RV *Investigator* Voyage Plan

Voyage #:	**IN2020_T01**		
Voyage title:	Collaborative Australian Postgraduate Sea Training Alliance (CAPSTAN): Training the Next Generation of Marine Scientists		
Mobilisation:	Fremantle Ports, Monday 9 March 2020		
Depart:	Fremantle Ports, Tuesday 10 March 2020		
Return:	Hobart, Thursday 19 March 2020		
Demobilisation:	Hobart, Friday 20 March 2020		
Voyage Manager:	Rod Palmer CSIRO O&A	Contact details:	rod.palmer@csiro.au
Chief Scientist:	Dr Veronica Tamsitt		
Affiliation:	University of New South Wales	Contact details:	veronica.tamsitt@gmail.com
CAPSTAN Director and Lead Principle Investigator:	Dr April Abbott		
Affiliation:	Macquarie University	Contact details:	april.abbott@mq.edu.au

Scientific objectives

The Collaborative Australian Postgraduate Sea Training Alliance Network (CAPSTAN) is a post-graduate at sea training initiative on the RV *Investigator*. Governed by a network of leading industry and university partners from within marine science and geoscience, CAPSTAN is a first of its kind programme which will transform the way marine science education is delivered.

A truly national education initiative, CAPSTAN offers a national approach to teaching and learning in the marine sciences whilst providing a platform for institutional, industrial and generational knowledge transfer and collaboration.

Our aims have arisen out of a national desire to:

- Develop an effective, efficient form of vessel-based tertiary education by involving stakeholders and post-graduate students, and by pooling national tertiary teaching expertise and personnel resources;
- Develop a national curriculum to standardise teaching protocols/methods and learning outcomes in this area in conjunction with the new data collection equipment and facilities of the Marine National Facility RV *Investigator*, the Integrated Marine Observatory System (IMOS) and external stakeholders, and;
- Provide and test a multi-disciplinary research-based teaching module for marine science postgraduates with opportunities for student mobility and national network development.

Voyage objectives

CAPSTAN 2020
The training objectives of CAPSTAN Voyage 3 are to:

- Enable national access to the RV *Investigator* to postgraduate students enrolled in Australian tertiary institutions.
- Provide hands-on training experiences with standard modern sampling equipment used in marine research, encompassing geological, biological, chemical, physical oceanographic and atmospheric equipment.
- Establish national network of new generation marine scientists.
- Continue the post-graduate training programs developed over the three-year trial pilot period.
- Involve a diverse number of national trainers and students in the program.
- Provide ECRs with the opportunity to gain experience as Chief Scientist/Co Chief Scientist.

We aim to deliver a program that encompasses the following:

1. Plan and participate in a multidisciplinary marine science research survey focusing on the core disciplines of e.g. oceanography, plankton ecology, geosciences, atmospheric and fisheries sciences.

2. Evaluate the physical, chemical, geological and biological factors that influence the abundance and distribution of marine organisms.
3. Increase awareness of large national and international datasets and their accessibility (e.g. AODN, SOCCOM, ARGO, etc)
4. Describe the application of various scientific sampling equipment and instrumentation on-board the RV *Investigator*.
5. Acquire, process and analyse quantitative and qualitative samples.
6. Perform data analysis, quality control, interpretation and integration of data collected by participants
7. Prepare a final cruise report.
8. Prepare and present an element of the final cruise report to peers and crew.
9. Master the skills required to operate and conduct oneself safely in the marine environment.
10. Attain basic sea safety and survival skills.

Operational Risk Management

No potentially high-risk work has been identified outside standard operations. Over the side operations include deployment of the CTD, Kasten coring, sediment grabs, camera deployment and plankton hauls. All these activities have been performed on the RV *Investigator* before, and standard safety protocols will be followed.

Media Activities

The MNF will seek to pursue opportunities that arise during the voyage to promote the science, scientists and ship, via conventional and social media channels, in consultation and/or collaboration with the relevant ship user.

Overall activity plan including details for first 24 hours of voyage

On site sampling time: 48 hours

<u>Training Program Outline</u>

- **Day 1-3:** Ship begins transit, students and trainers complete safety inductions and acclimate to ship; participants split into short shifts (8 hrs) with 4 hour overlap midday for whole group seminars and workshops; marine mammal and bird

observations begin; lab inductions completed and students trained in hydrochemistry; first workshop on science communication and blog posts.

- **Day 4-5**: On site operations with students and trainers on full 12-hour shifts (0200-1400 and 1400-0200); selected Chief Scientist runs operations on day 4 and 5 then students are chief scientist for the day until transit back to route.

