RV *Investigator* Voyage Plan

Voyage #:	**IN2017_T01**		
Voyage title:	Natural iron fertilisation of oceans around Australia: linking terrestrial dust and bushfires to marine biogeochemistry		
Mobilisation:	N/A		
Depart:	Sydney, 2000 Sunday, 24 September 2017		
Return:	Broome, 0800 Sunday, 08 October 2017		
Demobilisation:	N/A		
Voyage Manager:	Hugh Barker	**Contact details:**	Hugh.barker@csiro.au
Chief Scientist:	Andrew Bowie		
Affiliation:	UTAS	**Contact details:**	andrew.bowie@utas.edu.au
Principal Investigator:	Ryan Beemer		
Project name:	Interdisciplinary characterisation of the macro-mechanical behaviour of offshore sediments from Northern Australia		
Affiliation:	UWA	**Contact details:**	ryan.beemer@uwa.edu.au
Principal Investigator:	David Steinberg		
Project name:	Macumba Wreck		
Affiliation:	Department of Tourism and Culture, Northern Territory	**Contact details:**	david.steinberg@nt.gov.au
Principal Investigator:	Eric Woehler		
Project name:	Spatial and Temporal Variability in the Distribution and Abundance of Seabirds		
Affiliation:	BirdLife Australia UTAS	**Contact details:**	Eric.Woehler@utas.edu.au
Principal Investigator:	Katherine Walters		
Project name:	Exploring different science communication strategies for engaging the public in marine science		
Affiliation:	Griffith University	**Contact details:**	katie.walters@griffithuni.edu.au
Principal Investigator:	Vicki Stavropoulos & Ben Arthur		
Project name:	CSIRO Educator on Board		
Affiliation:	CSIRO	**Contact details:**	vicki.stavropoulos@csiro.au

Scientific objectives

Natural iron fertilisation of the oceans around Australia: linking terrestrial dust and bushfires to marine biogeochemistry

Oceans play a vital role in Earth's climate through the control of atmospheric CO2. An important component of this system is the iron cycle, in which iron-rich aerosols are transported from land via atmosphere to ocean. Iron is a key micronutrient for marine phytoplankton, the scarcity of which controls essential biogeochemical processes. This project will facilitate an integrated ship-based atmospheric observational program for trace elements in oceans around Australia. During the voyages, we will sample and conduct experiments on atmospheric particles containing terrestrial dust, bushfire smoke and anthropogenic emissions that are transported from Australia to its surrounding oceans. This will provide the critical information on atmospheric iron supply for ocean fertility and health, providing the science for predicting a key factor in the future impact of the oceans on climate. The project supports the training and research of two postgraduate PhD students from IMAS-UTAS.

Voyage objectives

Transit Objective

The main objective of this transit voyage is to move the vessel from Sydney to Broome prior to IN2017_V05. The objectives listed below are complementary with the transit.

Natural iron fertilisation of the oceans around Australia: linking terrestrial dust and bushfires to marine biogeochemistry

We will install an atmospheric sampling system for the clean collection of particles in the ship's aerosol lab. This system consists of vacuum pumps (Thomas Sheboygan 2107CD18), flow meters (DiTGM ML-2500) and filtration systems (Savillex PFA). The manifold is connected to air intake lines fed from the sampling nozzle located ~10 m above sea level on the foremast at the bow of the vessel. Samples will be collected on filters housed in 47 mm filtration holders located within a laminar flow hood (AirClean Systems) to avoid contamination. The system is controlled by automated sector control switch (pump controller) to ensure the system only samples 'clean' air from the forward sector (nominally between 270^{o} port and 90^{o} starboard), avoiding air impacted by the ship's exhaust. The system is capable of running up to 4 flow lines in parallel, to enable replicate sampling or to sample for different parameters using different filters on different lines. A newer more sophisticated version of this aerosol sampling system (including PM1, PM2.5, and TSP size selective inlets) is being developed at CSIRO and should be ready for installation on RV Investigator in the latter part of 2017.

Samples will be collected on a range of different filter types (polycarbonate, Whatman-41, cellulose, Teflon) suitable for different analytical needs. Filters will be changed approximately daily, depending on the aerosol loading, flow rates and amount of time the air inlet is in a suitable 'clean' air sector and sampling takes place. The sector sampling switch records the date/times and waypoints when the wind is 'in sector'. A range of procedural and field exposure blanks will be collected at sea, as well as preliminary leaching and dissolution experiments. Sampled filters will be stored frozen and returned to the shore-based laboratory for further experiments and analyses.

