JC150 Cruise Report
26th June to 12th August 2017
RRS James Cook

Zinc, iron and phosphorus co-Limitation in the Ocean (ZIPLoC)

PSO: Dr. Claire Mahaffey, University of Liverpool

JC150 Participants

Clare Davis

Claire Mahaffey

David Gonzalez Santana

Despo Polyviou

Elena Cerdan

Elizabeth Mann

Joanna Harley

Koko Kunde

Lewis Wrightson

Luke Johnson

Maeve Lohan

Malcolm Woodward

Neil Wyatt

Noelle Held

Petroc Shelley

Stephanie Sargent

Cruise Report Contents

Chapters:

1. Narrative for Cruise JC150
2. NMF-SS sensors information
3. Laboratory data processing of sensor data
4. Trace metal cruise report: sampling from CTD, FISH and analysis of dissolved iron and zinc
5. Bioassay experiments
6. Analysis of inorganic nutrients
7. Chlorophyll analysis and flow cytometry
8. Rates of alkaline phosphatase
9. Rates of nitrogen fixation
10. Determination of dissolved oxygen concentrations in seawater
11. In Situ Protein Sampling
12. Quantifying Trace Metals in Individual Cells
13. Gene expression in *Trichodesmium* in response to nutrients and trace metal addition
14. *Trichodesmium* colony abundance
15. Diel cycle in Trichodesmium and zonal patterns of Fv/Fm
16. Influence of nutrient availability on phosphorus acquisition strategies of marine microbes

Supplementary Information:

S1. JC150 Event log
S2. JC150 Station schedules
S3. Ti CTD cast sheets
S4. SS CTD cast sheets
S5. FISH logs
S6. Experiment A logs
S7. Experiment D logs
S8. Time-course experiment logs
S9. Nutrient sample logs
S10. McLane pump sample logs
S11. Cell quota grid log
S12. Plankton photos
S13. Lebus winch system report
S14. Sensors and Moorings BODC document checklist
S15. CTD sensor and geometry information sheets
S16. JC150 other sensor information
S17. JC150 spare CTD Sensor Information
S18. JC150 stainless steel sensor information
S19. JC150 titanium CTD sensor information

Narrative for Cruise JC150

The RRS James Cook departed on cruise JC150 from Point-de-Pitre, Guadeloupe at 21:30 on Monday 26th June 2017 and docked in Santa Cruz, Tenerife on 12th August at 07:00, after a period of 46 days at sea. JC150 was the sole cruise for the NERC funded project "Zinc, Iron and Phosphorus co-Limitation in the Ocean (ZIPLOc) and was a GEOTRACES process cruise. The main aim was to quantify the extent and impact of zinc-phosphorus and iron-phosphorus co-limitation on phytoplankton growth and biological processes in the subtropical North Atlantic Ocean. There were 16 scientists on board, which included 5 senior scientists, 3 PDRAs, 3 PhD students, 2 Masters students and 3 undergraduate students (Table 1). The departure of the cruise was delayed by 1 day, 13 hours and 45 minutes due to the delayed arrival of a user-owned container which was critical for the scientific objectives of the cruise.

Table 1. Cruise participants

Name	Institution	Email address
Jeff Benson	NMF	jrbn@noc.ac.uk
Elena Cerdan	University of Southampton	ecg1g15@noc.ac.uk
Dave Childs	NMF	
Clare Davis	University of Liverpool	davis@liverpool.ac.uk
David Gonzalez-Santana	University of Southampton	D.Gonzalez-Santana@soton.ac.uk
Joanna Harley	University of Southampton	joanna.harley@yahoo.co.uk
Noelle Held	Woods Hole Oceanographic Institute	nheld@whoi.edu
Luke Johnson	University of Liverpool	sgljohn5@liverpool.ac.uk
Korinna Kunde	University of Southampton	K.Kunde@soton.ac.uk
Maeve Lohan	University of Southampton	M.Lohan@soton.ac.uk
Claire Mahaffey	University of Liverpool	mahaffey@liverpool.ac.uk
Elizabeth Mann	Bigelow Marine Laboratory	emann@bigelow.org
Despo Polyviou	National Oceanography Centre	dp10g11@soton.ac.uk
Stephanie Sargeant	University of West England	Stephanie.Sargeant@uwe.ac.uk
Petroc Shelley	Plymouth Marine Laboratory	petroc.shelley@student.manchester.ac.uk
Owain Shepard	NMF	
Juan Ward	NMF	
Malcolm Woodward	Plymouth Marine Laboratory	emsw@pml.ac.uk
Lewis Wrightson	University of Liverpool	hllwrig2@student.liverpool.ac.uk
Neil Wyatt	University of Southampton	N.J.Wyatt@soton.ac.uk

Regular meetings with the Captain, Chief Engineer, Chief Officer, Purser, CPO(S), CPO(D), Jeff Benson, Owain Shepard, Juan Ward at 08:30 every morning allowed information to be shared on safety, the science schedule and ship operations. PSO Claire Mahaffey and Maeve Lohan attended these meetings from the science party.

During the cruise, all scientific work was recorded in GMT. Ship time was put forward one hour 5 times during the cruise.

Seven stations were occupied during a west to east transect, with stations being occupied for between 4 and 7 days (Table 2, Figure 1). Stations started at either 01:30 or 02:30 and lasted for 12 hours (see Supplementary Information S2 for station schedules). There were 259 events over 46 days. The events consisted of 35 titanium CTDs and 19 stainless steel CTDs, 30 deployments of 3 McLane pumps, 150 deployment of nets for collection of *Trichodesmium* colonies and 14

deployments of nets for zooplankton collection and 8 deployments of tubing to 40m for collection of large volumes of water for bioassay experiments. There were 19 bioassay experiments conducted during the research cruise, 10 experiments in 2 L bottles and 9 experiments in 20L carboys. Events are listed in Supplementary Information S1.

Figure 1. Ports, waypoints and stations occupied during JC150 from Guadeloupe to Tenerife on board the RRS James Cook. Details of station locations can be found in Table 1.

The uncontaminated sampling system or FISH was deployed at 17° 28'N, 60° 17.83'W on 27th June 2017 using a davit and winch on the starboard side of the ship (Figure 2). Surface water samples (7-10m depth) were collected before station 1, between stations and after station 7. Samples were collected using trace metal clean techniques (see Chapter 4). Between stations, the ship maintained a speed of 6 to 7 knots, allowing samples to be collected every 2 hours, except between stations 2 and 3 during which ship speed was increased to 10 knots and samples were collected every hour (FISH 35 to 51). There were 130 FISH samples collected over a distance of 1846 nm and the FISH was recovered on 8th August 2017 at 23°15 54' N, 28° 0.57'W.

Figure 2. Locations of 130 samples collected from the trace metal clean towed FISH during JC150.

Chapter 1. Narrative

Table 2. Summary of dates, location, water depth and event numbers associated with 7 stations and FISH sample numbers before and between stations.

Station ID	Dates occupied	Latitude	Longitude	Water depth on station (m)	Event numbers
FISH 1 to 16	27/06/17 to 29/06/17	17° 28'W	60° 17.83'W		1
Test station	28/06/17	20° 52.21'N	58° 18.64'W	5045	2 to 6
Station 1	29/06/17 to 03/07/17	22°N	58°W	5388	7 to 34
Station 1.5	04/07/17	22°N	56° 32.14'W	5261	35
FISH 17 to 34	03/07/17 to 05/07/17				
Station 2	05/07/17 to 11/07/17	22°N	54°W	5166	36 to 80
FISH 35 to 51	11/07/17 to 12/07/17				
Station 3	12/07/17 to 15/07/17	22°N	50°W	4335	81 to 104
FISH 53* to 70	15/07/17 to 17/07/17				
Station 4 (Snake pit)	17/07/17 to 19/07/17	23° 22'N	44°47'W	3480	105 to 131
FISH 71 to 88	20/07/17 to 22/07/17				
Station 5	22/07/17 to 25/07/17	23°N	40°W	5348	132 to 163
FISH 89 to 107	25/07/17 to 27/07/17				
Station 6 (Geotraces crossover station, GA03)	27/07/17 to	22°19.80'N	35° 52.20'W	5530	164 to 209
FISH 108 to 126	2/8/17 to 4/8/17				
Station 7	3/8/17 to 8/8/17	22°N	31°W	4988	210 to 258
FISH 127 to 130	08/08/2017				259

*No FISH 52

Despite the threat of a hurricane between 3rd and 7th July (information from National Hurricane Centre, Miami, Florida), the cruise was unaffected by adverse weather conditions.

There were a number of equipment failures at sea, both user owned (e.g McLane pumps) and NMF (winch for stainless steel CTD, see Supplementary Information S13 for report) but none of these failures had a detrimental impact on science. There were a number of safety incidents on board, including scientists being unknowingly exposed to UV radiation from a bulb in a laminar flow hood, a scientist catching their thumb in a door and a scientist dropping a shower cleaner on their foot.

Chapter 1. Narrative

Overall, the scientific objectives of the cruise were met. On board analyses of samples from the FISH revealed that we our transect captured strong gradients in iron, chlorophyll *a* and rates of alkaline phosphatase activity, while concentrations of phosphate and zinc remained relatively low (< 10 nM) along the entire transect. Our discrete stations were in typical oligotrophic subtropical waters. The filamentous nitrogen fixer, *Trichodesmium*, was observed at all stations. However, on board analysis of phytoplankton community structure revealed that water column and phytoplankton community structure was significantly different at station 7 compared to stations 1 to 6. The deep chlorophyll maximum was shallower (80-90m) compared to other stations (110-140m), *Trichodesmium* colony abundance increased and pennate diatoms were present at 40m.

NMF-SS Sensors Cruise Report

CTD systems configurations

1) Two CTD systems were prepared. The first water sampling arrangement was a 24-way stainless steel frame system (s/n SBE CTD9), and the initial sensor configuration was as follows:

Sea-Bird 9plus underwater unit, s/n 09P-77801-1182
Sea-Bird 3P temperature sensor, s/n 03P-5785, Frequency 0 (primary)
Sea-Bird 4C conductivity sensor, s/n 04C-2450, Frequency 1 (primary)
Digiquartz temperature compensated pressure sensor, s/n 129735, Frequency 2
Sea-Bird 3P temperature sensor, s/n 03P-4380, Frequency 3 (secondary)
Sea-Bird 4C conductivity sensor, s/n 04C-4143, Frequency 4 (secondary)
Sea-Bird 5T submersible pump, s/n 05T-4539, (primary)
Sea-Bird 5T submersible pump, s/n 05T-6916, (secondary)
Sea-Bird 32 Carousel 24 position pylon, s/n 32-19817-0243
Sea-Bird 11plus deck unit, s/n 11P-22559-0532 (main)
Sea-Bird 11plus deck unit, s/n 11P-19817-0495 (back-up logging)

2) The auxiliary input initial sensor configuration was as follows:

Sea-Bird 43 dissolved oxygen sensor, s/n 43-0619 (V0)
Benthos PSA-916T altimeter, s/n 41302 (V2)
Chelsea 2pi-PAR irradiance sensor, DWIRR, s/n PAR 09 (V3)
WETLabs C-Star transmissometer, s/n CST-1654DR (V4)
Chelsea Aquatracka MKIII fluorometer, s/n 88-2050-095 (V5)
Chelsea 2pi-PAR irradiance sensor, UWIRR, s/n PAR 01 (V6)
WETLabs light scattering sensor, s/n BBRTD-182 (V7)

3) Sea-Bird 9*plus* configuration file JC150_1182_NMEA.xmlcon was used for all the stainless steel CTD casts. Both PAR sensors removed for any casts deeper than 500m or deployed at night.

4) The second water sampling arrangement was a 24-way titanium frame system (s/n SBE CTD TITA1), and the initial sensor configuration was as follows:

Sea-Bird 9plus underwater unit, s/n 09P-71442-1142
Sea-Bird 3P temperature sensor, s/n 03P-4814, Frequency 0 (primary)
Sea-Bird 4C conductivity sensor, s/n 04C-3874, Frequency 1 (primary)
Digiquartz temperature compensated pressure sensor, s/n 124216, Frequency 2
Sea-Bird 3P temperature sensor, s/n 03P-5494, Frequency 3 (secondary)
Sea-Bird 4C conductivity sensor, s/n 04C-4139, Frequency 4 (secondary)
Sea-Bird 5T submersible pump, s/n 05T-5301, (primary)
Sea-Bird 5T submersible pump, s/n 05T4510, (secondary)
Sea-Bird 32 Carousel 24 position pylon, s/n 32-71442-0940
Sea-Bird 11plus deck unit, s/n 11P--22559-0532 (main)
Sea-Bird 11plus deck unit, s/n 11P-19817-0495 (back-up logging)

5) The auxiliary input initial sensor configuration was as follows:

Sea-Bird 43 dissolved oxygen sensor, s/n 43-0709 (V0)
Tritech PA-200 altimeter, s/n 6196.118171 (V2)
Chelsea Aquatracka MKIII fluorometer, s/n 088244 (V3)
Chelsea 2pi-PAR irradiance sensor, UWIRR, s/n PAR 03 (V4)
Chelsea 2pi-PAR irradiance sensor, DWIRR, s/n PAR 02 (V5)
WETLabs light scattering sensor, s/n BBRTD-759R (V6)
WETLabs C-Star transmissometer, s/n CST-1720TR (V7)

6) Sea-Bird 9*plus* configuration file JC150_1142_NMEA.xmlcon was used for all the titanium CTD casts. Both PAR sensors removed for any casts deeper than 500m or deployed at night.

Appendix A: Technical detail report

Stainless Steel CTD on CTD1

The termination on CTD 1 was found to be a new termination completed prior to commencing CTD operations. An insulation test was carried out and it achieved >294 MOhms with a resistance of ~80 Ohms. A newly supplied electromechanical swivel, manufactured by MDS, performed as expected for casts JC150_001S through JC150_050S.

Rosette position 1 did not release on the first deployment; lanyard tension reduced by installing a "block & tackle" type loop. The next deployment position 1 released properly, then failed to release on the third deployment. The pylon was examined and position 1 was found to be somewhat 'binding' in the latch trigger. The latch was then loosened slightly, and no further failures to release were noted.

NMEA data was not available for cast JC150_025S because of temporary failure of GPS supply.

The fluorometer went to negative volts at approximately 1200m on the downcast during deployment JC150_047S. The fluorometer resumed correct positive readings at 245m on the upcast. Cable investigated and found to be slightly discoloured on pins to "Y" cable; connector cleaned and reseated. No further voltage spikes were observed on the next deployment, JC150_050S.

After the last successful CTD the CTD wire was measured again and achieved values of:
Insulation test → >261 MOhms
Resistance → ~79 Ohms

Titanium CTD on Lebus 18.5mm MFW

The termination on the Lebus MFW was found to be an old termination completed prior to commencing trials/CTD operations. An insulation test was carried out and it achieved >300 MOhms with a resistance of ~342 Ohms.

Incorrect calibration value entered for the fluorometer on deployment JC150_002T; this was corrected for the next cast. The BBRTD was noisy during the upcast on deployment JC150_006T,

from 3400m onwards. The sensor was cleaned, all connecting cables checked, cleaned and re-installed. No further noise was observed during deployments JC150_008T onwards.

