RV *Investigator* Voyage Plan

VOYAGE #:	IN2024_V05
Version Number:	FINAL 2.1
Voyage title:	Untangling the causes of change over 25 years in the southeast marine ecosystem - Voyage III
Mobilisation:	Hobart, Sunday 10 November 2024 – Tuesday 12 November 2024
Onboarding:	Hobart, 0830-0930 Tuesday 12 November 2024
Depart:	Hobart, 1100 Tuesday 12 November 2024 to Selfs Point
Return:	Hobart, 0800 Friday 13 December 2024
Demobilisation:	Hobart, Friday 13 December 2024
Voyage Delivery Coordinator:	Claire Grubb
Voyage Manager:	Tegan Sime
Chief Scientist:	Dr Rich Little
Affiliation:	CSIRO

Scientific objectives

The marine waters of southeast Australia are one of a series of global ocean hotspots. In this region, the East Australian Current is extending pole-wards, resulting in warming of the ocean surface at a rate four times the global average. Many species have extended their distributions southward, with potential changes in local abundance. In addition, extreme events, such as marine heatwaves, are leading to additional impacts. Projections show that these changes, and the associated biological responses, are expected to continue in the next century.

In this hotspot lies the Australian Commonwealth Southeast Marine Park Network (SE-MPN), which was established in 2012 to protect the region's marine ecosystems and biodiversity, contribute to the National Representative System of Marine Protected Areas and help ensure the long-term ecological viability of Australia's marine ecosystems. It is unclear whether ecosystem changes observed in the region have also affected the marine parks, or whether the network has mitigated them. Understanding this better would help improve the ability of the marine park network to protect Australian heritage in the future.

In 2015, an expert scientific panel recommended an adaptive management approach for the Commonwealth marine reserve estate. It included the development of a research, monitoring and evaluation framework that supports robust evidence-based decision-making, and recommended, as part of the National Marine Science Plan 2015– 2025, establishment of baselines and development of early critical benchmarks to enable a sound assessment for effective management.

Also in this hotspot lie important fisheries, providing the bulk of fresh fish to Melbourne and Sydney markets. The Commonwealth-managed Southern and Eastern Scalefish and Shark Fishery (SESSF) catches about 20,000t, valued at $87 million in 2018-19, and about 20% of the value of Australian Commonwealth-managed fisheries. The trawl sector, which accounts for roughly 15,000t, spans the marine waters in the hotspot. Observations from the SESSF over the past 20 years have indicated changes in the abundance and composition of the main finfish species, manifest as declines in commercial catch rates. Concurrent with these declines, has been unprecedented high levels of catches and catch rates of other species such as ocean jackets and latchet. Additionally, stocks that were historically over-fished have not responded as expected, despite active fisheries management and a reduction in fishing effort. A recent review concluded that physical and ecosystem factors are likely to be either directly affecting the main species, or indirectly affecting other species they compete with or rely on. The general view is that the marine ecosystem has experienced and is experiencing significant change. Several hypotheses have been proposed; none have been tested but they are broadly categorised as being climate-related, or fishing-related. What is clear is that fish species from which ecosystem changes have been inferred, represent only a small part of the ecosystem under pressure, and it is not well understood. Potential changes in the abundance of tropical picoplankton extending into southern Australian waters is possible for example, which would have cascading effects since they do not support the same fish biomass as those associated with cooler waters.

The last survey of the ecosystem was conducted 25 years ago. This project will repeat the surveys to document changes and establish a new biological and environmental baseline to help answer three broad questions:

1. How and why have fish assemblages and species abundances changed in the southeast ecosystem, and can the causes be mitigated?
2. How does this affect the multiple-use management of the region, particularly conservation and biodiversity management of Australian Marine Parks and the hive of activity from fisheries, oil & gas, and renewable energy sectors?

3. What are the implications for marine spatial planning and adaptive management in the sectors that use the marine ecosystem?

It is also testing new monitoring techniques:

a. To detect and count seabirds using deck mounted video camera.

IN2024_V05 is the third of four monitoring surveys planned to help answer the above questions.