We will also opportunistically collect event-based clean rainwater samples using either a polyethylene funnel and collection bottle (when conditions allow), to quantify the trace metal deposition in the 'bulk' and 'precipitate-only' fractions. Ideally samples would be collected on upper and forward decks, either above the bridge or at the bow when heading into the wind.

The project also requests access to the RV *Investigator* trace metal clean underway supply system (preferably the outlet in the clean wet lab which has been designed for clean filtration and sampling in the laminar flow hood). This will enable us to correlate the atmospheric flux of trace elements with the surface in-water concentrations. Surface seawater will also be used for leaching and dissolution experiments on the collected atmospheric particles.

Our sampled aerosols will include terrestrial dust, processed soils, particles generated through biomass burning and industrial processes, and marine aerosols. Analyses and lab-based experiments will provide observations on 'bulk' measurements of micronutrient trace elements (including iron), their solubility in fresh and saline waters (Buck et al., 2006; Mackie et al., 2006; Baker and Jickells, 2006), their processing during long-range transport and cycling (Sedwick et al., 2008), and their bioavailability to marine phytoplankton. Isotopic tracers (radon-222, δ56Fe) and back-trajectories will be used to differentiate the source, fetch and air type.

Operational Risk Management

Bowie:

No potentially high risk work has been identified outside standard operations.

Woehler: Piggy Back Project 1:

Access to observational posts will be at the discretion of the Master and subject to existing protocols. No high-risk activities involved in seabird observation program.

Beemer: Piggyback Project 2:

Deck equipment used to collect sediment samples will be completed by ASP crew under Standard HSE procedures. No potentially high risk work has been identified outside standard operations.

Steinberg: Piggyback Project 3

No potentially high risk work has been identified outside standard operations.

Walters: Piggyback Project 4

No potentially high risk work has been identified outside standard operations.

Stavropoulos & Arthur: Educator On Board Project

No potentially high risk work has been identified outside standard operations.

Overall activity plan (including details for first 24 hours of voyage)

Bowie:

The aerosol sampling system will be started soon after leaving port in Sydney, and will run continuously until arrival in Broome.

Rain sampling opportunistically if conditions are suitable.

Start trace metal clean underway supply in open waters

Woehler:

Undertake seabird observations throughout the voyage during daylight hours (no impact on ship operations). Observations commence before sunrise and extend to sunset while weather conditions permit. Observations undertaken on all days while vessel is underway.

Beemer:

NOTE: Beemer will not be on board for the Transit. Sediment samples will be collected by CSIRO staff and ASP crew.

No special requirements during the first 24 hours. Once at sampling sites box cores are to be collected and stored in provided containers. Other researchers on the vessel are welcome to take small subsamples from the box cores for their research. Location and water depth data should be recorded at each site. Limit each container to 20 L of soil we will need five per box core. The proposal had 3-6 box cores being collected this would require 15-30 small containers.

- Climate exposure limitations
    - No special climate limitations, samples can be stored on the deck or in a climate controlled environment
- Separation of samples
    - Sample from each location should be stored separately. Material from two box cores at the same location can be mixed
    - This should not be an issue if small containers are used
- Sealing of samples
    - No special sealing precautions are need.
    - However, taping the containers shut would be beneficial
        - In case the containers were to tip over
        - To minimize any odor (sometimes the sediments can have a fishy smell)
- Availability of samples to researchers on the vessel
    - Researchers aboard the vessel are welcome to take small samples sediment (on the order of 1 L) if they believe it will be helpful for their research.
- Labelling of samples:

Example

Researcher: Ryan Beemer

- University: University of Western Australia
- Location Name: Browse Basin

Container: 4 of 5

Steinberg:

NOTE: Steinberg will not be on board for the Transit. Data will be collected by CSIRO staff.

Walters:

No special requirements for first 24hrs. The project requires communication with others on board, so researcher will hope to meet other researchers as convenient, and with permission, witness and document activities on board throughout the trip.

