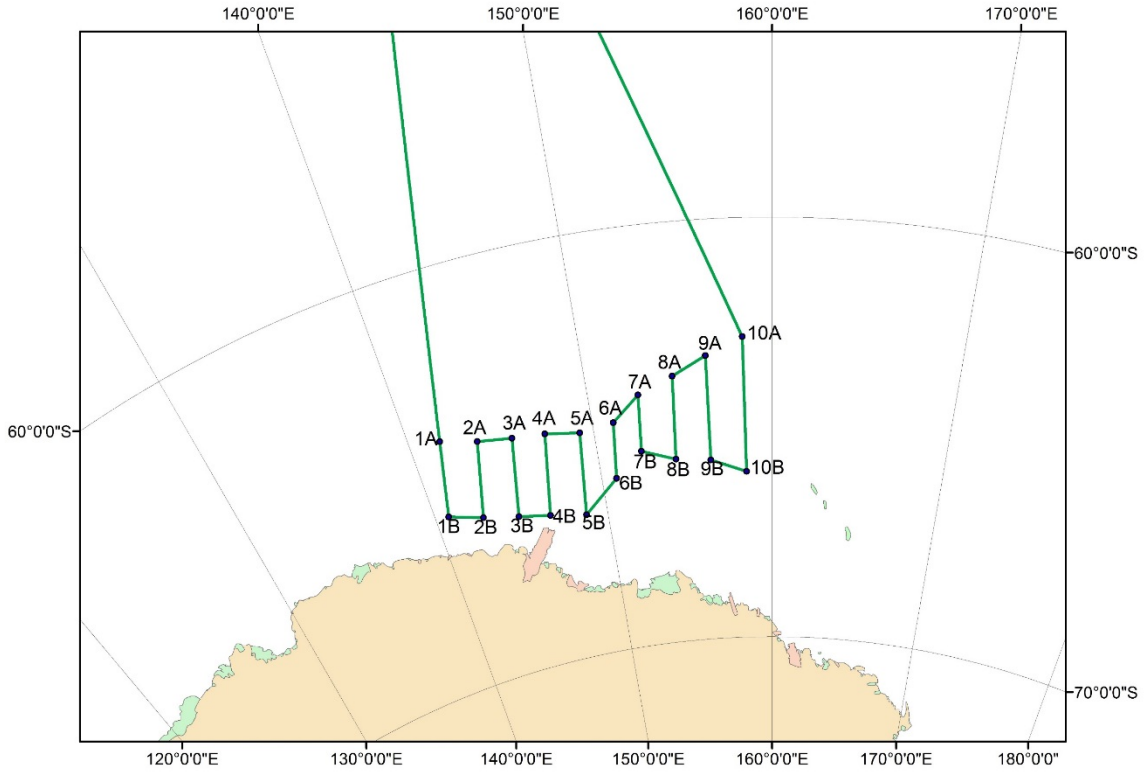


Figure 1: The operational area extends from the sea-ice out to the green lines, spanning the Dumont D'Urville Sea and western Ross Sea regions.

Waypoints and stations

Please note that the waypoints below are **indicative only**. The final position of the survey box will depend on the location of vocalising Antarctic Blue Whales. The transect box may occur a lot further east e.g. with Transect 1 starting at ~ 174°E 67°S. The northern most boundary of the survey box (1A, 2A, 3A etc) aligns roughly with the Southern Boundary. The southern-most boundary of the survey box (1B, 2B, 3B etc) aligns with expected sea-ice distribution for the region. Please note that the total steaming distances do not include "off-transect" work which will often occur – e.g. for whale observations, target trawls and acoustic distance sampling experiments. However, the distances, times and locations for these activities are unknown. Once "off-transect" work is completed we will continue north or south from the deviation point. When the ship reaches the northern or southern boundary of the survey box it will then steam to the next waypoint of the original transect.

Additional activities within the survey box include the deployment of an acoustic mooring (NSF) in a region where whales are present and the depth is < 3000 m. A drifter will also be deployed in a region where whales are present but > 120 kms away from sea-ice (to reduce the influence of sea-ice iron). The drifter will be re-visited every day for 5 days, and as often as possible thereafter. Finally, 24 hours will be allocated for cold water calibration of the EK60 on a very calm day and away from sea-ice. The locations and dates for all additional activities are unknown.



	Decimal Latitude	Decimal Longitude	Distance (NM)	Total Distance (NM)	Steaming time (hrs)	Total Steam (hrs)
Hobart	42° 52.20 S	147° 21.00 E	0	0	0	0
Storm Bay	43° 19.80 S	147° 21.54 E	18.5	18.5	1.7	1.7
Waypoint 1A (Transect 1)	-64° 01.47 S	141° 39.06 E	1268.1	1286.6	115.3	117
Waypoint 1B (Transect 1)	-65° 47.70 S	140° 46.31 E	108.5	1395.1	9.9	126.8
Waypoint 2B (Transect 2)	-66° 04.39 S	142° 41.44 E	50	1445.1	4.5	131.4
Waypoint 2A (Transect 2)	-64° 17.62 S	143° 36.59 E	109.5	1554.6	10	141.3
Waypoint 3A (Transect 3)	-64° 26.22 S	145° 29.97 E	50	1604.6	4.5	145.9
Waypoint 3B (Transect 3)	-66° 17.37 S	144° 43.75 E	113.1	1717.7	10.3	156.2
Waypoint 4B (Transect 4)	-66° 26.98 S	146° 34.55 E	45.6	1763.3	4.1	160.3
Waypoint 4A (Transect 4)	-64° 31.2 S	147° 18.88 E	117.6	1880.9	10.7	171
Waypoint 5A (Transect 5)	-64° 39.97 S	149° 13.41 E	50.1	1931	4.6	175.5
Waypoint 5B (Transect 5)	-66° 37.00 S	148° 42.62 E	118	2049	10.7	186.3
Waypoint 6B (Transect 6)	-65° 53.23 S	150° 50.98 E	67.9	2116.9	6.2	192.4
Waypoint 6A (Transect 6)	-64° 33.70 S	151° 09.66 E	80.1	2197	7.3	199.7
Waypoint 7A (Transect 7)	-63° 59.49 S	152° 42.54 E	53	2250	4.8	204.5

