RV *Investigator* Voyage Plan

Voyage #:	**IN2022_V08**		
Version number:	**FINAL**		
Voyage title:	Biodiversity Assessment of Australia's Indian Ocean Territories		
Mobilisation:	Sunday 25 September – Tuesday 27 September 2022: Darwin, NT		
Pre-voyage quarantine onshore (7 days) INCLUDES MOBILISATION ACTIVITIES (non-seagoing personnel only	Wednesday 21 September – Wednesday 28 September 2022		
Pre-voyage quarantine onboard (departing day 3)	Wednesday 28 September – Thursday 29 September 2022		
Depart:	Friday 30 September 2022: Darwin, NT		
Return:	0800 Thursday 03 November 2022: Fremantle, WA		
Demobilisation:	Thursday 03 November 2022: Fremantle, WA		
Voyage Delivery Coordinator:	Max McGuire	**Contact details:**	max.mcguire@csiro.au
Voyage Manager:	Margot Hind	**Contact details:**	Margot.hind@csiro.au
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Principal Investigators:	Lisa Kirkendale		

Voyage #:	IN2022_V08		
Affiliation:	Western Australian Museum	**Contact details:**	Lisa.Kirkendale@museum.wa.gov.au
Principal Investigators:	Andrew Hosie		
Affiliation:	Western Australian Museum	**Contact details:**	Andrew.Hosie@museum.wa.gov.au

Scientific objectives

1. Characterise benthic biodiversity from seamounts (100-3500 m) across the EEZ in Australia's Indian Ocean Territories (IOT) for the first time.
2. To provide specimens and tissues samples to taxonomists for species identification and descriptions.
3. Test whether the proposed bioregionalisation for the territories (Brewer et al 2009, derived from environmental data) is an adequate surrogate for patterns of seafloor diversity across a series of depth strata.
4. Assess the conservation significance of these seamount communities, particularly the presence of Vulnerable Marine Ecosystems (VMEs) including cold water coral and sponge communities.
5. Document spatial and bathymetric patterns of oceanographic characteristics and plankton distribution.
6. Substantially contribute to the AusSeabed project by maximising new Multibeam coverage.
7. Understand the biogeographical relationships of the fauna through community and evolutionary (DNA) comparisons with other Australian, west Pacific and Indian Ocean faunas.

Voyage objectives

1. Complete the Multibeam mapping of shallow water features prior to biological sampling.
2. Conduct biological sampling on 8 seamount clusters, around the flanks of the Cocos (Keeling) islands and at three sites on the abyssal plain, using 4m beam trawls and a heavy dredge (Sherman). In the event of bad weather some seamounts in the Raitt Ridge and S Cocos clusters will be abandoned.
3. Conduct video transects of up to four selected (20-2000 m) shallow water seafloor features.
4. Compile CTD/ADCP/echosounder data from selected seamount locations
5. Collect water samples for eDNA analyses from the CTD casts.
6. Collect plankton net samples from shallow water environments and zooplankton aggregations.
7. Transit along unmapped tracks to maximise Multibeam coverage of the area.
8. Communicate with the local island communities through live video links with schools and community centres on the islands.
9. Engage with Australian schools from the vessel through facilities set up by the BushBlitz program.
10. Communicate with Australian and International public and media through blogs, media releases and interviews from the vessel.

Voyage Specific Risk Assessment

This voyage has undergone a comprehensive risk assessment process. The full VSRA is at Appendix C.

Media Activities

CSIRO 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.

Organisation	Activities	Timing	Responsible person
Parks Australia/MV	Education and public engagement with local island communities describing voyage mission and voyage highlights, including live video links and pieces in the local papers.	Around Cocos Islands	Allyn White - Parks Australia
Bush Blitz/MV	Education activities organised with Australian schools	Voyage	Kate Cranney - BushBlitz
MV/Bush Blitz/MNF	On-going media interviews from the vessel on science discoveries.	Voyage	Tim O'Hara / Kate Cranney
MV	Voyage overview for "The Conversation"	Post voyage	Tim O'Hara
MV	Post voyage media on scientific results	Post voyage	Tim O'Hara