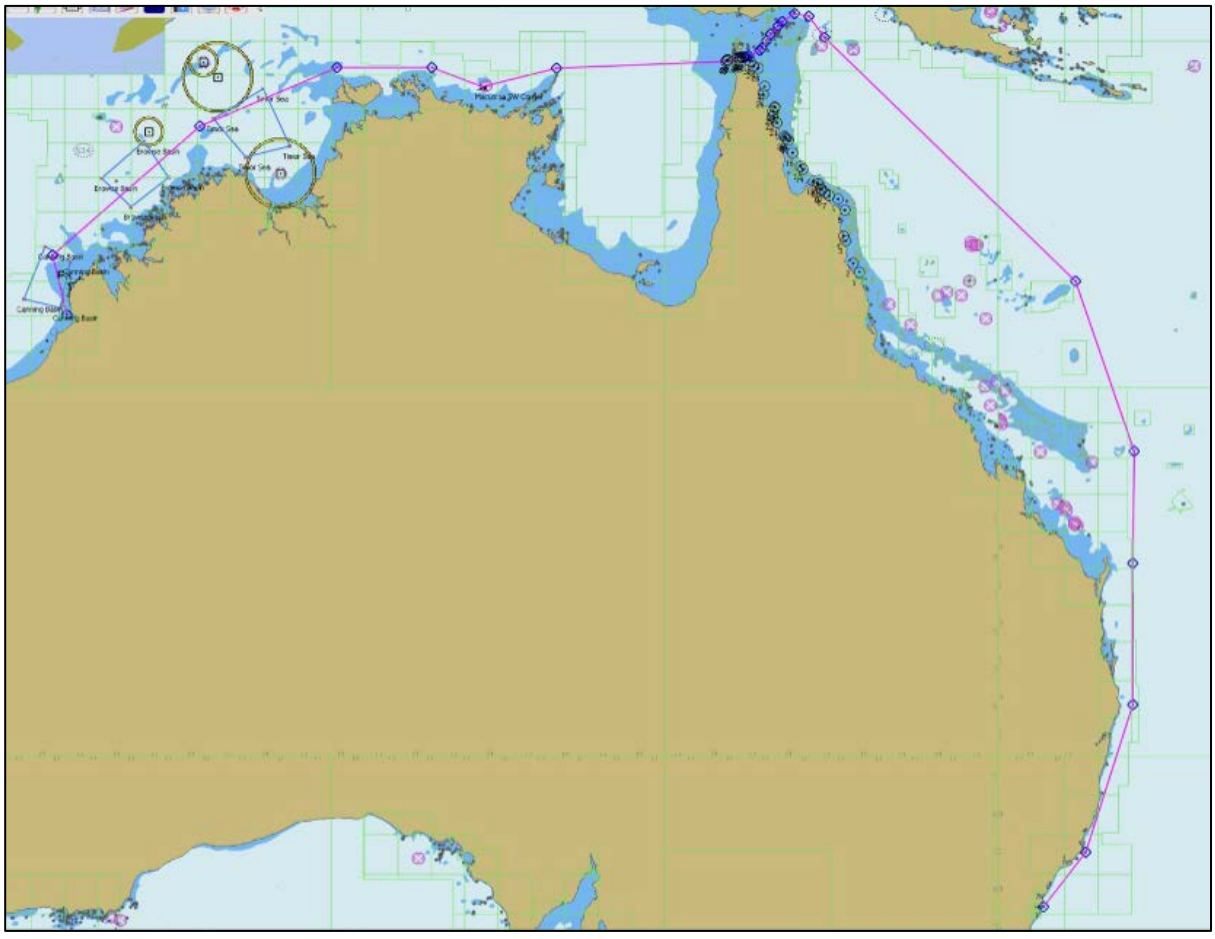
Activities might involve “interviewing” (casually) researchers, and photographing researchers, activities, and any wildlife or locations of interest, and chronicling “life on board a research vessel”

Stavropoulos & Arthur:

NOTE: Stavropoulos will not be on board for the Transit.

No special requirements for first 24hrs. Teachers will spend this time briefing and planning with MNF on-board liaison, as well as acclimating to ship life. Teachers will assist with science projects where suitable, and meet with researchers to discuss incorporating their research into curriculum materials for classroom use. We will liaise with Walters to ensure this is an efficient process for on-board scientists. Teachers will conduct several live classroom crosses via WebEx, which may require increased satellite time and short-term (~30min) impacts on ship Wi-Fi.

