RV *Investigator* Voyage Plan

Voyage #:	**IN2019_T02**
Voyage title:	**Deep seascapes of the Great Barrier Reef: Uncovering submarine canyons and landslides**
Depart:	Brisbane, am Friday, 4 October 2019
Return:	Darwin, am Monday, 14 October 2019
Voyage Manager:	Stephen Thomas
Chief Scientist:	Dr Robin Beaman
Affiliation:	James Cook University
Principal Investigator:	Dr Robin Beaman
Project name:	**Deep seascapes of the Great Barrier Reef: Uncovering submarine canyons and landslides**
Affiliation:	James Cook University
Principal Investigators:	Dr Dirk Erler
Project name:	**First measurements of nitrate isotopic composition in the Coral Sea**
Affiliation:	Southern Cross University
Principal Investigators:	Dr Eric Woehler
Project name:	**Spatial and temporal variability in the distribution and abundance of seabirds**
Affiliation:	University of Tasmania
Principal Investigators:	Dr Alain Protat
Project name:	**ORCA: Using the Investigator radar as a moving reference for the Australian operational radar network**

Affiliation:	Bureau of Meteorology
Principal Investigators:	Dr Rachel Przeslawski
Project name:	**Environmental baselines for Wessel Marine Park, northern Australia**
Affiliation:	Geoscience Australia

Scientific objectives

Supplementary Project 1: Deep seascapes of the Great Barrier Reef: Uncovering submarine canyons and landslides (Beaman)

Our overall aim is to better understand the deep (>100 m) underwater landscapes (or seascapes) of the Great Barrier Reef (GBR) by determining the spatial extent, character and timing of the primary erosive features that have sculpted the GBR margin: the submarine canyons and landslides.

We will achieve this by combining geophysical data collected from this voyage, with previously collected bathymetric and sub-bottom profile data and sediment cores to:

(A) Improve the bathymetric datasets available for the GBR continental slope and construct a comprehensive new inventory of the key landslides and canyons and their detailed geomorphic traits.

(B) Provide information at the regional-scale regarding the sedimentary processes and evolution of the margin, as a crucial first step towards understanding landslide susceptibility, tsunami hazard and improved risk assessments.

(C) Characterise the canyon systems on the far northern GBR to allow comparisons with the better-studied canyons on the central GBR, with respect to their geomorphic variability, gradients and relationship to shelf-edge reefs.

(D) Provide new data to construct and validate numerical, basin-scale, stratigraphic forward models used to test sedimentary source-to-sink processes in this mixed siliciclastic-carbonate setting.

(E) Provide the site survey data for a future International Ocean Discovery Program (IODP) Ancillary Project Letter (APL) proposal, to core the canyon deposits and recover coarse-grained, shallow-water carbonate sediments shed from the shelf, to better constrain the timing of the onset of the GBR.

Supplementary Project 2: First measurements of nitrate isotopic composition in the Coral Sea (Erler)

Upwelling is known to be an important source of nitrate to the outer reef ecosystems of the GBR. However, the frequency and duration of upwelling events, as well as the penetration of nitrate rich water into the GBR lagoon is poorly understood because of a lack of long-term records.

It is now possible to reconstruct spatial and temporal patterns of upwelling at the century-scale using a new coral skeleton isotopic technique. However, this technique is fundamentally reliant on knowing the nitrogen isotopic content of deep ocean nitrate in the Coral Sea. To date, no such data exists for the Coral Sea adjacent to the GBR.

This project aims to measure the nitrogen isotopic content of nitrate in the Coral Sea.

Supplementary Project 3: Spatial and temporal variability in the distribution and abundance of seabirds (Woehler)

This project will collect data to quantify the variability in the distribution and abundance of seabirds in the marine environment around Australia. The project will examine the relationships between physical oceanographic features and their use as seabird feeding areas.

The study also seeks to identify species assemblages, or associations, in the species of seabirds observed that are persistent over time. The project will collect new data for seabirds around Australia, for which there are very few (and in many cases, nil) data. The project will use standard survey methods to ensure compatibility with existing data sets for the same species in other areas.

Observations of marine mammals will also be shared with researchers to facilitate greater understanding of the role of oceanographic processes in the spatial and temporal distribution of marine mammals at sea around Australia.

The project will also provide a context to current research efforts tracking seabirds and marine mammals, which are often constrained to a relatively low number of instrumented individuals relative to the population as a whole.

Supplementary Project 4: ORCA: Using the *Investigator* radar as a moving reference for the Australian operational radar network (Protat)

The aim of the Optimizing Radar Calibration and Attenuation corrections (ORCA) project is to use the Investigator C-band Doppler dual-polarization weather radar (SEAPOL) and OceanRAIN ODM470 disdrometer as moving references to:

(A) Evaluate (and if needed improve) the calibration of selected coastal radars from the BOM operational weather radar network and investigate some aspects of these calibration techniques further.

(B) Characterise the regional variability of the so-called self-consistency dual-polarization calibration relationship using disdrometer observations for use in future operational calibration techniques.

Our second main aim is to develop C-band attenuation corrections for SEAPOL using unattenuated collocated S-band ground-based radar measurements from the operational radar network collected during the transit voyages.

Supplementary Project 5: Environmental baselines for Wessel Marine Park, northern Australia (Przeslawski)

This project aims to collect and analyse valuable environmental baseline information in a data-poor marine park. Specifically, we will use a combination of multibeam sonar and towed imagery to map the seafloor and characterise seafloor habitats in a northern area in the Wessel Marine Park region.

Collected data will be combined with the limited data available from previous surveys, as well as museum records, to test assumptions about the Wessel Marine Park drawn from the 2018 management plan. These assumptions are:

(A) Includes some of the most diverse environments in the North Marine Region.

(B) Includes some of the most species-rich environments in the North Marine Region.

(C) Supports a number of endemic species.

(D) Acts as a transition point for sessile invertebrate and fish species.

In addition, we will test the hypothesis that the raised seabed features (banks, shoals) in the park are relict reefs that formed at lower sea levels in the early Holocene period (ca. 12,000 to 7,000 years before present).

Results from this study will inform detailed implementation plans to be developed by the Department of Environment and Energy over the next 10 years. In particular, this study will expand the currently limited species inventory from the region, contribute to an assessment of the significance of raised geomorphic features in the park, and identify geomorphic features, habitats, or communities of interest.

Voyage objectives

Supplementary Project 1: Deep seascapes of the Great Barrier Reef: Uncovering submarine canyons and landslides (Beaman)

Equipment and operations

EM122 and EM710 multibeam swath data will be collected to obtain bathymetry and backscatter coverage of the submarine landslides and canyons to understand their spatial distribution, geomorphic character and surficial sedimentation patterns. Water column data will be acquired to identify if any demersal fish or plankton layers are associated with the landslides or canyons.

SBP120 sub-bottom profile data will also be collected to provide additional context for the nature of near-surface sediment and geological structure of the submarine landslides and canyons. Equipment will be utilised continuously for duration of the transit. The MNF GSM team will be assisted through the 12-hour shifts by the science team students and PIs.

Multibeam data will be edited for noise, sound velocity applied and GPS tides applied to the raw data. 3D visualisation of the various slope features will be constantly updated using a combination of Fledermaus, CARIS, ArcGIS/QGIS and GMT software. The aim is to have multibeam data completely edited by the time of arrival in Darwin.

Sound velocity profiles will be obtained by XBTs dropped along the way, SVP deployments and from any CTD profiles.

Sub-bottom profile data will be constantly updated to a dedicated Kingdom software project for fine-scale examination of sub-surface features. The aim is to have a fully interpreted Kingdom project completed by the time of arrival in Darwin.

General survey

The voyage will transit along the GBR continental slope (Figure 1, Table 2). These waypoints have been carefully chosen to survey the key landslides and canyons of interest, while minimising excessive deviations from the general track taken from Brisbane to Darwin. Waypoints have also been selected to obtain swath data that overlaps slightly with previous multibeam tracks, thereby extending the area of the slope surveyed.

Areas of interest

Four particular areas of interest along the GBR slope are the Swain slide, Bowl slide, Stapleton canyons, and Clack canyons (named for their proximity to particular reefs). Waypoints have been selected to carefully survey these areas to achieve near-100% seabed coverage in order to understand their full spatial distribution and geomorphic character (Figure 2).

Should time not permit all these surveys to be completed (e.g. poor weather), then the largest survey, Clack canyons, could be truncated or abandoned to enable the Investigator to be on time in Darwin.

Timing

The proposed waypoints along the Queensland margin (Leg1 WP 1 to WP 65) have a combined distance of 1476.64 nm. Planned at 11 kn, this distance equals 134.24 hours or 5.6 days. The allocated 15 hr (five CTDs) and 3 hr (radar calibration) for Supplementary Projects along the GBR margin add an additional 18 hr, equalling 152.24 hr or 6.34 days between Leg1 WP 1 to WP 65.