- **Day 6-10**: Ship transits from site to Hobart; bird and mammal surveys continue; students and trainers operate on 10-hour shifts with 6-hour overlap midday (0600-1600, 1000-2000) for students to process samples and complete science communication, writing, and data processing workshops; ship tours; blogs continue; students give small group presentations on their findings and contribute to cruise report.

Sample Collection:

- On site we will collect water, plankton, and sediment samples. Equipment will include CTD, Kasten core, grab sampler, rock dredge, and plankton nets. We will deploy the vertical tow camera (if available) to help students better understand the patchiness of the benthic habitat. The selected Chief Scientist will schedule the operations for the first 48 hours of over-the-side deployments, with students rotating between biological, chemical, geological, and physical sampling activities. Findings and sampling will be discussed daily with the entire science party and the Voyage Manager. The final 12 hours of over the side sampling will be determined by the students, advised by the voyage manager, Chief Scientist, and myself as part of a 'Chief Scientist for a day' exercise. Sediment samples will be processed on board using basic sedimentological approaches with the students learning to describe the samples in terms of color (Munsell), grain size, sphericity, rounding, and sorting. Students will learn to use their observations from bottom surveys and a preliminary grab sample to determine the suitability of a location for coring. Plankton will be identified and counted on board. Water samples will be analyzed on board following standard operations as instructed by Marine National Facility hydrochemists. Bird and mammal observations will be recorded with corresponding site information. Students will monitor underway data for the entirety of the voyage to identify key features that may correlate with bird and mammal observations (e.g. mixing front).

Site Flexibility:

- We are flexible on the exact location of the site. Our main constraint is that the time on site is about ½ way through the voyage (no sooner than day 3, no later than day 9) to allow participants to be adequately prepared to undertake the sampling and still have adequate time to process samples and measurement results on board for final presentations before making port. Sites are chosen to be scientifically interesting to a variety of disciplines and to minimize the deviation from the planned transit route of the vessel. Shallower water options also increases the number of deployments feasible within the allotted time frame providing more opportunity for

each student to see each type of deployment. We aim for the site chosen to be commensurate with the skills and specialty of our trainers and Chief Scientist.

Voyage track example

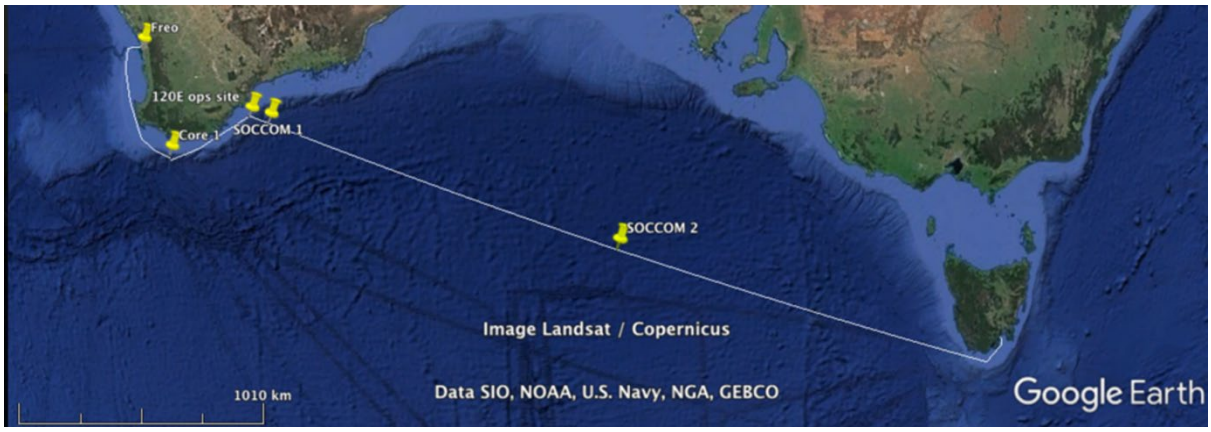


Fig 1: Proposed voyage track for IN2020_T01 from Fremantle to Hobart, with operations concentrated at 120E along the shelf slope at the Pallinup Canyon in the Bremer Bay region, west of the Bremer Marine Park, and a secondary operations site along the transit to Hobart for deployment of a SOCCOM float and a calibration CTD cast.