UWIRR PAR sensor during cast JC150_052T was noisy & spiked to zero for up and down deployments. Cable removed & checked; PAR s/n 03 bulkhead connector showing wear & discolouration. Bulkhead to be replaced post-cruise.

Numerous and frequent stops of the Lebus winch were observed during the upcast on deployment JC150_028T. These occurred whilst operating the haul control in either Auto or Joystick mode. These intermittent stops continued for the rest of the cruise, more frequently during deployments greater than 4500m and when hauling, but these also happened in veer and on any cast.

After the last successful CTD the Lebus cable was measured again and achieved values of:
Insulation test → Ohms >303 MOhms
Resistance → ~356 Ohms

Autosal

A Guildline 8400B, s/n 65764, was installed in the Electronics Workshop as the main instrument for salinity analysis. A second Guildline 8400B, s/n 68958, was ready to be installed in the Electronics Workshop as a spare instrument. The Autosal set point was 24C, and samples were processed according to WOCE cruise guidelines: The salinometer was standardized at the beginning of the first set of samples, and checked with an additional standard analysed prior to setting the RS. Once standardized the Autosal was not adjusted for the duration of sampling, unless the set point had to be changed. Additional standards were analysed every 24 samples to monitor & record drift. These were labeled sequentially and increasing, beginning with number 9001. Standard deviation set to 0.00002

No salinity standard was analysed for the first run of samples (titanium CTD crate 39).

Total number of CTD casts – 18 S/S frame, 36 titanium frame.
Casts deeper than 2000m – 1 S/S frame, 7 titanium frame.
Deepest casts - 2750m S/S frame, 5865m titanium frame.

Appendix A: Configuration files

Stainless CTD frame:

Date: 06/27/2017

Instrument configuration file: C:\Users\sandm\Documents\Cruises\JC150\SeaSave set-up files\JC150_1182_NMEA.xmlcon

Configuration report for SBE 911plus/917plus CTD

Frequency channels suppressed : 0
Voltage words suppressed   : 0

Chapter 2: NMF-SS sensors report

Computer interface   : RS-232C
Deck unit   : SBE11plus Firmware Version >= 5.0
Scans to average   : 1
NMEA position data added   : Yes
NMEA depth data added   : No
NMEA time added   : Yes
NMEA device connected to   : PC
Surface PAR voltage added   : No
Scan time added   : Yes

1) Frequency 0, Temperature

  Serial number : 03P-5785
  Calibrated on : 23 September 2015
  G   : 4.33666483e-003
  H   : 6.27860639e-004
  I   : 1.95309317e-005
  J   : 1.44320020e-006
  F0   : 1000.000
  Slope   : 1.00000000
  Offset   : 0.0000

2) Frequency 1, Conductivity

  Serial number : 04C-2450
  Calibrated on : 23 September 2015
  G   : -1.04297917e+001
  H   : 1.66032749e+000
  I   : -1.06444678e-003
  J   : 2.15248122e-004
  CTcor   : 3.2500e-006
  CPcor   : -9.57000000e-008
  Slope   : 1.00000000
  Offset   : 0.00000

3) Frequency 2, Pressure, Digiquartz with TC

  Serial number : 129735
  Calibrated on : 13 February 2014
  C1   : -6.064446e+004
  C2   : 6.966022e-001
  C3   : 1.971200e-002
  D1   : 2.882500e-002
  D2   : 0.000000e+000
  T1   : 3.029590e+001
  T2   : -6.713679e-005
  T3   : 4.165400e-006
  T4   : 0.000000e+000
  T5   : 0.000000e+000
  Slope   : 1.00000000
  Offset   : 0.00000
  AD590M   : 1.279181e-002

  AD590B   : -8.821250e+000

4) Frequency 3, Temperature, 2

  Serial number : 03P-4380
  Calibrated on : 15 March 2016
  G   : 4.37198817e-003
  H   : 6.54769713e-004
  I   : 2.35986185e-005
  J   : 1.83277079e-006
  F0   : 1000.000
  Slope   : 1.00000000
  Offset   : 0.0000

5) Frequency 4, Conductivity, 2

  Serial number : 04C-4143
  Calibrated on : 23 September 2015
  G   : -9.80524363e+000
  H   : 1.32455760e+000
  I   : -7.66178535e-004
  J   : 1.25065175e-004
  CTcor   : 3.2500e-006
  CPcor   : -9.57000000e-008
  Slope   : 1.00000000
  Offset   : 0.00000

6) A/D voltage 0, Oxygen, SBE 43

  Serial number : 43-0619
  Calibrated on : 11 September 2015
  Equation   : Sea-Bird
  Soc   : 5.71800e-001
  Offset   : -5.01000e-001
  A   : -4.53280e-003
  B   : 2.04410e-004
  C   : -3.59180e-006
  E   : 3.60000e-002
  Tau20   : 1.06000e+000
  D1   : 1.92634e-004
  D2   : -4.64803e-002
  H1   : -3.30000e-002
  H2   : 5.00000e+003
  H3   : 1.45000e+003

7) A/D voltage 1, Free

8) A/D voltage 2, Altimeter

  Serial number : 41302
  Calibrated on : 20 April 2007
  Scale factor : 15.000

Chapter 2: NMF-SS sensors report

  Offset   : 0.000

9) A/D voltage 3, PAR/Irradiance, Biospherical/Licor

  Serial number   : PAR 09
  Calibrated on   : 16 September 2014
  M   : 0.48036900
  B   : 1.05164300
  Calibration constant : 100000000000.00000000
  Multiplier   : 0.99960000
  Offset   : 0.00000000

10) A/D voltage 4, Transmissometer, WET Labs C-Star

  Serial number : CST-1654DR
  Calibrated on : 6 April 2017
  M   : 21.3025
  B   : -0.1299
  Path length : 0.250

11) A/D voltage 5, Fluorometer, Chelsea Aqua 3

  Serial number : 88-2050-095
  Calibrated on : 13 October 2016
  VB   : 0.294700
  V1   : 2.036300
  Vacetone : 0.420200
  Scale factor : 1.000000
  Slope   : 1.000000
  Offset   : 0.000000

12) A/D voltage 6, PAR/Irradiance, Biospherical/Licor, 2

  Serial number   : PAR 01
  Calibrated on   : 16 September 2014
  M   : 0.44703700
  B   : 1.57168300
  Calibration constant : 100000000000.00000000
  Multiplier   : 0.99930000
  Offset   : 0.00000000

13) A/D voltage 7, OBS, WET Labs, ECO-BB

  Serial number : BBRTD-182
  Calibrated on : 6 March 2017
  ScaleFactor : 0.003343
  Dark output : 0.660000

Scan length   : 45

Date: 06/28/2017

Chapter 2: NMF-SS sensors report

Instrument configuration file: C:\Users\sandm\Documents\Cruises\JC150\SeaSave set-up files\JC150_1142_NMEA.xmlcon

Configuration report for SBE 911plus/917plus CTD

Frequency channels suppressed : 0
Voltage words suppressed   : 0
Computer interface   : RS-232C
Deck unit   : SBE11plus Firmware Version >= 5.0
Scans to average   : 1
NMEA position data added   : Yes
NMEA depth data added   : No
NMEA time added   : Yes
NMEA device connected to   : PC
Surface PAR voltage added   : No
Scan time added   : Yes

1) Frequency 0, Temperature

  Serial number : 03P-4814
  Calibrated on : 2 June 2016
  G   : 4.30097269e-003
  H   : 6.24407303e-004
  I   : 1.83887653e-005
  J   : 1.24167544e-006
  F0   : 1000.000
  Slope   : 1.00000000
  Offset   : 0.0000

2) Frequency 1, Conductivity

  Serial number : 04C-3874
  Calibrated on : 22 March 2016
  G   : -1.05057679e+001
  H   : 1.39003062e+000
  I   : -1.28682298e-003
  J   : 1.62520592e-004
  CTcor   : 3.2500e-006
  CPcor   : -9.57000000e-008
  Slope   : 1.00000000
  Offset   : 0.00000

3) Frequency 2, Pressure, Digiquartz with TC

  Serial number : 124216
  Calibrated on : 26 February 2016
  C1   : -6.193577e+004
  C2   : -2.149353e-001
  C3   : 1.865100e-002
  D1   : 2.627600e-002
  D2   : 0.000000e+000

```
T1          : 3.027244e+001
T2          : -3.411760e-004
T3          : 4.320610e-006
T4          : 0.000000e+000
T5          : 0.000000e+000
Slope       : 1.00010000
Offset      : -1.14700
AD590M      : 1.279600e-002
AD590B      : -9.557250e+000
```

4) Frequency 3, Temperature, 2

```
Serial number : 03P-5494
Calibrated on : 22 July 2016
G           : 4.32431164e-003
H           : 6.26214009e-004
I           : 1.95927859e-005
J           : 1.51489330e-006
F0          : 1000.000
Slope       : 1.00000000
Offset      : 0.0000
```

5) Frequency 4, Conductivity, 2

```
Serial number : 04C-4139
Calibrated on : 14 July 2015
G           : -9.89538407e+000
H           : 1.46070291e+000
I           : -8.38494970e-004
J           : 1.56277943e-004
CTcor       : 3.2500e-006
CPcor       : -9.57000000e-008
Slope       : 1.00000000
Offset      : 0.00000
```

6) A/D voltage 0, Oxygen, SBE 43

```
Serial number : 43-0709
Calibrated on : 21 August 2015
Equation    : Sea-Bird
Soc         : 4.38300e-001
Offset      : -4.93700e-001
A           : -3.92760e-003
B           : 2.34950e-004
C           : -3.47620e-006
E           : 3.60000e-002
Tau20       : 1.04000e+000
D1          : 1.92634e-004
D2          : -4.64803e-002
H1          : -3.30000e-002
H2          : 5.00000e+003
H3          : 1.45000e+003
```

Chapter 2: NMF-SS sensors report

7) A/D voltage 1, Free

8) A/D voltage 2, Altimeter

  Serial number : 6196.118171
  Calibrated on : 14 Novemberl 2006
  Scale factor : 15.000
  Offset   : 0.000

9) A/D voltage 3, Fluorometer, Chelsea Aqua 3

  Serial number : 088244
  Calibrated on : 29-September-2016
  VB   : 0.185700
  V1   : 2.079400
  Vacetone   : 0.342300
  Scale factor : 1.000000
  Slope   : 1.000000
  Offset   : 0.000000

10) A/D voltage 4, PAR/Irradiance, Biospherical/Licor

  Serial number   : 03(T)
  Calibrated on   : 16-September-2014
  M   : 0.44064700
  B   : 1.76388700
  Calibration constant : 100000000000.00000000
  Multiplier   : 0.99980000
  Offset   : 0.00000000

11) A/D voltage 5, PAR/Irradiance, Biospherical/Licor, 2

  Serial number   : 02(T)
  Calibrated on   : 25-May-2016
  M   : 0.47920900
  B   : 1.05661800
  Calibration constant : 100000000000.00000000
  Multiplier   : 0.99950000
  Offset   : 0.00000000

12) A/D voltage 6, Transmissometer, WET Labs C-Star

  Serial number : CST-1720TR
  Calibrated on : 16-April-2015
  M   : 21.5037
  B   : -1.5698
  Path length   : 0.250

13) A/D voltage 7, OBS, WET Labs, ECO-BB

  Serial number : BBRTD-759R

Chapter 2: NMF-SS sensors report

   Calibrated on : 12-September-2016
   ScaleFactor : 0.003221
   Dark output : 0.041000

Scan length   : 45

J. Benson/D. Childs
12th August 2017

JC150 CTD processing report

Jo Hopkins

A total of 35 casts were completed with the 24-way titanium frame. See NMF technical reports for sensor serial numbers and channels.

Raw data files:

The following raw data files were generated:

       JC150_002t.bl (a record of bottle firing locations)
       JC150_002t.hdr (header file)
       JC150_002t.hex (raw data file)
       JC150_002t.con (configuration file)

Where _002 is the cast number

The wrong calibration values were used on deployment JC150_002T (but rectified for the next cast). A copy of the cast 3 configuration file was therefore renamed as JC150_002T.XMLCON and used in all further processing.

SBE Data Processing steps

The following processing routines were run in the SBEDataProcessing software (Seasave Version 7.23.2):

1. **DatCnv:** A conversion routine to read in the raw CTD data file (.hex) containing data in engineering units output by the CTD hardware. Calibrations as appropriate though the instrument configuration file (.CON) are applied.

   Data Setup options were set to the following:
          Process scans to end of file: yes
          Scans to skip: 0
          Output format: ascii
          Convert data from: upcast & downcast
          Create file types: both bottle and data
          Source of scan range data: bottle log .BL file
          Scan range offset: -2.5 seconds
          Scan range duration: 5 seconds
          Merge separate header file: No
          Apply oxygen hysteresis correction: yes (2 second window)
          Apply oxygen Tau correction: yes

   Selected output variables:
   - Time [seconds]
   - Pressure [db]
   - Temperature [ITS-90, °C] and Temperature 2 [ITS-90, °C], referring to primary and secondary sensors)
   - Conductivity and Conductivity 2 [S/m]
   - Salinity and salinity 2 [PSU, PSS-78]
   - Oxygen raw, SBE 43 [V]
   - Oxygen, SBE 43 [μmol/kg]

- Beam attenuation [1/m]
- Fluorescence [μg/l]
- PAR/irradiance, upwelling [W m^2]
- PAR/irradiance, downwelling [W m^2]
- Turbidity [m^{-1} sr^{-1}]
- Altimeter [m]
- Voltage channel 3: Fluorometer
- Voltage channel 4: Irradiance sensor (UWIR)
- Voltage channel 5: Irradiance sensor (DWIR)
- Voltage channel 6: Light scattering Wetlabs BBRTD
- Voltage channel 7: Transmissometer

2. **Bottle Summary** was run to create a .BTL file containing the average, standard deviation, min and max values at bottle firings. .ROS files were placed in the same directory as the .bl files during this routine to ensure that bottle rosette position was captured in the .btl file.

   Output saved to JC150_002t.btl

3. **Wild Edit:** Removal of pressure spikes
   Standard deviations for pass 1: 2
   Standard deviations for pass 2: 20
   Scans per block: 100
   Keep data within this distance of the mean: 0
   Exclude scans marked as bad: yes

4. **Filter:** Run on the pressure channel to smooth out high frequency data
   Low pass filter time B: 0.15 seconds

5. **AlignCTD:** Based on examination of different casts a 5 second advance was chosen for alignment of the oxygen sensor.

   This alignment is a function of the temperature and the state of the oxygen sensor membrane. The colder (deeper) the water the greater the advance needed. The above alignments were chosen as a compromise between results in deep (cold) and shallow (warmer) waters.

Figure 1: CTD cast 006 (left) without hysteresis correction, (middle) with hysteresis correction and (right) with hysteresis correction and 5 second alignment

Figure 2: CTD cast 006 (Temperature vs oxygen) without any alignment (left) and with a 5 second alignment (right)

6. **CellTM:** Removes the effect of thermal inertia on the conductivity cells. Alpha = 0.03 (thermal anomaly amplitude) and 1/beta = 7 (thermal anomaly time constant) for both cells.