	Decimal Latitude	Decimal Longitude	Distance (NM)	Total Distance (NM)	Steaming time (hrs)	Total Steam (hrs)
Waypoint 7B (Transect 7)	-65° 19.91 S	152° 29.80 E	80.8	2330.8	7.3	211.9
Waypoint 8B (Transect 8)	-65° 36.81 S	154° 25.16 E	51	2381.8	4.6	216.5
Waypoint 8A (Transect 8)	-63° 38.30 S	154° 39.19 E	118.9	2500.7	10.8	227.3
Waypoint 9A (Transect 9)	-63° 12.74 S	156° 29.45 E	55.7	2556.4	5.1	232.4
Waypoint 9B (Transect 9)	-65° 42.08 S	156° 26.07 E	149.7	2706.1	13.6	246
Waypoint 10B (Transect 10)	-66° 0.65 S	158° 29.70 E	54	2760.1	4.9	250.9
Waypoint 10A (Transect 10)	-62° 48.07 S	158° 26.90 E	193.1	2953.2	17.6	268.5
Hobart	-42° 52.20 S	147° 21.00 E	1257.9	4211.1	114.4	382.8

Time estimates

Date	Time	Activity
14/01/19	09:00	IGR tanks to be loaded and installed by AAD technicians.
16/01/19	8:00	MNF mobilisation day; loading of MNF RadVan, AAD RadVan, MNF TM laboratories, MNF TMR, Sonobuoy container, AAD liquid nitrogen container
17/01/19	8:00	AAD mobilisation Day 1; see above
18/01/19	8:00	AAD mobilisation Day 2; see above
19/01/19	8:00	Depart Hobart for Storm Bay
19/01/19	10:00	RMT and acoustics testing
19/01/19	16:30	AAD vessel, *Remora*, alongside RV *Investigator* in Storm Bay (weather dependent) with off boarding / on boarding of personnel
19/01/19	17:00	Depart Storm Bay for Waypoint 1A (start of Transect 1)
20/01/19	10:00	CTD and TMR testing
20/01/19	14:00	Deploy CPR
22/01/19	02:00	Retrieve CPR, Deploy CPR
23/01/19	14:00	Retrieve CPR (up to 4 deployments in total)
24/01/19	1900	Waypoint 1A (start of Transect 1)
25/01/19	0000	Waypoint 1B
25/01/19	0600	Waypoint 2B
28/01/19	1700	Waypoint 2A + *potential* process station + acoustic mooring deployment
30/01/19	1700	Depart Waypoint 2A for Waypoint 3A
31/01/19	0000	Waypoint 3A
3/02/19	1500	Waypoint 3B
4/02/19	0000	Waypoint 4B
6/02/2018	0000	Waypoint 4A
6/02/2018	0800	Waypoint 5A
10/02/2018	0000	Waypoint 5B

Date	Time	Activity
10/02/2018	0800	Waypoint 6B
13/02/19	0000	Waypoint 6A
13/02/2018	0800	Waypoint 7A
16/02/19	0000	Waypoint 7B
16/02/19	0800	Waypoint 8B
19/02/19	0000	Waypoint 8A
19/02/19	0800	Waypoint 9A
19/02/19	0900	Weather
23/02/19	1700	Waypoint 9B
24/02/2018	0000	Waypoint 10B
25/02/19	0000	Waypoint 10A
27/02/19	13:00	Waypoint 2A, retrieve acoustic mooring, re-sample process station
28/02/19	00:00	Weather
28/02/19	10:00	Depart Survey Area
5/03/19	10:00	Arrive Hobart
6/03/19	8:00	Demobilise

Given uncertainty around the location of the mesoscale survey box (*i.e.*, dependent on the presence and detection of vocalizing Antarctic blue whales), time estimates (as outlined above) are presented in a more aggregated format below. The following time estimates assume that transit times are sailed at 11 knots, and on-survey speed is 10 knots. If the full allowance for weather/ice/gear problems is not used, more 'with whales' or smaller-scale active acoustics surveying may occur. CTD/TMR, cold-water calibration and acoustic mooring deployment/retrieval times are based on experiences on other vessels, such as the RV *Aurora Australis*. Two timelines are included, one for a survey region ~ 130°E and the other ~175°E (i.e., northern Ross Sea).

140°E Survey Region			
Date	**Time (days)**	**Total time (cumulative; days)**	**Activity**
17-18 Jan	2	2	AAD Mobilisation
19-Jan	1	3	Depart and Storm Bay operations
20-23 Jan	3.4	6.4	Transit to first station (just south of Polar Front)
23-Jan	0.08	6.5	CTD+TMR (first station, just south of Polar Front)
24-Jan	1.62	8.1	Transit to survey area (e.g., 140E 63.725S)
	2	10.1	Find first ABW aggregation
	5	15.1	Process Station

140°E Survey Region			
Date	**Time (days)**	**Total time (cumulative; days)**	**Activity**
24 Jan	1	16.1	Cold water calibration of EK60, including CTD profile 30 mins prior - from the surface to 10 m below the calibration sphere depth
	0.2	16.3	Deploy acoustics mooring
	3	19.3	With-whales sampling
	7.5	26.7	Broad scale transects + within survey transiting
	5.8	32.6	CTD + TMR (35 @ 4 hrs)
	2.0	34.7	Trawls (50 @ 1 hr)
	3	37.7	Acoustic distance sampling experiment x 3
	0.2	37.8	Retrieve acoustic mooring
	5	42.8	Weather/ice/gear delays
1-5 Mar	5	47.8	Transit back to Hobart
6-Mar	1	49	Demobilisation