Waypoints and stations

	Decimal Latitude	Decimal Longitude	Distance (nm)	Total Distance (nm)	Steaming time (hrs)	Total Steam (hrs)
Fremantle	32° 3.13S	115°44.50E				
Shelf coring site	35°23.56S	115°53.85E	260	260	24	24
Bremer Bay ops site & SOCCOM float 1 deployment	34°52.32S	119°19.70E	170	430	16	40
SOCCOM float 2 deployment site	40°10.0S	132° 0.0E	681	1111	62	102
Storm Bay noise measurement site	43°05.45S	147°31.98E	741	1852	68	170
Hobart	42° 52.0S	147° 21.0E	20	1872	2	172

CTD Configuration (delete this section if not intended to be used)

	Please select:
Fundamentals:	
• Which CTD rosette to be used for this voyage (24 Niskin bottles or 36):	36
• Likely total number of casts:	5
• Likely maximum depth of deepest cast:	3000 m
• Lowered ADCP required:	Yes
Instrumentation (maximum 6 auxiliary channels in addition to 2x DO):	
• 2x pumped Temperature, Conductivity, Dissolved Oxygen circuits:	(Standard)
• Altimeter (required if operating anywhere near the sea floor):	Yes
• PAR Sensor (Biospherical QCP-2300):	Yes
• Transmissometer (Wetlabs C-Star 25cm):	Yes
• Fluorometer – Chlorophyll-a (Chelsea Aquatracka III – 430/685nm):	?
• Fluorometer – CDOM (Wetlabs FLCDOM – 370/460nm)	?
• Nephelometer (Seapoint Turbidity Meter)	No
• ECO-Triplet (Chlorophyll-a, CDOM & backscatter – maximum depth 2000m)	No
Hydrochemistry Analyses:	
• Salinity	Yes
• Dissolved Oxygen	Yes
• Nutrients: Nitrate	Yes
• Nutrients: Phosphate	Yes
• Nutrients: Silicate	Yes
• Nutrients: Nitrite	Yes
• Nutrients: Ammonia (special request after discussion with hydrochemistry)	Yes

Investigator equipment (MNF)

CTD Equipment and Support

- 36-bottle CTD-rosette with 12L Niskin bottles and
- MNF-O2, MNF-PAR, MNF-transmissometer, Strutton-backscatter, and US SOCCOM fluorometer, sensors mounted.
- Lowered ADCP with all heads working and logging
- Continuous Plankton Recorder (CPR)
- CTD voltage inputs calibrated to correctly log sensor inputs
- WOCE/Go-Ship compliant CTD data processing and output files to be provided, including error estimates for oxygen and nutrient parameters

Underway Equipment and Support

- Multibeam/Multifrequency bio-acoustic system, with MNF, supplied electronics, computing, and operational support
- Underway echosounder with bottom detection and real-time display
- Underway ADCP, with real-time display
- Underway thermosalinograph and fluorometer and real-time display
- Drop keel for thermosalinograph and ADCP data gathering
- Logging meteorological instruments including ISAR SST radiometer

Kasten corer equipment and support – ESC 1 container

- Support for deployment of kasten corer and retrieval

Rock Dredge

- Support for deployment of rock dredge and retrieval

Zooplankton Nets

- Support for deployment of zooplankton net/s and retrieval

Drop camera

Smith Mac Grab

User Equipment

The intention is to use MNF/CSIRO equipment as detailed above.

Tom Trull's FlBB sensor mounted on the CTD. *NOTE: FLBB sensor (remaining on board from IN2019_V05) is to be mounted on CTD facing into the open ocean.*

Special Requests

1. One of the CSIRO personnel on board will be available to approve communications (twitter, blog posts, etc) to support the science communication aspect of CAPSTAN program.

Time estimates

The following time estimates are based on a steaming speed of 11 knots.

Please include estimates of time for periods in between all activities noted below.

Date	Time	Activity
10 March 2020	Depart 0800	Steam to core site (24 hr steam). Bird/mammal survey in daylight
11 March 2020	Arrive at core site at 0800	Arrive core site at 0800: Core site 1: Geophysics survey (2 hours); grab and kasten core (1600 m depth) Depart core site 1 at 1200: Geophysics survey underway at 7nm/hr to core site 2