Voyage Objectives

Our sampling protocol is driven by the effects that we have hypothesised to explain apparent trends in fish abundance. These impacts include changes that have occurred to the benthic habitat (H1: habitat modification hypothesis), changing food webs (H2: habitat hypothesis); water column (H3: climate hypothesis), and fishery catch. They are not independent of each other and can operate either directly on the species or indirectly through the supporting habitats and associated trophic systems.

We will work 2 shifts of 12-hours to collect data on the demersal fish community composition, benthic habitat, water column, and prey fields.

The day shift will be responsible primarily for demersal fish trawl processing. We will also be casting CTDs and conducting mid-water trawl with the RMT for estimating the prey fields.

The night shift will conduct habitat analysis using the Deep Towed Camera. It will also sample the water column for small pelagic fish and micro-nekton.

An important part of our sampling will also be directed toward collecting samples for eDNA analysis. The eDNA sampling approaches use:

1. CTD samples that are paired to demersal trawl samples during daytime hours. CTD samples for eDNA purposes thus are restricted to location and time of demersal trawl.
2. A passive sampler attached to the DTC.

CTDs will also be used to record plankton samples, nutrients and for understanding the ocean dynamics, including climate variables.

Piggyback projects

FishSOOP Sensor Testing (Moninya Roughan, Veronique Lago UNSW)

Project Objectives

FishSOOP is Australia's Fishing vessel contribution to the Ship of Opportunity Program, and new Integrated Marine Observing System (IMOS) platform. Operating since early 2023 we have instrumented >30 vessels around Australia to collect temperature data with every fishing set. We have two sensors we have been using, the Moana TD200 and the Moana TD1000, which have a maximum depth of 200m and 1000m respectively. The manufacturer recently upgraded their pressure sensor on the TD1000, which we want to test in real life setting.

We previously did some tests on a few casts on a previous voyage with two sensors, but now we want to test them more thoroughly and see if they drift over time since the previous tests.

The two Moana TD1000 will be attached to the Rosette, at the same level than the temperature sensor from the CTD and deployed along with the regular scheduled CTD casts that are at depths <1000m. We will also have a deck-box installed on the deck of the ship to communicate the data in near real-time to our servers.

We will compare the data with the CTD data and the anomalies with the previous tests to see how well they perform and if they drift over time. This will help build confidence in the technology we use as part of the FishSOOP program.

Carbonate chemistry sampling in Bass Strait (Zanna Chase, UTAS)

Project Objectives

This Piggyback project will collect 30 samples for Dissolved Inorganic Carbon (DIC) and Alkalinity on the SEAMES-3 voyage (IN2024_V05). This work supports an initiative to study the efficacy and impact of Ocean Alkalinity Enhancement (OAE) in Bass Strait. There is currently limited information on inorganic carbon chemistry in Bass Strait. This data is needed to better understand the suitability of Bass Strait for OAE, to establish a baseline, and to assess our regional biogeochemical model. Preliminary data will also strengthen proposals to secure funding for future research. The project will contribute to an undergraduate summer project at UTAS that aims to review existing knowledge of oceanographic and environmental conditions in Bass Strait relevant to OAE. The work is being supported onboard by Claire Davies (CSIRO) and Jackson Griffin (UTAS).

Voyage Time Estimates

The following time estimates are based on a steaming speed of 10 knots.

Trawls are targeted for ODD numbered sites (e.g. S1.1), DTC for EVEN numbered sites (e.g. S2). There are 25 nominal sampling days, with 3 days factored for weather. The track is configured to head North, reaching Eden transfer location early morning of the 28th of November. The voyage will then continue to the northernmost sites, before turning and heading south and completing the sample program at site S12.

