RV *Investigator* Voyage Plan

VOYAGE #:	**IN2021_T01**
Version Number:	2.2-FINAL
Voyage title:	**Transit: Brisbane to Darwin**
Mobilisation:	Brisbane, 0800 Wednesday, 9 June 2021
Medical Clearance Period:	Brisbane, Thursday, 10 June 2021 – Friday, 11 June 2021 *(all participants and crew remain onboard once tested)*
Depart:	Brisbane, 1300 Saturday, 12 June 2021
Return:	Darwin, 0900 Wednesday, 23 June 2021
Demobilisation:	Darwin, Wednesday, 23 June 2021
Chief Scientist:	Dr Viena Puigcorbé (supporting remotely from onshore)
Affiliation:	Edith Cowan University
Supplementary Project name:	**Microplastics in the food chain: impact on the microbial and planktonic organisms.**
Principle Investigator	Dr Sophie Leterme
Affiliation:	Flinders University
Piggyback Project name:	**Linking the Biological Carbon Pump flux to microbial colonisation of sinking particles in the Southern Ocean in the Coral Sea**
Principle Investigator	Dr Viena Puigcorbé
Affiliation:	Edith Cowan University

Piggyback Project name:	**Dinoflagellates & broader planktonic assemblage observation**
Principle Investigator	Dr. Matt Gordon
Affiliation:	Defence Science & Technology Group (DSTG)
Piggyback Project name:	**BGC-Argo Float Deployment**
Principle Investigator	Dr. Tom Trull
Affiliation:	CSIRO
Piggyback Project name:	**Cosmic Ray Measurements**
Principle Investigator	Dr. Grahame Rosolen
Affiliation:	CSIRO
Piggyback Project name:	**Carbon Sampling**
Principle Investigator	Craig Neill
Affiliation:	CSIRO
Piggyback Project name:	**Flow cytometric classification of the phytoplankton community across Australia's top end**
Principle Investigator	Dr. Allison McInnes
Affiliation:	QUT

Voyage objectives

The primary objective of voyage IN2021_T01 is movement of RV *Investigator* from Brisbane to Darwin in preparation for IN2021_V04. Up to 72 hours of the transit voyage have been allocated to conduct scientific operations which will consist of a minimum of 12hrs devoted to the Supplementary Project: *Microplastics in the food chain: impact on the microbial and planktonic organisms*. The remaining time can be available for multiple Piggyback Projects. Some opportunistic mapping has been prepared should we be ahead of schedule.

Supplementary projects

1. Microplastics in the food chain: impact on the microbial and planktonic organisms

Principal Investigator: Dr Sophie Leterme (remote)

Dr. George Cresswell (participant)

Woody Drummond (participant)

Scientific and Voyage Objectives

Microplastics consist of pieces of plastic smaller than 5 mm, such as the microbeads found in domestic and personal care products. Plastic pollution of oceanic ecosystems can be observed anywhere on the planet, but microplastics create a global biological and chemical hazard due to their propensity to be ingested by marine life that is later consumed by humans. Small plastics can also adhere onto the surface of micro-organisms that are preyed upon by higher levels of the oceanic food chain such as fish. The aims of the project are:

i. assess the amount of plastics (micro through to pico in size) present in blue waters around Australia
ii. identify their impact on microorganisms at the base of the oceanic food chain.

12 hours of ship time have been allocated for the microplastics project. CTD deployments will be undertaken whilst ship is at rest with Hydra-Bios net deployments to be undertaken once CTD operations have been complete at each site.

At least three stations will be selected aiming for the regions of East of GBR and NT.

PRIMARY SAMPLING

Each primary sampling period will take about 3.5 hours (1.5 hour for the Hydra bios net tow (2 nets activated at 3 depths) at a speed of 2 knots, and 2 hours for the CTD deployment/recovery). The CTD to 1000m is shared with the Biological Carbon Pump (Puigcorbé /Bernasconi) project.

1. CTD will inform of the depth of the Deep Chlorophyll Maximum (DCM)
2. 3 Niskin bottles will be triggered at 3 depths, including: subsurface (S), DCM and 20 m above the bottom (B-20) (or at the maximum depth the Niskin bottles can be triggered).

3. Hydra Bios net tows (100µm) will be undertaken at each CTD station along the route of the ship (if possible). Two nets will be triggered at the surface, at the DCM and 20 m above the bottom (or at the maximum depth the net can be triggered).

12L of water from the Niskin bottles will be collected and passed through a 20 µm sieve. Microplastics collected on the sieve will be transferred into glass vials using metallic tweezers and kept at room temperature until analysis back in the laboratory at Flinders University.

After each net tow, the contents of the cod ends will be washed into plastic containers, at each depth, one of the samples will be kept in the fridge and the other will be preserved with ethanol within 15 min of the end of the tow.

SECONDARY SAMPLING

If possible, samples will also be collected at night, taking advantage of the CTD casts for other projects. Samples will be collected from Niskin bottles triggered at 5, 25, 80, 120, 200, 300, 400 and 500m to fit the 500m-CTD cast. 12L of water from the Niskin bottles will be collected and passed through a 20 µm sieve. Microplastics collected on the sieve will be transferred into glass vials using metallic tweezers and kept at room temperature until analysis back in the laboratory at Flinders University.

These samples will be used to:

1. Count the microplastics present in the samples under a fluorescent microscope.
2. Enumerate and identify zooplankton organisms
3. Assess if microplastics are attached to zooplankton organisms under SEM.
4. Collate the data into our data set that will be used to develop an oceanographic model of microplastic distribution and movement in Australian waters.