Date	Time	Activity
		Core site 2: kasten core (3000 m) Depart core site 2 at 1530, steam to canyon ops site (16 hour steam)
12 March 2020	Arrive at Canyon ops site At 0730	Arrive Ops site in Pallinup Canyon at 0730: Station1 ~300m isobath: geophysics survey (1 hour); CTD, plankton net hauls (target time 0900) Depart Station 1 at 1030: Geophysics survey underway at 7nm/hr to Station 2; Arrive Station 2 ~1000m isobath at 1130: CTD; plankton hauls (target time 1200); Geophysics survey as needed; Depart Station 2 at 1500, return to Station 1 Arrive Station 1 at 1600: Repeat CTD, plankton hauls at Station 1 (target time 2100); (note extra 3 hours buffer time here, if time geophysics survey to east along slope and bird/mammal survey) Depart Station 1 at 2130, return to Station 2 Arrive Station 2 at 2230. Repeat CTD, plankton hauls (target time 0000).
13 March 2020	Depart canyon ops site at 1400	Depart Station 2 at 0130. Geophysics survey underway at 7nm/hr to Station 3 as time permits; Arrive Station 3 ~2500m isobath at 0430: geophysics survey (2 hours); Kasten core (daylight), CTD, plankton net hauls (target time 1200), SOCCOM float 1 deployment (water depth >2500 m) depart for SOCCOM float 2 site
14 March 2020		Steam to SOCCOM float 2 site. Ongoing bird and mammal surveys in daylight hours.
15 March 2020		Steam to SOCCOM float 2 site. Ongoing bird and mammal surveys in daylight hours.
16 March 2020	Arrive at site at 0700	Complete CTD cast to 2000 m and deploy SOCCOM 2 float (4 hours); plankton tows if time permits
16 March 2020	Depart 1100	Steam to Hobart. Ongoing bird and mammal surveys in daylight hours.

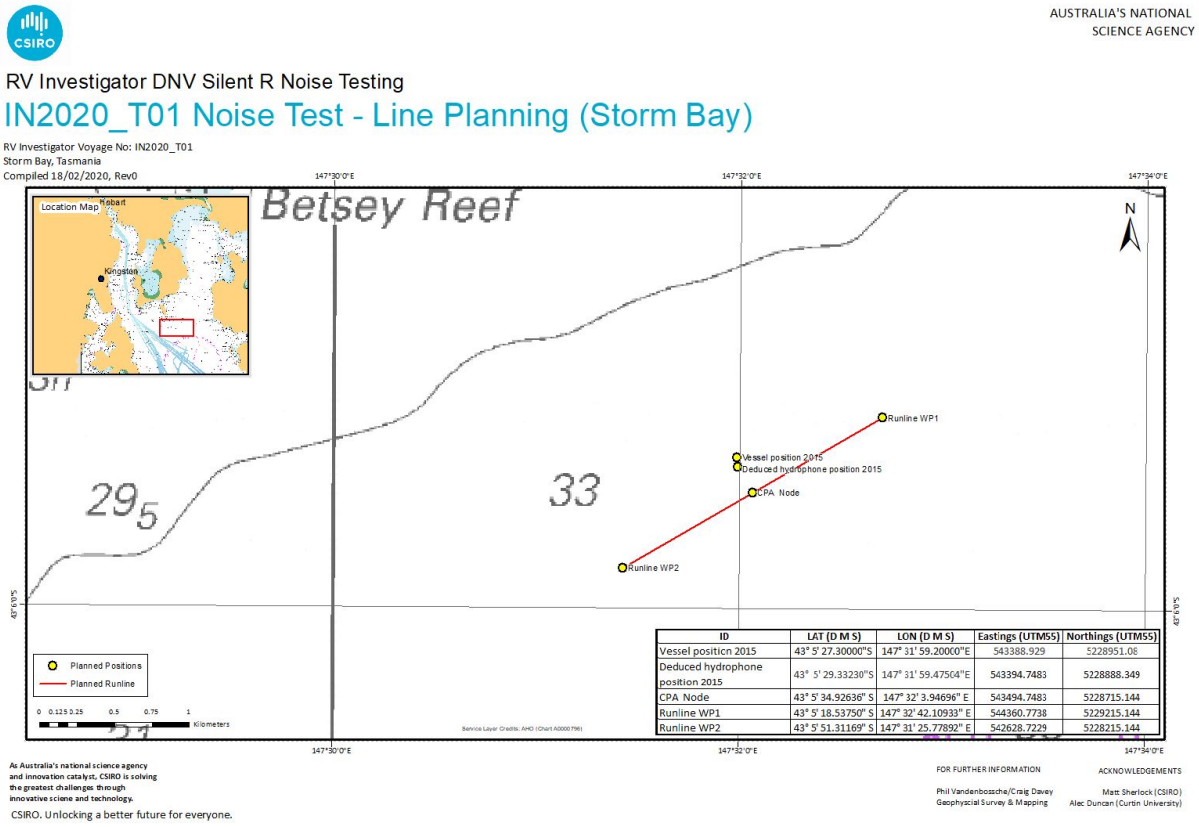
Date	Time	Activity
17 March 2020		Steam to Hobart. Ongoing bird and mammal surveys in daylight hours.
18 March 2020		Steam to Hobart. Ongoing bird and mammal surveys in daylight hours.
19 March 2020	Arrive Storm Bay 0800	Conduct MNF Noise Measurement assessments ~6 hrs
19 March 2020	Arrive 1600	Steam to Hobart. Ongoing bird and mammal surveys in daylight hours. V/l required to be alongside in daylight hrs.