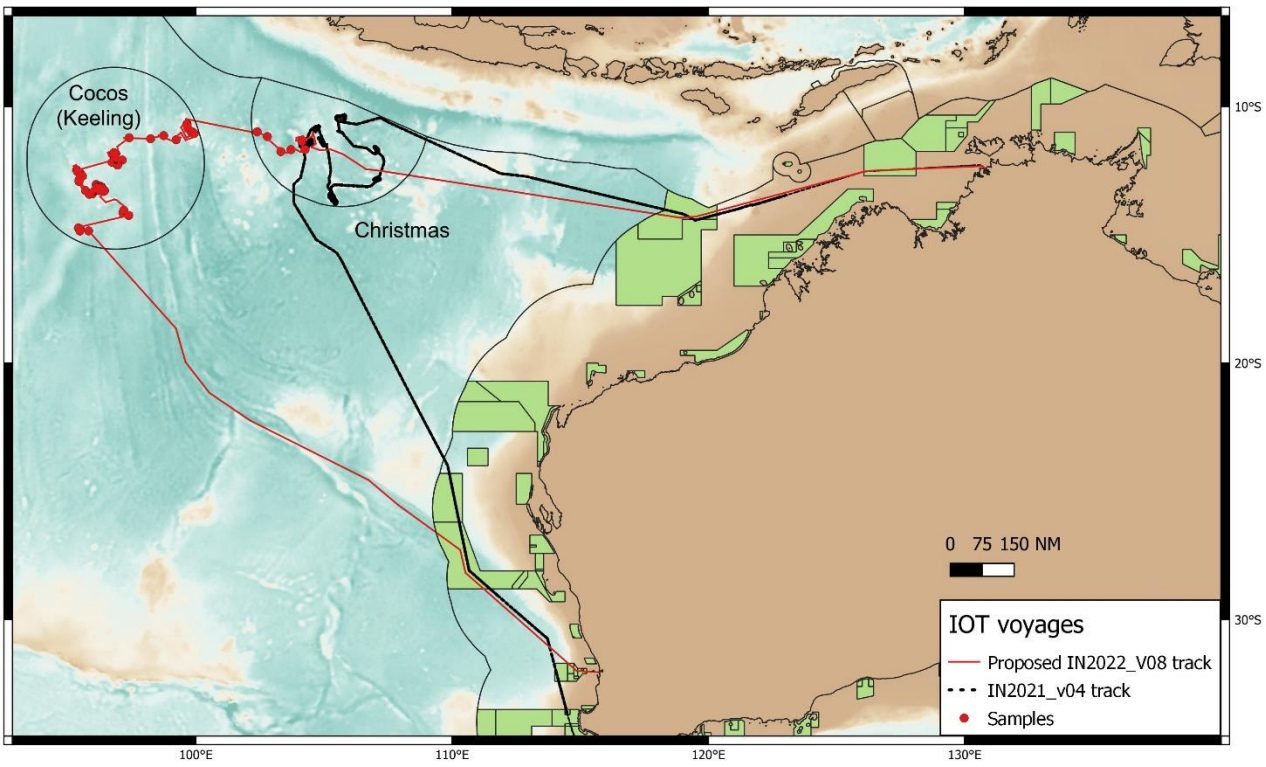
Overall activity plan including details for first 24 hours of voyage