   Output of steps 1-6 above saved in JC150_002t.cnv (24 Hz resolution)

7. **Derive:** Variables selected are
   Salinity and Salinty 2 [PSU, PSS-78]
   Oxygen SBE43 [μmol/kg]
   Oxygen Tau correction: yes (2 second window)

   Output saved to JC150_002t_derive.cnv (24 Hz resolution)

8. **BinAverage:** Average into 2Hz (0.5 seconds),
   Exclude bad scans: yes
   Scans to skip over: 0
   Casts to process: Up and down

9. **Strip:** Remove salinity and oxygen channels from the 2 Hz file that were originally created by DatCnv, but then later regenerated by Derive.

   Output saved to JC150_002t_derive_2Hz.cnv

Matlab processing steps
The following processing steps were performed in MATLAB:

(1) Create a .mat file of meta data with the following variables:

   CRUISECODE e.g. JC150
   DATE and TIME of the cast
   LAT and LON of the cast
   DEPTH (total water depth)
   CAST (CTD cast number, e.g. 002)
   STNNBR – so that the pre-existing Matlab scripts would run with minimal editing a
   variable STNNBR was created and set equal to the CAST number

   The above details were provided by the PI

   File created: JC150_metadata.mat

(2) Extract data from 2Hz averaged files (e.g. JC150_002t_derive_2Hz.cnv), merge with
   metadata and save into a matlab structure for each cast. Each file
   (JC150_002t_derive_2Hz.mat) contains the following <u>un-calibrated</u> channels.

   CTD002 =

            CRUISE: 'JC150'
             CAST: 2
           STNNBR: 2
             DATE: '28/06/2017'
             TIME: '15:35'
             LAT: 20.8700
             LON: -58.3125
           DEPTH: 5045   [m]
         CTDtime: [5477x1 double]   [seconds]
         CTDpres: [5477x1 double]   [db]
        CTDtemp1: [5477x1 double]   [°C]
        CTDtemp2: [5477x1 double]   [°C]
        CTDcond1: [5477x1 double]   [S/m]
        CTDcond2: [5477x1 double]   [S/m]
      CTDoxy_raw: [5477x1 double]   [V]
          CTDatt: [5477x1 double]   [1/m]
        CTDfluor: [5477x1 double]   [µg/l]
         CTDpar1: [5477x1 double]   [Wm^2] Upwelling
         CTDpar2: [5477x1 double]   [Wm^2] Downwelling
         CTDturb: [5477x1 double]   [m^{-1} sr^{-1}]
          CTDalt: [5477x1 double]   [m]
     CTDfluor_raw: [5477x1 double] [V]
    CTDpar_up_raw: [5477x1 double][V]
    CTDpar_dn_raw: [5477x1 double][V]
     CTDturb_raw: [5477x1 double] [V]
      CTDatt_raw: [5477x1 double] [V]

CTDsal1: [5477x1 double]   [PSU]
CTDsal2: [5477x1 double]   [PSU]
CTDoxy_umolkg: [5477x1 double]   [μmol/kg]
CTDflag: [5477x1 double]
CTDpar: [5477x1 double]   [Wm^2] Downwelling

(3) Manual identification of the surface soak (while waiting for pumps to turn on) and the end of the downcast using the 2Hz files. Times to crop were saved to JC150_titanium_castcrop_times.mat

(4) Extract data from 24Hz files (e.g. JC150_002t_derive.cnv), merge with metadata and save into a matlab structure for each cast. Only the downcast data was extracted using the times in JC150_titanium_castcrop_times.mat. The following <u>un-calibrated</u> channels were saved (e.g. to JC150_002t_derive.mat).

CTD002 =

CRUISE: 'JC150'
CAST: 2
STNNBR: 2
DATE: '28/06/2017'
TIME: '15:35'
LAT: 20.8700
LON: -58.3125
DEPTH: 5045   [m]
CTDtime: [24564x1 double] [seconds]
CTDpres: [24564x1 double] [db]
CTDtemp1: [24564x1 double][°C]
CTDtemp2: [24564x1 double][°C]
CTDcond1: [24564x1 double][S/m]
CTDcond2: [24564x1 double][S/m]
CTDsal1_1: [24564x1 double] [PSU]
CTDsal2_1: [24564x1 double] [PSU]
CTDoxy_raw: [24564x1 double]   [V]
CTDoxy_umolkg_1: [24564x1 double]   [μmol/kg]
CTDatt: [24564x1 double]   [1/m]
CTDfluor: [24564x1 double] [μg/l]
CTDpar1: [24564x1 double] [Wm^2] Upwelling
CTDpar2: [24564x1 double] [Wm^2] Downwelling
CTDturb: [24564x1 double] [m^{-1} sr^{-1}]
CTDalt: [24564x1 double]   [m]
CTDfluor_raw: [24564x1 double] [V]
CTDpar_up_raw: [24564x1 double]   [V]
CTDpar_dn_raw: [24564x1 double]   [V]
CTDturb_raw: [24564x1 double]   [V]
CTDatt_raw: [24564x1 double][V]
CTDsal1: [24564x1 double] [PSU]

CTDsal2: [24564x1 double]   [PSU]
CTDoxy_umolkg: [24564x1 double]   [µmol/kg]
CTDflag: [24564x1 double]
CTDpar: [24564x1 double]   [Wm^2] Downwelling

Note that '_1' for the first instances of salinity and oxygen in this file are variables before re-derivation in the SeaBird Processing routines.

Inspection of the turbidity channel (CTDturb) and comparison to the original raw voltage (CTDturb_raw) reveals a bug in the SeaBird DatCnv conversion module whereby the converted Wetlabs BBRTD light scattering output is reported to a fixed precision (Figure 3, left). Direct conversion using the scale factor (SF) and dark counts (DC) supplied in the manufacturer's calibration appears to rectify this problem (Figue 3, right). We therefore replace the original turbidity channel in the .cnv files with a corrected version using:

CTDturb = CTDturb_raw .* SF - (SF x DC)

SF = 3.221 x 10^{-3} (m^{-1} sr^{-1})/volts
DC = 0.0410 volts
Calibration values from 12th Sep 2016

This appears to reinstate the original resolution.

Figure 3: (left) Up and downcast turbidity from CTD 002 using SeaBird software (right) turbidity re-derived using manufacturer scale factor and dark counts

(5) De-spiking of downcast 24 Hz data. The salinity, conductivity, temperature, oxygen, attenuation, turbidity and fluorescence channels were all de-spiked. The worst spikes were identified using an automated routine (similar to WildEdit) where the data was scanned twice and points falling outside a threshold of *nstd* x standard deviations from the mean within a set window size were removed (turned into NaNs).

Table 1: Window size (#scans) and number of standard deviations from the mean (nstd) used for each channel.

Channel	Pass 1 window	Pass 1 nstd	Pass 2 window	Pass 2 nstd
Temperature, conductivity,	100	3	200	3
Salinity	200	2	200	3
Fluorescence, attenuation, oxygen	100	2	200	2
Turbidity	200	2	200	2

Auto-despiking saved to JC150_002t_derived _autospike.mat

(6) Average 24Hz (cropped and de-spiked data) into 1 db and 10 db bins. Linear interpolation used when no data available for averaging.

Files for each cast were created: JC150_002t_1db_dn.mat and JC150_002t_10db_dn.mat

All the 1 db profiles (except PAR and fluor) are then further smoothed with a 10 m running median window. To help preserve fine scale structure through the SCM a 3 m window was used for the fluorescence.

File output: JC150_002t_1db_dn_smth.mat

(7) <u>Un-calibrated</u>, 1 db and 10 db data were output to ascii text files.
   The following channels were exported:
   - Press (pressure in db)
   - temp1 and temp2 (primary and secondary temperature in deg C)
   - sal1 and sal2 (primary and secondary salinity in PSU)
   - oxy (Oxygen concentration in umol/kg)
   - fluor (chlorophyll-a concentration in ug/l)
   - turb (turbidity – light scattering in m^{-1} sr^{-1})
   - att (attenuation in m^{-1})
   - par (downwelling PAR in Wm^{-2})

Note that the secondary temperature and salinity sensors (mounted on the fin) are cleaner data streams. Also note that the PAR sensor was not mounted on all casts.

(8) Bottle firing information that can be used for calibrations was stripped from each .btl file and saved to JR150_ctd_bttls_05-Nov-2017.csv

<u>Observations</u> that might need some further consideration

 (a) The range of light scattering ('turbidity') values is small
 (b) The attenuation becomes negative in deeper water
 (c) The profiles of attenuation and turbidity (light scattering) are typically mirror images of one another

Calibration of sensors for salinity, oxygen and chlorophyll fluorescence

From the raw CTD data, sensor 2 data for temperature and salinity was deleted and sensor 1 data for both parameters was used for calculation of density.

Salinity calibration:

To calibrate the salinity 1 sensor, the following equation was applied based on the regression between sensor salinity data and bottle salinity data:

salinity CALIBRATED salinity = CTDSAL * 1.0012 – 0.0439

Oxygen calibration:

The raw oxygen sensor data was in units of μmol kg^{-1}. The units of bottle oxygen were in μmol L^{-1} and thus the units were converted to μmol kg^{-1} using density calculated from a set of equations published by UNESCO (1978). The following equation, developed using CTD oxygen sensor data versus bottle oxygen sensor data (both in μmol L^{-1}) was applied to CTD oxygen sensor data for calibration:

Oxygen CALIBRATED (μmol L^{-1}) = CTD O2 x 0.9768 + 5.3397

The oxygen data was then converted back to μmol kg^{-1} using density.

Chlorophyll fluorescence calibration:

The following equation, developed using CTD fluorescence data and extracted chlorophyll data, was applied to CTD fluorescence data for calibration:

Fluorescence CALIBRATED = CTD Fluor x 3.0192 – 0.0198

Trace Metal Cruise report
Sampling from CTD, FISH and analysis of dissolved iron and zinc

Maeve Lohan, Neil Wyatt, Korinna Kunde and David Gonzalez Santana

Sampling strategy

Trace metals are essential micronutrients for essential micronutrients used in the biological processes such as photosynthesis and nitrogen fixation. For example, iron can control primary productivity in many oceanic regions, while zinc and cobalt play a more targeted physiological role linked to specific biogeochemical cycles. The availability of iron, zinc and cobalt can regulate the biological uptake of dissolved organic phosphorus as these trace metals are the metal co-factors of alkaline phosphatases which cleave the phosphate bound to esters enabling phytoplankton to access the phosphate from DOP. Using trace metal incubations we aimed to determine the prevalence of zinc, iron and cobalt limitation of APA at each station along the transect.

While much is known about sources of these trace elements, internal recycling of these elements has remained elusive. Moreover remineralisation, which can replenish trace metal inventories at depth, can be seasonally resupplied to surface waters via mixing. Trace metals have different remineralisation length scales for example zinc is much shorter than that observed for iron. It is therefore essential to have high resolution trace metal sampling in upper 500 m to investigate the interplay between the physio-chemical speciation of dissolved and particulate trace metals. We also carried out full depth profiles of trace elements at each section.

Titanium CTD

To enable high-resolution water column sampling, two trace metal clean CTD casts were conducted at each station, one shallow cast to 650-700m and one cast from 600 m to 20 m from the seafloor. For each cast we always sampled at 40 m and ensured 2-3 depths were repeated to ensure intercalibration between both casts.

Seawater samples were collected at all 7 stations, using a titanium CTD rosette fitted with 24 x 10 L trace metal clean Teflon-coated OTE (Ocean Test Equipment) bottles with external springs, deployed on a Kevlar coated conducting wire. Upon recovery, the OTE bottles were transferred into a class 1000 clean air shipboard laboratory and pressurised (1.7 bar) with compressed air filtered in-line through a 0.2 μm PTFE filter capsule (Millex-FG 50, Millipore). All samples for trace metals were collected into trace metal clean low density polyethylene (LDPE, Nalgene) bottles. Unfiltered samples were collected for total dissolvable iron and zinc which is defined as iron and zinc, which is solubilized after at least 6 months of acidification to 0.024 M HCL. Samples for dissolved iron and zinc were filtered using 0.2 μm acetate membrane filter cartridge filters (Sartobran-300, Sartorius). The dissolved iron fraction was further separated by filtration into soluble (sFe) by in-line filtration through 0.02 μm syringe filters (Anotop, Whatman) at a flow rate of 1 ml min^{-1}. The colloidal iron is defined as the fraction, which passes through 0.2 μm filter but not a 0.02 μm filter. All samples for dissolved and soluble trace elements were acidified with ultra-pure HCL (UPA, Romil) to 0.024 M. Both iron and zinc are over 90% complexed by metal-binding ligands, which influence their bioavailability. Samples were collected for iron and zinc-binding ligands whereby 250- 500 ml was filtered through 0.2 μm acetate membrane filter cartridge filters (Sartobran-300, Sartorius). These samples will be stored frozen until analyses at the Univeristy of Southampton.

Chapter 4: Trace metal cruise report

Particulate samples were collected onto acid clean 25 mm Supor® polyethersulfone (PES) membrane disc filters (Pall, 0.45 μm) housed in acid cleaned Millipore Swinnex filter houses and connected to the OTE bottles using luer lock fittings and acid cleaned Bev-a-line tubing (Cole Parmer). Following filtration, the filter houses were removed and placed in a laminar flow bench. Using an all-polypropylene syringe attached to the top of the filter holder, residual seawater was forced through the filter using air from within the laminar flow bench. This ensures there is no spillage and loss of particulate material from face of filter when filter holder is opened, and will remove as much seawater as possible in order to reduce the residual seasalt matrix for analytical simplicity after the sample is digested. The filter holders were gently opened and the PES filter was folded in half using acid cleaned plastic tweezers, the filters were then placed in an acid washed 2 ml LDPE vials and frozen at -20°C until analysis.

From every cast and each OTE bottle macronutrient samples were collected unfiltered. The shallow cast had additional unfiltered samples for APA, chlorophyll, dissolved organic phosphorus. At selected stations (1, 4, 6) samples were collected for chromium and zinc isotopes. Six salinity samples were collected from each cast for calibration purposes. Dissolved oxygen samples were collected in triplicate from 12 depths from the deep cast for calibration.

Supplementary Information S3 details all samples collected from the trace metal titanium CTD.

Underway Towed Fish Sampling
Surface gradients in dissolved trace metals, APA, chlorophyll and inorganic nutrients and DOP are essential in understanding variability and to place the results from incubation studies in context. High-resolution underway surface samples were collected using a 'towfish' which was deployed off the starboard side of the ship. Surface seawater was pumped into the trace metal clean laboratory using a Teflon diaphragm pump (Almatec A-15) connected by acid-washed braided PVC tubing to a towed 'fish' positioned at approximately 2-3 m. Underway samples were collected every 2 hours along the transect between stations. Unfiltered samples were collected for inorganic nutrients (nitrate, nitrite, ammonium, phosphate and silicate), dissolved organic phosphorus, alkaline phosphatase activity, chlorophyll, flow cytometry and total dissolvable trace metals. Filtered samples for dissolved zinc and iron were collected through 0.8/0.2 μm polyethersulfone membrane filter capsule (Sartobran, Sartorius). In all, 130 towed fish time point samples were taken along the transect (Supplementary Information S5). Additional, large volume (2-10 L) filtered and unfiltered samples were collected coming onto station for different incubation experiments (iron and zinc enrichments with Trichodesmium, mangense, nickel and iron enrichments with Trichodesmium and zooplankton inubation studies).

Onboard analyses revealed that moving from west to east along the transect, a large gradient in dissolved iron (1.5 nM- 0.2 nM) and zinc (0.8 nM to 0.03 nM) concentrations was observed. The gradient in iron is consistent with a recent dust deposition event at the start of the cruise.