Piggy-back projects

The Southern Ocean Carbon and Climate Observations and Modelling (SOCCOM) project is a multi-institutional program focused on unlocking the mysteries of the Southern Ocean and determining its influence on climate. It includes an extension of the Argo array of profiling floats to include floats that are equipped with biogeochemical sensors for pH, oxygen, nitrate, chlorophyll, suspended particles, and downwelling irradiance. Newly developed sensors now allow profiling floats to also observe biogeochemical properties with enough accuracy for climate studies. This extension of Argo will enable an observing system that can determine the seasonal to decadal-scale variability in biological productivity, the supply of essential plant nutrients from deep waters to the sunlit surface layer, ocean acidification, hypoxia, and ocean uptake of CO2. SOCCOM is driving a transformative shift in our ability to observe and predict the effects of climate change on ocean metabolism, carbon uptake, and living marine resource management in the Southern Ocean, and contributing to a growing global biogeochemical-Argo array.

Housed at Princeton University and administered by the Princeton Environmental Institute, SOCCOM is supported by the National Science Foundation under NSF Award PLR-1425989. We will use this voyage to deploy 2 floats in the Great Australian Bight, which is currently a large gap in the SOCCOM float array.

MNF Underwater Noise Measurement assessment following Det Norske Veritas (DNV) guidelines be conducted in Storm Bay at the end of CAPSTAN voyage IN2020_T01 on the 19th March 2020. A baseline assessment was performed in April 2015 after the arrival of RV Investigator, and it has been recommended that this assessment be repeated after the recent dry-docking of the ship. This test will indicate if the acoustic signature of the ship still complies to the ship's design criteria of DNV Silent-R (the specification for research vessels). The underwater noise measurement will also provide vital diagnostic feedback on vessel machinery. This feedback will enhance planned maintenance scheduling and assist the vessel's engineering department with ensuring the operational status of the vessel's main machinery. The underwater noise measurement will provide a very useful tool in developing a vibration analysis baseline for the vessel's major machinery.
This activity requires ~6 hrs.



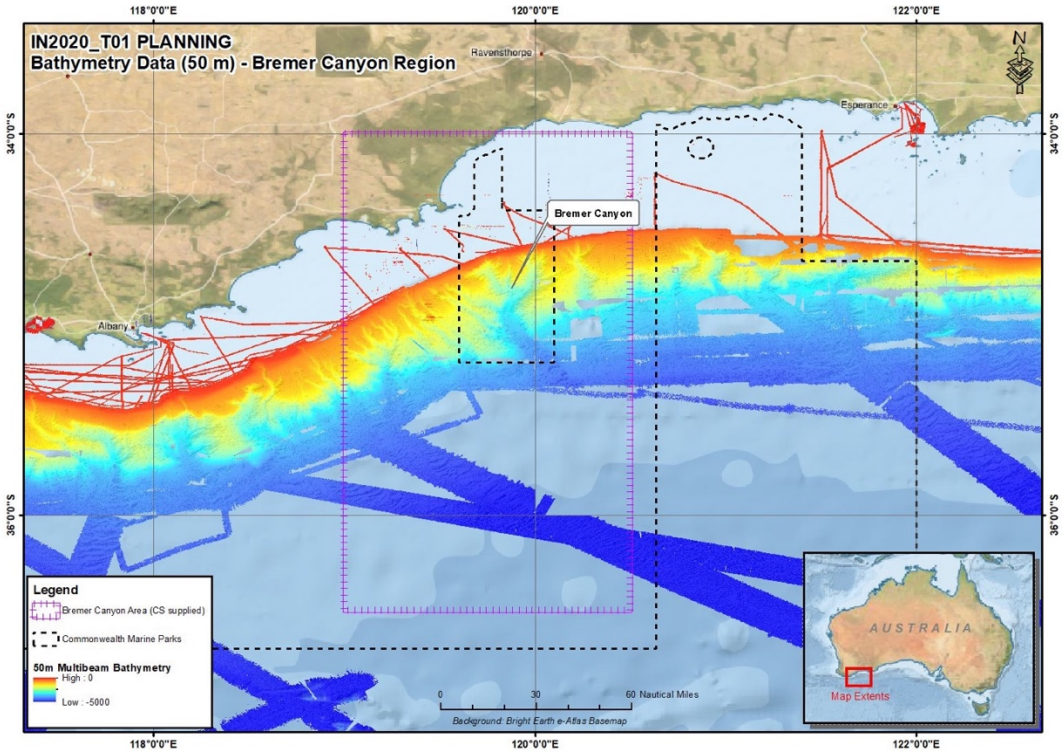
Permits

None required. Note operations will occur outside of the Bremer Marine Park.