Sample Summary:

Section	Niskin bottles	Hydra-Bios nets
PRIMARY	3 Niskin bottles triggered at 3 depths (S, DCM, B-20)	3 nets in total; 2 nets triggered at 3 depths (S, DCM, B-20)
SECONDARY	8 Niskin bottles; 1 Niskin bottle triggered at 8 depths (5, 25, 80, 120, 200, 300, 400 and 500m)	

Piggyback projects

1. Linking the Biological Carbon Pump flux to microbial colonisation of sinking particles in the Coral Sea

Dr Viena Puigcorbé (ECU) (remote)

Dr Rachele Bernasconi (participant)

Scientific and voyage objectives

This is a proposal to conduct preliminary research as a Piggyback project during the **IN2021-T01** voyage to support the Supplementary Project "*Linking the Biological Carbon Pump flux to microbial colonisation of sinking particles in the Coral Sea*" that was granted to join IN2019-V04 but that could not take place due to COVID restrictions.

We want to conduct the research in the Coral Sea because the oligotrophic areas of the ocean, as the Coral Sea, are expected to expand with the prediction of a future warmer ocean. Yet, these oceanic regions have been disregarded when referring to carbon export estimates. Recent research has shown that subtropical regions with picoplankton-dominant food webs are characterized by enhanced export efficiencies. Our knowledge on the role played by the microbial communities in the attenuation of the carbon export flux is in its infancy.

The advances in molecular techniques have allowed to increase dramatically the available data on microbial diversity and have made possible to answer ecological questions that refer to biogeography and community assembly, but have not yet been extensively applied to biogeochemical relevant questions involving the biological carbon pump (export of particulate organic carbon from the surface waters to the ocean's interior). With this initial project we aim to gather data to deepen our understanding on the carbon export and the impact of the microbial community in the carbon export efficiency in oligotrophic waters.

This project has two main goals:

1- ***Quantify carbon export*** by using a robust and extensively applied method based on the naturally occurring radioisotope pair 234Th: 238U. We will quantify carbon export fluxes and provide a comprehensive interpretation of the export fluxes by characterising the nature (i.e., organic carbon vs. biogenic silica content) of the settling particles. We will analyse size-fractionated particulate samples collected with *in situ* pumps at several depths along the water column (from 50 to 1,000 m) to evaluate the roles of the different particle sizes on the overall export flux.

2- ***Characterise the microbial communities*** using high-throughput genomics tools. These techniques generate a detailed view of community composition, including both the dominant organisms and those in low abundances. This allows following the origin of each microbial organism colonizing particles in the ocean and to trace them back to their depth of colonisation. In addition to the prokaryotes (16SrDNA and 16SrRNA), we will also look at the protists in the particles through use of 18S rDNA sequencing, to elucidate if the particles are biogenic (i.e. algae, zooplankton faecal pellets), and which protists colonise the particles and feed on the attached bacteria.

Sampling strategy

A modified sampling strategy is presented after a reduction in personal able to join RV *Investigator* due to COVID. A total of 4 CTD deployed to 1000m and 4 CTD deployed to 200m (in lieu of having the experience to use the In-Situ-Pumps) would be the aim to provide a good coverage of the area for our purposes. The stations would be located along the voyage track targeting areas off the shelf (and its slope) with a water

column deeper than 1,000 m. Accounting 3-4hr for CTD deployments, the estimated requested time would 12-16hr over the entire voyage, which would be shared with other participants.

1000m CTD requests:
- 234Th samples: 20-24 depths along the upper 1000 m. 5L needed
- Microbial community: 10 L seawater samples will be collected at the same depths where the in-situ pumps will be deployed in the upper 1000 m.

200m CTD requests:
-144L from depths between 50 and 200 m. The goal is to obtain the particulate fraction, which will be size fractionated using different filters. From the different particle sizes, radionuclide analyses will be done, together with CHN analyses, and DNA sequencing using high-throughput genomics tools. The filters can be subsampled, and other groups could benefit from this sampling.

Lab requirements

- Isotope Lab for spiking samples.
- Small space in GP dry lab to utilise Drying Oven

2. Flow cytometric classification of the phytoplankton community across Australia's top end

Dr Allison McInnes (QUT) (remote)

Project Details

Phytoplankton are a diverse group of autotrophic organisms that range in size, shape, activity, and role in marine ecosystems. Understanding the composition of the phytoplankton community offers insight into the functioning of these systems. Phytoplankton Class can be determined by pigment composition. Analysis of which offers compositional understanding of these important ecosystem engineers; hence much development has been done in analysis of pigments. Current methods require large volumes of water and are amalgamations of the total community pigments. The proposed research will utilise the spectral signature capability of the Cytek Aurora to classify phytoplankton using their pigment composition at the single cell level using small volumes.

Due to COVID-19 participant restrictions, the Cytek Aurora is not able to be installed onboard and a modified sampling program has been included to try and facilitate this work, with samples collected to be freighted back to Brisbane upon arrival in Darwin.

Objectives

Classify phytoplankton community composition, to the strain level (for Prochlorococcus and synechococcus), across Australia's top end on a highly spatially resolved transect using the underway system, to investigate phototroph diversity within the Coral Sea and Arafura Sea.

Correlate community composition with physical and chemical oceanographic measurements.

Sampling Strategy

Samples will be collected at set time/distance intervals from the underway tap. These samples will be preserved and frozen to run on the Cytek Aurora located in Brisbane.

Lab requirements

- Underway seawater lab: small bench space for sample collection and processing.
- Access to the -20 °C freezer for storage of temperature sensitive reagents (half of one shelf).
- Access to refrigerator for storage of temperature sensitive reagents (half of one shelf).