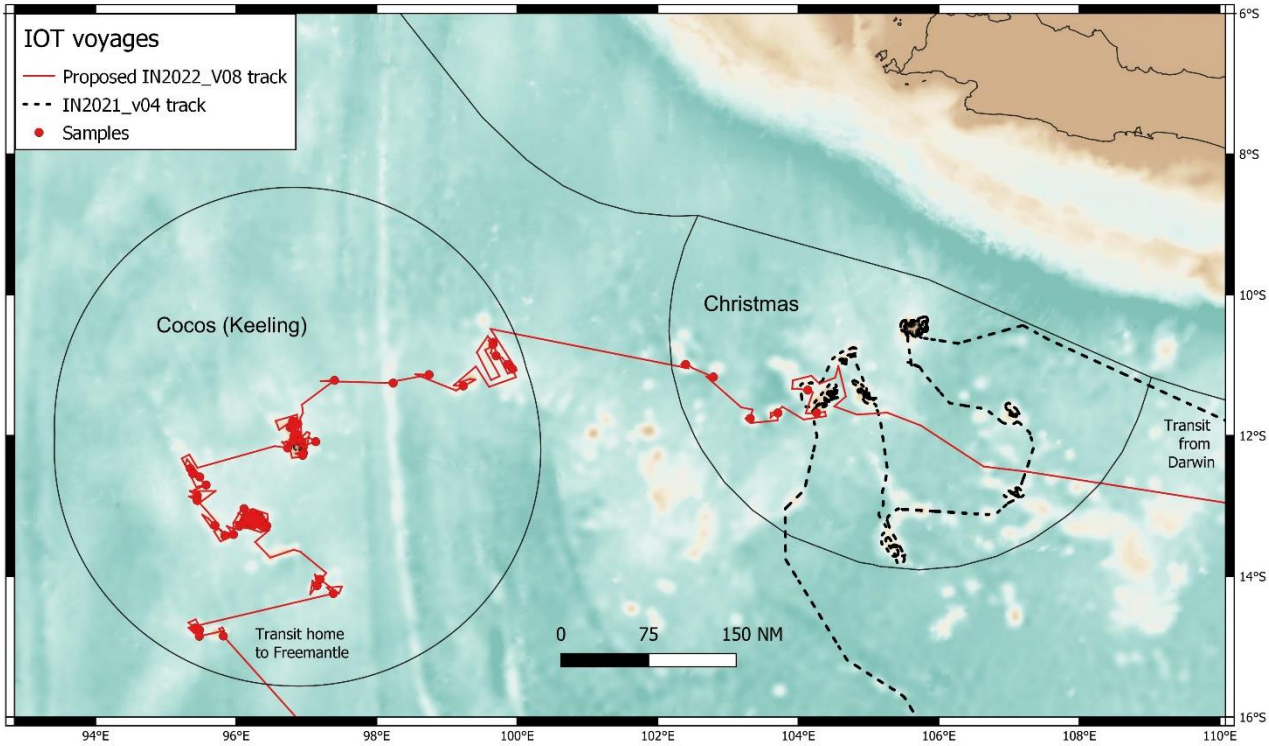
The first six days at sea will be the transit from Darwin to the Christmas Island region. The only scientific activities during this time will be Multibeam/underway data collection, seabird/cetacean observation, and communication activities. This will give us ample time to prepare the laboratories and personnel. The voyage track will deviate slightly from a direct route in order to avoid the Indonesian EEZ, and instead we will Multibeam a track that completes or compliments the mapping of 1) the canyon system in the Argo-Rowley MP, 2) several smaller seamounts to the SE of the Christmas Island EEZ, 3) the 'Eye of Sauron' caldera, and 4) the Balthazar seamount.

Overall sampling plan for the voyage

The Chief Scientist has proposed to conduct multibeam operations at night (2200-0600) and sampling operations during the day (0600-2200) as a starting point to our planned operations due to the dynamic nature of the scientific objectives of this voyage in that an exact daily plan will not be completely confirmed until the proposed sampling area has been surveyed.