Date	Leg	Activity	WP sites	Sample Day
12/11/2024 13/11/2024	1	Board RVI, Sea Going Inductions, Muster, Lab Inductions Transfer to Selfs Point for bunkers 1100 Departing Selfs Point and transiting to science area in Freycinet Marine Park. GSM Calibration line out of Storm Bay Test trawl gear and electronics (2 hours) CTD test cast & sampling training (2 hours)		
			S1.1, S2, S1.3, S1.2	1
			S3.3, S3.2, S3.1, S4	2
			S6, S5.1, S5.2, S5.3	3
			S7.3, S7.2, S7.1, S9.3	4
			N1.1, N1.2, N1.3, N2	5
			N3.2, N3.1, N3.3, N4	6
			N5.1, N5.2, N5.3, N6	7
			N7.2, N7.3, N7.1, N8	8
			N9.3, N9.1, N9.2, N10	9
			N12, N11.1, N11.2, N11.3	10
			N13.1, N13.3, N13.2, N14	11
			N15.3, N15.1, N15.2, N16	12
			N18, N17.1, N17.2, N17.3	13
28/11/2024		Personnel Transfer via launch @ Eden		
	2		N19.1, N19.2, N19.3, N20	14
			N21.2, N21.3, N21.1, N22.3, N22.2, N22.1	15
			N23.3, N23.2, N23.1, N24	16
			N25.3, N25.1, N25.2, N26	17
			N28.1, N28.2, N28.3, N27.3, N27.1, N27.2,	18
			N29.1, N29.3, N29.2, N30.1, N30.2	19
			N31.3, N31.1, N31.2, N32	20
			N33.3, N33.2, N33.1, N34	21
			N35.2, N35.3, N35.1, N36	22
			N37.1, N37.3, N37.2, N38	23
			S8, S10, S9.2, S9.1	24
			S11.1, S11.3, S11.2, S12	25
13/12/2024		Arrival Hobart		

Mid-Voyage Personnel Transfer - Eden

The voyage is staffed and planned around a mid-voyage swap of science staff in Eden via a launch. The transfer will happen in the morning of the 28th November with 3 off/ 3 on-signing science team members plus disembarkation of the MMA Safety Observer. A mandatory briefing pre-voyage on 5th November detailed the requirements and expectations around the transfer.

Nominal 24hr Plan

time	Operation	Teams
		Activities
0		
23.5	DTC	
23	(SIT)	
22.5		
22		
21.5		
21		
20.5	CTD	
20	(DAP + SIT)	
19.5		
19	MBES	Shift leader meeting
18.5	(GSM)	
18		
17.5		
17	trawl	
16.5	(FO)	
16		
15.5		
15		
14.5	multi-net	
14	(FO)	
13.5		
13		
12.5		Mid-day Plenary Shift changeover Briefing
12	trawl	
11.5	(FO)	
11		
10.5		SMT — Master, VM, CS
10	CTD	
9.5	(DAP + SIT)	
9		
8.5		
8		
7.5	trawl	
7	(FO)	
6.5		
6	CTD	Shift leader meeting
5.5	(DAP + SIT)	
5		
4.5	MBES	
4	(GSM)	
3.5		
3		
2.5		
2		
1.5	multi-net	
1	(FO)	
0.5		Mid-night Shift changeover briefing

Leadership team briefing

Standing Agenda

Fatigue / Materiel logistics	Matt L	
Ops	John K/Ni	Ben S
Mapping		
Trawl	Mibu	TJ
DTC	Candice	Ben S
RMT / Multi-net	Claire D	
CTD	Claire D	
data	Marg	
MNF	Tegan	
Birds	Jam	Carlie

Chairs (Week)	1 Rich
	2 Matt
	3 Marg
	4
	5

Fatigue

The following table is in place to support identification of voyage fatigue levels based on the scientific program and environmental conditions of the voyage. The management strategy listed is detailed to support the Voyage Management Team in decision making.

Does the Voyage Operational Plan introduce conditions which could increase fatigue?	☒ Yes ☐ No ☐ NA
Comments: The science program does not indicate any activities that exceed 12hrs. The location of the voyage is typically in shallow water with minimal transit distance between planned stations – this indicates rapid deployment/recovery times and therefore an increase in the total number of operations possible in a 24hr period. The science objectives have a day/night constraint with trawling.	
Detail Fatigue Management strategy: 1. Nominal 24hr plan is factoring breaks. 2. Daily Leadership/Shift Lead briefings will query fatigue levels and plan accordingly. 3. Full workflow for back deck/ops room operations will be reviewed after 1 week (or earlier if nominated) to identify any areas to improve (e.g. back deck ergonomics, timing for full end-to-end activity planning) 4. 5-7 days of continuous operations will be a trigger to discuss fatigue and if any pause needs to be considered – this shall be a joint agreement with Chief Scientist, Voyage Manager and Master.	

Voyage Track

The voyage track is near coastal with sampling occurring primarily between Freycinet Marine Park, Tasmania and trending northwards to approximately Narooma, New South Wales.