3. Dinoflagellates & broader planktonic assemblage observation

Dr Matt Gordon (DSTG) (remote)

Project outline

Dinoflagellates are a ubiquitous and ecologically important component of marine phytoplankton communities, with particularly notable species including those associated with harmful algal blooms (HABs) and those that bioluminesce. High-throughput sequencing offers a novel approach compared to traditional microscopy for determining species assemblages and distributions of dinoflagellates, which are poorly known especially in Australian waters.

The major aims for data collection activities during this voyage are:

1. collect water samples at night for taxonomic and molecular identification of dinoflagellate species;
2. record and compare environmental and physical characteristics (water quality parameters, sea state, wind, moonlight) against observed species composition / abundance; and
3. record and compare environmental and physical characteristics (water quality parameters, sea state, wind, moonlight) against observed bioluminescence activity.

Due to COVID-19 participant restrictions, a field kit with instructions has been provided to facilitate this sampling – which is proposed to be conducted by the participating ITSS student.

Sampling protocols

The main consideration of our research requirements is that our samples are to be taken during the night, no earlier than 2 hours after sunset and no later than 2 hours before sunrise.

Water collection - CTD request

- 4 L of water is requested from each discrete depth
- Night-time samples @ 5, 25, 50, 100, 150 m
- Preferable parameters to be recorded: Temperature, salinity, chlorophyll, conductivity, DO, pH, and turbidity

A 1 L water sample for each depth listed above is to be preserved in Lugols solution and stored @ ~4°C.

A further 2 L is to be processed through 1.2 µ self-preserving eDNA filters.

The final 2 L of water is to be processed through 0.45 µ filters using a vacuum pump filter system.

The UBAT (Underwater Bioluminescent Assessment Tool) that the MNF has an integration solution for, will be deployed on the 200m CTD and allowed to run for 2 minutes at each depth.

Lab Requirements

- Wet lab: 1 out of the 3 available to allow filtering of water samples. Access to a sink would be required.

4. BGC-Argo Floats

Dr Tom Trull (CSIRO) (remote)

Project Details

Biogeochemical-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. 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 Australia-India Strategic Research Fund (AISRF) Indian Ocean Bio-Argo project and the IMOS Argo-Australia facility.

We will use this transit to deploy 1 float in the Coral Sea, with a supporting CTD cast to 2,250m depth. Deployment of the BGC-Argo float will be done in waters deeper than 2000 and preferably deeper than 2500m, following the Safe Working Instruction and associated procedures via the A-frame or Crane.

The CTD cast provides sensor comparisons between the CTD and the float, and for this reason we would like the following 3 sensors to be mounted on the CTD:

1. User supplied Wetlabs FLBB sensor
2. MNF supplied Wetlabs CStar transmissometer
3. MNF supplied PAR sensor

The cat also allows collection of samples for calibration and improved interpretation of the float sensor records, as follows.

1. Water samples to be analysed by Hydrochemistry for salinity, oxygen, and nutrients (for comparison to the float salinity, oxygen, and nitrate sensors)
2. Water samples to be collected for analysis onshore for dissolved inorganic carbon (DIC) and alkalinity (this pair allows pH to be calculated for comparison to the float sensor)
3. Filtered particle samples for analysis onshore for plant pigments (for comparison to the Chlorophyll fluorescence sensor) and particulate organic carbon (POC, for comparison to the BB optical backscatter sensors).

Typically, we sample as follows, but with the depths adjusted to local oceanographic features such as minima and maxima in T, S, O2, etc. The deepest sample is taken at 2000m depth, but the cast is taken to 2250m depth to provide sensor data below the deepest sample.

5. Cosmic ray measurements

Dr Grahame Rosolen, CSIRO

Objectives

The objective of the project is to collect cosmic ray data at variable locations and look for correlations with space weather events and cosmic ray measurements with a similar detector located in Sydney. The wide range of latitudes covered by the voyage is particularly useful for this research. The acquisition of cosmic ray data at a range of latitudes has many benefits. Cosmic ray flux data provides a method of sampling the upper atmosphere as the flux of cosmic rays reaching the ocean surface is a function of the density and composition of the intervening atmosphere as well as space weather events. The data gathered can be used to investigate the susceptibility of sensitive electronic systems to cosmic radiation. The results of the analysis provide useful information for designing robust electronic systems for critical applications.

Project Details

The proposed work is to collect cosmic ray measurement data throughout the voyage. The cosmic ray detector provides a time stamped record of cosmic ray detections and these can be correlated with ship positional data to investigate the variation in cosmic ray flux with latitude and longitude. It will also be possible to compare this data with a log taken over a similar period at a land based cosmic ray detector in Sydney.

The purpose of this project is two-fold. The first objective is to acquire cosmic ray data at a range of latitudes as there is a dependence on cosmic ray flux with latitude. A ship is an ideal platform for measuring ground level cosmic ray flux as the ship is akin to a floating ground station. The ship can transit through continuous latitude steps so there are no gaps in the data and the ship moves sufficiently slowly to enable statistically meaningful cosmic ray measurements to be made. The second objective is to determine the attenuation properties and effect of the ship deck and Aerosol lab insulating material on the cosmic ray detections.

The proposal involves taking several CSIRO designed and built cosmic ray detectors on board. One is to be installed in the Aerosol lab, as before, and runs continuously from mains power. The detector element is mounted above the cable tray to minimise the effect of intervening material which can alter the energy of the incident cosmic rays. Rack space and mounting shelves have been retained in the Aerosol lab for future reinstallation of the cosmic ray detectors. Another detector is to be installed in the cabin and run continuously from mains power. The detector element is to be positioned adjacent to a porthole to minimise the amount of intervening material between the detector element and the sky. A portable detector which operates from batteries and so runs for defined periods may be deployed at various locations on the ship. These deployment locations and timing depends on the weather conditions during the voyage, the ability to access as much of the sky as possible and the need to operate from a battery power source. The data collected from the portable detectors can be compared with the data measured from the detectors operating in the Aerosol lab and in the cabin to determine the effects of the intervening material on the detection of cosmic rays. Some of the locations identified for conducting the experiments with the portable cosmic ray detector are listed below. On the Main level the sheltered science area, deck container area and deck starboard area. On Level 2 the bow area above the Aerosol lab and behind the container area. On Level 3 the stern area. On Level 4 the areas of the deck that have open access to the sky. On Level 5 the deck bow. On Level 7 Whale watching area and the open areas near the mast assembly and uptake. Some of the labs that may be suitable include the data processing lab and electronics workshop and the general-purpose dry lab.