Northern Ross Sea ~175°E			
Date	**Time (days)**	**Total time (cumulative; days)**	**Activity**
17-18 Jan	2	2	AAD Mobilisation
19-Jan	1	3	Depart and Storm Bay operations
20-23 Jan	3.4	6.4	Transit to first station (just south of Polar Front)
23-Jan	0.08	6.48	CTD+TMR (first station, just south of Polar Front)
	0.7		Transit to survey area decision point (e.g., ~ 148E 60S)
24-Jan	3.5	9.9	Transit to northern Ross Sea survey area
	2	11.9	Find first ABW aggregation
	5	16.9	Process Station
	1	17.9	Cold water calibration of EK60, including CTD profile 30 mins prior - from the surface to 10 m below the calibration sphere depth
	0.2	18.2	Deploy acoustics mooring
	3	21.2	With-whales sampling

Northern Ross Sea ~175°E			
Date	**Time (days)**	**Total time (cumulative; days)**	**Activity**
	2.5	23.6	Broad scale transects + within survey transiting
	5.9	29.5	CTD + TMR (35 @ 4 hrs)
	2.1	31.5	Trawls (50 @ 1 hr)
	3	34.6	Acoustic distance sampling experiment x 3
	0.2	34.7	Retrieve acoustic mooring
	5	39.7	Weather/ice/gear delays
1-5 Mar	7.5	47.2	Transit back to Hobart
6-Mar	1	49.0	Demobilisation

Piggy-back projects (if applicable)

Continuous Plankton Recorder (CPR)

Antarctic plankton are expected to be sensitive and vulnerable to climate change. The Southern Ocean CPR (SO-CPR) program was established in 1991 by the AAD as a monitoring program for krill and zooplankton. It provides sustained fundamental observations on variation in plankton biodiversity, distribution and abundance to detect and assess potential effects of climate change at the base of the food web. These observations underpin other research for management of the region. SO-CPR is a recognised international monitoring facility, supported by several nations and supporting other Antarctic and international monitoring programs.

We intend to deploy a CPR on transit to our operational area, and on return to Hobart. There may potentially be additional deployments during the main science survey – depending on our transit times between different locations. The CPR will be provided by the AAD and towed up to 450 NM on each occasion. The unit is usually towed about 100 m astern of the ship. Depending on sea conditions and the discretion of the officer-of-the-watch, the ship might need to briefly slow down for a few minutes on each occasion to enable the gear to be deployed or retrieved safely. The vessel may then continue at normal speed.

Permits

All of our activities south of 60°S require permits under the Antarctic Treaty system and this has been discussed with the AAD Policy Section. The permits/licences we require include:

- Commonwealth of Australia Antarctic Treaty (Environment Protection) Act 1980, Notice of Determination and Authorisation.
- Environmental Protection and Biodiversity (EPBC) permit for working with whales (Approval for Josh Smith, Lyn Irvine and David Donnelly, EPBC permit 17-0004 to work with cetaceans).
- AAD animal ethics committee approval (AAEC) – Two submissions (whale biopsy/UAS work and fish larvae).
- Civil Aviation Safety Authority (CASA) licence to fly drones – Josh Smith - Aviation Reference Number (ARN): 1045394.
- Firearms permits; Australian Antarctic Territory Weapons Ordinance 2001, Authorisation under Section 8 for; Michael Double (Firearms licence: 68266/5), Elanor Bell (Firearms licence: 76076/3), David Donnelly (Firearms Licence 822-792-90B Category A &B Longarm Lcience).

- CCAMLR have been officially advised of our voyage (no permit required).
- Department of Agriculture and Water Resources permits to import samples into Australia – Current permits received from Ratnarajah (iron – 0001721265, BICON – preserved and fixed animal and human specimens, BICON - water), Westwood (phytoplankton – 0002386975, BICON – preserved and fixed animal and human specimens), Kawaguchi/King (krill – 0001744685, live vertebrates – 0002369966), Laverock/O'Brien (soil and water samples - 0002603892), Williams (UAS soil and water samples - 0001721265), King (CPR samples, BICON - preserved and fixed animal and human specimens) , Kelly (biopsy, fecal and blow samples – 0002381535, samples under 20g or 20 ml – 0002359513).
- Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) permit to import samples of endangered species from overseas.
- Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) source licence for use of radioisotopes – S0055.
- Antarctic Marine Living Resources Conservation Act 1981, Permit AMLR 18-19-4101-INVESTIGATOR (permit to harvest marine organisms and carry out research with respect to marine organisms).

Personnel List

	Name	Team	Affiliation	Email
1.	Lisa Woodward	Voyage Manager	CSIRO MNF	Lisa.woodward@csiro.au
2.	Jay McGlashan	SIT Support	CSIRO MNF	Jay.mcglashan@csiro.au
3.	Will Ponsonby	SIT Support	CSIRO MNF	Will.Ponsonby@csiro.au
4.	Amy Nau	GSM Support	CSIRO MNF	Amy.nau@csiro.au
5.	Matt Boyd	GSM Support	CSIRO MNF	Matt.boyd@csiro.au
6.	Peter Shanks	DAP Support	CSIRO MNF	Peter.shanks@csiro.au
7.	Steve van Graas	DAP Support	CSIRO MNF	Steven.vangraas@csiro.au
8.	Kendall Sherrin	Hydrochemist	CSIRO MNF	Kendall.sherrin@csiro.au
9.	Gary Mitchell	Doctor	CSIRO MNF	drgarymitchell@gmail.com
10.	Alexander Vail	Media	British Broadcasting Corporation	alexander.vail@hotmail.com
11.	James Cox	Media	British Broadcasting Corporation	jamescox78@hotmail.com
12.	Michael Double	Chief Scientist	Australian Antarctic Division	mike.double@aad.gov.au
13.	Elanor Bell	Deputy Chief Scientist / Biogeochemist	Australian Antarctic Division	elanor.bell@aad.gov.au
14.	Karen Westwood	Voyage Project Manager / Biogeochemist	Australian Antarctic Division	karen.westwood@aad.gov.au
15.	Brian Miller	Cetacean Passive Acoustician	Australian Antarctic Division	brian.miller@aad.gov.au
16.	Ana Širović	Cetacean Passive Acoustician	Texas A&M University	asirovic@tamug.edu