Dissolved Fe distribution in the subtropical North Atlantic

Korinna Kunde

Introduction

Iron (Fe) is an essential micronutrient for biological processes during primary production such as nitrogen fixation and dissolved organic phosphorus (DOP) acquisition (Morel et al. 1991; Morel 2003). Despite its key roles, Fe is present only at nanomolar concentrations in the ocean as a results of its low solubility under oxic conditions (Boyd & Ellwood 2010). Hence, Fe (co-)limitation of primary production has been observed for example in various ocean settings (Boyd et al. 2007). Although the subtropical North Atlantic receives comparably large Fe inputs from atmospheric sources (Sedwick et al. 2005), it has been proposed that organic phosphorus acquisition is limited by Fe (and/or Zn, Co) in large parts of the North Atlantic oligotrophic gyre, especially in the parts of reduced dust inputs (Mahaffey et al. 2014). Iron, Zn and Co form the metal centre of alkaline phosphatase which facilitates the cleavage of phosphorus from the organic moieties in the DOP pool (Coleman 1992; Yong et al. 2014). To investigate the potential Fe limitation of alkaline phosphatase activity, dissolved Fe (dFe) (defined as passing through a 0.2μm filter) was measured along the surface gradient as well as in shallow high-resolution and full depth profiles.

Methods

Sampling – Dissolved Fe (dFe) samples were obtained Ti-CTD casts at seven stations across the transect. At each station a shallow (< 700 m) and a deep (>500 m full depth) profile were sampled resulting in 2 x 24 dFe samples per station and 336 in total. During transit between stations 129 additional dFe samples were collected from the underway FISH. All sampling took place in a clean van and samples were collected in acid-cleaned (one week soaked in 3 M HCl, one week in 0.5 M HCl, stored in 0.024 M HCl) LDPE bottles by attaching a 0.2 μm Sartobran filter to pressurized OTE bottles. All sampling bottles were rinsed three times with seawater prior to filling. The samples were acidified to pH 1.7 with ultrapure HCl (Romil, UpA) and left to equilibrate for at least twelve hours before analysis.

Analysis – Flow injection analysis with chemiluminescence detection (FIA-CL) was used to determine nanomolar concentrations of dFe (Obata et al. 1993; Obata et al. 1997). At least 15 min prior to analysis samples were spiked with 1 μl 0.01 M H_2O_2 per 1 ml of sample to allow any present Fe(II) to be oxidized to Fe(III). The sample was then buffered to pH 3.5 and pre-concentrated on a Toyopearl resin. Upon elution by HCl, the Fe entered a reaction stream with luminol, NH_4OH and H_2O_2 to induce the chemiluminescent oxidation of luminol detected by a photomultiplier tube. Each sample was measured in triplicate with a column loading time of 220 s, resulting in a total of approximately 16 min per run.

Figure 1 Dissolved Fe concentrations in the upper water column of Station 2.

Results

Dissolved Fe concentrations were analysed on board for the 7 high-resolution shallow casts and the underway gradient. Preliminary results indicate a strong influence of atmospheric inputs on surface ocean concentrations of dFe which ranged between 0.25 nM and 1.3 nM. This resulted in high concentrations in surface waters up to 1 nM which decreases with depth as Fe is scavenged onto particles. Lowest concentrations were observed at the deep chlorophyll maxima (DCM) due to biological uptake. Iron concentrations increased with depth to 0.6 nM. Generally, strong biological signals of Fe uptake were observed but pulses of high dust input, water mass intrusions and scavenging effects result in the variable distributions of dFe in the surface ocean along our transect. Figure 1 displays an example of the shallow profile at Station 2 at the western edge of the transect.

References

Boyd, P.W. et al., 2007. Mesoscale Iron Enrichment Experiments 1993–2005: Synthesis and Future Directions. , 612.

Boyd, P.W. & Ellwood, M.J., 2010. The biogeochemical cycle of iron in the ocean. *Nature Geoscience*, 3(10), pp.675–682.

Coleman, J.E., 1992. Structure and mechanism of alkaline phosphatase. *Annu. Rev. Biophys. Biomol. Struct*, 21, pp.441–483.

Mahaffey, C. et al., 2014. Alkaline phosphatase activity in the subtropical ocean: insights from nutrient, dust and trace metal addition experiments. *Frontiers in Marine Science*, 1, p.1–13 (Article 73).

Morel, F.M.M., 2003. The Biogeochemical Cycles of Trace Metals in the Oceans. *Science*, 300(5621), pp.944–947.

Chapter 4: Trace metal cruise report

Morel, F.M.M., Hudson, R.J.M. & Price, N.M., 1991. Limitation of productivity by trace metals in the sea. *Limnology and Oceanography*, 36(8), pp.1742–1755.

Obata, H. et al., 1997. Fundamental studies for chemical speciation of iron in seawater with an improved analytical method. *Marine Chemistry*, 56(1–2), pp.97–106.

Obata, H., Karatani, H. & Nakayama, E., 1993. Automated Determination of Iron in Seawater by Chelating Resin Concentration and Chemiluminescence Detection. *Analytical Chemistry*, 65, pp.1524–1528.

Sedwick, P.N. et al., 2005. Iron in the Sargasso Sea (Bermuda Atlantic Time-series Study region) during summer: Eolian imprint, spatiotemporal variability, and ecological implications. *Global Biogeochemical Cycles*, 19(4), p.n/a-n/a.

Yong, S.C. et al., 2014. A complex iron-calcium cofactor catalyzing phosphotransfer chemistry. *Science (New York, N.Y.)*, 345(6201), pp.1170–3.

Dissolved Zinc distribution in the subtropical North Atlantic

Neil Wyatt

Over 400 filtered (0.2 μm) seawater sub-samples were collected from 14 Ti-CTD trace metal casts and a surface towed fish (~3 m depth) for the determination of dissolved zinc (DZn) concentration. In addition, DZn sub-samples were collected during shipboard incubation experiments. The DZn data generated onboard served a dual purpose: 1) to validate the sample collection methods by highlighting any potential contamination sources in real-time and 2) to determine the real-time longitudinal distribution and biogeochemistry of DZn in the North Atlantic in order to adapt experimental design.

Methods

Following collection, all sub-samples were acidified (0.024 M HCl; Romil SpA) and then analyzed onboard ship for DZn concentration using flow-injection analysis with fluorimetric detection, as first described by Nowicki *et al*. (1994). Briefly, 20 mL of seawater was buffered in-line (pH 4.5) and then DZn pre-concentrated for 200 seconds onto a cation exchange resin (Toyopearl AF650 Chelate). The major seawater cations were rinsed from the resin with weak NH_4OAc before the DZn liberated from the resin with HCl and then mixed with p-tosyl-8-aminoquinoline (pTAQ, Sigma-Aldrich), which forms a stable fluorescent complex with Zn(II). The fluorescent reaction was measured by a Shimadzu RF-20A fluorimeter. Dissolved Zn was determined using two separate calibration curves, depending on ambient concentrations as Zn concentrations ranged from 30 pM to 4.5 nM at depth. Calibration standards were made using low Zn seawater collected from the towed 'fish'. An example curve is shown in Figure 2. Each sub-sample was run in triplicate with each complete analytical cycle taking 18 mins. The analysis produced excellent analytical figures of merit with detection limits 10-30 pM and excellent agreement with SAFe and GEOTRACES reference samples.

Surface DZn concentrations were low (0.14 ± 0.07 nM) within the North Atlantic oligotrophic gyre and are at their highest in the remote central basin. In the western and eastern sections of the gyre, DZn concentrations are often < 0.1 nM. Markedly higher values (0.35 – 0.81 nM) were observed in the far west of the basin before we transitioned into low Zn waters. The vertical distributions of DZn along the transect displayed typical nutrient-type profiles with low concentrations in the mixed layer followed by regeneration with increased depth. Waters below 500 m reached 4 nM DZn in the western North Atlantic. An example profile is shown in figure 3.

Figure 2. An example of typical calibration curve for dissolved zinc using flow injection analyses.

Figure 3. Dissolved zinc profile from Station 1.

Trace metal clean bioassays
Maeve Lohan

Two different types of trace metal bioassay's were conducted at each station, a small volume (2L) and a large volume (20L).

The small volume incubations consisted of either 3 different bioassay treatments (A, B, C) or and expanded version of A (see Supplementary Information S6 for details of amendments). From station 5 onwards experiment A was expanded to increase the number of iron, zinc and cobalt additions and to increase the number of replicates from 2 to 3. These were termed expanded A treatments. At station 5 we carried out two expanded A treatments, one with iron and zinc and another with zinc, iron and cobalt. At stations 6 and 7 we also carried out 2 expanded A treatments with zinc, iron and cobalt.

Experiment A: Zinc chloride and iron chloride were added to unfiltered seawater

Expanded A: Zinc chloride, cobalt chloride and iron chloride were added to unfiltered seawater.

Experiment B: To induce phosphate stress and maximum APA, we added nitrogen as 1 μM nitrate + ammonium alongside both zinc chloride and iron chloride additions as in Experiment A.

Experiment C: To assess whether APA is curtailed by low substrate availability, we added excess 0.5 μM DOP as a mixture of esters (adenosine monophosphate adenosine diphosphate, adenosine triphosphate, D-glucose phosphate, diethyl phosphonate) alongside zinc chloride and iron chloride as in Experiment A.

All polycarbonate bottles (2 L) and carboys (20 L) were acid cleaned at the University of Southampton under trace metal clean conditions. They were first rinsed 4 times with Milli-Q and then filled with 3 M HCl for one week, rinsed 4 times with Milli-Q and filled with 0.5 M HCL for one week. The bottles and carboys were then rinsed with Milli-Q 5 times and transported with a small volume of Milli-Q at the bottom. Between each experiment the bottles were rinsed with Milli-Q and a small volume of 2 M HCL added to the bottle or carboy, shaken and left for at least 24 hrs.

For experiments A, B and C unfiltered water was collected using the Ti-CTD, where all 24 bottles were tripped at 40 m. All casts took place pre-dawn. Upon recovery, the OTE bottles were transferred into a class 1000 clean air shipboard laboratory for sub-sampling. Each acid-clean 2L polycarbonate bottle was 1/3 filled from 3 different OTE sample bottles in the dark under red light to reduce any bottle effects. In total 72 x 2L bottles were filled in this manner. Filling time took less than 1 hour. Time zero samples for APA, chlorophyll, inorganic nutrients and trace metals were also collected. After filling these bottles were spiked in a laminar flow hood within the class 1000 clean air shipboard laboratory (see S6 for concentrations added). Bottles were then incubated for 48 hrs in the incubator van which were fitted with LED light panels on a 12 hour on/off cycle (Part no: LED-PANEL-300-1200-DW and LED-PANEL-200-6-DW, Daylight White, supplier Power Pax UK Limited). The temperature of the incubator van was controlled to match the temperature at 40 m which ranged from 25-27 ^{o}C.

After 48 hours samples were taken for APA, phosphate and chlorophyll measurements. From station 5 onwards only APA and chlorophyll measurement were taken. Nutrients analysis was discontinued as phosphate was less than 10 nM and remained less than 10 nM throughout the experiments and transect.

Experiment D These experiments involved scaling up experiment A from 2L to 23.5 L. We predominately focused on 2 individual amendments of iron, zinc and cobalt based on the results from experiment A. It was not possible to determine the K_s and V_{max} from experiment A, but there were distinct different trends observed at each station in APA upon the addition of iron, zinc and cobalt to experiment A. Supplementary Information S7 provides details of the additions made to experiment D. At stations 2-4 we added two iron and zinc concentrations and one cobalt concentration alongside the addition of N and esters as the largest response observed was upon the addition of nitrate and ammonium.

At stations 1 and 2, samples were collected using the Ti-CTD with all bottles tripped at 40 m as per experiment A, B, C set up. However, given the large volumes required for the experiment, three Ti-CTD casts were required. Sample collection was at local night (01:30 am). From each Ti-CTD cast the 23.5 L carboys were 1/3 filled to reduce any bias in sample timing or cast effects. Similar to experiments A, B and C, the carboys were filled and spiked in the dark under red light.

From station 3 onwards a pump system was used to sample for experiment D. This used similar acid-washed braided PVC tubing as used for the underway towed 'fish' sampling. The pump was deployed on the Kevlar line used for the McLane pumps on the starboard side using an epoxy coated weight. The tubing was attached to the Kevlar line using cable ties and tape and was deployed to 40 m. Seawater was pumped into the trace metal clean laboratory using a Teflon diaphragm pump (Almatec A-15) connected to the acid-washed braided PVC tubing. Unfiltered seawater was then used to rinse and fill the 23.5 L polycarbonate carboys. As up to 36 carboys were used for some experiment D set up, filling times were approximately 4-5 hours. The carboy filling protocol was that each carboy was half-filled first and then filled to distribute the total seawater collected across the total filling time. Carboys were filled at random and no replicates were filled directly after one from the same set. Time zero samples for APA, DOP, FCM, chlorophyll, inorganic nutrients and trace metals were also collected at the start, middle and end of the filling time. Time zero samples for proteins, trace metal cell quota and nitrogen fixation were also collected at one time point during the filling time.

After spiking with metal amendments, the polycarbonate carboys had parafilm placed around the lids and were incubated in the incubation container for 48 hrs under similar conditions as those for experiments A, B and C.

Unfortunately at station 3, the Teflon diaphragm pump failed and a large peristaltic pump was used with Masterflex tubing.

After 48 hours, the carboys were removed from the incubator van and placed in a class 1000 trace metal clean laboratory van. The outside of the carboys were rinsed with copious amounts of Milli-Q after the parafilm had been removed. A trace metal clean spigot was

placed on the carboy for sub-sampling. To ensure sampling times were at the same stage and comparable to the control, the carboys were removed in order of treatments rather than sample all triplicates for the control at the same time. For example, the control A1 was removed from the incubator at the same time as B1, C1, D1 etc. After the first set was sub-sampled (approx. 50 minutes), the second set e.g. A2, B2, C2 etc..

At station's 2 and 3, 4 L bottles were incubated alongside the 20 L carboys which were filled at the same time for gene subsampling by University of Southampton.

Sub-samples were taken in the following order:
1. Trace metals- 2 x 1L LDPE bottles were rinsed and filled
2. Cellular metal Quotas-a sub-set of treatments had 1 x 1L LDPE rinsed and filled
3. Nutrients- 2 x 60 ml bottles rinsed and filled
4. APA- Carboys labeled with number 1 had 5 x 125 mL polycarbonate bottles rinsed and filled for kinetics, carboys labelled with numbers 2 & 3 had 250 mL polycarbonate bottles rinsed and filled
5. Chlorophyll a – 1 x 1L bottle rinsed and filled
6. DOP- 1 x 125 ml HDPE bottle rinsed and filled
7. FCM- 1 x 125 mL polycarbonate bottle rinsed and filled
8. Nitrogen fixation- 1 x 4L polycarbonate bottle-over filled to ensure no bubble
9. Proteins- 1 x 10 L HDPE carboy filled
10. Genes- 1 x 4L polycarbonate bottle filled. Note samples with added cobalt were not subsampled for genes.

Time course experiments:

As all incubations were over 48 hour time period, two different time course experiments were carried out, one in the west (Stn. 2, experiment E) and one in the east (Stn. 6) to investigate how parameters such as APA, nutrients, chlorophyll, trace metals, proteins and genes change over 72 hours.