Voyage track example





	Location	Activity	latitude	longitude	Distance (nm)	Total Distance	Steaming time (hr)	Total Steam	Activity (hr)	Total activities	Date/Time
1	Darwin	Port	12° 29.4 S	130° 53.4 E							30/09/2021 8:00
2	Darwin Channel	Transit	12° 19.2 S	130° 41.4 E	16	16	1.41	1.41			30/09/2021 9:24
3	Oceanic Shoals	Transit	12° 30.6 S	126° 9.6 E	266	281	24.17	25.58			01/10/2021 9:35
4	Argo Canyon	Transit	14° 17.34 S	119° 30.54 E	403	684	36.61	62.2			02/10/2021 22:11
5		Transit	14° 20.16 S	118° 55.02 E	35	719	3.14	65.34			03/10/2021 1:20
6	Eye of Sauron	Transit	12° 30.84 S	107° 15.84 E	688	1407	62.56	127.9			05/10/2021 15:54
7		Transit	12° 26.34 S	106° 38.22 E	37	1444	3.37	131.27			05/10/2021 19:16
8		Transit	11° 51.5 S	105° 44.76 E	63	1507	5.72	136.99			06/10/2021 0:59
9		Transit	11° 40.4 S	105° 16.02 E	30	1537	2.75	139.74			06/10/2021 3:44
10		Transit	11° 42.1 S	104° 50.16 E	25	1563	2.31	142.05			06/10/2021 6:02
11	Balthazar	Transit	11° 35.1 S	104° 30.72 E	20	1583	1.84	143.89			06/10/2021 7:53
12	Balthazar	2xSled/trawl, 2xCTD	11° 46.3 S	104° 4.62 E	311	1755	34.26	168.73	3.20	3.20	07/10/2021 8:43
13	Glogg	Transit	11° 35.3 S	103° 46.32 E	21	1776	1.91	170.64		3.20	07/10/2021 10:38
14	Glogg	1xSled/trawl, 1xCTD	11° 47 S	103° 42.18 E	51	1807	6.09	176.57	1.75	4.95	07/10/2021 16:34
15	Attention	Transit	11° 49.3 S	103° 19.14 E	23	1829	2.06	178.63		4.95	07/10/2021 18:38
16	Attention	1xCTD, 1xSled/trawl	11° 35.9 S	103° 11.22 E	50	1856	5.55	184.37	2.25	7.20	08/10/2021 0:22
17	Cocos Basin abyss	Transit	11° 9.5 S	102° 41.34 E	39	1896	3.58	187.95		7.20	08/10/2021 3:57
18	Cocos Basin abyss	1xCTD, 1xSled/trawl	11° 10.1 S	102° 47.52 E	46	1902	6.63	193.75	2.75	9.95	08/10/2021 9:44
19	Lucia	Transit	11° 2.5 S	102° 29.7 E	19	1921	1.74	195.49		9.95	08/10/2021 11:29
20	Lucia	1xCTD, 1xSled/trawl	11° 2.6 S	102° 26.04 E	38	1939	4.87	201.37	2.75	12.70	08/10/2021 17:22
21	Scrooge	Transit	10° 29 S	99° 37.2 E	169	2109	15.4	216.77		12.70	09/10/2021 8:46
22	Scrooge	5xSled/trawl, 5xCTD	11° 18.4 S	99° 35.94 E	244	2352	35.18	265.7	13.80	26.50	11/10/2021 9:41
23	Rudist	Transit	11° 1 S	99° 24.72 E	21	2373	1.87	267.57		26.50	11/10/2021 11:34

	Location	Activity	latitude	longitude	Distance (nm)	Total Distance	Steaming time (hr)	Total Steam	Activity (hr)	Total activities	Date/Time
24	Rudist	1xSled/trawl, 1xCTD	11° 21.6 S	99° 7.8 E	90	2442	9.88	277.82	2.25	28.75	11/10/2021 21:49
25	East Cocos abyss	Transit	11° 7.7 S	98° 32.98 E	37	2479	3.36	281.18		28.75	12/10/2021 1:10
26	East Cocos abyss	1xSled/trawl, 1xCTD	11° 8 S	98° 44.7 E	48	2490	9.12	289.69	2.75	31.50	12/10/2021 9:41
27	Investigator Ridge	Transit	11° 15.2 S	98° 7.14 E	38	2528	3.42	293.1		31.50	12/10/2021 13:06
28	Investigator Ridge	1xSled/trawl, 1xCTD	11° 15.2 S	98° 14.04 E	44	2535	6.8	299.24	2.75	34.25	12/10/2021 19:14
29	West Cocos abyss	Transit	11° 13.5 S	97° 12.24 E	61	2595	5.52	304.76		34.25	13/10/2021 0:45
30	West Cocos abyss	1xSled/trawl, 1xCTD	11° 12.8 S	97° 24 E	72	2607	11.3	313.29	2.75	37.00	13/10/2021 9:17
31	Cocos Keeling	Transit	11° 33.6 S	96° 56.16 E	34	2641	3.12	316.41		37.00	13/10/2021 12:24
32	Cocos Keeling	14xSled/trawl,14xCTD,3xDTV,3x Net	12° 8.9 S	96° 33.06 E	420	3027	66.93	409.97	29.75	66.75	17/10/2021 9:58
33	Noel	Transit	12° 27.5 S	95° 26.94 E	67	3094	6.12	416.09		66.75	17/10/2021 16:05
34	Noel	6xSled/trawl, 6xCTD	12° 55.2 S	95° 26.63 E	266	3293	39.25	465.22	16.00	82.75	19/10/2021 17:13
35	Raitt Ridge	Transit	13° 4.2 S	95° 34.98 E	12	3305	1.11	466.32		82.75	19/10/2021 18:19
36	Raitt Ridge	3xSled/trawl, 3xCTD	13° 24.2 S	95° 57.72 E	133	3426	22.13	495.6	8.25	91.00	20/10/2021 23:35
37	Muirfield	Transit	13° 14.7 S	95° 57.54 E	10	3436	0.87	496.46		91.00	21/10/2021 0:27
38	Muirfield	21xSled/trawl,21xCTD,3xDTV,3x Net	13° 20.4 S	96° 28.49 E	4	378634	71.96	609.56	42.00	133.00	25/10/2021 17:33
39	Santa Ridge	Transit	13° 30.7 S	96° 16.14 E	16	3875	1.44	610.99		133.00	25/10/2021 18:59
40	Santa Ridge	MB only	13° 39.1 S	96° 54.9 E	61	3920	5.51	615.07		133.00	25/10/2021 23:04
41	S Cocos	Transit	13° 57 S	97° 16.87 E	28	3948	2.54	617.6		133.00	26/10/2021 1:36
42	S Cocos	3xSled/trawl,3xCTD	14° 14.6 S	97° 22.94 E	130	4049	19.46	642.78	8.25	141.25	27/10/2021 2:46
43	SW Cocos	Transit	14° 43.7 S	95° 19.26 E	123	4173	11.21	653.99		141.25	27/10/2021 13:59