	Name	Team	Affiliation	Email
17.	Kathleen Stafford	Cetacean Passive Acoustician	University of Washington	kate2@uw.edu
18.	Susannah Calderan	Cetacean Passive Acoustician	Australian Antarctic Division	susannah.calderan@scoter.org
19.	Elanor Miller	Cetacean Passive Acoustician	Australian Antarctic Division	elanorjh@gmail.com
20.	Joshua Lawrence	Active Acoustician	Australian Antarctic Division	r01jml14@abdn.ac.uk
21.	Nat Kelly	Marine Mammal Observer	Australian Antarctic Division	natalie.kelly@aad.gov.au
22.	Ailbhe Kavanagh	Marine Mammal Observer	University College Cork	ailbhe.kavanagh@ucc.ie
23.	Russell Leaper	Marine Mammal Observer	Australian Antarctic Division	russell@ivyt.demon.co.uk
24.	David Donnelly	Marine Mammal Observer	Australian Antarctic Division	ddonnelly6@yahoo.com.au
25.	Vanesa Reyes Reyes	Marine Mammal Observer	Australian Antarctic Division	vanesa.reyes@cethus.org
26.	Paula Olson	Marine Mammal Observer	Australian Antarctic Division	paula.olson@noaa.gov
27.	Charlotte Boyd	Marine Mammal Observer	University of Washington	boydchar@uw.edu
28.	Lynette Irvine	Marine Mammal Observer / Unmanned Aerial System Operator	Australian Antarctic Division	lynette.irvine@utas.edu.au
29.	So Kawaguchi	Krill Scientist	Australian Antarctic Division	so.kawaguchi@aad.gov.au
30.	Rob King	Krill Scientist	Australian Antarctic Division	rob.king@aad.gov.au
31.	Jessica Melvin	Krill Scientist	Institute for Marine and Antarctic Studies	jessica.melvin@utas.edu.au
32.	Olivia Johnson	Krill Scientist	Institute for Marine and Antarctic Studies	olivia.johnson@utas.edu.au
33.	Haiting Zhang	Krill Scientist	Institute for Marine and Antarctic Studies / Shanghai Ocean University	haiting.zhang@utas.edu.au
34.	Joshua Smith	Unmanned Aerial System Operator / Marine Mammal Observer	Murdoch University	Joshua.Smith@murdoch.edu.au
35.	Lavenia Ratnarajah	Biogeochemist - iron	University of Liverpool	L.Ratnarajah@liverpool.ac.uk
36.	Thomas Holmes	Biogeochemist - iron	Institute for Marine and Antarctic Studies	thomas.holmes@utas.edu.au
37.	Abigail Smith	Biogeochemist - iron	Institute for Marine and Antarctic Studies	abigail.smith@utas.edu.au

	Name	Team	Affiliation	Email
38.	James O'Brien	Biogeochemist - DMS	University of Technology Sydney	James.OBrien@student.uts.edu.au
39.	Madeleine Brasier	Biogeochemist - oceanography	University of Liverpool	madeleine.brasier@utas.edu.au
40.	Clara Rodriguez Vives	Biogeochemist - oceanography	Institute for Marine and Antarctic Studies	clara.rodriguezvives@utas.edu.au
	Andrew Cawthorn	Technician (will be off boarded)	Australian Antarctic Division	Andrew.cawthorn@aad.gov.au
	Kym Newbery	Technical (will be off boarded)	Australian Antarctic Division	Kym.newbery@aad.gov.au

Signature

Your name	Mike Double
Title	Chief Scientist
Signature	
Date:	10/12/18

List of additional figures and documents

Nil

Appendix A

Scientific equipment and facilities provided by the Marine National Facility

Some equipment items on the list may not be available at the time of sailing. Applicants will be notified directly of any changes.
Indicate what equipment and facilities you require from the Marine National Facility by placing an **X** in the relevant box.

(i) Standard laboratories and facilities

Name	Essential	Desirable	Notes/Comments
Aerosol Sampling Lab			
Air Chemistry Lab	X		
Preservation Lab	X		
Constant Temperature Lab	X		Required for Kreisel tanks (King)
Underway Seawater Analysis Laboratory	X		
GP Wet Lab (Dirty)	X		
GP Wet Lab (Clean)	X		
GP Dry Lab (Clean)	X		
Sheltered Science Area	X		
Observation deck 07 level	X		
Walk in Freezer	X		
Blast Freezer	X		
Ultra-Low Temperature Freezer (-80^{0}C)	X		Required for krill and zooplankton sampling (King)
Walk in Cool Room	X		Required for microbial incubations
Salt water ice machine	X		

(ii) Specialised laboratory and facilities

(May require additional support)

Name	Essential	Desirable	Notes/Comments
Modular Radiation Laboratory	X		
Modular Trace Metal Laboratory (TMR1-blue)	X		
Modular Trace Metal Laboratory (TMR2-white)	X		Cannot be overstacked
Modular Hazchem Locker			
Deck incubators	X		
Stabilised Platform Container			
Clothing container	X		To be stored in the hold

(iii) Standard laboratory and sampling equipment

Name	Essential	Desirable	Notes/Comments
CTD - Seabird 911 with 36 Bottle Rosette			
CTD -Seabird 911 with 24 Bottle Rosette	X		• Require MNF support to trigger Niskin bottles (scientists to advise depths)
Total number of Casts:	35		
Maximum depth:	1500 m		
Analyses required for each deployment: (indicate which are required and the number of samples per deployment)			• MNF supplied hydrochemist to carry out oxygen, salinity and nutrient analyses. Approximately 35 CTD casts in total for the voyage. • WOCE/Go-Ship compliant CTD data processing and output files to be provided, including error estimates for oxygen and nutrient parameters
Salinity	X		• 24 samples per deployment
Dissolved oxygen	X		• 24 samples per deployment
Nutrients:			*Note: analytical throughput based on 2 hydrochemists/24hours:* - *Nutrients, dissolved oxygen, salinity. Sampling ration 1:1:1 equates to 48:48:48* - *Nutrients, dissolved oxygen, salinity. Sampling ratio 2:1:1 equates to 72:36:36*