Equipment

The cosmic ray measuring equipment consists of three pieces which are the detector electronics, the power supply and detector head. All three components are housed in metal boxes and these boxes are attached to the base plate of a standard 19" rack. The rack mounted system is 485 mm wide by 385 mm deep and 90 mm high. The total system weighs about 7 kg. It is proposed to use both fixed and portable cosmic ray detectors on the voyage. The fixed detectors are placed in both the Aerosol lab and cabin and run continuously. The portable detector operates temporarily and may be placed at various locations on the ship.

6. Carbon Sampling

Craig Neill, CSIRO (remote)

Objectives

The objective of the project to acquire surface sea water samples for dissolved inorganic carbon (DIC) and total alkalinity (TA) through the Coral Sea between Brisbane and Cape York. The samples will be used as an inter-comparison with a sampling program for another vessel, the Japanese car carrier Trans Future 5, that is run by O&A.

Project Details

The proposed work is to collect DIC and TA samples from the ship's underway sea water line every 6 hours from offshore of Brisbane to the continental shelf approaching Cape York. 250 ml glass bottles will be filled from the sampling tap in the underway sea water lab according to instructions provided by the Ocean Carbon Observations team. The samples will be preserved with mercuric chloride, which will be provided by the carbon team together with appropriate training and SWI. Samples will be sent by air freight from Darwin together with the BGC Argo samples.

Equipment

The only equipment required are the sample bottles, mercuric chloride, an auto-pipette, and PPE (gloves, lab coat, glasses), all of which will be provided.

Opportunistic Mapping

The MNF has notified Parks Australia of our track and timing and they have collaborated with the GSM team to identify a mapping area in the West Cape York Marine Park. This is purely in the case of being ahead of schedule and having to fill time after exiting the Torres Strait.
The execution of this mapping will be reviewed onboard after the first half of the voyage and a better idea of time available is possible.

Voyage Risk Assessment (VRA)

This voyage has undergone a comprehensive risk assessment process. The full VRA is available as a separate document.

Media & Outreach 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.

Indigenous Time at Sea Scholarship – ITSS

CSIRO and the Marine National Facility (MNF) are striving to increase access to STEM (science, technology, engineering, and mathematics) opportunities for Aboriginal and Torres Strait Islander students.

ITSS offers Aboriginal and Torres Strait Islander university students a unique opportunity to gain experience on a world-class marine research vessel, supporting Australia's atmospheric, oceanographic, biological and geoscience research from the tropics to the Antarctic ice-edge. ITSS brings students on board RV Investigator to work alongside scientists and technicians to assist with research and gain valuable at-sea research experience. ITSS will support one student on this voyage.