Voyage track example



Waypoints and stations

Way Point	Latitude S (DD.dddd)	Longitude E (DD.dddd)
1	-33.83307072	151.3610837
2	-32.45708387	152.6297841
3	-28.66565576	154.0384527
4	-24.85583121	153.9650815
5	-21.82070893	153.9705309
6	-17.04473419	152.2303984
7	-10.2265754	144.68569
8	-9.28597179	144.3322798
9	-9.196015262	143.8923724
10	-9.446153503	143.5243311
11	-9.568751389	143.4049004
12	-9.79934895	143.1807049
13	-10.01379295	143.0641257
14	-10.22623889	142.9234007
15	-10.30085852	142.8543586
16	-10.44864649	142.5260746
17	-10.4799961	142.4507223
18	-10.49851939	142.3829776
19	-10.49774077	142.2793005
20	-10.50883333	142.2511667
21	-10.5105	142.2023333
22	-10.56183333	142.1291667
23	-10.57166667	141.9113333
24	-10.605	141.83
25	-10.82196443	136.7552229
26	-11.36126667	134.5395
27	-10.7930313	133.007351
28	-11.111468	130.696572
29	-10.79605493	130.1796845
30	-12.52079418	126.0792963
31	-13.5963223	123.03924
32	-16.26603902	121.6499492
33	-17.96447488	122.0879903

Time estimates

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

Date	Time	Activity
25/09/2017	08:00	Depart Sydney
Transit Condition Dependent	TBC	Sediment Collection Point: North of Tiwi Islands/ Bathurst Island
Transit Condition Dependent	TBC	Sediment Collection Point: Browse Basin
8/10/2017	08:00	Arrive Broome

Piggy-back projects

Piggy Back Project 1: Spatial and Temporal Variability in the Distribution and Abundance of Seabirds

The project seeks to quantify the distribution and abundance of seabirds at sea around Australia using standardised seabird survey protocols. One or two dedicated observers will collect real-time data on seabirds observed within 300m transect during daylight hours while the vessel is underway. Incidental observations will be collected while the vessel is stationary (e.g. CTD stations) or while the vessel is deploying/recovering moorings. The data collected will be compatible with previous seabird at sea surveys conducted around Australia and farther south, allowing for analyses and assessments to be extended by the current surveys. The distribution of seabirds at sea is strongly linked with oceanographic features such as convergences that concentrate prey at densities that allow for efficient foraging by seabirds. Our surveys on the voyage will link with oceanographic investigations to identify the types and strengths of oceanographic features at which we observe different species of seabirds that utilise different methods of feeding (surface seizing, diving etc.). No dedicated ship time is required for the seabird surveys. Surveys are conducted by observers while the vessel is underway during daylight hours.

Piggy Back Project 2: Interdisciplinary characterisation of the macro-mechanical behaviour of offshore sediments from Northern Australia

The behaviour of offshore sediments under load is very important to understand from an engineering prospective. It will dictate whether a submarine slope will fail and result in a tsunami. It will also determine the size of anchors needed to secure a renewable energy infrastructure. In spite of this importance very little public data on the mechanical properties of offshore Northern Australian soil is available to researchers. This project aims to collect and study the geotechnical behaviour of offshore soils in Northern Australia and make it available to the public. It will provide valuable data for researchers trying to understand and predict submarine landslides and for engineers researching anchoring systems for renewable energy systems.

We propose collecting three box cores, with the Octopus box corer (Currently on board), at three different locations along the transit route. Our goal is to collect samples with high quantities of benthic or planktonic foraminifera with the specific goal of understand how the variation in the soils bio geology impacts their mechanical properties. This should be easily achieved across the majority of Northern and North West Australia.

Our plan is to sample at one site North of Tiwi Islands/ Bathurst Island and one site in the Browse Basin (possible two sites if time prevails)

The geologist on the project is still looking at locations North of Tiwi Islands/Bathurst Island. He has selected 5 potential sites in Browse Basin. He suggested sampling at one of the Browse Basin locations listed below. They are located approximately 70 km north of Browse Island and have water depths of approximately 300 m. Any location between points 1 and 3 would be useful.

If sampling at one of the top three locations is not possible we could potentially get the sediment we are looking for from location 4 or 5. The tides are stronger here, which would have a negative effect of the sediment deposition from our prospective, but they should be acceptable and are much closer to the planned route.