Name	Essential	Desirable	Notes/Comments
			- *Nutrients only collection from every depth 160 maximum analytical output*
Nitrate	X		• 24 samples per deployment
Phosphate	X		• 24 samples per deployment
Silicate	X		• 24 samples per deployment
Nitrite	X		• 24 samples per deployment
Ammonia (special request after discussion with hydrochemistry			
Lowered ADCP	X		• Fully functional, with all heads working and logging.
MNF Auxiliary Instrumentation for CTD Rosette (please indicate which you require. Note 6 auxiliary sensor channels are generally available:			• CTD voltage inputs calibrated to correctly log sensor input
Dissolved oxygen sensor	X		
Altimeter (required if operating anywhere near the sea floor)	X		
PAR Sensor (Biospherical QCP-2300)	X		
Transmissometer (Wetlabs C-Star 25cm)	X		
Fluorometer- Chlorophyll-a (Chelsea Aquatracka 111 – 430/685nm	X		
Flurometer – CDOM (Wetlabs)	X		
Nephelometer (Seapoint Turbidity Meter)			
ECO-Triplet (2,000m max depth, chlorophyll, CDOM & backscatter)	X		
Sonardyne USBL System	X		• Sonardyne USBL acoustics communications link, and ship underway data system for control of RMT net. Loan of CSIRO Sonardyne submersible acoustic modem.
Milli -Q System	X		
Laboratory Incubators	X		

Name	Essential	Desirable	Notes/Comments
Heavy Duty Electronic Balance (80kg)	X		
Medium Duty Electronic Balance (15kg/5g resolution)	X		
Light Duty Electronic Balance (3kg/1g resolution)	X		
Surface Net (mouth area 1m^2) 335 micron, 500 micron, 1,000 micron mesh available – please specify			
Bongo Net (500 micron mesh only, not instrumented) ring diameter 485mm 0.018m^2			
Smith Mac grab			
Dissecting Microscopes (x4, please specify number required.	X		One dissecting microscope to be located in the Dirty Wet lab.

(iv) Specialised laboratory and sampling equipment

Name	Essential	Desirable	Notes/Comments *(These items may require additional MNF support staff)*
TRIAXUS – Underway Profiling CTD			Notes: Triaxus is a pilotable towed vehicle capable of carrying a variety of instrumentation. Constant depth towing or undulating profiles (e.g. cyclic depth pattern from 10m to 200m) are possible. Towing speed depends on the tow profile, instrumentation payload and prevailing conditions. Typically, undulations from the surface to 200m are possible at 8knt, with slower speeds for deeper profiles and faster for constant-depth towing. Maximum achievable depth typically 300m Usual instrumentation: SBE9plus (pressure sensor and communication hub) and dual pumped temperature/conductivity/dissolved oxygen circuits. Usual auxiliary instrumentation includes an ECO-Triplet (Chl, CDOM, backscatter), transmissometer, PAR sensor, and Laser Optical Plankton Counter.
Desired towing profile:			
Additional instrumentation:			

Name	Essential	Desirable	Notes/Comments *(These items may require additional MNF support staff)*
(Please supply, make and model and datasheets. Also a contact person for discussion on integration.			
Continuous Plankton Recorder (CPR)			• AAD supplying their own CPR – see "User equipment"
Deep towed camera			
Piston Coring System			
Gravity Coring System			
Multi Corer			
Kasten Corer			
XBT System	X		• 2 per day plus launcher
Trace Metal Rosette and Bottles	X		• MNF TMR and Kevlar on the associated block and winch, along with all of the operational infrastructure/support. • TMR Deck Box (to house the TMR) and deck slot.
Sherman epibenthic sled			
Trace- metal in-situ pumps (x4)			See *"Non-MNF owned equipment"* section below for additional 2 units
Rock Dredges			
EZ Net (maximum of 10 nets for depth stratified sampling. Mouth area of 1m^2 Indicate mesh size required:			
335 micron			
500 micron			
1,000 micron			
Rock saw (requires a trained science personnel)			
Portable pot hauler			
Beam Trawl			

Name	Essential	Desirable	Notes/Comments *(These items may require additional MNF support staff)*
Trawl doors (pelagic or demersal)			
MIDOC (multiple opening/closing codend system for pelagic trawl			
Stern Ramp (please select exposed *OR* installed)	**Ramp Exposed**	**Deck covers installed**	
	X		
Trawl monitoring instrumentation (ITI) (2,000m depth limit)			
Trawl nets: Mid water research trawl Wing end spread usually 21m Average headline height 8.97m Mouth area (on average) 188.37m^2 Mesh size 200mm in mouth area grading to 10mm in cod end.			
Radiosonde Receiver System			

(v) Equipment and sampling gear requiring external support

(May require additional support from applicants)

Name	Essential	Desirable	**Please give this careful consideration, as there is no guarantee that these resources will be available unless specifically requested. Liaise with Voyage Operations Manager as required. Additional staff may be required for these activities.**
Seismic compressors			
Seismic acquisition system			

(vi) Underway systems

Atmospheric Underway Systems

Name	Essential	Desirable	Notes/Comments
75kHz ADCP	X		• Fully functional. • ADCP to be turned off as much as possible, but will be utilised for short periods at a time – likely for 3 minutes on the hour, with echosounders off. Also prior to mooring deployment.
150kHz ADCP	X		
Multibeam echo sounder EM122 12kHz (100m to full ocean depth)			• To be off during the voyage.
Multibeam echo sounder EM710 70-100kH (0-1000m approx.)			• To be off during the voyage.
Sub-Bottom Profiler SBP120			• To be off during the voyage.
Scientific Echo Sounders EK60 (6 bands, 18kHz-333kHz)	X		• EK60 echosounder with MNF supplied electronics, computing, and operational support. Real-time display. • To be fully calibrated. MNF GSM to supply calibration equipment, as agreed.
Multibeam Scientific Echo Sounder ME70 (70-100 kHz)	X		• ME70 echosounder with MNF supplied electronics, computing, and operational support. Real-time display.
Omnidirectional Echo Sounder SH90	X		• SH90 echosounder with MNF supplied electronics, computing, and operational support. Real-time display. • Logging licence for SH90.
Gravity Meter			