The first time course experiment involved incubating 33 x 23.50 L carboys. Sampling began at midnight local time and involved 3 Ti CTD casts. The carboys were part filled from all 4 casts to remove any bias from each cast and 3 different OTE bottles were sampled for each carboy from each cast. Carboys were also filled at random and no replicates were filled directly from the same OTE bottles from each cast. Time zero samples were collected from each cast. After spiking with metal amendments (see Supplementary Information S8), the polycarbonate carboys had parafilm placed around the lids and were incubated in the incubation container for 72 hrs. The carboys were sub-sampled every 6 hours under trace metal clean conditions for APA, chlorophyll and nutrients over 72 hours. A spigot was placed on the carboy after 6 hours i.e. the first sub-sampling time point. This was then covered with a plastic bag and tapped before being placed back in the incubator. At each sub-sampling time point the spigots and carboys were rinsed with copious amounts of Milli-Q. Sub-samples were taken for APA, nutrients and chlorophyll.

The second time-course experiment was set up at station 6 (see Supplementary Information S8). This experiment was expanded to include sub-sampling for all parameters (APA, chlorophyll, nutrients, DOP, FCM, trace metals, cellular trace metal quota, nitrogen fixation, proteins and genes) and was sampled every 12 hours (10 am and 10 pm local time). The carboys were filled using the trace metal braided PVC tubing deployed on the Kevlar wire to 40m. The carboys were rinsed with trace metal clean fish water prior to filling (23:00 local time) and filling began at 01:30 local time. Each carboy was filled half way first and then filled to distribute the total seawater collected across the total filling time and took 5.2 hours.

Due to the number of sub-samples taken, a carboy was sacrificed for each time point and with the limited number of carboys available triplicate carboys could only be taken every 24 hrs. Therefore every 12 hours, one carboy from each treatment (see Supplementary Information S8) was sacrificed at random and every 24 hours, 3 carboys from each treatment were sacrificed at random. At each sampling time point, samples were collected for:

1) Trace metals
2) Cellular metal quotas
3) Nutrients
4) APA
5) DOP
6) FCM
7) Chlorophyll
8) Nitrogen fixation
9) Proteins
10) Genes

Analyses of inorganic nutrients
Malcolm Woodward and Petroc Shelley, Plymouth Marine Laboratory

Nutrient concentrations were determined throughout the cruise from samples collected from the Ti CTD, bioassay experiments (for ZIPLOc, Stephanie Sargent and Koko Kunde) and FISH samples along the ~ 1800 nm transect. Specifically, micromolar concentrations of phosphate, nitrate, nitrite and silicate were made as well as nanomolar concentrations of nitrate, phosphate, nitrite and ammonium. Phosphate was of specific interest to ZIPLOc.

In addition to collecting and analysing samples for ZIPLOc, we took 3 sets of water samples for certified nutrient reference materials which are to be made available globally through the international SCOR nutrient working group #147. The samples consisted of surface, mid depth (600m) and deep (2500m) Atlantic Ocean water. The seawater was filtered and pasteurised on board using an oven. The seawater will be sent to JAMSTEC, Japan, to allow the preparation of 2 new batches certified Nutrient reference materials. See Supplementary Information S9 for details fo samples collected.

SAMPLING and ANALYTICAL METHODOLOGY:
Sample preparation and procedure

Acid clean 60m ml HDPE Nalgene bottles were used for all the nutrient sampling, these were aged, acid washed and cleaned initially, and stored with a 10% acid solution between sampling. Water column depth profile samples were taken from the OTE bottles from the Trace Metal CTD system and sub-sampled into the Nalgene nutrient bottles from within the trace metal clean laboratory on-board the RRS James Cook. The sample bottle was washed 3 times before taking final sample, and capping tightly. These were then taken immediately to the nutrient analysers in the chemistry lab and analysis conducted as soon as possible after sampling. Nutrient free (Semperguard) gloves were used and other clean handling protocols were adopted as close to those according to the GO-SHIP protocols.

Analytical methods: The micro-molar segmented flow colorimetric auto-analyser used was the PML 5- channel (nitrate, nitrite, phosphate, silicate and ammonium) Bran and Luebbe AAIII system, using classical proven analytical techniques. The instrument was calibrated with home produced nutrient stock standards and then compared regularly against Nutrient Reference Materials, from KANSO Technos, Japan for quality control and checking of analytical standardisation. Specifically batches CA and BU were used during the cruise.

The analytical chemical methodologies used were according to Brewer and Riley (1965) for nitrate, Grasshoff (1976) for nitrite, Kirkwood (1989) for silicate and phosphate, and Mantoura and Woodward (1983) for dissolved ammonium.

Nanomolar analysis was carried out for ammonium using a fluorimetric detection differential gas diffusion technique, based on Jones R.D, 1991. Nanomolar nitrate, nitrite and phosphate were analysed using segmented flow colorimetric techniques with 2 metre Liquid waveguides as the analytical flow cells to improve the analytical detection limits. Nitrate and nitrite used the same colorimetric methods as for the micromolar system and for phosphate we used the Zhang and Chi (2002) method.

Nutrient CRM Samplings: Three different water masses were sampled by a full stainless steel CTD with 24 x 20 litre OTE bottles. The samples were filtered through an Acropak 1000 Capsule Filter, Supor membrane 0.1μm/0.1μm, and the water filled into plastic cubitainers. The water was then pasteurised at about 90°C for 36 hours. Following this the waters were boxed and labelled and then prepared for collection and shipping to JAMSTEC Japan. The waters will then be processed

and bottled as new mid and deep Atlantic seawater CRM's and made available globally through the International SCOR Working Group #147.

Sampling details:
Sample 1: Friday 7th July, 2017. Between: 1201-1320.
Sample taken from a depth of 600 metres, Position: Lat: 22^0 00'N, Long: 54^0 00'W
24 Plastic Cubitainers each containing 15 litres seawater.
Sample 2: Monday 24th July, 2017. Between: 1600-1700.
Sample taken from a depth of 3 metres, Position: Lat: 23^0 02'N, Long: 39^0 47'W
9 Plastic Cubitainers each containing 20 litres seawater.
Sample 3: Tuesday 1st August, 2017. Between: 0335-0455.
Sample taken from a depth of 2500 metres, Position: Lat: 22^0 19.8'N, Long: 35^0 52.199'W
24 Plastic Cubitainers each containing 15 litres seawater.

Cruise Summary, initial results.
The 5-channel autoanalyser, nanomolar ammonium and waveguide analysers worked generally well throughout the cruise. Some problems with phopho-esters and/or cobalt additions may have degraded/poisoned the nutrient autoanalyser copper cadmium reduction column. KANSO nutrient reference materials (Batches BU and CA) were run regularly to check analyser integrity and analytical continuity from one day to the next. Very good continuity in sensitivity for all 5 channels was found, demonstrating good overall analytical performance. Initial ODV profile results for nitrate, phosphate and silicate from the CTD profiles for the cross Atlantic transect stations are shown below:

Thanks:
To the officers, crew and engineers of the RRS James Cook for a safe voyage, and the NMF technicians for their professional approach, and for keeping it all going.

References:

Brewer P.G. and Riley J.P., 1965. The automatic determination of nitrate in seawater. Deep Sea Research, 12, 765-72.

Grasshoff K., 1976. Methods of seawater analysis. Verlag Chemie, Weinheim and New York, 317pp.

Kirkwood D., 1989. Simultaneous determination of selected nutrients in seawater. ICES CM 1989/C:29.

Mantoura, R.F.C and Woodward, E.M.S, 1983. Estuarine, Coastal and Shelf Science, 17, 219-224.

Jones, Ronald. D. (1991), Limnology and Oceanography, 36(4), 814-819.

Jia-Zhong Zhang and Jie Chi, 2002.Automated Analysis of Nanomolar Concentrations of Phosphate in Natural Waters with Liquid Waveguide. Environ. Sci. Technol., 36 (5), pp 1048-1053

Determination of chlorophyll-a concentration and phytoplankton community structure in the subtropical Atlantic Ocean

Luke Johnson and Clare Davis, University of Liverpool

Introduction

It is currently unclear if phytoplankton growth in the subtropical North Atlantic is potentially Zn-P and/or Fe-P co-limited. To investigate this idea, the concentrations of chlorophyll *a* were used as a proxy for phytoplankton biomass during bioassay experiments during JC150. Chlorophyll a concentrations were determined at the start and end of experiments (A, B, C, D and E, see chapter 5 and S6, S7 and S8 for details of experiments) to determine the growth response of phytoplankton to the addition of metals (zinc, iron and cobalt) and nutrients (nitrate, ammonium and organic phosphorus compounds). In addition, concentrations of chlorophyll a were used to assess the vertical distribution of phytoplankton as well as the surface gradients in phytoplankton along the ~1800 nm of the west to east transect (see S3 and S5). Samples were also taken for phytoplankton community structure via flow cytometry analyses to assess the change in community in incubations and also along the 1800 nm transect (see S6, S7, S7 for experiments and S5 for Fish Logs).

Method

(a) Water samples for Ziploc experiments (A,B,C &D) were collected at 40 metres using a Titanium CTD loaded with twenty-four 10L Niskin bottles or a pump hose and surface pump deployed to 40 m (see Chapter 5 for details). Upon return, the Niskin bottles were transferred to a clean container van to be sampled by the trace-metal team. From these bottles numerous samples were constructed (72 for A,B,C, 21 for D), each being treated with varying concentrations of key nutrients and trace metals (NO_3^-, NH_4^+, Fe, Zn, Co, etc.). Samples were incubated (24°C, under light) 48 hours (or varying times during the time course experiment) to allow for measurable biomass growth. T=0 samples were processed immediately to determine the initial chlorophyll concentration. T=48 or time course were collected using 1L amber HDPE sample bottles and filtered immediately.

(b) Water column profiles were collected from 225 metres to 15 metres using a Titanium CTD loaded with varying numbers of twenty four 20L Niskin bottles. Niskin bottles were transferred to a clean container van where the trace-metal team transferred 1L of seawater from each selected depth into a 1L amber HDPE sample bottle. Samples were processed immediately to determine the varying chlorophyll a concentrations through the water column.

(c) Samples for a transmeridian surface transect were collected using a towfish between three and five metres. Seawater was pumped directly into a clean container van where 1L was transferred into an amber HDPE sample bottle by the trace-metal team every two hours whilst in transit (See Supplementary Information S5). Samples were processed immediately to determine the chlorophyll concentrations along the voyage route.

Sample processing – Depending on which experiment the sample being analysed belonged to, between 200mL and 1000mL of seawater was filtered using a vacuum filtration rig through either a 25mm polycarbonate filter (0.2μm pore size) or a 25mm GF/F (0.7μm pore size) – *see table 1.*

After filtration, filters were placed in glass test tubes with plastic screw caps and submerged in 5mL of 90% acetone and stored for 24 hours in a 4°C refrigerator.

Experiment	Typical volume filtered	Filter used
A, B & C	500mL – 1000mL	Whatman 25mm GF/F (0.7µm)
D	200mL	Whatman nucleopore 25mm (0.2µm)
FISH transect	1000mL	Whatman 25mm GF/F (0.7µm)
Water column profile	500mL – 1000mL	Whatman 25mm GF/F (0.7µm)

Table 1. Details of filters used during experiments.

Analysis – Chlorophyll concentrations were determined by measuring the fluorescence of the acetone solution after 24 hours. A Turner Design Trilogy fluorometer was used to give a value in raw fluorescence units (RFU). These RFU values were used to calculate chlorophyll concentrations using a calibration curve derived from the measurement of a standard solution range. Standards between 0.05 µg per L and 1 µg per L were prepared using a pure chlorophyll a standard derived from spinach and dissolved in 90% acetone.

Results

Figure 1. Surface concentration of Chlorophyll along the JC150 voyage route

Figure 2. Chlorophyll concentration through the water column at station 4

Sample collection for flow cytometry

Unfiltered seawater samples were collected for flow cytometry analysis from experiment D (all stations, see S7) and the underway fish sampling surface transect to gain insight into microbial community composition (see S5). In brief, 1.8 mL unfiltered seawater sample collected under trace metal clean conditions was transferred to a 2 mL cryovial containing 20 µL of 50 % glutaraldehyde solution. The vial was then inverted 10 times to allow the bubble to mix the solutions together prior to storage in the dark at 4 ºC for up to 12 hours before storage at -80 ºC until analysis in the laboratory. Analysis will be conducted by Glen Tarran of the Plymouth Marine Laboratory.

Alkaline phosphatase activity and DOP

Clare Davis, University of Liverpool

Phosphorus (P) is an essential macronutrient for all life on Earth due to its role in key cellular components such as genetic biomolecules (DNA and RNA), energy transfer molecules (ATP) and cell structure (phospholipids). Phytoplankton and bacterioplankton can assimilate DIP directly via a high affinity uptake pathway, while assimilation of molecularly more complex dissolved organic phosphorus (DOP) requires that the molecule first be remineralized to separate DIP from the C moiety. Thus, phytoplankton have a strong metabolic preference for the assimilation of DIP over DOP to meet their cellular phosphorus demands. However, when DIP is in short supply, many marine organisms are known to synthesize hydrolytic enzymes in order to access the DOP pool.

Alkaline phosphatases (AP) are a well studied group of metallo-enzymes that hydrolyse phosphomonester bonds and are ubiquitous in the marine environment. The activity of this broad group of nonspecific phosphomonoesterases can be induced by microbial communities under low DIP concentrations and repressed under high DIP concentrations. As such, enhanced alkaline phosphatase activity (APA) has commonly been used as an indicator of DIP-limitation in oligotrophic surface ocean regions. Quantifying the rate of APA involves incubating seawater samples (either filtered or unfiltered) with a synthetic substrate, e.g., 4-methylumbelliferyl-phosphate (MUF-P), that upon hydrolysis of the phosphomonoester bond releases a soluble fluorescent compound, in this case, methylumbelliferone (Ammerman, 1993). Enzyme kinetics can be derived from hydrolysis rate assay experiments and are used to characterize the maximum potential rate of reaction, Vmax, and the inverse of the enzyme affinity for a substrate, Km.

The metal dependence of AP is becoming increasingly prominent (e.g. Mahaffey et al. 2014). As the proteins responsible for APA contain metal co-factors, specifically zinc for the protein PhoA (Coleman 1992) and iron for the protein PhoX (Yong et al. 2014), there is the implication that the availability of these metals may affect APA. Mahaffey et al (2014) demonstrated that APA in the subtropical North Atlantic was limited by the availability of zinc, thus suggesting potential zinc-phosphorus co-limitation. In addition, previous studies demonstrate greater dissolved zinc: phosphate uptake ratios (Jakuba et al. 2008), increased cellular zinc requirements (Twining et al. 2010) and greater production of the zinc containing protein PhoA (Cox and Saito, 2013) in low DIP regions. New evidence also suggests the potential for iron regulation of APA (Yong et al. 2014), therefore suggesting potential co-limitation of APA due to low zinc and/or iron availability and exacerbation of DIP limitation by limiting access to DOP.

Through a series of structured incubation experiments involving spiking of natural communities with zinc and iron metal additions along a transmeridional transect, our aim was to determine the prevalence of zinc and iron limitation of APA in the phosphate deplete subtropical North Atlantic Ocean, and the implications of this potential co-limitation on biological activity, specifically phytoplankton growth, primary production and nitrogen fixation.