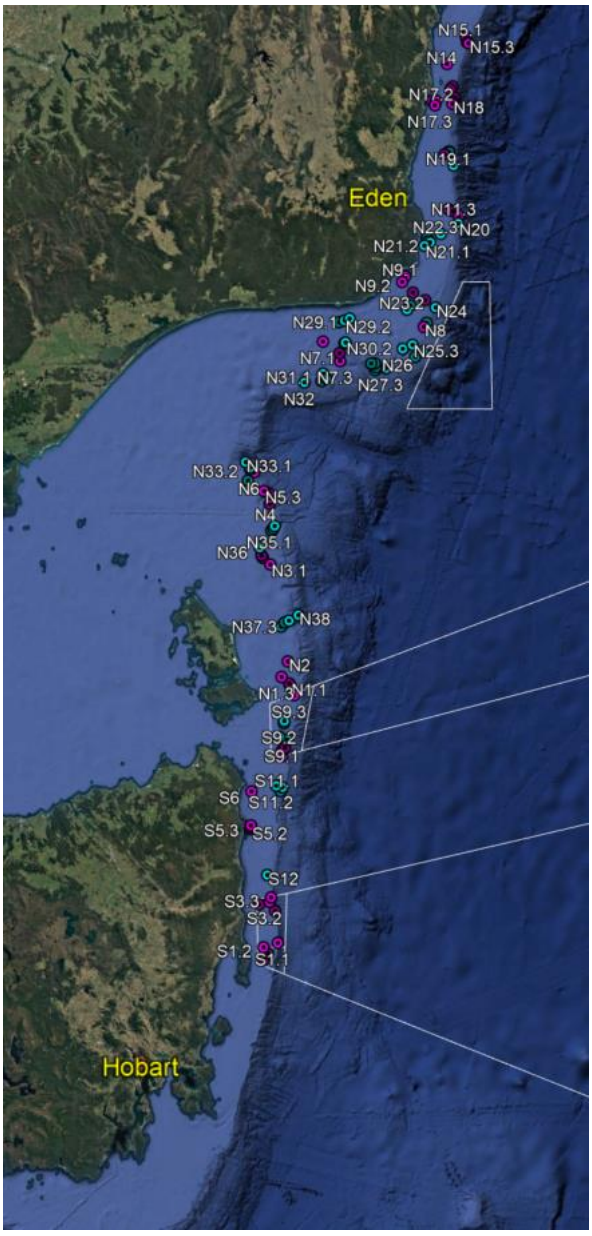


Figure 1: Full program overview. Purple are Leg 1 and blue are Leg 2

Waypoints and stations

General work area indicated. Waypoints and science stations are managed externally to the Voyage Plan

SITE	LAT (DDM)	LONG (DDM)
Hobart (start/end)	42° 52.20	147° 21.00
Southern Work Area	42° 11.81	148° 29.49
East coast Tasmania	39° 28.10	148° 33.35
Central Work Area: Gippsland - Eden	37° 02.63	150° 19.52
Northernmost site	35° 55.41	150° 27.54

Permits

This voyage will traverse through and conduct science in the following Marine Parks:

- Freycinet Marine Park
- Flinders Marine Park

Approved activities are covered by:

- Science Permit PA2022-00143 (Specific Demersal trawl limits are defined in this permit should be referred to with any operational planning in these areas)
- MNF Permit
    i. PA2020-00041-1 Permit - South-east Network,
    ii. Permit variation PA2020-00041-7 - South-east Network
    iii. Permit variation PA2020-00041-14- South-east Network

SCIENCE PERMITS

Jurisdiction	Dept / Agency	Permit Name	Approved	Permit Duration/Expiry	Permit Number
VIC	VFA	Scientific Permit	15/05/2023	**31-Jul-25**	RP1510
VIC	DELWP	Flora & Fauna Guarantee Act Permit	10/02/2023	**30-Jun-25**	10010701
NSW	DPI	Section 37 Permit - Scientific Collection Permit	20/04/2023	**20-Apr-26**	FP23/7
TAS	DPNRE	Living Marine Resources Act 1995 Permit	28/10/2024	**31-Aug-25**	24083
C' wealth	AFMA	Scientific Permit	30/10/2024	**31-Jan-25**	1005950
C' wealth	DCCEEW	Part8A Permit (Biological resources)	27/06/2023	**31-Jul-25**	AU-COM2023-582
C' wealth	Parks Aus	Marine Parks Entry Permit	26/06/2023	**01-Aug-25**	PA2022-00143-1
	CSIRO	Animal Ethics Permit		**31-Dec-25**	2022-28