Atmospheric Underway Sensors

Name	Essential	Desirable	Notes/Comments
Nephelometer			
MAAP (multi angle absorption photometer)			
SMPS (scanning mobility particle sizer)			
Radon detector			
Ozone detector			
CPC (Condensation Particle Counter)			
Picarro spectrometer (analysis of CO_2/CH_4/H_2O)			
Aerodyne spectrometer (analysis of N_2O/CO/H_2O)			
CCN (Cloud Condensation Nuclei)			
Polarimetric Weather Radar			

Underway Seawater Instrumentation

Name	Essential	Desirable	Notes/Comments
Thermosalinograph	X		
Fluorometer	X		
Optode	X		
pCO2	X		

Seawater systems

Name	Essential	Desirable	Notes/Comments
Trace metal	X		
Scientific clean	X		
Raw	X		

Non MNF owned equipment which may be accessed

Name	Essential	Desirable	Please give this careful consideration, as there is no guarantee that these resources will be available unless specifically requested. Liaise with Voyage Operations Manager as required. Additional staff may be required for these activities.
D & N Francis winch			
Box Corer			
University of Tasmania (UTAS) in-situ pumps (x2)			
EM2040			
ORE Deck Box from CSIRO O&A	X		• Back-up CSIRO ORE deck box for communicating with acoustic releases on the mooring in case user supplied system fails.
• Use of the CSIRO SIMRAD temperature depth sensors (x2)	X		• Fabrication of mounting bracket complete. Sensors to be mobilised by MNF.
• Loan of CSIRO Sonardyne submersible acoustic modem.	X		

Special Requests – MNF Scientific Equipment and Facilities

Passive Acoustics (Team Leader – Brian Miller)

- We require space (preferably on a radio antenna mast) to mount our own radio antennas to receive VHF signal from sonobuoys
- Space in conference room (Level 02) for work-station set-up.
- Facilities (including A-frame and MNF net drum) for deployment and retrieval of an acoustic mooring: winch that can handle 3000 lbs and up to 4000 m of line (a TSE winch has been used before as seen in these specs: http://www.whoi.edu/sbl/liteSite.do?litesiteid=6992&articleId=13007)
- Indoor cargo/storage space (dry non-frozen) for 500 Sonobuoys (6 pallets with a 102x115x120cm, 670kg footprint each) with 2 nally bins as a staging area in the laboratories (or another dry and warm location near the aft deck).
- Indoor storage space for acoustic mooring gear during transits – approx. footprint 2 * 1 m.
- Deck space requirements for acoustic mooring: 1.5 * 1.5 m box and reels of mooring line; weight would have additional footprint, but expect it could be within 1 * 1 m; some number of reels (~10?) with line (dependent on length of mooring needed).
- Bench space 2 * 1.5 m to work on acoustic mooring gear a day or two before/after mooring deployment/recovery.

Visual Observations, video-tracking and biopsy (Team Leaders – Nat Kelly, Virginia Andrews-Goff)

- Mesh for a non-slip pathway to bow and taut lines – to be provided by ASP
- Use of camera system on Level 05 with data to be saved on ships severs. Specific timeframe data to be downloaded by the MNF on request
- External 220 volt power required for video-tracking station(s) on Level 05.
- Gun locker with restricted access located in the Chief Scientist's cabin and ammunition stored in the Master's safe. Master only to hold keys to both of these locations.

Active Acoustics (Team Leaders – Joshua Lawrence, Martin Cox)

- Working drop keel for bioacoustics, thermosalinograph and ADCP data gathering. Drop keel to be lowered to 4.0 m and ship steaming at 10 knots
- MNF to supply EK60 calibration equipment.

Krill Trawls (Team Leader – So Kawaguchi)

- 10 foot container slot for AAD RMT net gear container, preferably at deck level for the transfer of net bars (2.4 m long and approximately 50 kg)

Unmanned aerial systems (UAS) operations (Team Leaders – Joshua Smith, Guy Williams)

- Laminar flow cabinet Clean Dry Lab

Biogeochemistry (Team Leader – Karen Westwood)

- Fume hood for filtration rack Clean Dry Lab

Other

- Sufficient storage space for refrigerated, frozen and ambient samples. Volumes TBA
- If time, we would like to have the AAD RadVan loaded on the MNF mobilisation day on the 16th January

Underway Equipment and Support:

- Working and logging underway thermosalinograph and fluorometer and real-time display
- Sonardyne USBL ship mounted transponder
- Working and logging ship's position, UTC date/time
- Incoming PAR
- Underway CO_2

VIDEO CONFERENCING / DATA COMMUNICATION REQUIREMENTS

Passive Acoustics (Team Leader – Brian Miller)

- A national marine electronics association global positioning system (NMEA GPS) feed is required for our sonobuoy workstation (serial or transmission control protocol, TCP).
- Back-up of 3 TB for NSF acoustic mooring
- MNF/CSIRO deck gear for acoustic mooring deployment/retrieval – quick release, grapple hooks and tag lines, soldering station/expendables.

Visual Observations, video-tracking and biopsy (Team Leaders – Nat Kelly, Virginia Andrews-Goff)

- Use of camera system on Level 05 with data to be saved on ships severs. Specific timeframe data to be downloaded by the MNF on request.

Active Acoustics (Team Leaders – Joshua Lawrence, Martin Cox)

- Back-up of data to AAD NAS drive
- Data download once every 6 hours

Krill Trawls (Team Leader – So Kawaguchi)

- Sonardyne USBL acoustics communications link, and ship underway data system for control of RMT net. Loan of CSIRO Sonardyne submersible acoustic modem.

Other

- DAP to write script for satellite imagery; sea ice, sea-surface temperature, chlorophyll. One image per day would suffice.
- 6 MB of sea-ice data to be emailed from AAD to ship per day. Receiver of data (Nat Kelly) to have their quota increased.
- Approximately 30 minutes prior to cold water calibration of the EK60, a sound velocity profile (temperature, salinity, pressure) will need to be measured using the CTD. The CTD profile data needs to be accessible as soon as possible thereafter, and needs to be in an ASCII format.