Voyage track

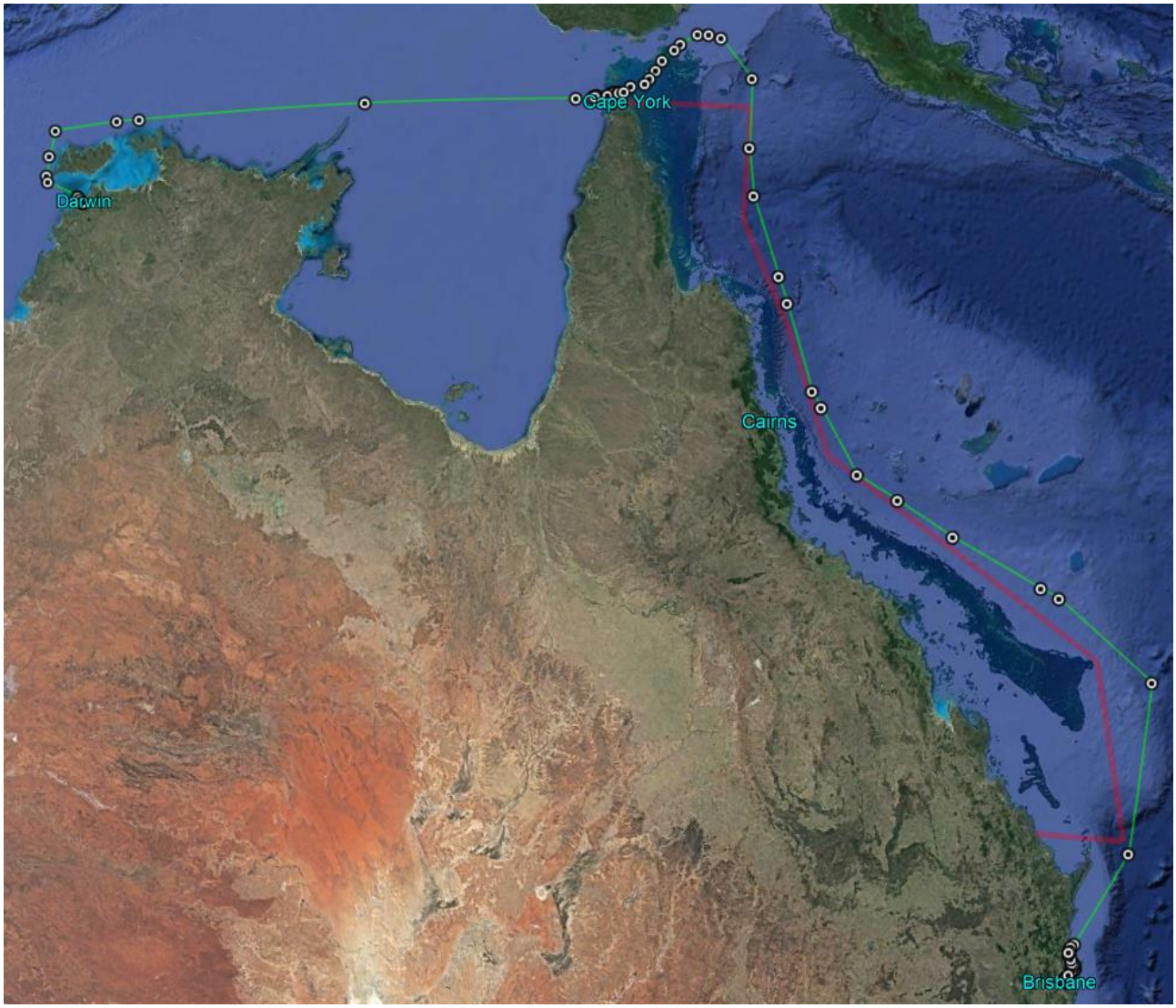

Figure 1: Proposed voyage track (Green), with GBRMP boundary highlighted (Red)

CTD Configuration

	PLEASE SELECT:
Fundamentals:	
Which CTD rosette to be used for this voyage (24 or 36 Niskin bottles):	36
Likely total number of casts:	12
Likely maximum depth of deepest cast:	2,250m
Lowered ADCP required:	yes
Instrumentation (maximum 6 auxiliary channels in addition to 2x DO):	
2x pumped Temperature, Conductivity, Dissolved Oxygen circuits:	(Standard)
Altimeter (required if operating anywhere near the sea floor):	Yes
PAR Sensor (Biospherical QCP-2300):	Yes
Transmissometer (Wetlabs C-Star 25cm):	Yes, BGC-Argo
Fluorometer – Chlorophyll-a (Chelsea Aquatracka III – 430/685nm):	Yes
Fluorometer – CDOM (Wetlabs FLCDOM – 370/460nm)	Yes
Nephelometer (Seapoint Turbidity Meter)	Yes
ECO-Triplet (Chlorophyll-a, CDOM & backscatter – maximum depth 2000m)	Yes, BGC-Argo Or user-supplied Wetlabs FlBb
Hydrochemistry Analyses:	
Salinity	103

	PLEASE SELECT:
Dissolved Oxygen	103
Nutrients: Nitrate	103
Nutrients: Phosphate	103
Nutrients: Silicate	103
Nutrients: Nitrite	103
Nutrients: Ammonia	103

**UBAT instrument to be fitted to frame for night-time casts

Permits

- GBRMPA Permit Number G19/41954.2 (5 February 2020 to 20 September 2024; MNF blanket permit for GBR Marine Park) (NOTE: track not currently entering GBRMPA)
- Parks Australia Permit Number PA2020-00041-5 (24 June 2020 to 20 August 2023; MNF blanket permit for Coral Sea Marine Park)
- Parks Australia Permit Number PA2020-00041-4 (24 June 2020 to 20 August 2023; MNF blanket permit for the North Network of Marine Parks)

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	x	Cosmic ray detector installed in existing rack allocation.
Air Chemistry Lab		
Preservation Lab		
Constant Temperature Lab (Min temp: 2^{o}C / Max temp 35^{o}C)		
Underway Seawater Analysis Laboratory	x	Sample collection and filtration for two piggyback projects.
GP Wet Lab (Dirty)	x	
GP Wet Lab (Clean)	x	Sample filtration for all molecular analyses, HPLC, POC etc. All projects requiring access to sinks and power boards for filtration. Ideally 1 full bench per team.

STANDARD LABORATORIES AND FACILITIES		
NAME	**REQUIRED**	**NOTES/COMMENTS**
GP Dry Lab (Clean)	x	Location and operation of the spectral flow cytometer and portable dry oven for two piggyback projects.
Sheltered Science Area		
Observation Deck 07 Level		
Internal Freezer (Dirty Wet lab) (Min temp -25^{o}C / Max temp 0^{o}C) Volume: >20m^{3}		
Clean Freezer (Dirty Wet lab) (Min temp -25^{o}C / Max temp 0^{o}C) Volume: >2.5m^{3} Co-located within the Internal freezer and separated by a door		
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.		
Cool Room (Dirty Wet lab) (Min temp 0^{o}C / Max temp 10^{o}C)		
Ultra-Low Temperature Freezers x2 (Main Deck) Min temp -80^{o}C / Max temp -80^{o}C)	x	BGC-Argo preservation of HPLC and POC samples (total volume ~ 1 Litre) Sample preservation for DNA analyses (1 cryovial rack ~25x25x5 cm) Storage and preservation of all molecular samples, HPLC, POC,
YODA Freezers (x2) (Clean Dry lab) (Min temp -20^{o}C / Max temp 10^{o}C)	x	1 freezer set to –20 ^{o}C for the storage of samples for the spectral flow cytometer.