Signature

Your name	Veronica Tamsitt
Title	Chief Scientist
Signature	
Date:	20/01/2020

List of additional figures and documents



Compilation of 50 m resolution bathymetry data from the Bremer Canyon region. Compiled by Phil Vandenbossche from MNF.

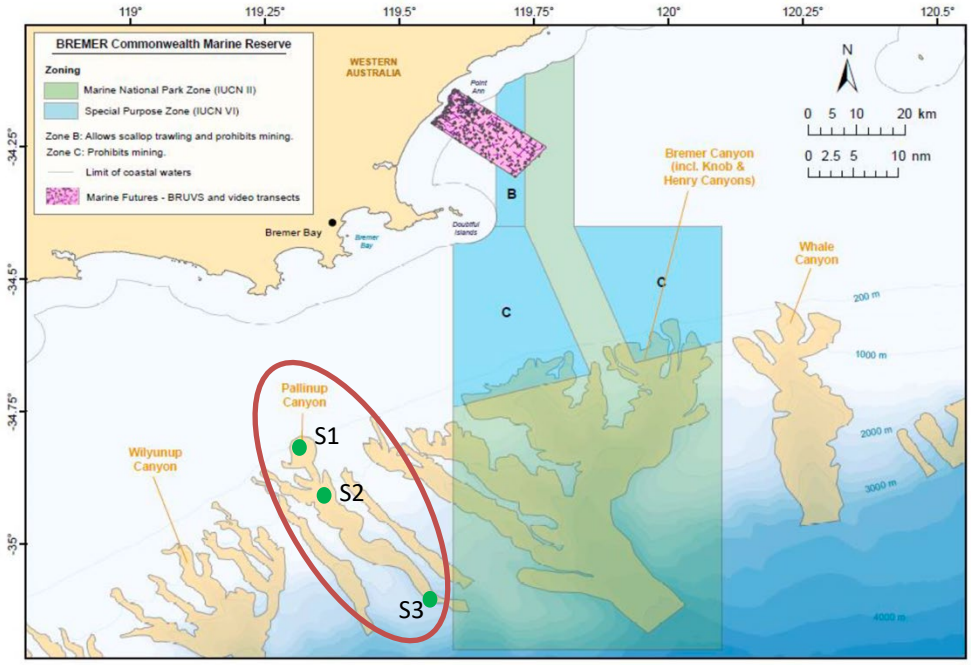


Fig. 6 from Bremer Canyon Science Workshop Report – NESP Marine Biodiversity Hub Emerging Priorities Project Report, 2016 showing the canyons in the Bremer Canyon region. Operations will be conducted west of the Bremer Marine Park, in the Pallinup Canyon, marked by the red oval. Proposed ops site stations 1 (300 m depth), 2 (1000 m depth), and 3 (2500 m depth) marked by green circles.