Supplementary Project 2: First measurements of nitrate isotopic composition in the Coral Sea (Erler)

Equipment and operations

Nitrate is the most prevalent inorganic form of inorganic nitrogen in the Coral Sea. A number of previous cruises have measured the concentration of nitrate in the Coral Sea, but none have measured its isotopic composition. The method for the collection of nitrate isotope samples is identical to the sampling of nutrients and is performed using a Niskin bottle and a high resolution CTD logger (to determine the exact depth that samples are collected at). Samples are collected at multiple depths, and based on the data from previous cruises, the best approach would be to collect samples every 50 m down to 500 m. When water samples reach the surface, they are filtered into acid washed bottles and frozen immediately. I anticipate that water sample collection will take approximately 3 - 5 hours per site. Samples must be kept frozen and I will need to use either ice packs or dry ice to keep samples frozen at the completion of the cruise. Ideally, I would like collect samples from 5 locations along the continental shelf adjacent to the GBR (south to north).

In addition to the nitrate isotope samples, additional samples will be taken for nitrous oxide concentration and isotopic composition. There are no measurements of nitrous oxide concentration or isotopic composition for deep ocean water in the Coral Sea. This data will help constrain the nitrous oxide flux during upwelling. To further constrain this budget, we plan to perform continuous measurements of nitrous oxide concentration in surface waters during transit. This will be performed with a Picarro greenhouse gas analyser coupled to a gas exchange system.

Areas of interest

Five sites have been selected along the Queensland margin:

Site	Decimal Latitude	Decimal Longitude	Latitude	Longitude	Location
1	24° 52.32	154° 03.16	-24.8720000	154.0527000	Fraser Island
2	20° 31.01	151° 49.94	-20.5168400	151.8323877	Swain Reefs
3	18° 41.99	148° 18.19	-18.6998913	148.3031412	Central GBR
4	15° 42.40	145° 51.61	-15.7066123	145.8601516	Ribbon Reefs
5	11° 11.01	144° 06.46	-11.1834874	144.1076977	Cape York

Table 1. Five sites for CTD nitrate sampling (see Figures 1 and 2).

Timing

Three hours are allocated for each CTD site, hence 15 hours are planned with the vessel stationary.

Supplementary Project 3: Spatial and temporal variability in the distribution and abundance of seabirds (Woehler)

Equipment and operations

Seabird at sea data will be collected according to the method described by the BIOMASS Working Party on Bird Ecology. This method has been used by Australian Antarctic Division (AAD) personnel since 1980/81 and reflects the standard protocol for obtaining seabird at sea data.

Observations will be made continuously while the vessel is underway during daylight hours from the specifically designed Observation Deck onboard *Investigator*. It is hoped that three seabird observers will be placed on the nominated Research and Transit Voyages.

Briefly, all seabirds within a 300 m forward quadrant will be recorded, with details of their ages (where identifiable) and behaviours (such as feeding, sitting on water etc.). By using standard methods, the data collected on these voyages will be able to be integrated with other datasets collected adjacent with, or in overlapping areas (e.g. Australian Antarctic Division surveys 1980/81 onwards).

Observations of marine mammals are also included (in the absence of dedicated marine mammal observers) using standard protocols. Observation of marine debris are also recorded.

Data will be entered in real time on laptops connected to the ships oceanographic and GPS system to automatically record abiotic and biotic data alongside seabird observational records. Standardised methods of data collection ensure continuity and compatibility with extant data for the same species elsewhere and with similar studies of other species.

No equipment is required, apart from access to the Observation Deck on Level 7.

Areas of interest

The seabird observation program is passive and has no influence on the ship track.

Timing

The observation program is undertaken continuously during daylight hours from *Investigator*.

Supplementary Project 4: ORCA: Using the Investigator radar as a moving reference for the Australian operational radar network (Protat)

Equipment and operations

For the ORCA project, the voyage objectives are to collect Investigator C-band Doppler dual-polarization weather radar (SEAPOL) and OceanRAIN ODM470 disdrometer observations of precipitation collocated with as many radars from the BOM operational radar network located along the coast from Brisbane to Darwin in an opportunistic manner. When no precipitation is present, we will make use of the SEAPOL radar data in clear air to compare ground clutter measurements along the coast. This project will require a non-standard radar configuration for the Investigator radar, which will replicate that of the operational weather radar (14 elevations on a 6-minute cycle). This scanning strategy will be introduced in the radar control software before the ship leaves port.

Areas of interest

Anytime the ship will be close enough (<150 km) from a coastal radar of the operational network, we will collect measurements useful for the ORCA project. Brisbane, Townsville, Cairns, Warruwi and Darwin should be our main opportunistic targets:

Radar	Decimal Latitude	Decimal Longitude
Brisbane	27° 43'	153° 14'
Townsville	19° 25'	146° 33'
Cairns	16° 49'	145° 41'
Warruwi	11° 39'	133° 23'
Darwin	12° 28'	130° 56'

Table 2. Coastal radar sites.

Timing

We would like to request that the Chief Scientist consults on behalf of PI Protat (who is not going on the ship) with the Master, Voyage Manager and PIs on board to agree to stop the vessel and stay on station for one hour if there is precipitation when the vessel is within 150 km of the Brisbane, Townsville, Cairns, Warruwi or Darwin radars. As there are only three hours allocated to our ORCA project, this can only be done for three of these five radars, at the discretion of the lead Chief Scientist and on board Management Team.

Supplementary Project 5: Environmental baselines for Wessel Marine Park, northern Australia (Przeslawski)

Equipment and operations

Multibeam operations will be undertaken during the first 6 hours to acquire continuous high-resolution bathymetry and backscatter data in the study area. Data will be acquired with the *Investigator*'s EM710 according to the MNF's current protocols and supplemented by the *Seafloor Mapping Field Manual for Multibeam Sonar*. Anticipated speed during multibeam acquisition will be 8 knots but will be adjusted as needed according to sea state and heading. Beam width at a depth of 60 m in the study area will be ~140 m, with 30% overlap.

Towed imagery stations will be confirmed using mapping from multibeam operations. Towed imagery operations will follow national consistent protocols from the *Marine Sampling Field Manual for Towed Underwater Camera Systems*, with the exception of the recommended downward-facing stills camera to be substituted with the forward-facing stills camera on the *Investigator*'s deep-tow system.

The camera will be deployed for 1000 m (~30 minutes bottom time at 1 knot) along depth and geomorphic gradients along each sampling transect. Real-time video footage will be characterised using a qualitative habitat characterisation to identify transition zones. This will provide an immediate characterisation of habitat, while annotation of the still images undertaken during the post-processing will provide a quantitative assessment.

Areas of interest

The Wessel Marine Park is located off the remote coast of northern Australia, adjacent to Cape Wessel and the surrounding archipelago. The marine park overlaps an Indigenous Protected Area (IPA) due to its significance to local indigenous communities and efforts to protect and monitor the health of culturally significant and threatened species.

The Marine Park and its surrounding waters adjacent to the transit route and the Wessel Islands are considered a biodiversity hotspot, thought to support a number of endemic species, as well as a variety of unique sponge and coral communities.

We will focus on a northern grid immediately adjacent to the transit route and the Wessel Marine Park (Area II in Figure 5). This grid will expand on previous mapping in 2005 and biological sampling in 2013 undertaken over a deep hole and possible terrace. If the transit voyage is well ahead of schedule, we will instead undertake mapping and camera operations within a grid in the centre of the Habitat Protection Zone of the Wessel Marine Park (Area I in Figure 5).

Timing

Multibeam operations will commence immediately upon arrival at the Wessel Marine Park region, with continuous multibeam coverage generated for six hours and used to inform the subsequent towed imagery. Priority mapping is indicated by lines in Figure 5, while the grey box shows the secondary mapping area to be continued if time permits.

Operational Risk Management

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

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

Day	Date	Time	Activity
Friday	4	0900	Sail at ~0900 (time yet to be confirmed). Commence ~4 hr transit across Moreton Bay
Friday	4	1300	Exit from Moreton Bay at Leg1 WP 1. Commence ~12 hr transit to CTD site 1 off Fraser Island at Leg1 WP 3
Saturday	5	0100	Arrive at CTD site 1. Conduct 500 m CTD deployment for 3 hr
Saturday	5	0400	Depart CTD site 1. Commence ~22 hr transit to Swain slide survey at Leg1 WP 4
Saturday	5	0600	Enter GBR Marine Park
Sunday	6	0200	Arrive at Leg1 WP 4. Commence Swain slide survey for 7 hr

Table 3. Overall activity plan for first days of voyage IN2019_T02 during October 2019.