The two target locations in rank of importance are (Final Location TBC):

Sediment Point Priority	**Title**	**Longitude**	**Latitude**
1	Browse Basin	1) 123.283135E 2) 123.03924E 3) 122.465195E 4) 124.734427E 5) 124.025348E	1) 13.123404S 2) 13.596322S 3) 14.214982S 4) 13.262305S 5) 13.671572S
2	North of Tiwi Islands/Bathurst Island	130.696572E	11.111468S

Piggy Back Project 3: Macumba Wreck

The search for the Macumba will be based on a grid search area defined by the interpretation of historic marks and discounting areas previously searched. The size of the search area and the methodology used will, in part, be informed by the tools available and also the amount of time committed to the task. It is hoped that 6-12 hours searching and recording can be committed to the task although if successful early, less overall time will be required. If the voyage can only commit to passing through the search area once, or a far limited number of times, this is still a worthwhile exercise.

In a multi beam or side scan sonar survey the lanes will be defined by the sonar coverage, taking into account the need for overlap to accommodate the gap beneath the sonar fish itself. As the sea bed terrain in the general area is flat it's surmised that there will be little topography to create shadows and complicate interpreting the signal. We appreciate that multi beam is provided and the Heritage Branch can supply a side scan sonar if need be.

Other than the side scan and multi-beam another commonly used tool is a magnetometer. Magnetometers are particularly good in search for the search of iron and steel wrecks. A search pattern within the search area using a magnetometer will be similar, with a fish towed following predetermined lanes. The magnetometer signal will be significant as this is a 2,500 ton steel ship in a relatively shallow seabed, although the device will need to be adjusted to accommodate the high ambient noise of the areas ferrous geology. A basic calculation taking into account the magnetometer, the size of the vessel and the depth of the water will determine the search lanes.

Once the wreck is located the multi beam and/or side scan sonar will be used to take multiple impressions of the wreck. Adjusting the run of the ship will provide multiple perspectives of this complex archaeological site. ROV cameras are not listed on the ship equipment list, but other partners may be sourced to provide this. Remote video has been used on marine life surveys of wrecks in the Northern Territory previously. The ship's bottom profilers will be used to determine heights of the seabed and wreckage to provide a profile of the wreck and guide future dive operations.

Once the wreck is located and a series of side scan runs over the wreck completed any further research on the marine survey of the wreck can be supported. Biological surveys may focus on the biodiversity of surface life, water column and wreck dwelling species. Side scan sonar can capture the scale and location of a 'bait ball' for example. ROV can be used to record wreck dwelling species and benthic life. Remote wreck surveys provide unique challenges for both maritime archaeologists and marine biologists, and the Macumba project will provide an opportunity to develop synergies and shape strategies to record these complex sites.

Piggy Back Project 4: Education

Science communication traditionally uses the "knowledge deficit" model, which assumes that if people simply understand the science, they'll care about its implications. However, there's a great deal of recent research (particularly regarding climate change) to suggest this is NOT the case, and that changing people's attitudes and behaviours may require different strategies such as moral framing, narrative, or even the use of marketing tools. All of this has to be attempted in the changing media landscape which includes social and new media, making the science communicator's job rather challenging!

I would like to test some of the above strategies by following the journeys of the scientists – or if this is not possible, following the journey of the science which is undertaken on board IN2017-T01, and sharing these journeys with the public by use of a variety of written and visual styles (for example: blog posts, short videos, infographics, curated image / twitter stories, etc.).

No special scientific equipment would be required - I would only need the agreement of the scientists on board, that they might be willing to chat to me, and that they'd be happy to share stories (of their science, and/or of themselves) with the public. If required, output can be distributed to scientists, and their organisations, for fact-checking before it is released publicly.

For this project I understand there's very limited access to internet and social media, and that public communications will of necessity not be real-time but disseminated after the fact. This would mean that endeavours on board would consist mostly of preparation of diverse communication of the same material, to measure engagement "success". Web- and social-media metrics could help accomplish this, so if MNF/CSIRO's would be willing to help distribute this information and provide metrics, it would be beneficial.

Stavropoulos & Arthur: Educator On Board Project

'CSIRO Educator on Board' is a professional development program for Australian STEM (science, technology, engineering and mathematics) school teachers. Two teachers will sail on board *Investigator* for short (<2 week) voyages. Participants will: observe and assist alongside scientists and contribute to the national collaborative marine research effort, update their own STEM content knowledge, conduct and coordinate educational and outreach activities including live video broadcasts from the ship, develop curriculum linked resources, such as lesson plans, to be shared with other teachers, and promote *RV Investigator* and its research efforts.