	Location	Activity	latitude	longitude	Distance (nm)	Total Distance	Steaming time (hr)	Total Steam	Activity (hr)	Total activities	Date/Time
44	SW Cocos	4xSled/trawl,4xCTD	14° 50.8 S	95° 49.07 E	214	4263	30.08	683.36	10.50	151.75	28/10/2021 19:21
45		Magnetometer	18° 38.8 S	99° 13.44 E	301	4564	27.34	711.2	0.50	152.25	29/10/2021 23:11
46		Magnetometer	19° 57.7 S	99° 35.88 E	82	4646	7.43	718.63		152.25	30/10/2021 6:37
47		Magnetometer	21° 9.4 S	100° 31.68 E	89	4735	8.08	726.7		152.25	30/10/2021 14:42
48		Magnetometer	22° 13.9 S	102° 6.54 E	109	4844	9.94	736.64		152.25	31/10/2021 0:38
49		Magnetometer	24° 33.2 S	106° 43.92 E	290	5134	26.4	763.04		152.25	01/11/2021 3:02
50		Magnetometer	25° 32.2 S	107° 54.3 E	87	5221	7.9	770.94		152.25	01/11/2021 10:56
51		Magnetometer	27° 16.8 S	110° 18.84 E	167	5388	15.15	786.09		152.25	02/11/2021 2:05
52		Transit	28° 10.3 S	110° 31.2 E	55	5443	4.97	791.06		152.25	02/11/2021 7:03
53	Perth Canyon	Transit	32° 0 S	114° 51.78 E	322	5765	29.28	820.84	0.50	152.75	03/11/2021 12:50
54	Fremantle	Transit	32° 3 S	115° 45.3 E	46	5810	4.14	824.97		152.75	03/11/2021 16:58

CTD Configuration

	Please select:
Fundamentals:	
• Which CTD rosette to be used for this voyage (24 Niskin bottles or 36):	36
• Likely total number of casts:	66
• Likely maximum depth of deepest cast:	5500
• Lowered ADCP required:	X
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):	X
• PAR Sensor (Biospherical QCP-2300):	
• Transmissometer (Wetlabs C-Star 25cm):	X
• Fluorometer – Chlorophyll-a (Chelsea Aquatracka III – 430/685nm):	X
• Fluorometer – CDOM (Wetlabs FLCDOM – 370/460nm)	X
• Nephelometer (Seapoint Turbidity Meter)	X
• ECO-Triplet (Chlorophyll-a, CDOM & backscatter – maximum depth 2000m)	X
Hydrochemistry Analyses:	
• Salinity	X
• Dissolved Oxygen	X
• Nutrients: Nitrate	X
• Nutrients: Phosphate	X
• Nutrients: Silicate	X
• Nutrients: Nitrite	X
• Nutrients: Ammonia (special request after discussion with hydrochemistry)	

Test CTD

A test CTD will be undertaken prior to our first planned CTD cast at **Balthazar Seamount.**
This requirement is a single cast to a minimum of 1000m, firing half the bottles at the maximum depth of the cast, followed by firing of the remaining bottles near the chlorophyll maximum (requiring one stop on the retrieval).
This test CTD is essential to the MNF Hydrochemistry team and supports the training of samplers, testing of Niskin bottles, collection of a tracking standard for the voyage, and ongoing quality and uncertainty calculations.
Time Estimates: approximately 1 hour.