Voyage track

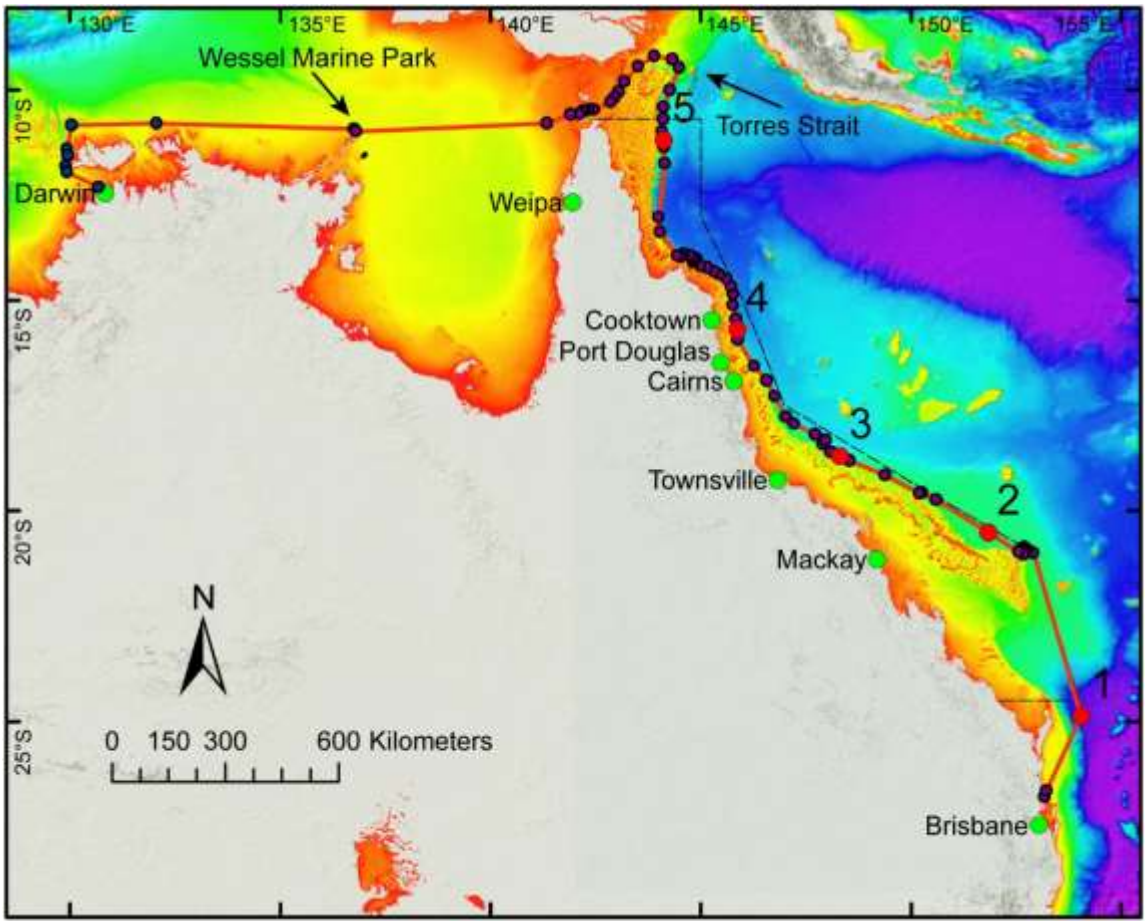

Figure 1. Map of entire IN2019_T02 voyage track (red line) joining waypoints (brown dots) from Brisbane to Darwin. Five CTD sites along the Queensland margin are shown (red dots). For planning purposes, the voyage is divided into three legs: Leg1 Brisbane to Torres Strait; Leg2 Torres Strait to Wessel Marine Park; and Leg3 Wessel Marine Park to Darwin.

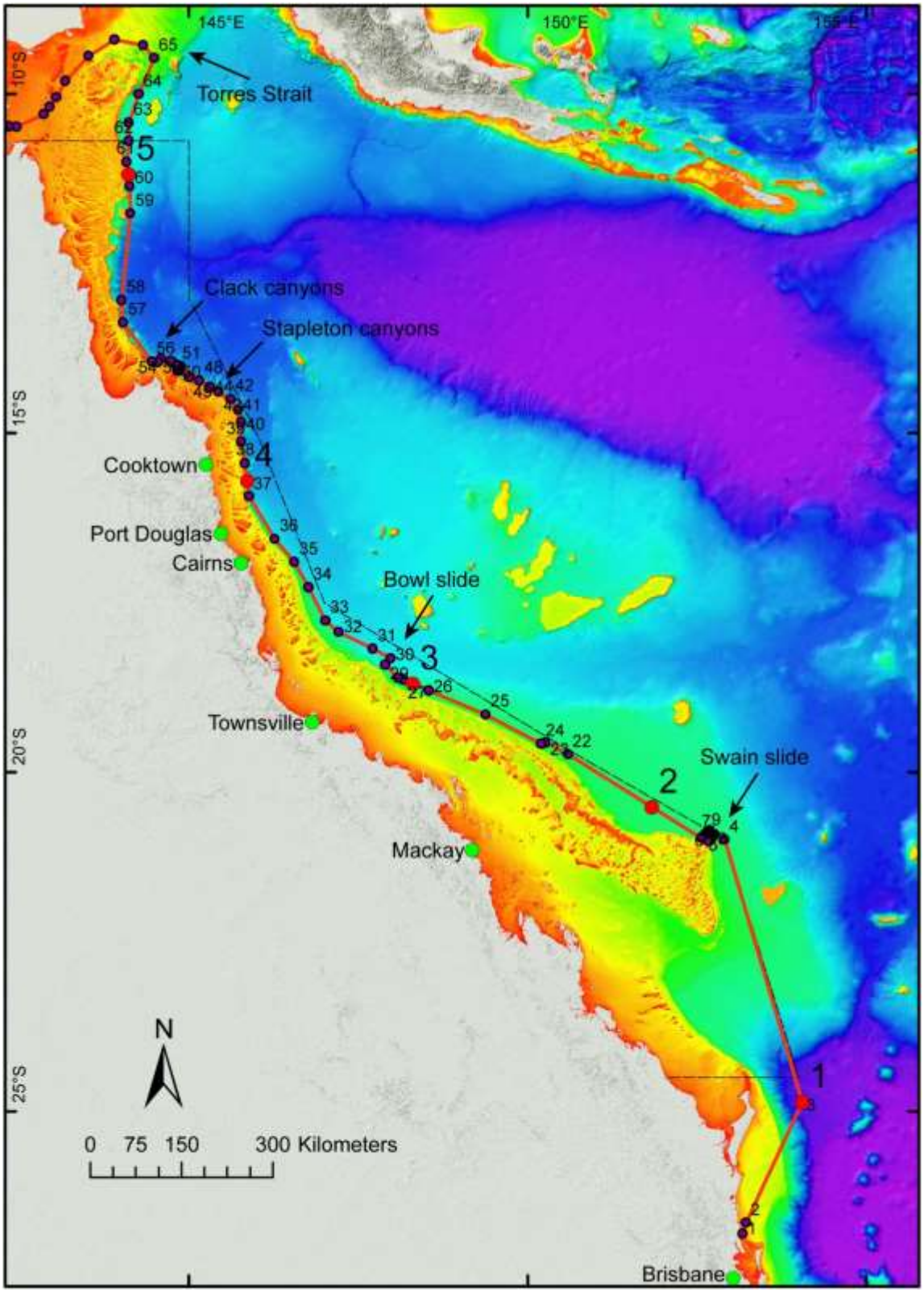

Figure 2. Voyage track for Leg1 Brisbane to Torres Strait along the GBR continental slope. Four systematic surveys shown at: (A) Swain slide; (B) Bowl slide; (C) Stapleton canyons; and (D) Clack canyons. Five CTD sites along the Queensland margin are shown (red dots). See Table 3 for waypoints. See Table 1 under Voyage Objectives for CTD site positions.