Investigator equipment (MNF)

1. Air Sampling Pump Controller -- Sector control switch used to switch vacuum pumps on/off and enable sampling of air only when the ship is in a 'clean' sector (i.e., prevents contamination of samples by sampling air impacted by the ship's exhaust); requires Ethernet data feed of ship's met data
2. Access to the trace metal clean underway supply system (in laminar flow hood outlet in clean wet lab)
3. Access to Milli-q system (in GP dry lab (clean))
4. Access to aerosol sampling lab, GP wet lab (clean), blast freezer and controlled temperature lab
5. Access to data from underway systems (Thermosalinograph, Atmospheric Underway Sensors, Biological Oceanography Underway Sensors)
6. Octopus - Box corer
7. Smith mac grab (back-up to box corer)

User Equipment

1. Aerosol sampling system (UTAS/CSIRO), includes pumps, flow meters, tubing and filtration holders
2. Laminar flow hood (UTAS), To be installed in aerosol lab, for clean sampling and sample handling
3. Sampling bottles (UTAS), to collect seawater from ship's trace metal clean underway supply (in laminar flow hood outlet in clean wet lab)
4. Precipitation (Rain) Sampler (UTAS), polyethylene funnel and collection bottle, to be installed on 05 level outside of bridge equipment room (no power required), and opened manually during rain events
5. Beemer: Sediment Sampling Containers, as specified in research details above.
6. Steinberg: Imaginnex - Side Scan Sonar

Special Requests

1. Aerosols team require access to laminar flow hood in wet clean lab of the ship to sample from the trace metal clean underway supply system
2. Aerosols team require access to chemical storage locker (for up to 3 L of concentrated hydrochloric acid)
3. ASP – please provide advance notice of incineration events and a final record of incineration events for the voyage to the atmospheric team.

IN2017_T01 tasks to be undertaken by ASP and MNF support teams in preparation for IN2017_V05 departure from Broome (See Attached V05_Mobilisation Task List):

4. SIT - Interface and testing of bongo nets
5. ASP – trawling net drum preparation for V05
6. ASP / MNF – monitoring of V05 user supplied freezer container

Permits

N/A

Personnel List

1.	Hugh Barker	Voyage Manager	CSIRO MNF
2.	Aaron Tyndall	SIT Support	CSIRO MNF
3.	Will Ponsonby	SIT Support	CSIRO MNF
4.	Stuart Edwards	GSM Support	CSIRO MNF
5.	Amy Nau	GSM Support	CSIRO MNF
6.	Frances Cooke	GSM Support	CSIRO MNF
7.	Steve Van Graas	DAP Support	CSIRO MNF
8.	Pamela Brodie	DAP Support	CSIRO MNF
9.	Cassie Schwanger	Hydrochemistry Support	CSIRO MNF
10.	Linda Gaskell	MNF Research Assistant	CSIRO MNF
11.	Morgane Perron	Research Support	UTAS
12.	Eric Woehler	Principle Investigator	UTAS
13.	Katie Walters	Principle Investigator	Griffith University
14.	Ben Arthur	Education and Outreach	CSIRO MNF
15.	Jesse Hawley	Communications	CSIRO
16.	Christian Halverson	Teacher	Department of Education – New South Wales
17.	Chantelle Cook	Teacher	Department of Education – Western Australia

Please note: The MNF support staff numbers in this table are the absolute minimum and the numbers will increase depending on the activities being undertaken on the voyage. It may include Hydrochemists in addition to the other groups.

Signature

Your name	Andrew Bowie
Title	Chief Scientist
Signature	Andrew Bowie
Date:	22 August 2017

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
Aerosol Sampling Lab	X	
Air Chemistry Lab	X	
Preservation Lab		
Constant Temperature Lab		
Underway Seawater Analysis Laboratory		
GP Wet Lab (dirty)		
GP Wet Lab (Clean)	X	
GP Dry Lab (Clean)	X	
Sheltered Science Area		
Observation deck 07 level	X	
Walk in Freezer		
Clean Freezer	X	
Blast Freezer		
Ultra-Low Temperature Freezer		
Walk in Cool Room	X	