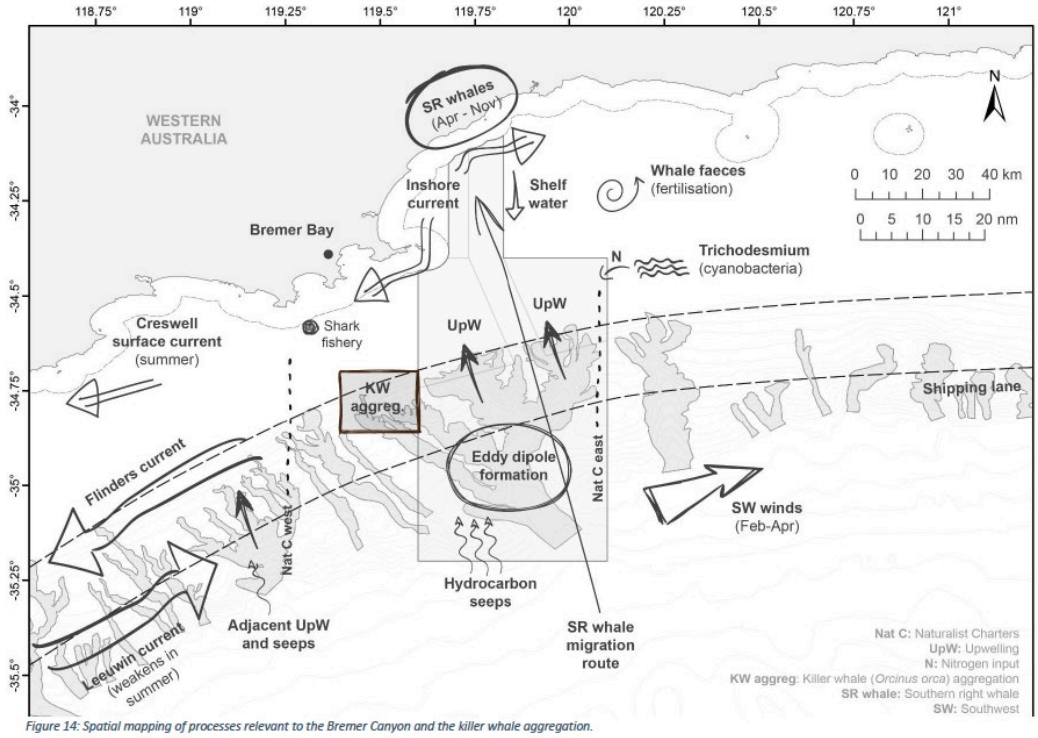


Figure 14: Spatial mapping of processes relevant to the Bremer Canyon and the killer whale aggregation.

Fig. 14 from Bremer Canyon Science Workshop Report – NESP Marine Biodiversity Hub Emerging Priorities Project Report, 2016.

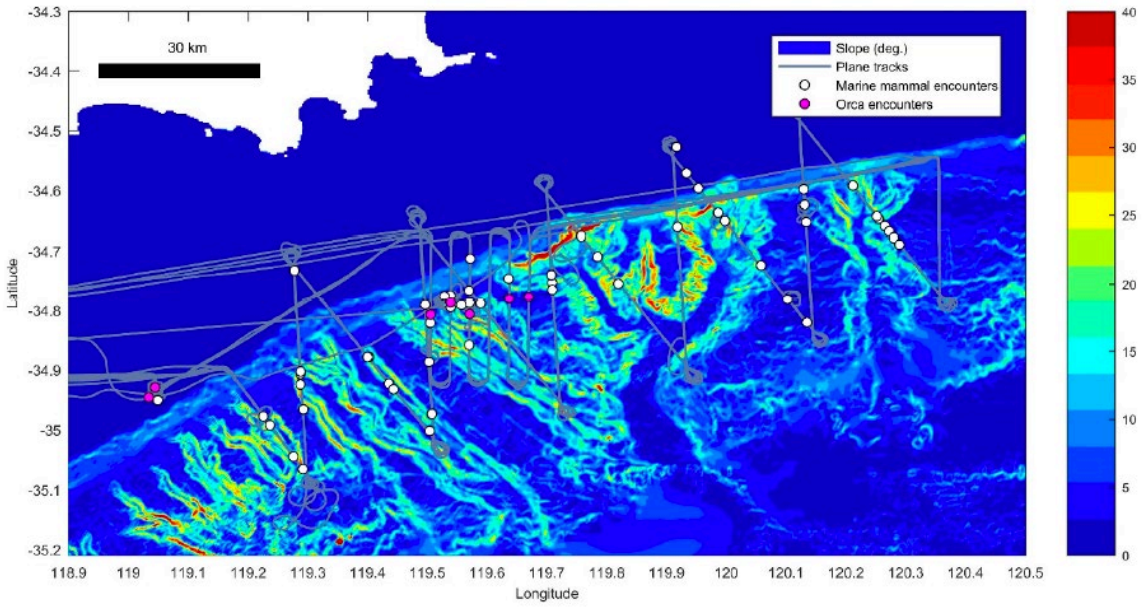


Figure 13: Slope of the seafloor (degrees) with killer whale (pink) and other marine mammal (white) encounters from plane surveys in 2017.

Fig. 13 from Salgado-Kent at al. report on *Habitat preferences and distribution of killer whales (Orcinus orca) in the Bremer Sub-Basin, Australia*.