MOBILE LABORATORY AND FACILITIES *(MAY REQUIRE ADDITIONAL SUPPORT)*			
NAME	**ESSENTIAL**	**DESIRABLE**	**NOTES/COMMENTS**
Modular Isotope Laboratory	x		R. Bernasconi using this 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			
Stabilised Platform Container			
Clothing Container			

STANDARD SAMPLING EQUIPMENT			
NAME	**ESSENTIAL**	**DESIRABLE**	**NOTES/COMMENTS**
CTD - Seabird 911 with 36 Bottle Rosette	x		The 36-bottle rosette is requested to accommodate a streamlined sampling program across the different projects.
CTD - Seabird 911 with 24 Bottle Rosette			
Lowered ADCP			
Continuous Plankton Recorder (CPR)			

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:		x	UBAT sensor for CTD – Matt Gordon has worked with SIT to have this integrated
Piston Coring System			
Gravity Coring System			
Multi Corer			
Kasten Corer			
Smith Mac Grab			
Rock Dredges			
Rock Saw			
Seaspy Magnetometer			
Portable Pot Hauler			
Equipment to measure seawater sound velocity/CTD:			
XBT System			
Valeport Rapid SV			
Valeport Rapid CTD			
Valeport SVX2			
Trace Metal Rosette and Bottles			

SPECIALISED SAMPLING EQUIPMENT			
NAME	**ESSENTIAL**	**DESIRABLE**	**NOTES/COMMENTS (THESE ITEMS MAY REQUIRE ADDITIONAL MNF SUPPORT STAFF)**
Trace Metal In-situ Pumps (x6)			
Deep Towed Camera			
Drop Camera			
Sherman Epibenthic Sled			
Brenke Sled			
EZ Net (Multiple net system, 1m x 1m)			
Hydro-Bios MultiNet (1m x 1m)	X		100-micron, 335-micron
Surface Net (1m x 1m)			
Bongo Net 485mm diameter			
Beam Trawl			
MIDOC			
Pelagic Trawl System (net, doors)			
Demersal Trawl System (net, doors)			
RMT-8 (Rectangular Midwater Trawl) Utilises a single warp so can be deployed on the general-purpose towing wire in self-contained mode. Must be deployed with stern ramp covered.			
RMT-16 (Rectangular Midwater Trawl) Utilises a single warp so can be deployed on the general-purpose towing wire in self-			

SPECIALISED SAMPLING EQUIPMENT			
NAME	**ESSENTIAL**	**DESIRABLE**	**NOTES/COMMENTS (THESE ITEMS MAY REQUIRE ADDITIONAL MNF SUPPORT STAFF)**
contained mode. Must be deployed with stern ramp covered.			
Trawl Monitoring Instrumentation (ITI) (2,000m depth limit)			
Stern ramp	**INSTALLED**		

RESEARCH SUPPORT INFRASTRUCTURE			
NAME	**ESSENTIAL**	**DESIRABLE**	**NOTES/COMMENTS**
Salt Water Ice Machine (Dirty Wet lab)			
Radiosonde Receiver System			
Laboratory Incubators (Clean Dry lab)			
Deck Incubators			
Milli-Q System	x		Cleaning of filtration equipment, bottles, tubing etc, required for all projects.
Sonardyne USBL System			

SCIENTIFIC / SAMPLE ANALYSIS SYSTEMS				
MICROSCOPES:				**NOTES/COMMENTS**
BRAND / MODEL	**TYPE**	**ESSENTIAL**	**DESIRABLE**	Refer to the “MNF microscopes procedure” for more information
Leica / M80	Dissecting			
Leica / M80	Dissecting			
Leica /MZ6	Dissecting			

SCIENTIFIC / SAMPLE ANALYSIS SYSTEMS				
MICROSCOPES:				**NOTES/COMMENTS**
Olympus / CH	Compound			
Olympus /CH	Compound			
Leica / MTU282	Camera tube			
Adapters for tube / Nikon	Pentax			
Ring Light *2 / MEB121	LED			
Heavy Duty Electronic Balance (80kg)				
Medium Duty Electronic Balance (15kg/5g resolution)				
Light Duty Electronic Balance (3kg/1g resolution)				

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)			
Multi Beam Echo Sounder EM710 70-100kHz (0-1000m approx.)			
Sub-Bottom Profiler SBP120			

ACOUSTIC UNDERWAY SYSTEMS			
NAME	**ESSENTIAL**	**DESIRABLE**	**NOTES/COMMENTS**
Scientific Narrowband Echo Sounders EK60 (6 bands, 18kHz-333kHz)			
Scientific Narrowband/Broadband Echo Sounders EK80 (6 bands, 18kHz-333kHz)			
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)			

ATMOSPHERIC UNDERWAY SENSORS			
NAME	**ESSENTIAL**	**DESIRABLE**	**NOTES/COMMENTS**
Polarimetric Weather Radar			

UNDERWAY SEAWATER SYSTEMS AND INSTRUMENTATION			
NAME	**ESSENTIAL**	**DESIRABLE**	**NOTES/COMMENTS**
Thermosalinograph	x		BGC-Argo sensor comparison and piggyback projects requiring underway sampling.
Fluorometer	x		BGC-Argo sensor comparison and piggyback projects requiring underway sampling.
Optode	x		BGC-Argo sensor comparison and piggyback projects requiring underway sampling.
pCO2	x		BGC-Argo sensor comparison and piggyback projects requiring underway sampling.