(ii) Specialised laboratory and facilities

May require additional support

Name	Essential	Desirable
Modular Radiation Laboratory		
Modular Trace Metal Laboratories		
Modular Hazchem Locker		
Deck incubators		
Stabilised Platform Container		

(iii) Standard laboratory and sampling equipment

Name	Essential	Desirable
CTD - Seabird 911 with 36 Bottle Rosette		
CTD -Seabed 911 with 24 Bottle Rosette		
LADCP		
Sonardyne USBL System		
Milli -Q System	X	
Laboratory Incubators		
Heavy Duty Electronic Balance		
Medium Duty Electronic Balance		
Light Duty Electronic Balance		

Name	Essential	Desirable
Surface Net		
Bongo Net		
Smith Mac grab	X	
Dissecting Microscopes		

(iv) Specialised laboratory and sampling equipment

May require additional support

Name	Essential	Desirable
TRIAXUS – Underway Profiling CTD		
Continuous Plankton Recorder (CPR)	X	
Deep tow camera		
Piston Coring System		
Octopus Box Corer	X	
Gravity Coring System		
Multi Corer		
XBT System		
Trace Metal Rosette and Bottles		
Sherman epibenthic sled		
Trace- metal in-situ pumps		
LADCP		
Rock Dredges		
EZ Net		
Rock saw		
Portable pot hauler		
Beam Trawl		
Trawl doors (pelagic or demersal)		
Stern Ramp		
Trawl monitoring instrumentation (ITI)		
Radiosonde		

(v) Equipment and sampling gear requiring external support

May require additional support from applicants

Name	Essential	Desirable
Seismic compressors		
Seismic acquisition system		

Underway systems

Acoustic Underway Systems

Name	Essential	Desirable
75kHz ADCP		
150kHz ADCP		
Multi Beam echo sounder EM122 12kHz (100m to full ocean depth)		
Multi Beam echo sounder EM710 70-100kHz (0-1000m approx.)		
Sub-Bottom Profiler SBP120		

Name	Essential	Desirable
Scientific Echo Sounders EK60 (6 bands, 18kHz-333kHz)		
Gravity Meter		
Trace metal clean seawater supply	X	

Atmospheric Underway Sensors

Name	Essential	Desirable
Nephelometer	X	
MAAP (multi angle absorption photometer)	X	
SMPS (scanning mobility particle sizer)	X	
Radon detector	X	
Ozone detector	X	
Manifold instrumentation (intake temperature and humidity)	X	
Picarro spectrometer (analysis of CO_2/CH_4/H_2O)	X	
Aerodyne spectrometer (analysis of N_2O/CO/H_2O)	X	
O2 analyser	X	
Manifold instrumentation (intake temperature and humidity)	X	
CCN (Cloud Condensation Nuclei)	X	
MOUDI (Micro-Orifice Uniform Deposit Impactors)	X	
NOx monitor	X	
Polarimetric Weather Radar	X	

Underway Seawater Instrumentation

Name	Essential	Desirable
Thermosalinograph	X	
Fluorometer	X	
Optode	X	
PCO2	X	

In addition, the following MNF equipment is required to be installed in the aerosol lab:

1. Air Sampling Pump Controller (built by Ian McRobert, CSIRO) -- Sector control switch used to switch vacuum pumps on/off and enable sampling of air only when the ship is in a 'clean' sector (i.e., prevents contamination of samples by sampling air impacted by the ship's exhaust); requires Ethernet data feed of ship's met data

2. The continuous plankton recorder (CPR) is a method of collecting phyto- and zooplankton data over large spatial areas and time scales. Plankton are very sensitive indicators of changing ocean conditions and ecosystem health. The AusCPR program has been running since 2009 using research vessels and Ships of Opportunity to monitor the plankton in the Australian region. The program has focused heavily on the East Australian Current, the Great Australian Bight and the Great Barrier Reef as these are regions of high scientific interest and easily accessible. However, the North and West of Australia are under sampled, predominantly due to lack of suitable shipping traffic. This voyage gives us the opportunity to draw a more complete picture of how plankton changes across Australian waters and fill in missing information about species distributions and abundances. Once analysed the data will be freely available through the AODN portal.

NOTE: The CPR will be deployed in two location for the duration of 150nm for each deployment. The first deployment on completion of the Macumba wreck search until the first sediment sampling location, and the second deployment from the final sediment sampling site until Broome. The CPR will be charged by CSIRO Staff and deployed by the ASP crew.