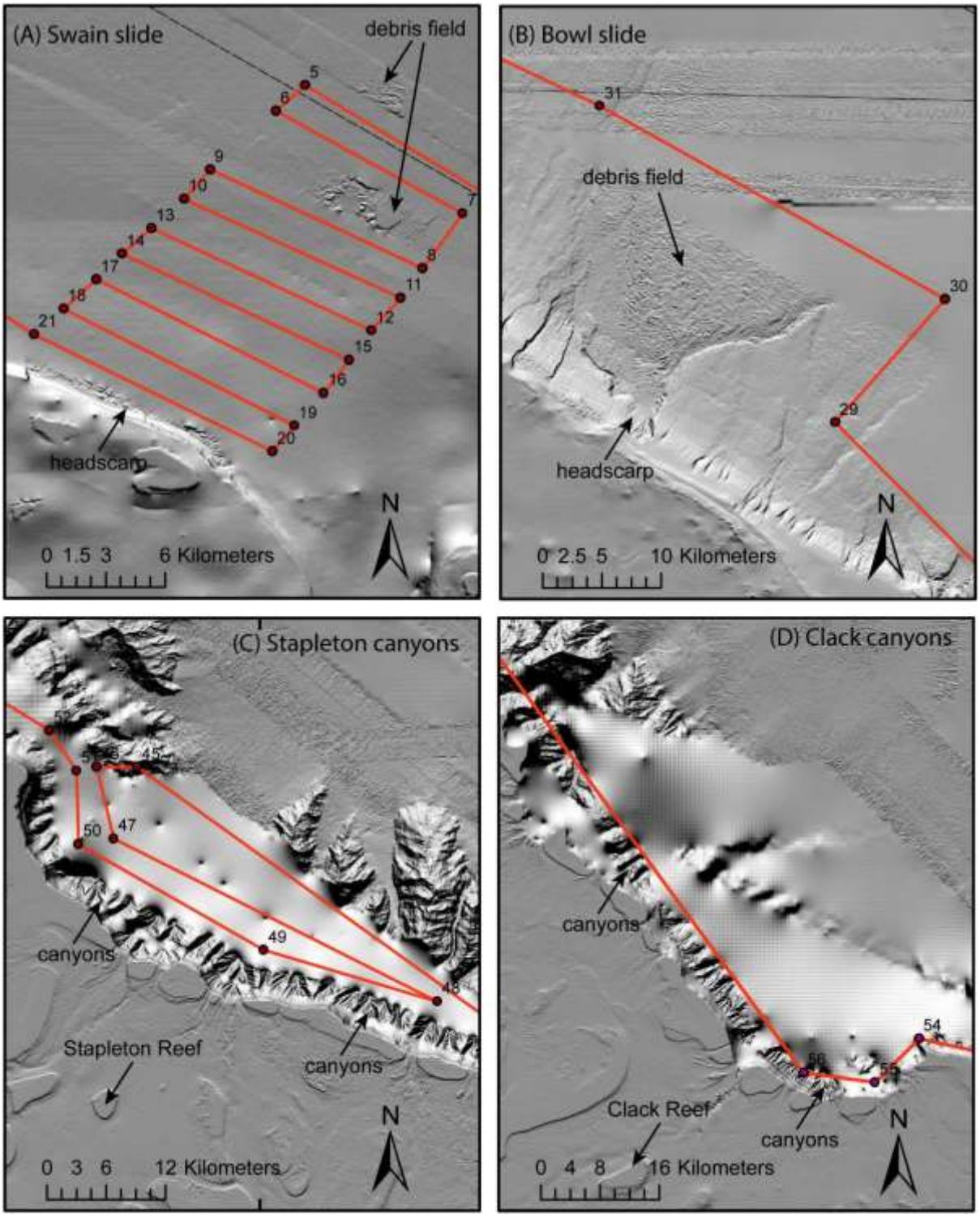

Figure 3. Close up views of systematic surveys at: (A) Swain slide; (B) Bowl slide; (C) Stapleton canyons; and (D) Clack canyons. Note, Swain slide is the priority for survey followed by Bowl slide, Stapleton canyons and then Clack canyons.

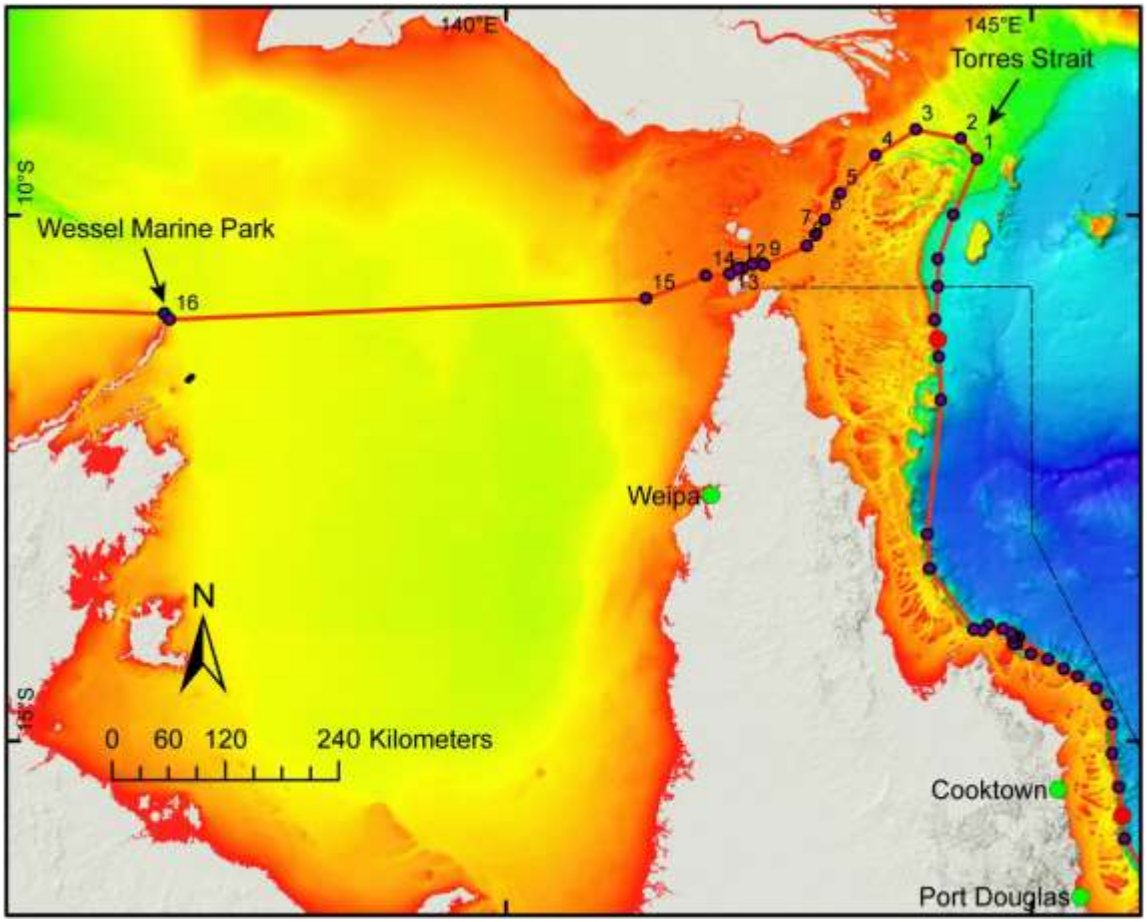

Figure 4. Voyage track for Leg2 Torres Strait to Wessel Marine Park. See Table 4 for waypoints.