SEAWATER SYSTEMS			
NAME	**ESSENTIAL**	**DESIRABLE**	**NOTES/COMMENTS**
Trace metal clean seawater supply	x		Underway sampling for two piggyback projects.
Scientific clean seawater supplied to laboratories			
Raw seawater available on deck and in laboratories			

Appendix B: User Supplied Equipment

NOTE: User supplied equipment will remain the responsibility of the science party throughout the voyage. The MNF technicians and ship's crew endeavour to assist wherever possible, however the MNF take no responsibility for the pre-deployment checks or repairs and maintenance of this equipment

Owner	Item name	Weight	Dimensions	Location on Vessel
Grahame Rosolen	Cosmic ray detector	7 kg per detector	438 mm * 375 mm * 90 mm	Aerosol Lab 24/7
Grahame Rosolen	Cosmic ray detector	7 kg per detector	438 mm * 375 mm * 90 mm + small detector element	In cabin 24/7
Grahame Rosolen	portable cosmic ray detectors	7 kg per detector	330 mm * 200 mm * 200 mm + small detector element	Various locations on the ship temporarily
Tom Trull	BGC-Argo Float	71 kg	180cm tall 30cm cylinder	stored upright in low traffic area near trawl deck
Tom Trull	3x in-line filtration rigs	10kg	each 30x30x30cm	CTD room
Tom Trull	filtration consumables	2kg	30x20x60 crate	CTD room
Tom Trull	Wetlabs FlBB sensor	1kg	20cmlongx10cm cylinder	CTD room
Tom Trull	Quick releases and lanyards for float deployment	2kg	30x30x20cm	Supplied to Bosun
Viena Puigcorbé	BOX UAB 1	45 kg	60x80x40 cm	GP wet lab - clean
Viena Puigcorbé	BOX 6 ECU	65 kg	60x80x40 cm	GP wet lab - clean
Viena Puigcorbé	BOX 3 ECU	35 kg	85x61x45 cm	GP wet lab - clean
Viena Puigcorbé	BOX 2 ECU	30 kg	85x61x45 cm	GP wet lab - clean
Viena Puigcorbé	BOX 1 ECU	30 kg	77x58x57 cm	GP wet lab - clean
Viena Puigcorbé	Bunnings box	20 kg	40x40x55 cm	GP wet lab - clean
Woody Drummond	Vacuum pump	5.3 kg	17x19x22 (cm)	GP wet lab - clean

Appendix C: Hazardous Materials Manifest

Responsible Person	Hazardous Material Name	Hazardous Material UN Number	Poison Schedule Number	Permit held for Hazardous Material	State or Territory in which Permit is held	Class	2nd Class	Concentration	Quantity: Total	Quantity: Units	Container Size	Location of Use	Location of Storage
Tom Trulll	Ethanol, absolute	1170	S1	N/A		Class 3 - Flammable Liquid		100%	200	mL	100	Underway Seawater Laboratory	Underway Seawater Laboratory
Grahame Rosolen	LiPo Batteries								10			Aerosol Laboratory	
Grahame Rosolen	Cadmium	2570	N/A	N/A		Other - specify in notes			70	gm	inside metal box	Aerosol Laboratory	Aerosol Laboratory
Viena Puigcorbé	Nitric Acid	2031	S6	N/A		Class 8 - Corrosives	Class 5.1 - Oxidising Agents	70%	5	L	2.5L (glass)	CTD laboratory	Preservation Laboratory
Viena Puigcorbé	Hydrocloric Acid	1789	S6	N/A		Class 8 - Corrosives		36%	2.5	L	2.5L (glass)	CTD laboratory	GP Wet Laboratory - Clean
Viena Puigcorbé	Ammonia Solution	2672	S6	N/A		Class 8 - Corrosives		28-30%	5	L	2.5L (glass)	CTD laboratory	GP Wet Laboratory - Clean
Viena Puigcorbé	Thorium Tracer in nitric acid	2031				Class 8 - Corrosives		5M	60	mL	100 mL plastic bottles	Radiation Laboratory	Radiation Laboratory
Tom Trull	mercuric chloride solution, saturated	2024	S7	Yes	TAS	Class 6 - Toxic		7.40%	120	mL	2x 60 mL plastic bottles	Underway Seawater Lab	Underway Seawater Lab
Woody Drummond	Ethanol, absolute	1170	S1	N/A		Class 3 - Flammable Liquid		100%	3	L		GP Wet Laboratory - Dirty	GP Wet Laboratory - Dirty

Appendix D: CTD / Water Budget

STATIONS 1-3 (1000 m CTD – Sophie and Viena's projects)

Team		HYDROCHEM			RACHELE/VIENA		SOPHIE	
		O_2	salinity	nutrients	Th-234	Bacteria		
	vol (L)	0.5	0.5	0.5	5	10-20	~36	
Depth	**Bottle**							**vol (L)**
1000	**1**					10		10.0
1000	**2**	0.5	0.5	0.5	5			6.5
700	**3**					10		10.0
700	**4**	0.5	0.5	0.5	5			6.5
500	**5**					10		10.0
500	**6**	0.5	0.5	0.5	5			6.5
400	**7**	0.5	0.5	0.5			10	11.5
400	**8**						12	12.0
400	**9**						12	12.0
300	**10**					10		10.0
300	**11**	0.5	0.5	0.5	5			6.5
300	**12**						12	12.0
300	**13**						12	12.0
300	**14**						12	12.0
200	**15**	0.5	0.5	0.5	5			6.5
150	**16**					10		10.0
150	**17**	0.5	0.5	0.5	5			11.5
120	**18**	0.5	0.5	0.5	5			6.5
120	**19**						12	12.0
120	**20**						12	12.0
120	**21**						12	12.0
100	**22**	0.5	0.5	0.5	5			11.5
80	**23**	0.5	0.5	0.5	5			6.5
80	**24**						12	12.0
80	**25**						12	12.0
80	**26**						12	12.0
70	**27**	0.5	0.5	0.5	5			6.5
50	**28**					10		10.0
50	**29**	0.5	0.5	0.5	5			11.5
25	**30**	0.5	0.5	0.5	5		5	11.5
25	**31**						12	12.0
25	**32**						12	12.0
5	**33**	0.5	0.5	0.5	5			6.5
5	**34**						12	12.0
5	**35**						12	12.0
5	**36**						12	12.0
Sample count		14	14	14	13	6	18	