Signature

Your name	Richard Little
Title	Chief Scientist
Signature	
Date:	8/11/2024

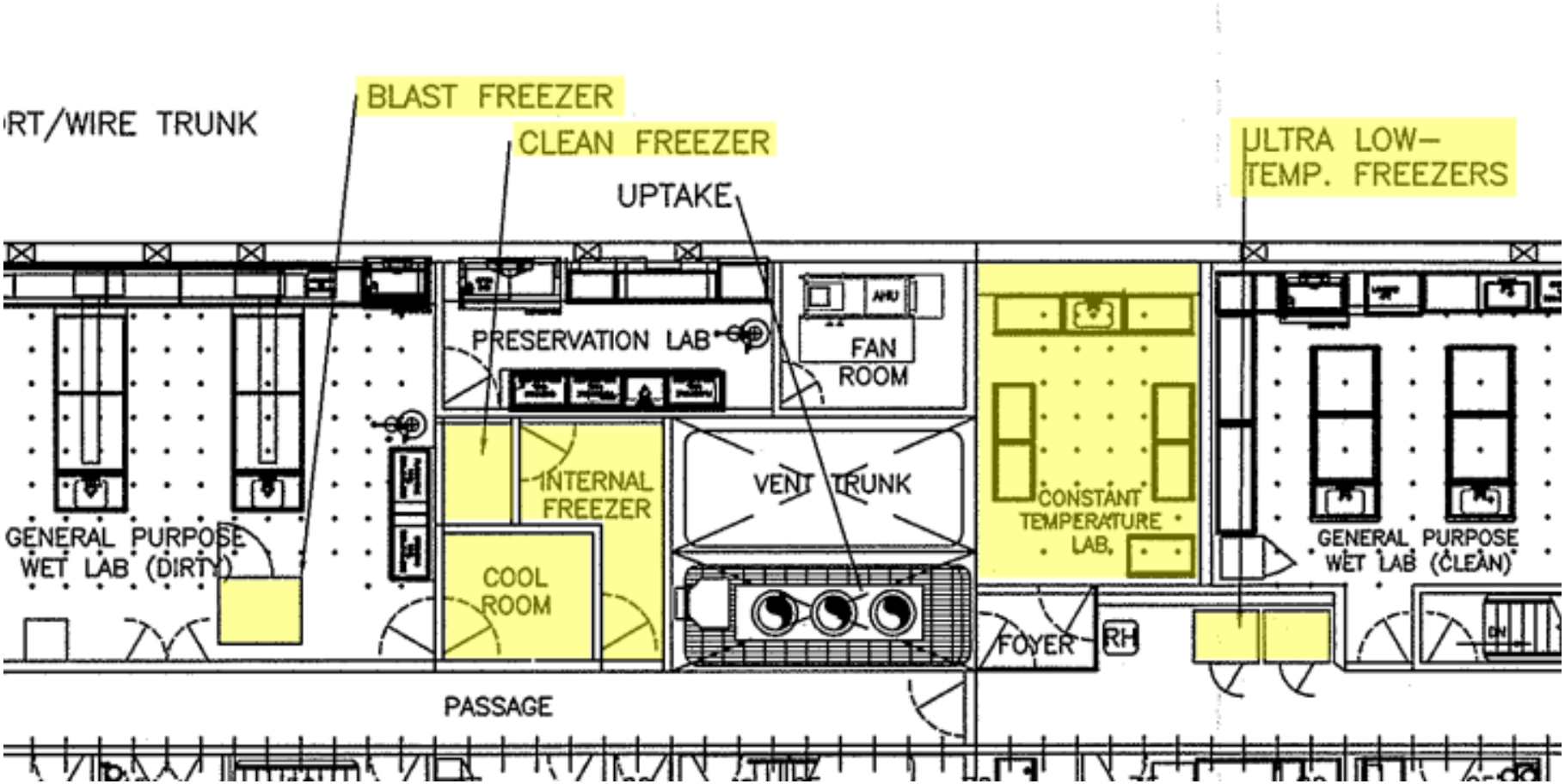
Appendix A

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.