Permits

- Access to Biological Resources in a Commonwealth Area for Non-Commercial Purposes
- Approval for Activity in a Commonwealth Marine Reserve (for Palau Keeling): SPA 2022-CKI01-MV
- Australian Fisheries Management Authority Scientific Permit (outside 12 nm): #1005452
- WA Government General Fisheries Permit (within 12 nm)
- Museums Victoria Animal Ethics Committee approval: #MVAEC-202201

List of additional figures and documents

- Appendix A - MNF Equipment
- Appendix B - Equipment Manifest
- Appendix C - Hazardous Materials Manifest
- IN2021_V04 site descriptions.pdf

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	**Required**	**Notes/Comments**
Aerosol Sampling Lab		
Air Chemistry Lab		
Preservation Lab	X	• Preserving benthic samples
Constant Temperature Lab	X	• Bioluminescence experiments/live animal aquaria, 4 degrees C
Underway Seawater Analysis Laboratory	X	• Niskin sample retrieval?
GP Wet Lab (Dirty)	X	• Beam trawl/dredge sample sorting and identification
GP Wet Lab (Clean)	X	• Fish identification and preparation
GP Dry Lab (Clean)	X	• Invertebrate microscope identification
Sheltered Science Area	X	• Preparation for sample recovery
Observation Deck 07 Level	X	• Bird/cetacean observations
Walk in Freezer	X	Preservation of frozen samples
Blast Freezer	X	
Ultra-Low Temperature Freezer (-80^{0}C) X2	X	Preservation of tissue samples and Niskin samples
Walk in Cool Room	X	Temporary storage of catch

(ii) Mobile laboratory and facilities *(may require additional support)*			
Name	**Essential**	**Desirable**	**Notes/Comments**
Modular Radiation Laboratory (Isotope lab)			
Trace Metal Niskin Sampling Container (TM1-blue)			
Trace Metal Seawater Analysis Laboratory (TM2-white)			
Trace Metal Rosette and Niskin Storage Container			
Modular Hazchem Locker	X		
Stabilised Platform Container			
Clothing Container			

(iii) Standard sampling equipment			
Name	**Essential**	**Desirable**	**Notes/Comments**
CTD - Seabird 911 with 36 Bottle Rosette	X		Temp, salinity, O2, turbidity, Fluorometer
CTD - Seabird 911 with 24 Bottle Rosette			
Lowered ADCP	X		Fine scale current measurements over seamounts
Continuous Plankton Recorder (CPR)			

(iv) Specialised sampling equipment			
Name	**Essential**	**Desirable**	**Notes/Comments** *(these items may require additional MNF support staff)*
TRIAXUS – Underway Profiling CTD			
Desired towing profile:			
Additional instrumentation:			

(iv) Specialised sampling equipment			
Name	**Essential**	**Desirable**	**Notes/Comments** *(these items may require additional MNF support staff)*
(please supply, make and model and datasheets and a contact person for discussion on integration)			
Piston Coring System			
Gravity Coring System			
Multi Corer			
Kasten Corer			
Smith Mac Grab		X	Backup
Rock Dredges		X	In case very rocky seafloors are found
Rock Saw			
Seaspy Magnetometer	X		
Portable Pot Hauler			
Equipment to measure seawater sound velocity/CTD:			
• XBT System	X		• 2 per day provided
• Valeport Rapid SV			
• Valeport Rapid CTD			
• Valeport SVX2			
Trace Metal Rosette and Bottles			
Trace Metal In-situ Pumps (x6)			
Deep Towed Camera	X		
Drop Camera			
Sherman Epibenthic Sled	X		