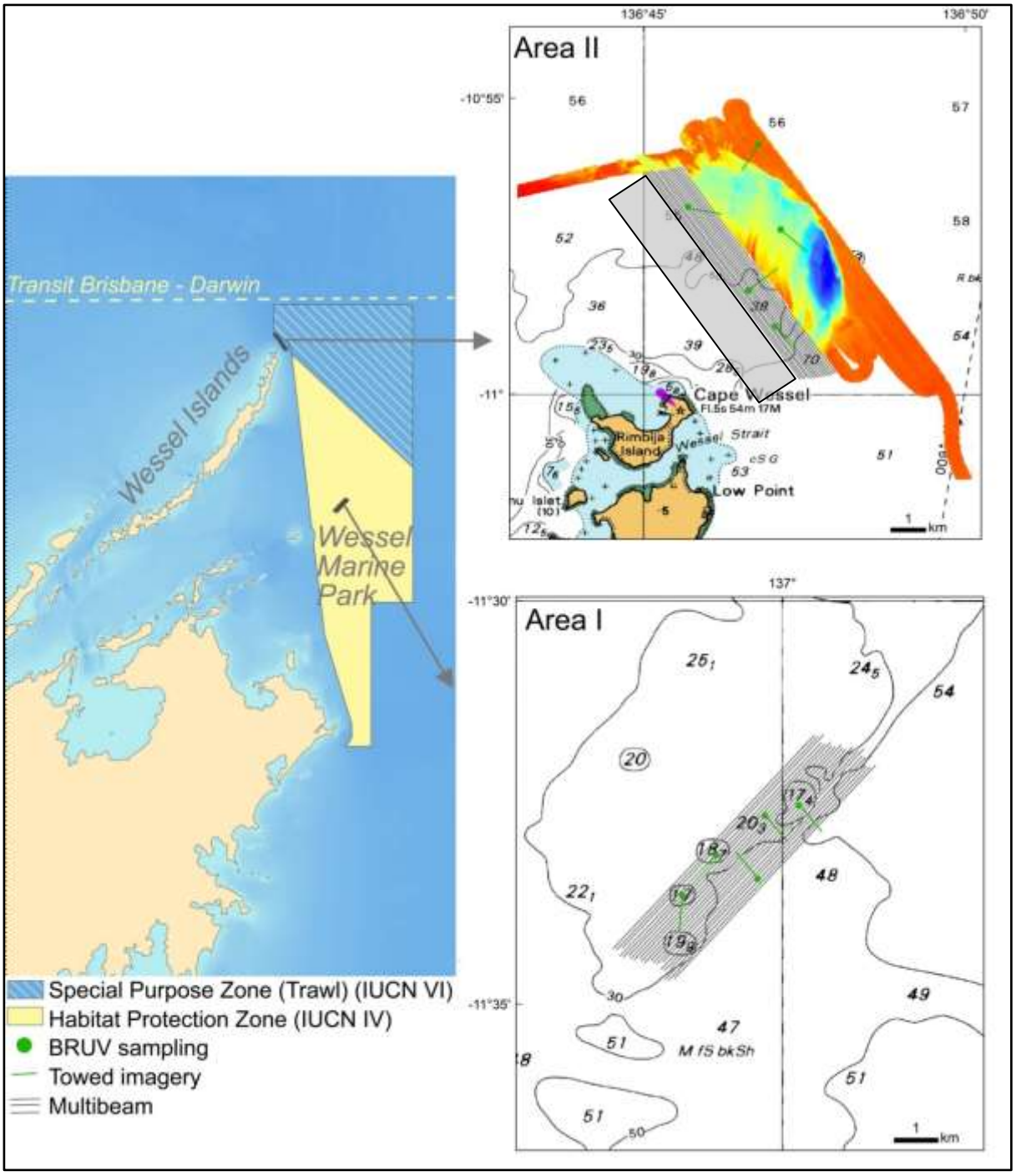

Figure 5. Close up views of the systematic survey at Wessel Marine Park: Area II is the planned priority for survey, with black lines indicating the priority multibeam area and gray box indicating secondary multibeam area. If more time than planned becomes available, then the location will change to Area I inside the Habitat Protection Zone of the Wessel Marine Park.

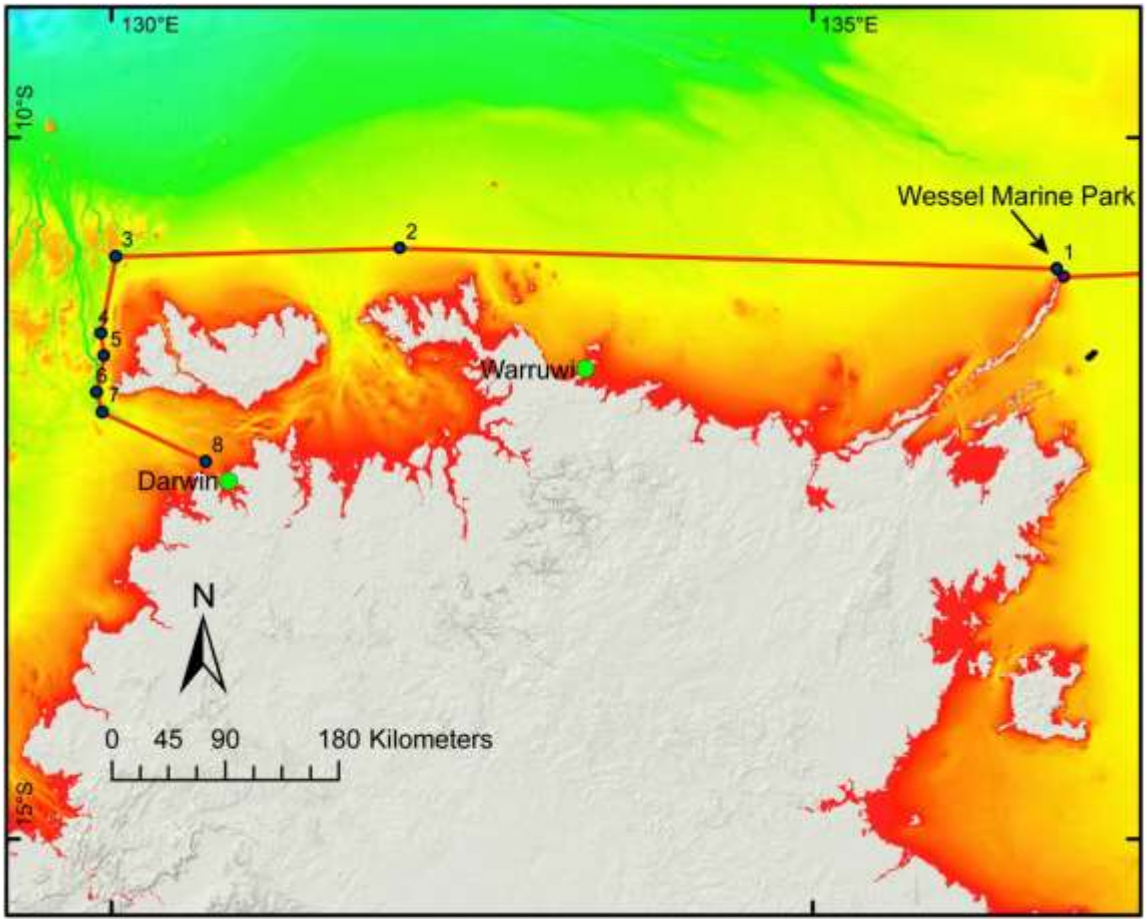

Figure 6. Voyage track for Leg3 Wessel Marine Park to Darwin. See Table 5 for waypoints.

Waypoints and stations

Way point	Location	Decimal Latitude	Decimal Longitude	Distance (nm)	Total Distance (nm)	Steaming Time (hrs)	Total Steam (hrs)
1	Caloundra	26° 48.70	153° 11.00				
2	Gneering Shoals	26° 39.00	153° 13.70	9.96	9.96	0.91	0.91
3	Yoshikawa 2015	24° 52.32	154° 3.16	115.27	125.23	10.48	11.38
4	Swain corner	21° 0.00	152° 54.80	240.33	365.56	21.85	33.23
5	start Swain slide survey	20° 51.90	152° 41.40	14.91	380.47	1.36	34.59
6	Swain slide survey	20° 52.60	152° 40.60	1.02	381.49	0.09	34.68
7	Swain slide survey	20° 55.40	152° 45.70	5.54	387.02	0.50	35.18
8	Swain slide survey	20° 56.90	152° 44.60	1.81	388.84	0.16	35.35
9	Swain slide survey	20° 54.20	152° 38.80	6.06	394.89	0.55	35.90
10	Swain slide survey	20° 55.00	152° 38.10	1.03	395.92	0.09	35.99
11	Swain slide survey	20° 57.70	152° 44.00	6.14	402.06	0.56	36.55
12	Swain slide survey	20° 58.60	152° 43.20	1.17	403.23	0.11	36.66
13	Swain slide survey	20° 55.80	152° 37.20	6.27	409.50	0.57	37.23
14	Swain slide survey	20° 56.50	152° 36.40	1.02	410.52	0.09	37.32
15	Swain slide survey	20° 59.40	152° 42.60	6.48	417.00	0.59	37.91
16	Swain slide survey	21° 0.30	152° 41.90	1.11	418.11	0.10	38.01
17	Swain slide survey	20° 57.20	152° 35.70	6.57	424.67	0.60	38.61
18	Swain slide survey	20° 58.00	152° 34.80	1.16	425.83	0.11	38.71
19	Swain slide survey	21° 1.20	152° 41.10	6.70	432.53	0.61	39.32
20	Swain slide survey	21° 1.90	152° 40.50	0.89	433.42	0.08	39.40
21	end Swain slide survey	20° 58.70	152° 34.00	6.86	440.28	0.62	40.03
22	east Hydro Pass	19° 44.60	150° 36.10	133.03	573.31	12.09	52.12
23	west Hydro Pass	19° 34.00	150° 16.10	21.61	594.93	1.96	54.08
24	Hyde Reef	19° 35.00	150° 12.20	3.81	598.74	0.35	54.43
25	Ellen Reef	19° 9.20	149° 23.20	52.94	651.68	4.81	59.24