Appendix B

User equipment and facilities to be provided by the Chief Scientist

List the equipment that will be brought on board under the Lead Principal Investigator/Principal Investigator responsible for the item.

The Voyage Operations Manager will advise if a RV *Investigator* Application form will be required for your nominated equipment. A deck layout will be developed from the information provided here and in the RVI Voyage Specific Equipment Installation Form.

Owner	**Item name**	**Supporting information (weight, dimensions, location on board)**	Please give this careful consideration, as there is no guarantee that these resources will be available unless specifically requested. Liaise with Voyage Operations Manager as required. Do you require any equipment to be fitted to the vessel? What services (e.g. electricity, water) are required to support the equipment? Are there any special procedures to be followed with the new equipment, radiation work, lasers, small boat work or diving? Do you need to test any equipment or procedures before sailing or under controlled conditions? These activities will require separate approvals.	**RV *Investigator* Equipment Application form required?** ***MNF use only (Y/N)***
Brian Miller	Sonobuoys	• 500 sonobuoys (5-6 pallets 102x115x120 cm, 670 kg each).	• Pallets to be stored in a 20ft container in the ship's hold. • A staging area in the GP Dirty Wet lab will be established.	Received
	Yagi & omnidirectional VHF antennas	• To receive VHF signal from sonobuoys. • To be installed high-up on the ship (preferably masts). - Yagi VHF antenna dimensions approximately 1 x 2 m. Whip VHF		Included with sonobuoys application form (see above)

Owner	Item name	Supporting information (weight, dimensions, location on board)	Please give this careful consideration, as there is no guarantee that these resources will be available unless specifically requested. Liaise with Voyage Operations Manager as required. Do you require any equipment to be fitted to the vessel? What services (e.g. electricity, water) are required to support the equipment? Are there any special procedures to be followed with the new equipment, radiation work, lasers, small boat work or diving? Do you need to test any equipment or procedures before sailing or under controlled conditions? These activities will require separate approvals.	**RV *Investigator* Equipment Application form required?** ***MNF use only (Y/N)***
		antenna approximately 2.5 m in length. - Ideally antennas will have unobstructed 'line of sight' (360° for standard antenna; 90° aft facing for yagi) and should be away from transmitting radio sources. - Both antennas will be connected to the sonobuoy workstation low-loss coaxial cable (LMR400) and optionally via masthead amplifiers (powered over the coaxial cable).		
	Acoustic mooring	• One line (up to 3000 m) with 2 systems attached (active and passive). Mooring, including the anchor, weighs approx. 1000 kg	• Spooling of line to drum on 14/1. Polyprop is 5/8" thick. • AAD to liaise with CSIRO moorings team to utilise pneumatic spooler prior to transfer to the ship's net drum.	Received

Owner	**Item name**	**Supporting information (weight, dimensions, location on board)**	Please give this careful consideration, as there is no guarantee that these resources will be available unless specifically requested. Liaise with Voyage Operations Manager as required. Do you require any equipment to be fitted to the vessel? What services (e.g. electricity, water) are required to support the equipment? Are there any special procedures to be followed with the new equipment, radiation work, lasers, small boat work or diving? Do you need to test any equipment or procedures before sailing or under controlled conditions? These activities will require separate approvals.	**RV *Investigator* Equipment Application form required?** ***MNF use only (Y/N)***
	ORE deck box	• For communicating with acoustic releases on the mooring	• To be connected to *Investigator's* hull mounted 12kHz transducer to communicate with mooring acoustic releases. • AAD will provided their own 12kHz back-up (see below).	
	12kHz transducer	• 12kHz transducer to be used as a back up for *Investigator's* hull mounted transducer.		
Nat Kelly / Virginia Andrews-Goff	Bow platform	• For photo identification and biopsy of whales.	• Framed system and installation to be provided by MNF, clamped to the ships bow by ASP and tether for observer	Received
	Observation boxes	• To house members of the sightings teams as they search for whales	• Installation of two outdoor stations (wind-breaks) on Level 05 (2 observer boxes). • All wind-breaks to be disassembled and re-assembled on ship for installation.	Received

Owner	Item name	Supporting information (weight, dimensions, location on board)	Please give this careful consideration, as there is no guarantee that these resources will be available unless specifically requested. Liaise with Voyage Operations Manager as required. Do you require any equipment to be fitted to the vessel? What services (e.g. electricity, water) are required to support the equipment? Are there any special procedures to be followed with the new equipment, radiation work, lasers, small boat work or diving? Do you need to test any equipment or procedures before sailing or under controlled conditions? These activities will require separate approvals.	**RV *Investigator* Equipment Application form required?** ***MNF use only (Y/N)***
	Big Eyes binoculars	• For use by observers to detect whales at the horizon	• Installation of additional box for Big Eyes. • EPIRB on Level 05 not to be obstructed at any time. • Cover for Big Eyes to be provided by AAD.	Received
	Video tracking system	• Use of camera system on Level 05 with data to be saved on ships severs. Specific timeframe data to be downloaded by the MNF on request.		Received
	Firearms for whale biopsies – x 4.	• To conduct non-lethal research. The firearms are used to deploy tags and to collect biopsy samples for genetic analyses.	• Bolt and barrel to be disassembled on 2 firearms. Gun locker with restricted access located in the Chief Scientist's cabin and ammunition stored in the Master's safe. Master only to hold keys to both of these locations.	