1.1. Method: Overview

Total APA was measured in unfiltered seawater samples using the synthetic fluorogenic substrate 4- methylumbeliferyll-phosphate (MUFP, Sigma Aldrich), as described in Ammerman (1993). Stock solutions of MUFP at 100 mM in 2-methoxyethanol were prepared and subsequently diluted with deionized water to make a 200 μM stock in Milli-Q deinionsed water prior to each experiment. In brief, 125 mL, 250 mL or 1 L of seawater was spiked with the MUFP substrate to final concentrations of 500 nM or 2000 nM MUFP for single substrate additions, or a series of replicates were incubated over a final MUFP concentration range from 100 nM to 2000 nM for the determination of enzyme kinetic parameters, Vmax and Km. Once spiked, samples were incubated in polycarbonate bottles in triplicate in the temperature and light adjusted reefer container for up to 12 hours.

Hydrolysis of MUFP to the fluorescent product, 4- methylumbelliferone (MUF), was measured at regular intervals (typically every 90 minutes) over a period of up to 8 - 12 hours. This was conducted using a Turner 10Au field fluorometer (365 nm excitation, 455 nm emission) after addition of a buffer solution (3 : 1 sample: 50 mM sodium tetraborate solution, pH 10.5). A calibration was produced at the start and end of the cruise using MUF standards (concentration range 0–1000 nM) to ensure linearity of the fluorescence of MUF over the expected concentration range. Fluorescence response factors were determined daily using freshly prepared 200 nM MUF stocks and was used to convert the rate of change in fluorescence to MUFP hydrolysis rate, here considered to be synonymous with volumetric APA (nM P h^{-1}). Boiled seawater blanks (500 nM MUFP) were incubated in parallel with samples to ensure that there was no significant change in fluorescence due to abiotic degradation or hydrolysis over time.

Enzyme kinetic parameters were determined using data from the incubation of seawater with variable concentrations of MUFP (100–2000 nM MUFP). Estimation of Michaelis- Menten parameters of APA was performed using transformations of the Michaelis-Menten equation to produce substrate-response curves or linear regression plots. Here, the maximum hydrolysis rates (Vmax) and half saturation constant (Km) were determined using the Hanes-Woolf plot graphical linearization of the Michaelis-Menten equation following Duhamel et al. (2011). All APA data and derived kinetic parameters were later normalised to chlorophyll-*a* concentrations.

Figure 1, Change in 4-methylumbelliferone fluorescence over time for a surface CTD sample.

Figure 2, Summary of kinetics test to determine saturating MUFP concentration.

APA kinetics test 20°36 N 58°39 W

1.2. Experiments A, B, C

Experiments A, B, and C involved the incubation of seawater spiked with zinc, iron and cobalt, respectively, in 2 L polycarbonate bottles over a 48-hour period. At the breakdown of the incubation, 1 L was removed from the incubation bottle for nutrient and chlorophyll-*a* analysis and the remaining 1 L was spiked with MUFP (final concentration 500 nM) directly and incubated in the same bottle to reduce risk of contamination. APA was determined for every sample in experiments A, B and C.

1.3. Experiment D

Experiment D involved the incubation of seawater spiked with zinc, iron and cobalt and in some cases also inorganic nitrogen and organic phosphorus esters in 20 L polycarbonate bottles for 48-hours. At the breakdown of the incubation, each carboy was subsampled under trace metal clean conditions. Five replicate 125 mL polycarbonate bottles were filled from the first of each triplicate to be subsampled and spiked with final concentrations of MUFP of 100 nM, 200 nM, 500 nM, 1000 nM and 2000 nM for the determination of enzyme kinetics. Subsequent samples within a triplicate were incubated in 250 mL polycarbonates with a final MUFP concentration of 500 nM. APA was determined for every sample in experiment D.

1.4. CTD

Unfiltered seawater samples were collected from all but one of the shallow (<1000 m) titanium CTD casts. Five replicate 125 mL or triplicate 250 mL polycarbonate bottles were filled from each Niskin bottle that was sampled under trace metal clean conditions for the determination of enzyme kinetics where the final MUFP concentration ranged from 100 – 1000 nM, while 250 mL samples were incubated for single MUFP concentration additions (see Table 1).

Table 1. Summary of APA sampling from CTD casts.

Date	Station	CTD number	Number of depths	MUFP concentration (nM)
02-07-2017	1	9	9	2000
14-07-2017	3	27	7	100, 200, 500, 800, 1000

18-07-2017	4	31	8	100, 200, 500, 800, 1000
23-07-2017	5	37	3	500
23-07-2017	5	38	7	500
01-08-2017	6	48	8	500
06-08-2017	7	52	7	500

1.5. Surface transect from the trace metal clean fish underway pump system

Unfiltered trace metal clean surface water samples were collected from the fish during transit between stations to form a surface transect in APA, amongst other parameters. Samples were incubated in 250 mL polycarbonate bottles with a final MUFP concentration of 2000 nM between stations 1 and 2, and thereafter 500 nM. Boiled seawater blanks were conducted in parallel with each sample during these experiments at the same MUFP concentration. A detailed sample list is available via the fish log sheets.

1.6. *Trichodesmium spp.* incubations

Nitrogen fixation is a significant global source of new nitrogen in the marine environment. *Trichodesmium* (*Tricho.*) are important diazotrophic cyanobacteria that convert N_2 to ammonium (NH_4^+). As such, the growth of nitrogen fixers is never limited by nitrogen but is limited by other nutrients, the two most significant nutrients being iron and phosphorus. Therefore, understanding the capacity of *Tricho.* communities in the chronically low PO_4^{3-} subtropical North Atlantic to utilise the ambient dissolved organic phosphorus pool to meet their cellular P requirements is key to enhancing our understanding of global nutrient cycles.

During this cruise, several experiments were conducted to determine the APA for *Tricho.* colonies sampled using either a 200 µm mesh sized trace metal clean and/or a 63 µm mesh sized plankton net. These experiments were conducted to compliment the genomic work of D. Polyviou and S. Sargeant. Amongst these experiments were nutrient addition incubation experiments where *Tricho.* picked from 15 m hauls conducted with a 200 µm mesh trace metal clean net were incubated in 0.2 µm filtered trace metal clean surface water and spiked with zinc, iron, phosphate, organic phosphorus, inorganic nitrogen and incubated for 24 hours. APA was determined in these experiments at T_{zero} (i.e. the initial APA of *Tricho.* prior to nutrient addition) and at T_{final} (i.e. after 24 hours) in each treatment with final MUFP concentrations of 500 nM. Colonies were incubated in colony densities of either 20 or 50 colonies per 150 mL in the light and temperature controlled reefer container (see Table 2).

Table 2. Summary of *Trichodesmium* nutrient incubation experiments.

Date	Station	MUFP concentration (nM)	Number of colonies per incubation	Nutrient additions
29-06-2017	1	500	50	Control, $+PO_4^{3-}$, +Fe, $+FePO_4^{3-}$
03-07-2017	1	500	50	Control, $+PO_4^{3-}$, +Zn, $+ZnPO_4^{3-}$
06-07-2017	2	500	20	Control, $+PO_4^{3-}$, +Zn, +Fe, $+ZnPO_4^{3-}$, $+FePO_4^{3-}$
12-07-2017	3	500	20	Control, +inorganic N, +organic P, +Fe, $+FePO_4^{3-}$, +Zn, $+ZnPO_4^{3-}$

15-07-2017	3	500	20	Control, +inorganic N, +organic P, +Fe, +FePO$_4^{3-}$, +Zn, +ZnPO$_4^{3-}$
20-07-2017	4	500	20	Control, +inorganic N, +organic P, +Fe, +FePO$_4^{3-}$, +Zn, +ZnPO$_4^{3-}$ plus filtered seawater only treatments
25-07-2017	5	500	20	Control, +inorganic N, +PO$_4^{3-}$, +organic P, +Zn, +ZnPO$_4^{3-}$, +Fe, +FePO$_4^{3-}$ plus filtered seawater only treatments

Tricho were also sampled on separate occasions from both incubation experiments and net hauls over a diel or part diel cycle, respectively, and incubated in triplicate in 0.2 µm filtered trace metal clean surface seawater with final MUFP concentrations of 100 nM to accompany the Fv/Fm measurements obtained by E. Cerdan-Garcia. As above, for the net partial diel cycle experiments *Tricho.* colonies were picked after 15 minute net hauls at 15 m using a 200 µm mesh trace metal clean net. Colonies were incubated at densities of either 10 or 20 per 150 mL of filtered trace metal clean surface seawater in polycarbonate bottles in the light and temperature controlled reefer container (see Table 3).

Table 3. Summary of *Trichodesmium* diel cycle incubations.

Date	Station	MUFP concentration (nM)	Number of colonies per incubation	Sample type
01-07-2017	1	500	50	Incubation
24-07-2017	5	100	10	Net
29-07-2017	6	100	10	Net
06-08-2017	7	100	20	Net

Figure 3, A summary of *Tricho* part-diel incubations sampled from the net on a) 24th July at Station 5 and b) 6th August at Station 7.

a) APA from diel nets 24-Jul

b) APA from diel nets 06-Aug

In addition to these, *Tricho* were collected from a range of depths using both the 200 μm mesh trace metal clean net and the 63 μm plankton net. *Tricho.* were incubated with 20 colonies in 125 mL of filtered trace metal clean seawater to determine whether APA rates of *Tricho* colonies varied with depth. These experiments were conducted in compliment to samples collected by N. Held for proteomic analysis. APA was determined after MUFP additions made up to a final concentration of 100 nM (see Table 4).

Table 4. Summary of *Trichodesmium* depth experiment incubations.

Date	Station	MUFP concentration (nM)	Number of colonies per incubation	Haul depth (m)	Net mesh type
07-07-2017	2	500	20	15	200 μm
07-07-2017	2	500	20	200	63 μm
24-07-2017	5	500	20	15	200 μm (predawn and noon)
24-07-2017	5	500	20	200	63 μm (predawn and noon)
29-07-2017	6	500	20	15	200 μm (predawn and noon)
29-07-2017	6	500	20	200	63 μm (predawn and noon)
31-07-2017	6	500	20	15	200 μm (morning and afternoon)
31-07-2017	6	500	20	200	63 μm (morning and afternoon)
07-08-2017	7	100	20	15	200 μm
07-08-2017	7	100	20	40	200 μm
07-08-2017	7	100	20	90	200 μm
07-08-2017	7	100	20	160	200 μm

For further detail on any of these experiments see "*Trichodesmium* nutrient incubations", "*Trichodesmium* diel cycle", and "*Trichodesmium* depth experiment" sections.

1.7. Zooplankton incubations

The role of APA in remineralisation is still relatively poorly understood. Many marine microbes other than PO_4^{3-} limited phytoplankton are known to produce APases. Through a series of incubation experiments during the cruise, we investigated whether zooplankton were a potential source of APA to the water column to ascertain whether they may play an important role in the remineralisation of organic phosphorus at the base of the euphotic layer.

Net hauls were conducted before dawn from 200 m depth using a 63 μm mesh plankton net on a Kevlar winch system with a haul speed of 10 m/min. Zooplankton were picked by E. Cerdan-Garcia and washed twice in 0.2 μm filtered trace metal clean surface sea water prior to transfer to their respective incubation bottles. All incubations were conducted in triplicate with specific replicate numbers of zooplankton being incubated in either 250 mL or 1 L of 0.2 μm filtered trace metal clean surface seawater and unfiltered surface seawater in polycarbonate bottles, with associated controls incubated in parallel. Incubations were conducted in the dark and at controlled temperature in the reefer container. After a consistent 30 minute acclimation period, incubation bottles were spiked with MUFP to a final concentration of 2000 nM and incubated for up to 8 hours, during which time regular fluorescence readings were taken using the Turner 10Au fluorometer. Due to variability in zooplankton abundance the density of zooplankton in each incubation varied between stations (see Table 5).

Table 5. Summary of zooplankton incubation experiments.

Date	Station	Net mesh (μm)	Haul depth (m)	Zooplankton density (L^{-1})	Incubation volume (L)
07-07-2017	2	63	200	9	0.25
07-07-2017	2	63	15	9	0.25
09-07-2017	2	63	200	8, 16, 24, 32	0.25
14-07-2017	3	63	200	5	1
19-07-2017	4	63	200	5	1
24-07-2017	5	63	200	3	1
31-07-2017	6	63	200	6	1
06-08-2017	7	63	200	15	1
07-08-2017	7	200	200	2, 4, 6	1

2. Dissolved organic phosphorus (DOP)

Phytoplankton and bacterioplankton utilize dissolved inorganic phosphate (DIP) as a P source to support growth in preference to dissolved organic phosphorus (DOP; Bjorkman and Karl 1994). DOP is an array of organic molecules that range in size and complexity from relatively labile compounds like phosphomonesters to more refractory molecules like phosphonates (Kolowith et al. 2001). In the surface subtropical open ocean, DOP production is often decoupled from consumption. In combination with a long-lived refractory DOP pool (40 nM; Karl and Bjorkman 2002), this decoupling results in DOP concentrations that can be 5 – 10 times higher than those of DIP (Mather et al. 2008; Reynolds et al. 2014), which may be chronically low (< 10 nM, Mahaffey et al. 2014). Therefore, it was important to determine the ambient DOP concentrations during our sampling campaign in addition to any changes in the DOP pool during our incubation experiments to gain insight into the potential availability and utilisation of this phosphorus pool.

Unfiltered seawater samples were collected under trace metal clean conditions for determination of DOP concentrations from each bottle of experiment D, the shallow (<1000 m) titanium CTD casts, and from the underway fish sampling (see respective log sheets for more detailed sample lists). Samples were collected in 125 mL HDPE bottles (acid washed, Fisher Scientific) and stored at -20 °C for later analysis in the laboratory.

In brief, total dissolved phosphorus (TDP) will be determined using the high temperature acid persulfate technique as described in Lomas et al (2010) with the following modifications. Standards will be prepared in P-free artificial seawater using potassium monobasic phosphate ($KHPO_4$, Sigma Aldrich). Samples and standards will be autoclaved (121°C, 40 min) in 40 mL aliquots in tightly sealed 50 mL glass Pyrex® bottles with Teflon® lined screw caps after addition of 5 mL potassium persulfate solution (64 g/L). Following oxidation samples will be left to cool overnight and then precipitated using the MAGIC technique (Karl and Tein 1992) by addition of 5 mL 1M NaOH solution (Sigma Aldrich). Following centrifugation (1000 x g, 60 min), the supernatant will be discarded and the sample/standard pellet will be completely dissolved in 40 mL 0.1 M HCl (Trace metal grade, Sigma Aldrich). Analytical blanks will be determined as described in Lomas et al (2010).

Total dissolved phosphorus will be determined in triplicate as dissolved inorganic phosphorus (DIP) concentrations after persulfate oxidation of the samples by the molybdenum blue method (Murphy and Riley, 1962) using a Bran and Leubbe QuAAtro 5-channel autoanalyser (DIP detection limit 50 nM). Dissolved organic phosphorus (DOP) will be taken as the difference between TDP and DIP determined prior to persulfate oxidation (i.e. DOP = TDP - DIP; DOP detection limit 40 nM). In this case, DIP values will be taken from the phosphate data of Malcolm Woodward, PML, obtained during the cruise.