26	east Viper Reef	18° 48.10	148° 33.00	51.97	703.66	4.72	63.97
27	west Viper Reef	18° 38.70	148° 10.20	23.56	727.22	2.14	66.11
28	Anzac Reef	18° 36.70	148° 5.50	4.92	732.14	0.45	66.56
29	start Bowl slide survey	18° 25.20	147° 54.00	15.79	747.93	1.44	67.99
30	Bowl slide survey	18° 19.60	147° 59.00	7.32	755.26	0.67	68.66
31	end Bowl slide survey	18° 10.80	147° 43.30	17.31	772.57	1.57	70.23
32	Palm Passage	17° 56.30	147° 13.00	32.26	804.82	2.93	73.17
33	Moss Reef	17° 46.00	147° 1.10	15.29	820.11	1.39	74.56
34	Gloria Knolls Slide	17° 16.70	146° 46.00	32.53	852.65	2.96	77.51
35	Flora Pass	16° 54.20	146° 33.80	25.26	877.90	2.30	79.81
36	Grafton Pass	16° 33.80	146° 16.40	26.28	904.18	2.39	82.20
37	Agincourt Reef	15° 56.20	145° 53.20	43.52	947.70	3.96	86.15
38	Ribbon 4 Reef	15° 26.70	145° 49.80	29.54	977.24	2.69	88.84
39	Ribbon 8 Reef	15° 7.60	145° 46.40	19.29	996.53	1.75	90.59
40	Ribbon 10 Reef	14° 50.40	145° 46.40	17.12	1013.64	1.56	92.15
41	No Name Reef	14° 39.70	145° 43.80	10.94	1024.58	0.99	93.14
42	Carter Reef	14° 30.00	145° 37.10	11.63	1036.21	1.06	94.20
43	Hilder Reef	14° 23.50	145° 26.50	12.14	1048.36	1.10	95.31
44	start Stapleton canyons survey	14° 19.20	145° 18.80	35.48	1083.84	3.23	98.53
45	Stapleton canyons survey	14° 0.90	144° 53.30	8.61	1092.45	0.78	99.31
46	Stapleton canyons survey	14° 0.90	144° 51.10	30.73	1123.17	2.79	102.11
47	Stapleton canyons survey	14° 4.80	144° 52.20	2.14	1125.31	0.19	102.30
48	Stapleton canyons survey	14° 13.70	145° 9.70	3.98	1129.29	0.36	102.66
49	Stapleton canyons survey	14° 10.90	145° 0.20	19.32	1148.61	1.76	104.42
50	Stapleton canyons survey	14° 5.10	144° 50.10	9.63	1158.24	0.88	105.29
51	end Stapleton canyons survey	14° 1.10	144° 50.00	11.38	1169.62	1.03	106.33

52	U/N Reef	13° 58.90	144° 48.50	3.98	1173.60	0.36	106.69
53	U/N Reef	13° 56.00	144° 43.80	5.40	1179.00	0.49	107.18
54	start Clack canyons survey	13° 54.20	144° 35.70	8.07	1187.07	0.73	107.92
55	Clack canyons survey	13° 57.40	144° 32.50	4.45	1191.52	0.40	108.32
56	Clack canyons survey	13° 56.70	144° 27.30	5.10	1196.63	0.46	108.78
57	end Clack canyons survey	13° 22.20	144° 2.00	42.24	1238.87	3.84	112.62
58	Ham Reef	13° 2.30	144° 0.70	19.84	1258.71	1.80	114.43
59	Great Detached Reef	11° 45.70	144° 8.50	76.59	1335.29	6.96	121.39
60	Moulter Reef	11° 21.20	144° 7.70	24.39	1359.68	2.22	123.61
61	U/N Reef	10° 59.80	144° 5.10	21.44	1381.12	1.95	125.56
62	exit GBRMP	10° 41.10	144° 6.70	18.67	1399.79	1.70	127.25
63	south Bligh Channel	10° 25.30	144° 6.90	15.72	1415.51	1.43	128.68
64	north Bligh Channel	10° 0.00	144° 15.60	26.59	1442.09	2.42	131.10
65	Flinders Entrance	9° 28.00	144° 29.20	34.54	1476.64	3.14	134.24

Table 4. Waypoints for Leg1 Brisbane to Torres Strait.

Way point	Location	Decimal Latitude	Decimal Longitude	Distance (nm)	Total Distance (nm)	Steaming Time (hrs)	Total Steam (hrs)
1	Flinders Entrance	9° 28.00	144° 29.20				
2	Torres Strait	9° 16.57	144° 19.83	14.66	14.66	1.33	1.33
3	Torres Strait	9° 11.46	143° 54.30	25.73	40.39	2.34	3.67
4	Torres Strait	9° 26.08	143° 31.42	26.88	67.27	2.44	6.12
5	Torres Strait	9° 47.99	143° 10.83	29.80	97.07	2.71	8.82
6	Torres Strait	10° 02.77	143° 02.36	16.91	113.98	1.54	10.36
7	Torres Strait	10° 11.19	142° 56.97	9.92	123.90	0.90	11.26
8	Torres Strait	10° 17.90	142° 51.69	8.46	132.36	0.77	12.03
9	Prince Wales Channel	10° 28.61	142° 27.28	26.29	158.65	2.39	14.42
10	Prince Wales Channel	10° 28.28	142° 21.09	6.10	164.75	0.55	14.98
11	Prince Wales Channel	10° 30.39	142° 15.28	6.09	170.84	0.55	15.53
12	Prince Wales Channel	10° 30.58	142° 12.54	2.70	173.54	0.25	15.78
13	Prince Wales Channel	10° 33.59	142° 07.90	5.46	179.00	0.50	16.27
14	Round Island	10° 34.56	141° 54.49	13.23	192.23	1.20	17.48
15	Gulf Carpentaria	10° 48.00	141° 20.07	36.41	228.64	3.31	20.79
16	Wessel Marine Park	10° 59.57	136° 47.96	267.78	496.42	24.34	45.13

Table 5. Waypoints for Leg2 Torres Strait to Wessel Marine Park. Note Leg2 WP 1 is the same as Leg1 WP 65.

Line No.	Location	Start Latitude	Start Longitude	End Latitude	End Longitude	Distance (nm)
1	Wessel Marine Park region	10° 56.14	136° 45.57	10° 59.65	136° 47.98	4
2	Wessel Marine Park region	10° 56.16	136° 45.52	10° 59.66	136° 47.94	4
3	Wessel Marine Park region	10° 56.17	136° 45.49	10° 59.67	136° 47.90	4
…	Continue mapping for 6 hour or until line 24 is complete					4
24	Wessel Marine Park region	10° 56.43	136° 45.50	10° 59.88	136° 46.89	4

Table 6: Coordinates for mapping lines of Wessel Marine Park (Area II), starting at the easternmost line shown in Figure 5.

Way point	Location	Decimal Latitude	Decimal Longitude	Distance (nm)	Total Distance (nm)	Steaming Time (hrs)	Total Steam (hrs)
1	Wessel Marine Park	10° 56.18	136° 45.01				
2	Cobourg Peninsula	10° 47.4	132° 03.6	276.84	276.84	25.17	25.17
3	Melville Island	10° 50.84	130° 01.85	119.78	396.62	10.89	36.06
4	Bathurst Island	11° 23.93	129° 55.51	33.50	430.12	3.05	39.10
5	Bathurst Island	11° 33.43	129° 56.94	9.75	439.87	0.89	39.99
6	Bathurst Island	11° 49.17	129° 53.54	15.80	455.67	1.44	41.42
7	Bathurst Island	11° 57.48	129° 56.08	8.63	464.30	0.78	42.21
8	Darwin	12° 18.69	130° 40.6	48.08	512.38	4.37	46.58

Table 7. Waypoints for Leg 3 Wessel Marine Park to Darwin.

CTD Configuration

	Please select:
Fundamentals:	
• Which CTD rosette to be used for this voyage (24 Niskin bottles or 36):	24
• Likely total number of casts:	5
• Likely maximum depth of deepest cast:	500 m
• Lowered ADCP required:	no
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)	
• ECO-Triplet (Chlorophyll-a, CDOM & backscatter – maximum depth 2000m)	yes
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

NOTE: FLBB sensor (remaining on board from IN2019_V05) must be mounted on CTD facing into the open ocean.