(iv) Specialised sampling equipment			
Name	**Essential**	**Desirable**	**Notes/Comments** *(these items may require additional MNF support staff)*
Brenke Sled			
EZ Net (Multiple net system, 1m x 1m)			
Hydro-Bios MultiNet (1m x 1m)			
Surface Net (1m x 1m)	X		350 micron mesh
Bongo Net 485mm diameter			
Beam Trawl	X		
MIDOC			
Pelagic Trawl System (net, doors)			
Demersal Trawl System (net, doors)			
Trawl Monitoring Instrumentation (ITI) (2,000m depth limit)			
Stern ramp	**Exposed**		Required for beam trawl, towed camera

(v) Research support infrastructure			
Name	**Essential**	**Desirable**	**Notes/Comments**
Salt Water Ice Machine	X		
Radiosonde Receiver System			
Laboratory Incubators			
Deck Incubators			• Temperature controlled deck incubators
Milli-Q System			
Sonardyne USBL System	X		

(vi) Scientific / sample analysis systems

Name		Essential	Desirable	Notes/Comments
Microscopes:				• Refer to the "MNF microscopes procedure" for more information
Brand / model	*Type*			
• Leica / M80	Dissecting	X		
• Leica / M80	Dissecting	X		
• Leica /MZ6	Dissecting	X		
• Olympus / CH	Compound	X		
• Olympus /CH	Compound			
• Leica / MTU282	Camera tube	X		
• Adapters for tube / Nikon	Pentax	X		
• Ring Light *2 / MEB121	LED	X		
Heavy Duty Electronic Balance (80kg)		X		
Medium Duty Electronic Balance (15kg/5g resolution)		X		
Light Duty Electronic Balance (3kg/1g resolution)		X		

(vii) Underway systems

Acoustic Underway Systems

Name	Essential	Desirable	Notes/Comments
75kHz ADCP	X		
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	Some mapping of shallow water required (20-100 m)
Sub-Bottom Profiler SBP120			

(vii) Underway systems

Acoustic Underway Systems

Name	Essential	Desirable	Notes/Comments
Scientific Echo Sounders EK60 (6 bands, 18kHz-333kHz)	X		
Multibeam Scientific Echo Sounder ME70 (70-100 kHz)			
Omnidirectional Echo Sounder SH90			
Gravity Meter	X		

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			

Underway Seawater Systems and Instrumentation			
Name	**Essential**	**Desirable**	**Notes/Comments**
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	X		

(viii) Equipment and sampling gear requiring external support (may require additional support from applicants)			
Name	**Essential**	**Desirable**	**Please give this careful consideration, as there is no guarantee that these resources will be available unless specifically requested. Liaise with your Voyage Operations Manager as required.** **Additional staff may be required for these activities.**
Seismic Compressors			
Seismic Acquisition System			

(ix) Non-MNF owned equipment which may be accessed

Name	**Essential**	**Desirable**	**Please give this careful consideration, as there is no guarantee that these resources will be available unless specifically requested. Liaise with Voyage Operations Manager as required.** **Additional staff may be required for these activities.**
D & N Francis winch			• 15mm electro-optical cable

(ix) Non-MNF owned equipment which may be accessed

Name	Essential	Desirable	Please give this careful consideration, as there is no guarantee that these resources will be available unless specifically requested. Liaise with Voyage Operations Manager as required. Additional staff may be required for these activities.
Box Corer			
UTAS In-Situ Pumps (x2)			
EM2040			• Shallow water Multibeam echosounder system

Appendix B

User Supplied Equipment

Owner	Item name	Location on Vessel
Museums Victoria	Additional microscopes	Dry lab
Museums Victoria	Sorting/Preserving equipment, including drums, trays, bottles, bags, forceps etc	Cool room, dry & wet lab
Museums Victoria	Ethanol	Hazchem locker
Museums Victoria	Formaldehyde	Hazchem locker

Appendix C

Hazardous Materials Manifest

Responsible Person	Hazardous Material Name
Mel Mackenzie	Special Methylated Spirits (95 SG F3)
Mel Mackenzie	Ethanol Absolute
Di Bray	Formaldehyde
Di Bray	Borax
Tiffany Sih	RNAlater
Tiffany Sih	Propylene glycol
Mel Mackenzie	Magnesium Chloride
Di Bray	Clove oil
Di Bray	Aqua-S
Mel Mackenzie	White King bleach
OBJBruce DeagleOBJ	Liquid nitrogen