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So Kawaguchi	Krill IGR tanks (x2)	• Floor area in dirty wet lab of 2 x 1600 mm (l) x 980 mm (w) x 1000mm (h) for installation of two krill IGR tanks. Wet weight when each tank when full is 1200 kg. • Bench space for krill processing and a microscope.	• Two tanks will need to be secured in the dirty wet lab on 14/1. They need a supply of continuous scientific clean seawater of sufficient volume (20 litres per minute) and a drain to pump the waste to. • Comes in two parts; an internal HDPE plastic tank and an outside stainless steel supporting frame. The frame comes in first and is bolted to the 610mm grid pattern on the floor of the lab. Then the plastic tank drops inside. Finally the sea water supply and waste lines are connected.	Received
	RMT 1+8 nets	• Two Rectangular Midwater Trawl Nets (RMT 1+8) in boxes – one is a spare • General oceanographic analogue flow sensor for mouth of RMT • 10 foot AAD RMT net gear container	• Trawl deck equipment and support for deployment by ASP on all shifts. Up to 80 trawls to be conducted. - Connection of RMT to rated wire, capable of deploying to 200 m at 3 knts. Shock load up to 2.5 t, assume	Received

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			that this will be via hard eye and shackle/hammerlock - RMT net electronics will require periodic charging of lithium batteries in a suitable location - Topside laptop or PC for controlling RMT net and displaying retrieved data	
Joshua Smith	Unmanned aerial systems	• DJI Phantom 4 Pro drone (https://www.dji.com/phantom-4-pro/info) • SplashDrone 3 'Fishing Edition' (https://www.swellpro.com/waterproof-splash-drone-3-fisherman-info.html#Specification-1)	• Use of bow or main deck to deploy UAS, weather dependent • Storage and work area requirements TBA	Received (provisional approval confirmed)

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Karen Westwood	AAD radiation van	• Including TriCarb 2910 TR scintillation counter (radioisotope laboratory). • Radioisotope work is to be conducted in the AAD RadVan (^{14}C). A "Radioisotope Application Form" has been submitted and comments of the assessment provided. • Sole person to be working in AAD RadVan for extended periods and requires comms with the bridge	• The AAD RadVan will need to be connected to the RV *Investigator* power supply (but no plumbing). • AAD RadVan requires no flue connection.	Received
		• HPLC filtration rack (2 m^2) • DNA filtration rack (2 m^2) • Microbial filtration rack (2 m^2) in a fume hood	• To be placed in clean wet lab (bench-based) • Microbial rack requires a fume hood	
	• Hard-lined cage pallet 1-2		• Cage pallets will be in same 10 foot container as liquid nitrogen – to be placed on upper level behind MNF and AAD	

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			RadVans (cage pallets are for offloading radioactive waste)	
	• Cage pallet	• Containing lugols bottles, consumables and spare parts		
	• Spectrophotometer			
	• Liquid Nitrogen	• 10 foot container • 20 L dewar in wet lab • 1 L dewar	• Container will house 200 L liquid nitrogen in decanting dewar and will be sited on Level 02 behind the RadVan. • 20L dewar to be placed in wet lab for samples. • 20L dewar to be placed in clean dry lab and ratchet strapped to bench leg. • 1 L dewar for transport of liquid nitrogen between dewars.	
	• FIA (iron-analyser)	• To be installed in trace-metal clean laboratory	• 240v – has been used previously on IN2016_V01 and IN2018_V01.	

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	• Microscope with UV lamp	• Dirty Wet Lab		
	• Drifters (x 10)	• Will be palletised. 2 x boxes, 1170x1270x1200 with 5 drifters in each box. Each drifter weighs 27kg.	• To be stored in the Sheltered Science Area (need to be dry).	
	• CPR	• To be deployed at 40 °S and retrieved 450 NM later. Stored on the back deck.		Received
Rob King	• Kreisel tanks	• Installed on benches in temperature controlled laboratory and reservoir tanks on the floor (50-100 L).	• Fish bins will also be secured to the floor by science participants containing jars of hatching krill eggs (34 x 21 x 38 cm (lxwxh), 17L).	Received
Clara Rodriguez Vives	• FIRe fluorometer	• Connect to underway system in Underway Seawater lab, as per previous voyage	• Underway fluorometry measurements. • MNF SIT staff to assist in lab set up.	Y

Special Requests – User Equipment

Passive Acoustics (Team Leader – Brian Miller)

- Acoustic workstation (located in a quiet area to allow listening) with cables (as short as possible) running to antennas

Visual Observations, video-tracking and biopsy (Team Leaders – Nat Kelly, Virginia Andrews-Goff)

- Space on the Bridge on port-side for set-up of visual observations laptop
- Bridge space for 1 x visual observations participant during poor weather plus a permanent space on the bridge to locate the visual observations laptop. A visual observer is to operate the laptop if possible.

Active Acoustics (Team Leaders – Joshua Lawrence, Martin Cox)

- Desktop computer for data processing and hard-drive for back-up (48 TB)

Krill Trawls (Team Leader – So Kawaguchi)

- We will spend a day in Storm Bay doing testing once we depart on IN2019_V01. Two technicians to come on board whilst two scientists stay ashore. Intended ship departure at 08:00 on 19th January. Technician and scientist transfer to/from ship in Storm Bay through the use of AAD vessel, *Remora,* at 16:30 on the same day (assuming all goes well with the testing). The main testing will likely be in the vicinity of Cape Raoul (require 100 to 150m water for final tests). Shallower shots can be completed as we steam to the final testing position. If weather conditions are unsuitable alternate locations will be considered.

VIDEO CONFERENCING / DATA COMMUNICATION REQUIREMENTS

Active Acoustics (Team Leaders – Joshua Lawrence, Martin Cox)

- Back-up to AAD NAS drive during voyage
- Data upload every 6 hours

Visual Observations, video-tracking and biopsy (Team Leaders – Nat Kelly, Virginia Andrews-Goff)

- An NMEA GPS feed is required for the visual observations laptop
- 6.4MB sea ice data transfer to Natalie Kelly daily

Other

- Data back-up of 20 GB per day required for passive acoustic work
- Data backup of 3 TB for NSF Mooring

SEA TRIAL

On the day of voyage departure (8am Saturday 19th January) RV *investigator* will steam to Storm Bay for a day of sea trials. Prior to ship departure, two scientific personnel will be off-boarded and two AAD technicians will be on-boarded. It is envisaged that sea trials in Storm Bay will cease at 4.30 pm and the AAD vessel, *Remora,* will then come alongside *Investigator* to swap personnel (2 scientists/technicans on/off). The *Remora* will be launched at Port Arthur for this operation. If weather conditions at Storm Bay are not suitable, an alternative location will be sought for sea trials and this personnel swap. Options will be discussed with Karen Westwood (Project Manager) a few days prior to voyage departure, once close-range forecasts are received.