3. Acknowledgements

Measurement of rates of nitrogen fixation
Lewis Wrightson and Claire Mahaffey

Introduction

Marine nitrogen fixation is the major source of new nitrogen to the marine environment. In the ocean nitrogen is fixed by organisms known as diazotrophs such as the cyanobacteria *Trichodesmium.* In order to fix nitrogen diazotrophs require the enzyme nitrogenase. Nitrogenase has a high iron requirement and hence iron can limit nitrogen fixation and can lead to further nitrogen limitation in oligotrophic regions, such as the sub-tropical North Atlantic. Iron and phosphate have been shown to co-limit nitrogen fixation revealing interesting dynamics that can occur between two elements. In response to phosphate limitation, nitrogen fixers produce an enzyme called alkaline phosphatase that allows them to access the large pool of organic phosphorus in the ocean. However, alkaline phosphatase has a zinc and iron requirement and recent evidence suggests that alkaline phosphatase activity may be limited by the availability of these two metals. Here, we investigate the impact of the alleviation of zinc and iron limitation of alkaline phosphate on the rate of nitrogen fixation using a series of metal addition bioassays.

Methods

Samples were collected from experiment D incubations (see S7) and from one FISH (See S5) collection during transit between each station. For each treatment and FISH cast samples were taken in triplicate except for station 2 and 3 where samples were taken in duplicate. Firstly each 4.5 L bottle was overfilled using silicon tubing ensuring that no bubbles were trapped within the bottle. Bottles were then sealed using a septum cap (part no: DS2168-0384 autoclave septum closure, Thermo scientific) ensuring that no headspace remained in the bottle. Each 4.5 L bottle was then spiked with 8 mL of $^{15}N_2$ gas (product no: NLM-363-0, lot No: I-21065/AR0664758, 2 bottles were used switched bottles at station 4) through the septum cap using a 10 mL gas tight syringe (part no: 81656, Hamilton) Samples were then strapped to a cable drum and rolled for 15 minutes to allow for sufficient mixing of the gas and the sample (Figure 1). After 15 minutes the samples were removed from the cable drum and a sub sample was removed using a 20 mL pipette and transferred to a 12 mL vacutainer which was sealed with no bubbles. The 4.5 L bottles were then topped up using the remaining sea water from the corresponding incubations, the minimum volume was used to remove the headspace and the bottles were once again sealed with no bubbles. The samples were then incubated for 24 hours using light banks which were switched on during hours of daylight. After 24 hours the samples were vacuum filtered through Whatman GFF 0.7 µM pore size 25 mm diameter (cleaned at 450 °C for 24 hours). Filters were placed in foil lined petri dishes and frozen for analysis at the University of Liverpool. For sample collection from the FISH ~18 L of seawater was collected in a 20 L carboy with a tap. Three 4.5 L bottles were then filled using the same method as above.

The sub-samples collected from each bottle were analysed using a Hiden Analytical MIMS (Membrane inlet mass spectrometer) which was used to determine the isotopic composition of N_2 gas present in each sample and therefore allowing the percentage enrichment of $^{15}N_2$ gas to also be determined. For station samples, the atom % enrichment of ^{15}N ranged from 4.37 and 15.17 %. Atom % enrichment of ^{15}N for FISH samples varied from 5.05 to 16.01 %.

Number of nitrogen fixation collected at each station is shown in Table 1. FISH sample number when samples for nitrogen fixation were obtained is provided in Table 2.

Figure 1: 4.5 L bottles used for nitrogen fixation incubations strapped to cable drum used to roll samples.

Table 1: Number of nitrogen fixation samples collected at each station. Date of collection and station location is also shown.

STATION No.	Experiment	Date	Lat (° N)	Lon (° W)	Number of Nitrogen fixation samples
1	EXP D	03/07/2017	22° 0.00'	58° 0.00'	24
2	EXP D	11/07/2017	22° 0.00'	54° 0.00'	27
3	EXP D	15/07/2017	22° 0.00'	50° 0.00'	27
4	EXP D	20/07/2017	23° 22.00'	47° 57.00'	39
5	EXP D	25/07/2017	23° 0.00'	40° 0.00'	24
6	EXP D-UP	28/07/2017	22° 19.80'	35° 52.30'	36
6	EXP D	02/08/2017	22° 19.80'	35° 52.30'	30
7	EXP D	05/08/2017	22° 0.00'	31° 0.00'	24

Table 2: FISH sample number when samples were collected for nitrogen fixation, showing date and time of collection.

FISH No	Date	Time (GMT)	Number of Nitrogen fixation samples
017	03/07/2017	18:00	3
028	04/07/2017	17:15	3
040	11/07/2017	18:00	3
064	16/07/2017	15:00	3
082	21/07/2017	15:00	3
100	26/07/2017	14:00	3
121	03/08/2017	16:00	3

Determination of dissolved oxygen concentrations in seawater
Claire Mahaffey

Concentrations of dissolved oxygen were determined from seawater samples collected from Niskin bottles attached to the titanium CTD only in order to calibrate the oxygen sensor attached to the rosette frame. Water samples were collected from CTD006T, 019T, 031T, 037T and 046T. Seawater was collected from at least 12 depths between 5868m and 100m and samples were collected in triplicate. Procedures for reagent preparation, sample collection and sample analysis are outlined below.

1. Reagent preparation
Reagents were prepared on board using the following recipes:

Manganese chloride reagent (3 M): Dissolve 600 g of manganese chloride tetrahydrate ($MnCl_2.4H_2O$) in 400 ml distilled water and make up to 1 liter in a volumetric flask.

Alkaline iodide reagent: Dissolve 320 g sodium hydroxide (NaOH) in 500 ml distilled water (HEAT EVOLVED, ADD NaOH slowly) and, separately, dissolve 600 g sodium iodide in 500 ml distilled water. Mix the two solutions 1:1, by volume.

Sulfuric acid reagent (10 N): a 10N sulphuric acid solution was purchased so no dilution was required.

Sodium thiosulfate reagent (0.2N)
Dissolve 12.41 g of reagent grade sodium thiosulfate ($Na_2S_2O_3. 5H_2O$ and make up to one liter with distilled water.

Potassium iodate reagent (0.025 N)
Dissolve 0.8918 g of dry (100°C, 2 hours) KIO_3 into 800 ml distilled water and bring up to 1 liter in a volumetric flask.

A potassium iodate standard was purchased from OSIL (**CSK 0.0100 N KIO_3 1° standard)** for standardization of sodium thiosulphate.

2. Sample collection
Seawater samples for determination of oxygen were collected by the trace metal team from the OTE bottles in the trace metal clean container. Samples were taken from the deepest to the shallowest depth. Three samples were taken per depth. A sample tube was placed into the bottom of the bottle and water from the OTE bottle was used to fill and flush the bottle three times before filling. The sample bottle was capped and the sample bottle number was recorded. All samples were capped before coming out of the trace metal clean container.

Using automated dispensers and ensuring the tip of the dispenser is in the water sample, 1ml of MANGANESE CHLORIDE and 1 ml of ALKALINE IODIDE was added to 3 bottles from one depth. The stopper was immediately placed on the bottle and samples were shaken vigorously for 30 seconds. After the brown precipitate had formed, samples were shaken again for a further 30 seconds. Samples were stored underwater for at least 6 hours and up to 48 hours before analysis.

3. Reagent blanks and standardisation of sodium thiosulphate.
A Metrohm Titrando Titrator was used for automated titrations and a platinum electrode was used for potentiometric analysis of the Winkler titration.

Five glass bottles were rinsed with MQ water and 100ml of MQ water was added to each bottle. Reagents were added in the following order, ensuring that the bottles were stoppered and shaken between addition of each reagent: 1 ml of 10 N sulphuric acid, 1 ml of alkaline iodide and 1 ml of manganese chloride. If a yellow colour developed, the solution was discarded and process started again. The glass bottle containing 100ml of MQ water plus reagents was placed on the Metrohm stir plate and a magnetic stir bar was added to the bottle. 5ml of 0.025N Potassium Iodate standard was

added to the bottle and the solution turned brown. The method 'Reagent Blank' was selected. The electrode and dispenser were inserted into the bottle and the titration was started.
Two additional aliquots of the standard was added and at the end of the titration, the values for V1, V2, V3 and V1-V1 and V2-V3 were recorded in the laboratory book. The determination of the blank was repeated at least 3 times.

For standardisation of the sodium thiosulphate, 5 glass bottles were rinsed and completed filled with MQ water. Reagents were added in the following order, ensuring that the bottles were stoppered and shaken between addition of each reagent: 1 ml of 10 N sulphuric acid, 1 ml of alkaline iodide and 1 ml of manganese chloride. If a yellow colour developed, the solution was discarded and process started again. The solution from one bottle was poured into a clean plastic beaker and a magnetic stirrer was added.
The method 'Standardisation of thiosulphate' was selected. In the boxed titled Normality, 0.01 was inserted as the concentration of the KI commercial standard. In the box titled 'Sample Size', 5 was entered and in the box titled 'Sample Size Unit', ml was entered. 5ml of 0.01 N potassium iodate was added to the beaker. The beaker was placed on the stir plate. The electrode and dispenser were inserted into the beaker and the titration was started.
The titration was complete once the solution turned clear and the volume of titre as EPI volume and concentration of thiosulphate was recorded in the laboratory book. The titration was completed at least 3 times until the coefficient of variation was better than 1%.

4. Determination of oxygen in seawater.

Samples were analysed after 6 hours and before 48 hours after collection. 1ml of 10 N sulphuric acid was added to the sample bottle and the bottle was shaken until the brown precipitate dissolved. The method 'Dissolved oxygen' was selected on the software. A magnetic stirrer was added to the bottle and the titration was performed directly in the glass bottle. The electrode and dispenser were inserted into the bottle and the titration was started. The EP1 volume (ml) was recorded against each sample bottle number. The CTD number, Niskin bottle and depth were matched to the sample bottle number using the cast sheet. The concentration of oxygen (μmol L^{-1}) was calculated using the following equations in which all volumes are in ml and concentrations are in units of normality

$$\frac{(\text{End Point vol} \times 1000 - \text{Reagent Blank} \times 1000) \times Thiosulphate\ Normality \times 0.25)}{(Bottle\ volume \div 1000) - 0.002 - DO_R}$$

$$where\ DO_R = 1000 \times 2 \times 0.0758 \div bottle\ volume$$

The CTD oxygen concentrations were converted to μmol L^{-1} and were correlated with bottle oxygen concentrations. The regression equation was used to calibrated the CTD oxygen data.

Figure 1. Relationship between CTD oxygen concentration and bottle oxygen concentration for JC150 titanium CTDs only.

In Situ Protein Sampling
Noelle Held

Introduction

In situ samples for proteomics were acquired throughout the cruise transect. The goal is two fold – 1. To acquire a picture of cell physiology (the global proteome) and associated changes through observed nutrient gradients and 2. To quantify PhoX, PhoA, and associated proteins in the microbial populations probed by the core Ziploc experiments (the targeted proteome).

This data will provide important context for the biological interpretations of the Ziploc project results. For instance, we expect to observe changes in alkaline phosphatase concentration concurrent with observations of alkaline phosphatase activity throughout the transect (answering the question "where" the alkaline phosphatase is). However, as no one has yet attempted to match alkaline phosphatase activity to protein abundance, it is possible that a non-linear correlation will be observed. These samples thus provide a unique opportunity to study the coherence between protein activity and concentration in the ocean. Thanks to small changes in the amino acid sequence of alkaline phosphatase, we may also be able to establish the contribution of various plankton groups to the total alkaline phosphatase (answering the question "who" the alkaline phosphatase belongs to).[1]

The global proteome will provide a picture of the relative abundance of thousands of proteins in the ambient seawater. Based on these results, a subset of proteins will be selected for absolute quantitation. Targets of interest at this time include iron, phosphorous and zinc related biomarkers, specifically the iron stress proteins Flavodoxin and IdiA[2], the phosphorous sensors PhoB and PhoR, nitrogen stress protein P-II[3], and and zinc containing proteins such as DNA polymerase III. Using novel phosphoproteomics methods currently being adapted in the Saito lab, we may even be able to observe the cell signaling phosphorylation of PhoB and PhoR, the two component sensory system that controls transcription of alkaline phosphatase in cyanobacteria.[4] These samples also provide us with an opportunity to explore regulatory networks involving phosphate, iron, and zinc regulatory proteins, which may represent a specific adaptation to co-limitation in the ocean.[5]

Another important outcome of the in situ sampling is evaluation of the stability of the proteome at the experimental depth (typically 40m). In situ samples were generally taken on the same day as each of the core Ziploc experiments, giving us a picture of the ambient microbial population. The long stations on JC150 also provided us with a unique opportunity for the emerging field of marine metaproteomics. Recent discussions have raised the question of the impact of natural variability on biological interpretations made by comparisons of in situ "omics" samples taken on different days. Since we were able to take multiple 40m protein samples at each station, we will be able to gain a picture of the variability at this depth, which may inform interpretation of this dataset and others.

Methods

In situ McLane pumps were deployed, generally three at time, at various depths from surface to 400m (see Supplementary Information S10 for details of deployments and volumes pumped etc). Sampling was concentrated at the experimental depths in the euphotic zone as well as near the deep chlorophyll maximum. Pumps were outfitted with two filter heads – one trace metal clean mini-MULVS filter head and one standard McLane filter head. In general, over 500L of seawater passed through 51μm (Nitex), 3 μm (Versapor), and 0.2 μm (Supor) filter stacks on each filter head. The mini-MULVS filter heads were used for primary sampling operations, including samples for proteins, phosphoproteins, metallomics, particulate metals, and DNA/RNA samples for Liz Mann and Julie Robidart. The standard McLane filter heads were used to collect extra biomass for the method development and testing. A diagram of the filter splits and a summary of samples collected is provided below. The filters were kept on ice throughout processing, and filter splits immediately frozen at -80C. The samples will be transported back to Woods Hole Oceanographic

Chapter 11: Proteins

Institution in a dry shipping dewar, where proteins will be extracted and analyzed as previously described.[3] Targeted and global proteomics data will be made available to project partners, and after publication will be made publicly available in the Ocean Protein Portal currently under development.

Many thanks to Owain Shepherd and Dave Childs for technical assistance well above the call of duty, and to Mick and the rest of the deck crew for fantastically smooth deploy and recovery. Thanks also to Liz and Annie for help deploying, recovering, and processing the samples.

Diagram 1. McLane filter fraction diagram for 0.2 µm and 3 µm Mini-MULVS filter head samples. 51 µm filters were split in half for proteomics and phosphoproteomics sampling. Standard McLane filter head samples were collected by splitting the filter in half (3 µm filter) or quarters (0.2 µm filter) for ease of transportation and extraction.