Time estimates

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

Day	Date	Time	Activity
Friday	4	0900	Sail at ~0900 (time yet to be confirmed). Commence ~4 hr transit across Moreton Bay
Friday	4	1300	Exit from Moreton Bay at Leg1 WP 1. Commence ~12 hr transit to CTD site 1 off Fraser Island at Leg1 WP 3
Saturday	5	0100	Arrive at CTD site 1. Conduct 500 m CTD deployment for 3 hr
Saturday	5	0400	Depart CTD site 1. Commence ~22 hr transit to Swain slide survey at Leg1 WP 4
Saturday	5	0600	Enter GBR Marine Park
Sunday	6	0200	Arrive at Leg1 WP 4. Commence Swain slide survey for 7 hr
Sunday	6	0900	Depart Swain slide at Leg1 WP 21. Commence ~5 hr transit to CTD site 2 between Leg1 WP 21/22
Sunday	6	1400	Arrive at CTD site 2. Conduct 250 m CTD deployment for 3 hr
Sunday	6	1700	Depart CTD site 2. Commence ~10 hr transit to potential weather radar calibration at Leg1 WP 24
Monday	7	0300	Arrive at weather radar calibration site. Conduct calibration for 1 hr
Monday	7	0400	Depart weather radar calibration. Commence ~11 hr transit to CTD site 3 between Leg1 WP 26/27
Monday	7	1500	Arrive at CTD site 3. Conduct 350 m CTD deployment for 3 hr
Monday	7	1800	Depart CTD site 3. Commence ~3 hr transit to Bowl slide survey at Leg1 WP 29
Monday	7	2100	Arrive at start of Bowl slide survey. Commence Bowl slide survey for 2 hr
Monday	7	2300	Depart Bowl slide at Leg1 WP 31. Commence ~1 hr transit to potential weather radar calibration between Leg1 WP 31/32
Tuesday	8	0001	Arrive at weather radar calibration site. Conduct calibration for 1 hr
Tuesday	8	0100	Depart weather radar calibration. Commence ~11 hr transit to potential weather radar calibration at leg1 WP 36
Tuesday	8	1200	Arrive at weather radar calibration site. Conduct calibration for 1 hr
Tuesday	8	1300	Depart weather radar calibration. Commence ~5 hr transit to CTD site 4 between Leg1 WP 37/38
Tuesday	8	1800	Arrive at CTD site 4. Conduct 500 m CTD deployment for 3 hr
Tuesday	8	2100	Depart CTD site 4. Commence ~9 hr transit to Stapleton canyons survey at Leg1 WP 44
Wednesday	9	0600	Arrive at Leg1 WP 44. Commence Stapleton canyons survey for 7 hr
Wednesday	9	1300	Depart Stapleton canyons at Leg1 WP 51. Commence ~2 hr transit to Clack canyons survey at Leg1 Wp 54
Wednesday	9	1500	Arrive at Leg1 WP 54. Commence Clack canyons survey for 5 hr
Wednesday	9	2000	Depart Clack Canyons at Leg1 WP 57. Commence ~12 hr transit to CTD site 5 between Leg1 WP 60/61
Thursday	10	0800	Arrive at CTD site 5. Conduct 500 m CTD deployment for 3 hr
Thursday	10	1100	Depart CTD site 5. Commence ~10 hr transit to entrance to Torres Strait at Leg1 WP 65
Thursday	10	2100	Arrive end of Queensland margin transit at Leg1 WP 65
Thursday	10	2100	Commence ~45 hr transit from Torres Strait at Leg2 WP 1 to Wessel Marine Park at Leg2 WP16

Saturday	12	1800	(time to be confirmed) Arrive at Wessel Marine Park at Leg2 WP 16. Commence Environmental baselines work for 15 hr. Time zone change GMT +9.5
Saturday	12	0900	(time to be confirmed) Depart Wessel Marine Park at Leg3 WP 1. Commence ~48 hr transit to Darwin at Leg3 WP8
Monday	14	0900	Arrive at Darwin Port at Leg3 WP 8
Monday	14	1000	(time to be confirmed) Berth Darwin Port

Table 6. Times estimates for activities and transit for voyage IN2019_T02 during October 2019.

Piggy-back projects

***Trichodesmium* sampling**

Trichodesmium is an important but poorly understood part of the marine environment. It is thought to be responsible for a significant majority of nitrogen fixation in the ocean; understanding its habitat and range is therefore an important part of understanding ocean primary productivity. Around Australia, *Trichodesmium* is most commonly seen along the northern Queensland coast. However, knowledge of *Trichodesmium* is relatively scarce as it is impossible to culture in laboratory studies and difficult to accurately observe in-situ. Basic questions such as the spatial patterns and seasonal cycles of *Trichodesmium* remain poorly understood.

This project will contribute to the observational record of *Trichodesmium* by collecting and analysing seawater samples at locations adjacent to the Great Barrier Reef. Surface samples will be collected at existing planned CTD cast locations, so there will be no impact on the voyage track or scheduling. These observations will assist researchers to answer those questions outlined above. They will also aid in the verification of *Trichodesmium* remote sensing algorithms, as well as biogeochemical ocean forecast systems such as the eReefs.

Sampling will include:

1. A 200 mL sample from the surface during CTD casts for isolation and culturing of *Trichodesmium.* The samples are decanted into 250 mL tissue culture flasks and kept under normal light at room temperature (20^{o}C)
2. A sample (50 mL) from the surface filtered through 0.2 µm Sterivex filters during CTD casts for genetic analysis of *Trichodesmium*. Filters should be labelled with station, CTD number, volume of sample filtered and then bagged and frozen at -80^{o}C.
3. Samples collected from the Continuous Plankton Recorder (CPR), see below for methodology.
4. Where the CPR is not being towed, a one litre sample collected from the ships underway system, collected twice a day for the duration of the transit (max 20 samples). Samples are immediately preserved with Lugols iodine and are best stored in the dark, at normal room temperature (20 ^{o}C)

In the event that an extensive surface bloom of *Trichodesmium* is encountered, there will be sufficient sampling equipment (bottles, tissue culture flasks, filters, preservatives) that an opportunistic sample may be collected, if deemed safe and appropriate by voyage/ships management.

AIR-BOX integration and calibration (Schofield)

The integration and calibration of the AIR-BOX (a containerised laboratory which houses aerosol atmospheric monitoring instruments), guest instruments in the aerosol laboratory and air chemistry laboratories, as well as optical instruments located on deck 5, will occur during this voyage. This is in preparation for the upcoming voyage IN2019_V06, during which the AIR-BOX will be utilised in conjunction with RV *Investigator*'s aerosol laboratory and air chemistry laboratory to continuously collect comprehensive atmospheric chemistry and aerosol measurements.

PI Schofield will coordinate with the AIR-BOX consortium to conduct atmospheric biogenic air measurements, aerosol composition, aerosol profile and oxidative capacity measurements to understand the emissions and processing of sulphur and halocarbons from the ocean in this region. Trace-gas and aerosol observations near the Great Barrier Reef will be made continuously throughout this transit voyage.

Continuous Plankton Recorder (CPR) sampling will also occur in conjunction with the AIR-BOX measurements. The CPR will be deployed during the longer legs of the transit (i.e. between CPR deployments and mapping surveys). CPR deployments will also be scheduled around the deployments of other towed equipment (e.g. SVPs). One cassette can be used to sample plankton on tows of up to 450 nm. Where the cassette is towed for

<450 nm (i.e. the vessel is required to stop for a CTD deployment or to conduct survey mapping work), the CPR will be retrieved and potentially redeployed, following suitable protocols to indicate the start and end of each deployment. The CPR sampling will occur in conjunction with measurements of atmospheric halocarbons and DMS. Establishing the plankton community composition will be advantageous to understanding what plankton species are associated with high atmospheric concentrations.

Voyage legs potentially suitable for CPR deployments include:

1. Fraser Island (post-CTD 1) to Swain Reefs (pre-Swain slide survey). Distance: 200 nm.
2. Swain Reefs (post-CTD 2) to central GBR (pre-CTD 3). Distance: 100 nm.
3. Central GBR (post-CTD 3) to northern GBR (pre-CTD 4). Distance: 200 nm.
4. Northern GBR (post-Stapleton canyons survey) to Cape York (pre-CTD 5). Distance: 100 nm.
5. Arafura Sea (post-Torres Strait exit) to Wessel Marine Park (pre-Wessel Island survey). Distance: 300 nm.
6. Wessel Island (post-Wessel Island survey) to Bathurst Island (pre-arrival in Darwin). Distance: 400 nm.

CSIRO Educator on Board program (CSIRO MNF)

CSIRO Educator on Board is a professional development program for Australian STEM (science, technology, engineering and mathematics) school teachers which aims to support teacher professional development and provide students with a window on the real world application of STEM. Educator on Board puts teachers on voyages to assist with scientific operations and share their on-board experience with students across Australia through live ship-to-shore video broadcasts. Teachers will also develop curriculum-linked resources based on the ship and underway science to create a pool of lessons to share in schools across Australia. Two teachers will be joining this voyage as part of the Educator on Board program, and will be encouraged to assist with science operations where possible, in consultation with the Principal Investigators and MNF on board liaison.

BGC-Argo float deployment (Dr Tom Trull, CSIRO)

Biogeochemical-Argo (BGC-Argo) is the 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. These newly developed sensors now allow profiling floats to also observe biogeochemical properties with sufficient 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. Biogeochemical-Argo will drive 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.

The Australian contribution to global Biogeochemical-Argo is coordinated through the BGC-Argo sub-facility component of Argo-Australia.