STANDARD LABORATORIES AND FACILITIES		
NAME	**REQUIRED**	**NOTES/COMMENTS**
Aerosol Sampling Lab		
Air Chemistry Lab		
Preservation Lab	X	Sample photography
Constant Temperature Lab (Min temp: ~4°C / Max temp ~35°C)	X	Sample storage 4°C
Underway Seawater Analysis Laboratory		
GP Wet Lab (Dirty)	X	Fish measuring and dissecting
GP Wet Lab (Clean)	X	Pelagic trawl (Mammoth) analysis and sorting
GP Dry Lab (Clean)	X	
Sheltered Science Area	X	Fish sorting
Observation Deck 07 Level	X	
Internal Freezer (Dirty Wet lab) (Min temp -25°C / Max temp 0°C) Volume: >20m^3	X	-25 °C

STANDARD LABORATORIES AND FACILITIES		
NAME	**REQUIRED**	**NOTES/COMMENTS**
Clean Freezer (Dirty Wet lab) (Min temp -25^{o}C / Max temp 0^{o}C) Volume: >2.5m^{3}	X	-25 ^{o}C
Blast Freezer (Dirty Wet lab) (Min temp -30^{o}C / Max temp 0^{o}C) Internal volume >1.5m^{3} Capable of reducing the temperature of 150kg of water from +20C to -30C in one hour.	X	-30 ^{o}C
Cool Room (Dirty Wet lab) (Min temp 0^{o}C / Max temp 10^{o}C)	X	0 ^{o}C
Ultra-Low Temperature Freezers x2 (Main Deck) Min temp -80^{o}C / Max temp -80^{o}C)	X	-80 ^{o}C
YODA Freezers (x2) (Clean Dry lab) (Min temp -20^{o}C / Max temp 10^{o}C)	X	2 freezers set at 4C Storing filtered water from: 1. CTD 2. OCD



STANDARD SAMPLING EQUIPMENT			
NAME	**ESSENTIAL**	**DESIRABLE**	**NOTES/COMMENTS**
Continuous Plankton Recorder (CPR)			

SPECIALISED SAMPLING EQUIPMENT			
NAME	**ESSENTIAL**	**DESIRABLE**	**NOTES/COMMENTS (THESE ITEMS MAY REQUIRE ADDITIONAL MNF SUPPORT STAFF)**
Equipment to measure seawater sound velocity/CTD:			
XBT System			
Valeport Rapid SV			
Valeport Rapid CTD			
Valeport SVX2			
Deep Towed Camera	X		
Hydro-Bios MultiNet (Mammoth) (1m x 1m)	X		100-micron mesh and 500-micron mesh
Surface Net (1m x 1m)			
Bongo Net			
Beam Trawl			
MIDOC			
Pelagic Trawl System (net, doors)			
Demersal Trawl System (net, doors)	X		Headline camera to be attached
RMT-16 (Rectangular Midwater Trawl)			
Trawl Monitoring Instrumentation (ITI) (2,000m depth limit)			ITI will be onboard
Stern ramp	**EXPOSED**		

RESEARCH SUPPORT INFRASTRUCTURE			
NAME	**ESSENTIAL**	**DESIRABLE**	**NOTES/COMMENTS**
Saltwater Ice Machine (Dirty Wet lab)	X		
Radiosonde Receiver System			
Laboratory Incubators (Clean Dry lab)			
Deck Incubators			
Milli-Q System			
Sonardyne USBL System			

SCIENTIFIC / SAMPLE ANALYSIS SYSTEMS				
MICROSCOPES:				**NOTES/COMMENTS**
BRAND / MODEL	**TYPE**	**ESSENTIAL**	**DESIRABLE**	
Leica / M80	Dissecting	X		
Leica / M80	Dissecting	X		
Leica /MZ6	Dissecting			
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		

SCIENTIFIC / SAMPLE ANALYSIS SYSTEMS			
MICROSCOPES:			**NOTES/COMMENTS**
Light Duty Electronic Balance (3kg/1g resolution)	X		