ALL STATIONS (200 m CTD – SUBSTITUTE OF ISP)

ADD UBAT AND SAMPLE FOR MATT IF THE CTD IS 2h AFTER SUNSET OR BEFORE SUNRISE

Team		RACHELE/VIENA	MATT
		POC	ZOOPLANKTON (ONLY IF CTD IS AT NIGHT)
	vol (L)	144	2+1 (+cleaning)
Depth	**Bottle**		
200	**1**	12	
200	**2**	12	
200	**3**	12	
200	**4**	12	
200	**5**	12	
200	**6**	12	
150	**7**		4
150	**8**	12	
150	**8**	12	
150	**9**	12	
150	**9**	12	
150	**10**	12	
120	**11**	12	
120	**12**	12	
120	**13**	12	
120	**14**	12	
120	**15**	12	
100	**16**		4
100	**17**	12	
100	**20**	12	
100	**21**	12	
100	**22**	12	
100	**23**	12	
80	**24**	12	
80	**25**	12	
80	**26**	12	
80	**27**	12	
80	**28**	12	
50 (DCM)	**29**	12	
50 (DCM)	**30**	12	
50 (DCM)	**31**	12	
50 (DCM)	**32**	12	
50 (DCM)	**33**	12	
50 (DCM)	**34**		4
25	**35**		4
5	**36**		4

STATION 4: 2250 m CTD-ARGO FLOAT

Team		HYDROCHEM					RACHELE for ARGO		RACHELE/VIENA		
		O_2	DIC	ALK	salinity	Nut	*HPLC (ARGO)*	POC (ARGO)	Th-234	Bacteria	
	vol (L)	0.5	0.75	0.75	0.5	0.5	4	2	5	10-20	
Depth	**Bottle**										vol (L)
2000	**1**	0.5	0.75	0.75	0.5	0.5					3.0
1800	**2**	0.5			0.5	0.5					1.5
1600	**3**	0.5	0.75	0.75	0.5	0.5					3.0
1400	**4**	0.5			0.5	0.5					1.5
1200	**5**	0.5	0.75	0.75	0.5	0.5					3.0
1000	**6**									10	10.0
1000	**7**	0.5			0.5	0.5			5		6.5
900	**8**	0.5	0.75	0.75	0.5	0.5					3.0
700	**9**									10	10.0
700	**10**	0.5			0.5	0.5			5		6.5
600	**11**	0.5	0.75	0.75	0.5	0.5					3.0
500	**12**									10	10.0
500	**13**	0.5			0.5	0.5			5		6.5
450	**14**	0.5	0.75	0.75	0.5	0.5					3.0
400	**15**	0.5			0.5	0.5					1.5
350	**16**	0.5			0.5	0.5					1.5
300	**17**									10	10.0
300	**18**	0.5	0.75	0.75	0.5	0.5			5		8.0
250	**19**	0.5			0.5	0.5					1.5
200	**20**	0.5	0.75	0.75	0.5	0.5			5		8.0
175	**21**	0.5			0.5	0.5					1.5
150	**22**									10	10.0
150	**23**	0.5			0.5	0.5			5		11.5
120	**24**						4	2			6.0
120	**25**	0.5	0.75	0.75	0.5	0.5			5		8.0
100	**26**	0.5			0.5	0.5			5		11.5
80	**27**						4	2			6.0
80	**28**	0.5	0.75	0.75	0.5	0.5			5		8.0
70	**29**	0.5			0.5	0.5			5		6.5
50	**30**						4	2			6.0
50	**31**									10	10.0
50	**32**	0.5			0.5	0.5			5		11.5
25	**33**						4	2			6.0
25	**34**	0.5	0.75	0.75	0.5	0.5			5		8.0
5	**35**						4	2			6.0
5	**36**	0.5	0.75	0.75	0.5	0.5			5		8.0
Sample Counts		**25**	**12**	**12**	**25**	**25**	**5**	**5**	**13**	**6**	

STATION 4 (500 m CTD -Sophie's project)

ADD UBAT AND SAMPLE FOR MATT IF THE CTD IS 2h AFTER SUNSET OR BEFORE SUNRISE)

		O_2	Salinity	Nut	SOPHIE	MATT	
	vol (L)	0.5	0.5	0.5	36	4	
Depth	**Bottle**						vol (L)
500	**1**	0.5	0.5	0.5			1.5
500	**2**				12		12.0
500	**3**				12		12.0
500	**4**				12		12.0
400	**5**	0.5	0.5	0.5			1.5
400	**6**				12		12.0
400	**7**				12		12.0
400	**8**				12		12.0
300	**9**	0.5	0.5	0.5			1.5
300	**10**				12		12.0
300	**11**				12		12.0
300	**12**				12		12.0
200	**13**	0.5	0.5	0.5			1.5
200	**14**				12		12.0
200	**15**				12		12.0
200	**16**				12		12.0
150	**17**					4	4.0
120	**18**	0.5	0.5	0.5			1.5
120	**19**				12		12.0
120	**20**				12		12.0
120	**21**				12		12.0
100	**22**					4	12.0
50 (DCM)	**23**	0.5	0.5	0.5			1.5
50 (DCM)	**24**				12		12.0
50 (DCM)	**25**				12		12.0
50 (DCM)	**26**				12		12.0
50 (DCM)	**27**					4	4.0
25	**28**	0.5	0.5	0.5			1.5
25	**29**				12		12.0
25	**30**				12		12.0
25	**31**				12		12.0
25	**32**					4	4.0
5	**33**	0.5	0.5	0.5		4	5.5
5	**34**				12		12.0
5	**35**				12		12.0
5	**36**				12		12.0
Sample count		8	8	8	24	5	