We will use this voyage to deploy 2x BGC-Argo floats at Dirk Erler's (Supplementary Project 2) CTD site #1. In addition, samples will be collected from the CTD Niskin bottles in order to calibrate the float sensors: including salinity, oxygen and nitrate by the MNF Hydrochemistry team, and TCO2, Alkalinity, POC (particulate organic carbon) and Pigments (chlorophyll and other pigments) by CSIRO Oceans & Atmosphere laboratories. Deployment of the floats will be managed by the MNF in conjunction with the deck crew. CTD samples will be managed by PI Erler and the on board Hydrochemistry team.

Permits

GBR Marine Park Permit Number G41782.1 (27 March 2019; Beaman/Webster/Erler/Woehler/Protat permit for GBR Marine Park).

GBR Marine Park Permit Number G19/41954.1 (4 September 2019; MNF blanket permit for GBR Marine Park).

Parks Australia Permit Number PA2018-00005-1 (commenced 20 August 2018; MNF blanket permit for Commonwealth Marine Parks).

Parks Australia Permit Number PA2019-00006 (from 1 October 2019 to 31 October 2019; Przeslawski permit for Wessel Marine Park).

Signature

Your name	Dr Robin Beaman
Title	Chief Scientist
Date:	5 August 2019

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		X	
Air Chemistry Lab		X	
Preservation Lab			
Constant Temperature Lab	X		Storage of *Trichodesmium* samples. Set to 20°C under normal room lighting.
Underway Seawater Analysis Laboratory	X		Installation of Dirk Erler's Picarro system for dissolved GHG analysis
GP Wet Lab (Dirty)			
GP Wet Lab (Clean)	X		For seawater sample processing - vacuum pump to be supplied by Erler
GP Dry Lab (Clean)			
Sheltered Science Area			
Observation deck 07 level	X		
Walk in Freezer	X		Set at -20°C
Blast Freezer			
Ultra-Low Temperature Freezer (-80^{0}C) X2	X		Storage of *Trichodesmium* samples. Both required.
Walk in Cool Room			
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	X		Mobilised in Brisbane for IN2019_V06
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			
CTD - Seabird 911 with 24 Bottle Rosette	X		
Lowered ADCP			
Sonardyne USBL System			
Milli-Q System	X		
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)			• Please specify 335 micron, 500 micron, or 1,000 micron mesh
Bongo Net (not instrumented) ring diameter 485mm 0.018m^2			• 500 micron mesh only
Smith Mac grab			

(iii) Standard laboratory and sampling equipment

Name	Essential	Desirable	Notes/Comments
Dissecting Microscopes (x4)			• 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		ORCA : to compare plankton activity with atmospheric aerosol measurements
Deep towed camera	X		There will almost certainly be difficulty obtaining good imagery due to high turbidity and strong currents. If possible, a very experienced MNF camera operator and technician able to adjust camera settings onboard would be ideal.
Piston Coring System			
Gravity Coring System			
Multi Corer			
Kasten Corer			

(iv) Specialised laboratory and sampling equipment

Name	Essential	Desirable	Notes/Comments *(These items may require additional MNF support staff)*
XBT System	X		• 2 per day provided (cannot be deployed within GBRMPA)
Valeport Rapid SV/CTD	X		
Valeport SVX2	X		
Trace Metal Rosette and bottles			
Sherman epibenthic sled			
Trace- metal in-situ pumps (x6)			• See non-MNF owned section below for additional 2 units
Rock Dredges			
EZ Net (maximum of 10 nets for depth stratified sampling. Mouth area of 1m^2)			• 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			
150kHz ADCP			
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		X	ORCA: Collecting aerosol measurements along the coast would be a good opportunity to document the aerosol properties and their latitudinal variability. This would also provide context to understand the variability of the precipitation properties along the coast.
Multi Angle Absorption Photometer (MAAP)		X	
Scanning Mobility Particle Sizer (SMPS)		X	
Radon detector		X	
Ozone detector		X	
Condensation Particle Counter (CPC)		X	
Picarro spectrometer (analysis of CO_2/CH_4/H_2O)		X	
Aerodyne spectrometer (analysis of N_2O/CO/H_2O)		X	
Cloud Condensation Nuclei (CCN)		X	
Polarimetric Weather Radar	X		

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

Appendix B - User equipment and facilities to be provided by the Chief Scientist

Owner	Item name	Weight	Dimensions	Location on Vessel
Dirk Erler	500 mL serum bottles x 50	35 kg	2 eskies - 65 x 30 x 40 cm	Fridge storage
Dirk Erler	50 mL falcon tubes	2 kg	esky 30 x 30 x 30 cm	Freezer
Dirk Erler	200 exetainers	5 kg	esky 30 x 30 x 30 cm	Fridge storage
Dirk Erler	Syringes	200 g	Nally bin #1	Wet lab
Dirk Erler	Syringe filters	200 g	Nally bin #1	Wet lab
Dirk Erler	Filter papers	200 g	Nally bin #1	Wet lab
Dirk Erler	Vacuum pump	15 kg	Nally bin #1	Wet lab
Dirk Erler	Filtration manifold	5 kg	Nally bin #2	Wet lab
Dirk Erler	Picarro G2301	30 k	1 m x 50 cm x 50 cm	Underway seawater lab
University of Melbourne - AIR-BOX	Sea-state cameras	5kg	LxWxH 30x15x15cm	Deck 05 railing
University of Melbourne - AIR-BOX	Eddy Flux package	10kg	LxWxH 70x15x40cm	On the main aerosol mast
University of Melbourne - AIR-BOX	MAXDOAS	Optics 5kg (railing) 10kg Spectrometer (3 RU) + laptop	Optics LxWxH 30x20x20 cm Spectrometer 3 RU	Deck 5 railing for optics, 10m fibre optic cable run inside to spectrometer and laptop
University of Melbourne - AIR-BOX	miniMPL	180 kg	Enclosure: 64 x 64 x 77 cm Scanning unit on top: 35 x 52 x 20 cm	Housing requires crane lift to deck 5. Location on deck 5 against railing, and secured to the deck (as housing has wheels best that a wooden boxing to prevent movement combined with 4 secure points)
University of Melbourne - AIR-BOX	u-Dirac	30kg	instrument: 50x50x20 columns: LxWxH 10x25x120cm	Aerosol Laboratory - port bench
Macquarie University - University of Melbourne - AIR-BOX	Tekran	15kg	Instrument:3RU + laptop	Aerosol Laboratory - port bench
University of Melbourne - AIRBOX	Spectronus	60kg	1000x450x900 (mm L x W X H)	Air Chemistry Laboratory - port bench - see Ruhi's lab layout

Owner	Item name	Weight	Dimensions	Location on Vessel
University of Melbourne / Queensland University of Technology	AIR-BOX	8.1Tonnes	High 20" shipping container. With aerosol mast and supports ~2m mounted on the roof	Level 02, port foredeck container space.
Queensland University of Technology	NAIS – Neutral Cluster and Air Ion Spectrometer	60 kg	W - 305 mm L - 580 mm H - 810 mm	Within AIRBOX (Level 02, port foredeck container space)
Queensland University of Technology	VHTDMA – Volatility Hygroscopicity Tandem Differential Mobility Analyser	150 kg	1.2 x 0.6 x 1.25 m	Within AIRBOX (Level 02, port foredeck container space)
Queensland University of Technology	AMS: Aerosol Mass Spectrometer	180 kg	W - 104cm L - 61cm H - 135cm	Within AIRBOX (Level 02, port foredeck container space)
Queensland University of Technology	CIMS: Chemical ionisation Mass Spectrometer	145 kg	59.1 x 42.1 x 82.6 (cm) Scroll pump: 44 x 34 x 34 (cm)	Within AIRBOX (Level 02, port foredeck container space)
Bureau of Meteorology	BASTA - 95 GHz cloud radar	~60 kg	(LxWxH) 120x70x100cm	Stabilised Platform container
Bureau of Meteorology	RMAN Lidar	~110 kg	(LxWxH) 80x65x115cm	Stabilised Platform container
Bureau of Meteorology	Micro-rain radar	~20 kg	(LxWxH) 50x50x100cm	Deck 05
Bureau of Meteorology	OceanRAIN disdrometer			Main mast, second highest platform preferred *(has been integrated previously)*
Tom Trull	2 BGC-Argo floats	25kg each	20cm cylinder x 160cm high	General Purpose Wet Lab - Dirty (main)
Tom Trull	2 x in-line filtration systems	5 kg	50 x 50 x 50 cm	CTD room
Tom Trull	Bin for sample storage	0.5 kg	20 x 20 x 10 cm	In -80 C freezer
Tom Trull	3 x crates TCO2/Alk sample bottles	5 kg	50 x 50 x 25 cm	Underway Seawater Lab in purpose built racks
Tom Trull	1x FLBB sensor	1 kg	15 cm cylinder x 20cm high	Mounted on CTD facing into open ocean, e.g. as previously mounted on IN2019_V02