Underway systems

ACOUSTIC UNDERWAY SYSTEMS			
NAME	**ESSENTIAL**	**DESIRABLE**	**NOTES/COMMENTS**
38kHz ADCP			
75kHz ADCP	X		
150kHz ADCP	X		
Multi Beam Echo Sounder EM124 12kHz (100m to full ocean depth)	X		
Multi Beam Echo Sounder EM712 40-100kHz (0-1000m approx.)	X		
Multi Beam Echo Sounder EM2040			
Sub-Bottom Profiler SBP129			
Scientific Narrowband Echo Sounders EK60 & EK80(6 bands, 18kHz-333kHz)	X		
Multibeam Scientific Echo Sounder ME70 (70-100 kHz)			
Omnidirectional Echo Sounder SH90			
Gravity Meter			

ATMOSPHERIC UNDERWAY SENSORS			
NAME	**ESSENTIAL**	**DESIRABLE**	**NOTES/COMMENTS**
Nephelometer			
Multi Angle Absorption Photometer (MAAP)			
Scanning Mobility Particle Sizer (SMPS)			
Radon Detector			
Ozone Detector			
Condensation Particle Counter (CPC)			
Picarro Spectrometer (analysis of CO_2/CH_4/H_2O)			
Aerodyne Spectrometer (analysis of N_2O/CO/H_2O)			
Cloud Condensation Nuclei (CCN)			
Polarimetric Weather Radar			
Filter Aerosol Sampling units (FAS) x 3			

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	X		
Raw seawater available on deck and in laboratories	X		

CTD Configuration

Note #1: On every departure a test CTD is to be undertaken, ideally 24 hours prior to the first planned CTD cast. 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. Please allow for this cast in your voyage's Time Estimates (approximately 1 hour).

Plan for the following maximum rate of analyses based on 2 Hydrochemists:

48 nutrients, 48 dissolved oxygen, 48 salinity analyses per 24 hours; OR

72 nutrient, 36 dissolved oxygen, 36 salinity analyses per 24 hours; OR

160 nutrient analyses (only) per 24 hours.

	PLEASE SELECT:
Fundamentals	
Which CTD rosette to be used for this voyage (24 or 36 Niskin bottles):	36
Likely total number of casts:	60
Likely maximum depth of deepest cast:	400m
Standard CTD Configuration - Instrumentation (maximum 6 auxiliary channels plus 2 x DO) 6000m	
1 x SBE9+ (CTD) 2 x SBE3P Temperature Sensors 2 x SBE4C Conductivity Sensors 2 x SBE5T pumps	Yes
2 x SBE43 Dissolved Oxygen Sensors	Yes
1 x Tritech PA200/500 Altimeter	Yes
1 x Biospherical QCP2300HP PAR Sensor	Yes
1 x Wetlabs C-Star 25cm Transmissometer	Yes
1 x Wetlabs ECO FLCDRTD Fluorometer – CDOM (370/460nm)	Yes
1 x Wetlabs ECO FLBBRTD Fluorometer – Chlorophyll-a & Backscatter (2 x channels - 470/695nm)	Yes
Alternative Instruments (Instruments highlighted in grey can be substituted from standard configuration)	
Seapoint Turbidity Meter – Nephelometer	
Chelsea Aquatracka III (430/685nm) Fluorometer – Chlorophyll-a	Yes
Seabird SUNA – Ultraviolet Nitrate Analyzer (**Serial Connection - 2000m**)	Yes
Standard LADCP Configuration – Instrumentation: 6000m	
1 x Teledyne 300 kHz LADCP (Slave - Up) 1 x Teledyne 150 kHz LADCP (Master - Down) 1 x 48V Deep Sea Battery	Yes

	PLEASE SELECT:
Alternative LADCP Configuration - Instrumentation: 6000m	
1 x Teledyne 300 kHz LADCP (Slave - Up) 1 x Teledyne 300 kHz LADCP (Master - Down) 1 x 48V Deep Sea Battery	No
Hydrochemistry Analyses	
Salinity	Yes
Dissolved Oxygen	Yes
Nutrients: Nitrate	Yes
Nutrients: Phosphate	Yes
Nutrients: Silicate	Yes
Nutrients: Nitrite	Yes
Nutrients: Ammonia	Yes

*FishSOOP sensors will be mounted on the rosette as per the approved Piggyback project defined