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			
Preservation Lab			
Constant Temperature Lab			• Please indicate the required setpoint temperature
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) X2	X		
Walk in Cool Room	X		
Salt water ice machine			

(ii) Specialised laboratory and facilities *(may require additional support)*

Name	Essential	Desirable	Notes/Comments
Modular Radiation Laboratory			
Modular Trace Metal Laboratory (TM1-blue)			
Modular Trace Metal Laboratory (TM2-white)			• Cannot be overstacked
Trace metal rosette and bottles			• 10 foot container
Modular Hazchem Locker			
Deck incubators			
Stabilised Platform Container			
Clothing container			• The use of this container will be identified by MNF

(iii) Standard laboratory and sampling equipment

Name	Essential	Desirable	Notes/Comments
CTD - Seabird 911 with 36 Bottle Rosette	X		
CTD - Seabird 911 with 24 Bottle Rosette			
Lowered ADCP	X		
Sonardyne USBL System			
Milli-Q System			
Laboratory Incubators			
Heavy Duty Electronic Balance (80kg)			
Medium Duty Electronic Balance (15kg/5g resolution)			
Light Duty Electronic Balance (3kg/1g resolution)			
Surface Net (mouth area 1m^2)	X		• Please specify 335 micron, 500 micron, or 1,000 micron mesh
Bongo Net (not instrumented) ring diameter 485mm 0.018m^2	X		• 500 micron mesh only
Smith Mac grab	X		
Dissecting Microscopes (x4)	X		• Please specify number required

(iv) Specialised laboratory and sampling equipment

Name	Essential	Desirable	Notes/Comments *(These items may require additional MNF support staff)*
TRIAXUS – Underway Profiling CTD			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: (Please supply, make and model and datasheets. Also a contact person for discussion on integration.			
Continuous Plankton Recorder (CPR)	X		
Deep towed camera			
Piston Coring System			
Gravity Coring System			
Multi Corer			
Kasten Corer	X		
XBT System			• 2 per day provided
Trace Metal Rosette and bottles			
Sherman epibenthic sled			
Brenke Sled			
Rapid Cast SVP			
Magnetometer			
Drop Camera	X		
Trace- metal in-situ pumps (x6)			• See non-MNF owned section below for additional 2 units
Rock Dredges	X		

(iv) Specialised laboratory and sampling equipment

Name	Essential	Desirable	Notes/Comments *(These items may require additional MNF support staff)*
EZ Net (maximum of 10 nets for depth stratified sampling. Mouth area of 1m^2)		X	• Please specify 335 micron, 500 micron, or 1,000 micron mesh
Rock saw			• Requires trained science personnel
Portable pot hauler			
Beam Trawl			
Pelagic trawl system (net, doors)			• Contact MNF to discuss net and mesh dimensions
Demersal trawl system (net, doors)			• Contact MNF to discuss net and mesh dimensions
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)			
Radiosonde Receiver System			

(v) Equipment and sampling gear requiring external support *(may require additional support from applicants)*

Name	Essential	Desirable	
Seismic compressors			
Seismic acquisition system			

(vi) Underway systems

Acoustic Underway Systems

Name	Essential	Desirable	Notes/Comments
75kHz ADCP	X		
150kHz ADCP	X		
Multi Beam echo sounder EM122 12kHz (100m to full ocean depth)	X		
Multi Beam echo sounder EM710 70-100kHz (0-1000m approx.)	X		
Sub-Bottom Profiler SBP120	X		
Scientific Echo Sounders EK60 (6 bands, 18kHz-333kHz)	X		
Multibeam Scientific Echo Sounder ME70 (70-100 kHz)	X		
Omnidirectional Echo Sounder SH90			
Gravity Meter			

Atmospheric Underway Sensors

Name	Essential	Desirable	Notes/Comments
Nephelometer			
Multi Angle Absorption Photometer (MAAP)			
Scanning Mobility Particle Sizer (SMPS)			
Radon detector			
Ozone detector			
Condensation Particle Counter (CPC)			
Picarro spectrometer (analysis of CO_2/CH_4/H_2O)			
Aerodyne spectrometer (analysis of N_2O/CO/H_2O)			
Cloud Condensation Nuclei (CCN)			
Polarimetric Weather Radar			

Underway Seawater Systems and Instrumentation

Name	Essential	Desirable	Notes/Comments
Thermosalinograph			
Fluorometer			
Optode			
pCO2			

Seawater systems

Name	Essential	Desirable	Notes/Comments
Trace metal clean seawater supply			
Scientific clean seawater supplied to laboratories			
Raw seawater available on deck and in laboratories.			

Non MNF Owned Equipment which may be accessed

Name	Essential	Desirable	
D & N Francis winch			• 13mm electro-optical cable
Box Corer			
UTAS In-Situ Pumps (x2)			
EM2040			• Shallow water multibeam echosounder system