Summary of sample profiles collected

Sample type	# Samples
Protein	182
Phosphoprotein	182
Metal	135
Metallome	135
DNA (Robidart)	135
DNA (Mann)	135
Sandbox	336

References
1. Saito, M. a. *et al.* Needles in the blue sea: Sub-species specificity in targeted protein biomarker analyses within the vast oceanic microbial metaproteome. *Proteomics* n/a-n/a (2015). doi:10.1002/pmic.201400630
2. Webb, E. A., Jakuba, R. W., Moffett, J. W. & Dyhrman, S. T. Molecular assessment of phosphorus and iron physiology in Trichodesmium populations from the western Central and western South Atlantic. *Limnol. Oceanogr.* **52,** 2221–2232 (2007).
3. Saito, M. A. *et al.* Multiple nutrient stresses at intersecting Pacific Ocean biomes detected by protein biomarkers. *Science* **345,** 1173–7 (2014).
4. Martiny, A. C., Coleman, M. L. & Chisholm, S. W. Phosphate acquisition genes in Prochlorococcus ecotypes: Evidence for genome-wide adaptation. *Proc. Natl. Acad. Sci.* **103,** 12552–12557 (2006).
5. Chakraborty, S., Sivaraman, J., Leung, K. Y. & Mok, Y. K. Two-component PhoB-PhoR regulatory system and ferric uptake regulator sense phosphate and iron to control virulence genes in type III and VI secretion systems of Edwardsiella tarda. *J. Biol. Chem.* **286,** 39417–39430 (2011).
6. Walworth, N. G. *et al.* Mechanisms of increased Trichodesmium fitness under iron and phosphorus co-limitation in the present and future ocean. *Nat Commun* **7,** 1–11 (2016).

Mn and Ni Addition Incubations
Noelle Held

Introduction

As part of my thesis work, I have been characterizing various two component regulatory systems in *Trichodesmium* and other marine microbes. Of particular interest is the *Trichodesmium* manganese sensor, composed of the histidine kinase ManS and the response regulator ManR. I have also identified a putative nickel sensing two component system in this organism. To supplement laboratory studies of these sensory systems, I performed Mn and Ni addition incubations of *Trichodesmium* at each JC150 station. I also performed whole seawater Ni addition incubations to assess the effect on the whole community. The incubations will be processed for proteomics and phosphoproteomics (see In Sito Protein Sampling for more details) to determine the effect of the metal additions on these sensory systems.

Methods

Trace metal clean, 0.2uM filtered surface water was collected near station from the Tow-Fish and placed into overfilled TM clean 250mL PETG bottles. Trichodesmium colonies were collected, generally in mid to late morning, from a 200uM clean net deployed at 15m for 15 minutes. 30-50 *Trichodesmium* colonies were picked under trace metal clean conditions, rinsed twice, and added to the bottles. Metals were added as metal chlorides in pH 2 adjusted Q water in the following concentrations: Ni (2nM), Mn (5nM), Fe (1nM). For whole seawater incubations, 4L fresh TM clean unfiltered seawater was collected from the tow-fish and immediately spiked with 2nM Ni. Incubations ran for 12-48 hours, then promptly filtered onto 0.2 μm supor filters, flash frozen, and stored at -80C. The samples will be transported back to Woods Hole Oceanographic Institution in a dry shipping dewar, where proteins will be extracted and analyzed as previously described.[1]

Reference:

[1]Saito, M. A. *et al.* Multiple nutrient stresses at intersecting Pacific Ocean biomes detected by protein biomarkers. *Science* **345,** 1173–7 (2014).

Summary of *Trichodesmium* Incubations by Station

Station 1

Treatments	Date started	Duration (h)	# colonies	Proteins
T0	7/2/17	24	50	x
Control	7/2/17	24	50	x
Mn	7/2/17	24	50	x
Ni	7/2/17	24	50	x
Mn+Ni	7/2/17	24	50	x

Station 2

Treatments	Date started	Duration (h)	# colonies	Proteins
T0	7/6/17	24	50	x
Control	7/6/17	24	50	x
Mn	7/6/17	24	50	x
Ni	7/6/17	24	50	x
Mn+Ni	7/6/17	24	50	x

Station 3

Treatments	Date started	Duration (h)	# colonies	Proteins
T0	7/10/17	12	20	x
Control	7/10/17	12	20	x
Mn	7/10/17	12	20	x
Ni	7/10/17	12	20	x
Mn+Ni	7/10/17	12	20	x
Control	7/10/17	24	20	x
Mn	7/10/17	24	20	x
Ni	7/10/17	24	20	x
Mn+Ni	7/10/17	24	20	x

Station 4

Treatments	Date started	Duration (h)	# colonies	Proteins	FRRF
T0	7/19/17	24	30	x	x
Control	7/19/17	24	30	x	x
Mn	7/19/17	24	30	x	x
Ni	7/19/17	24	30	x	x
Fe	7/19/17	24	30	x	x
Mn + Ni	7/19/17	24	30	x	x
Mn + Fe	7/19/17	24	30	x	x
Ni + Fe	7/19/17	24	30	x	x

Station 5

Treatments	Date started	Duration (h)	# colonies	Proteins	FRRF
T0	7/24/17	24	30	x	x
Control	7/24/17	24	30	x	x
Mn	7/24/17	24	30	x	x
Ni	7/24/17	24	30	x	x
Fe	7/24/17	24	30	x	x
Mn + Ni	7/24/17	24	30	x	x
Mn + Fe	7/24/17	24	30	x	x
Ni + Fe	7/24/17	24	30	x	x

Station 6

Treatments	Date started	Duration (h)	# colonies	Proteins	FRRF
T0	7/29/17	48	30	x	x
Control	7/29/17	48	30	x	x
Mn	7/29/17	48	30	x	x
Ni	7/29/17	48	30	x	x
Fe	7/29/17	48	30	x	x
Mn + Ni	7/29/17	48	30	x	x
Mn + Fe	7/29/17	48	30	x	x
Ni + Fe	7/29/17	48	30	x	x
Treatments	Date started	Duration (h)	# colonies	Proteins	FRRF
T0	8/1/17	24	30	x	x
Control	8/1/17	24	30	x	x
Mn	8/1/17	24	30	x	x
Ni	8/1/17	24	30	x	x
Fe	8/1/17	24	30	x	x
Mn + Ni	8/1/17	24	30	x	x
Mn + Fe	8/1/17	24	30	x	x
Ni + Fe	8/1/17	24	30	x	x

Station 7

Treatments	Date started	Duration (h)	# colonies	Proteins
T0	8/4/17	24	30	x
Control	8/4/17	24	30	x
Ni	8/4/17	24	30	x
Fe	8/4/17	24	30	x
Ni + Fe	8/4/17	24	30	x
Treatments	Date started	Duration (h)	# colonies	Proteins
T0	8/6/17	24	30	x
Mn	8/6/17	24	30	x
Fe	8/6/17	24	30	x
Mn + Fe	8/6/17	24	30	x
Control	8/6/17	24	30	x

Summary of Whole Seawater Incubations by Station

Station 5						
Treatments	Date started	Duration	Volume (L)	Proteins	Chl-a	Cell quotas
Control	7/23/17	24	4	x	x	x
Ni	7/23/17	24	4	x	x	x

Station 6				
Treatments	Date started	Duration	Volume (L)	Proteins
Control	7/28/17	24	4	x
Ni	7/28/17	24	4	x
Treatments	Date started	Duration	Volume (L)	Proteins
Control	7/29/17	48	4	x
Ni	7/29/17	48	4	x

Investigating *Trichodesmium* populations at depth
Noelle Held, Clare Davis

Introduction

Early in the cruise we observed changes in *Trichodesmium* distribution during the course of the day and at different depths. To investigate this further, we sampled *Trichodesmium* colonies from various depths (typically 15m and 200m) during the day and night, measured alkaline phosphatase activity, and sampled for proteins and phosphoproteins. These samples provide preliminary data for future studies of *Trichodesmium* populations at depth

Methods

Plankton nets were deployed at either 15m for 15 minutes or as a 200m trawl at 10m/s. The mesh size was 200 µm for the 15m net and 63 µm for the 200m nets. Twenty *Trichodesmium* colonies were selected, rinsed once, and APA activity measured as previously described. Biomass was also collected onto 4 µm supor filters and flash frozen for protein analysis ashore. Biomass will also be obtained for protein analysis from the in situ McLane pumps. At Station 7, we adjusted the methodology to use the same 200 µm net for each sample, deploying a plankton net to 160m, 90m (DCM), 40m and 15m for 15 minutes before trawling rapidly to surface.

Summary of experiments

Chapter 11: Proteins

Station 2				
Depth	**Time**	**Date**	**APA**	**Proteins**
15m	2:30	7/7/17	x	x
200m	2:30	7/7/17	x	x
15m	12:00	7/7/17	x	x
200m	12:00	7/7/17	x	x

Station 5				
Depth	**Time**	**Date**	**APA**	**Proteins**
15m	4:00	7/24/17	x	x
200m	4:00	7/24/17	x	x
15m	12:00	7/24/17	x	x
200m	12:00	7/24/17	x	x

Station 6				
Depth	**Time**	**Date**	**APA**	**Proteins**
15m	6:00	7/29/17	x	x
200m	6:00	7/29/17	x	x
15m	13:00	7/29/17	x	x
200m	13:00	7/29/17	x	x
Depth	**Time**	**Date**	**APA**	**Proteins**
15m	6:00	7/31/17	x	x
200m	6:00	7/31/17	x	x
15m	13:30	7/31/17	x	x
200m	13:30	7/31/17	x	x

Station 7						
Depth	**Time**	**Date**	**APA**	**Proteins**	**Microscopy**	**Chl-A**
15m	4:30	8/7/17	x	x	x	x
40m	4:53	8/7/17	x	x	x	x
90m	5:15	8/7/17	x	x	x	x
160m	5:40	8/7/17	x	x	x	x

Experiment D protein sampling
Noelle Held, Joanna Harley

Methods:

Approximately 10L from each incubation were filtered onto 0.2 µm Sterivex cartridge filters, with 25mm 0.2 µm supor filters used to collect additional volumes once the cartridge filter clogged. Samples were flash frozen in liquid nitrogen and immediately stored at -80C. Global and targeted proteomes will be analyzed ashore as previously described.[3]

Reference:

[1]Saito, M. A. *et al.* Multiple nutrient stresses at intersecting Pacific Ocean biomes detected by protein biomarkers. *Science* **345,** 1173–7 (2014).

Trichodesmium diel sampling for proteomics
Noelle Held

Introduction
      Trichodesmium is known to have regular physiological fluctuations throughout the course of the day. We are interested in how the abundance of various proteins and protein modifications in *Trichodesmium* colonies might reflect these changes. We sampled *Trichodesmium* throughout the day, concentrating on the early morning hours. These samples will used for method development and study of *Trichodesmium* proteins, as well as modifications including phosphorylation and glycosylation that are thought to change during the diel cycle.

      Many thanks to Elena, Despo, Annie and Steph for assistance with the nets!

Methods
      Plankton nets (200 μm) were deployed at 15m for 15 minutes approximately every two hours from 2:30 to 13:30. Samples were taken for proteomics by directly picking colonies onto 0.2 or 0.4uM supor filters to avoid crushing. Filters were flash frozen in liquid nitrogen and stored at -80C. Proteins will be extracted and analyzed as previously described, using care to protect fragile protein modifications.[1] Specialized protein modification enrichment procedures will be used to preserve signals from modified proteins.

Reference:
1. Walworth, N. G. *et al.* Mechanisms of increased Trichodesmium fitness under iron and phosphorus co-limitation in the present and future ocean. *Nat Commun* **7,** 1–11 (2016).

Quantifying Trace Metals in Individual Cells

Elizabeth Mann

The aim of the JC150 cruise is to test the hypothesis that the trace metals iron and zinc could determine primary productivity through their ability to regulate the activity of alkaline phosphatase (AP) and therefore access to organic phosphorus. Water samples were taken from initial or *in situ* water along gradients in zinc, iron, and phosphate encountered across the subtropical Atlantic Ocean. Large volume (20L) bottle incubations with *in situ* phytoplankton populations (Experiment D) were used to increase the zinc and iron to concentrations at which a community response in terms of alkaline phosphatase activity (APA) was expected. Control bottles with no added metals were also included. The bottles were incubated in a temperature controlled container and samples collected at T=0 and T=48 hours.

In order to gain some insight into how individual phytoplankton groups respond to the *in situ* metal and nutrient gradients as well as to the experimental manipulations, samples were taken for synchrotron-based X-ray fluorescence (SXRF). This method can distinguish between phytoplankton and particulate matter and can quantify the elements Si, P, Mn, Fe, Ni, Co, V and Zn in each individual target cell. Carbon content per cell will be estimated using the cell size (determined by microscopy) using well established conversion factors. The resulting metal to carbon and metal to P ratios will be linked to bulk changes in APA and total chlorophyll as well as to the abundant environmental data collected (metal concentrations and speciation, inorganic and organic nutrient concentration, genomics and proteomics). We will focus on metal quotas in phytoplankton groups representative of the *in situ* community – the cyanobacteria *Synechococcus*, picoeukaryotes, autotrophic flagellates and small dinoflagellates for each of the experimental conditions and time points. The ability to match measured iron and zinc quotas with the level of APA and known phosphate acquisition genes and proteins will enhance our ability to interpret results in mixed phytoplankton communities. These data will significantly increase our understanding of how the complex interactions between inorganic nutrient and trace metal requirements can limit marine primary productivity and allow for accurate parameterization and modeling of these interactions in global climate models.

Methods
The methods used for the collection of SXRF samples are listed in Twining et al., 2003 with a few modifications. Briefly, all procedures were done with trace metal clean reagents under clean conditions – with the exception of steps involving glutaraldehyde which were performed in a fume hood. Roughly two liters of seawater was filtered through 2u PC or Isopore filters by gravity and less than 5 psi vacuum pressure using a hand pump. The last 35 to 40 mLs of water were used to re-suspend the cells caught on the filter. These cells were preserved at a final concentration of 0.5% EM grade glutaraldehyde, which was previously stripped of trace metals by passage through a Dowex 50Wx8 resin column and adjusted to pH=8. After fixation with glutaraldehyde for at least 30 mins at 4C in the dark, the preserved cells were slowly poured into 50mL Falcon tubes containing fitted Araldite bases to which two to three Au transmission electron microscopy grids (Electron Microscopy Sciences, FCF-200-Au, formvar carbon film on 200 mesh gold grids) were attached with tape. Target cells were fixed to the grids by centrifugation at ~3300 rpm for 30 minutes. After centrifugation, the water was carefully poured off and the Araldite bases removed. As quickly as possible, the grids were removed

using Teflon coated tweezers and washed with one drop of QH2O. After drying for 5 minutes, the grids were taped to grid sticks that fit into the SXRF apparatus (two grids per grid stick).

Treatments Sampled for SXRF Analysis

Given the logistic restrictions of running SXRF samples, only four treatments or less were sampled from each Experiment D. Samples were also taken from two +Ni incubations set-up by Noelle Held; one from bulk water (+Ni) and one using 2x washed *Trichodesmium* colonies (Trich). A summary table is below, for a complete list of grids see the associated Excel file "JC150 Mann Cruise Report Grid Log", now as Supplementary Information S11

Station	Date	Exp	Treatment			
1	7/3/2017	D	T=0, Initial			
	7/5/2017	D	T=48, Ctrl	T=48, 1 nM Zn	T=48, 2 nM Fe	
2	7/9/2017	E	T=0, Initial			
	7/11/2017	D	T=0, Initial			
	7/13/2017	D	T=48, Ctrl	T=48, 2 uM N	T=48, N + 1 nM Zn	T=48, N +1 nM Fe
3*	7/15/2017	D	T=0, Initial			
		D	T=48, Ctrl	T=48, 2 uM N	T=48, N + 0.5 nM Zn	T=48, N +0.5 nM Fe
4	7/20/2017	D	T=0, Initial			
	7/22/2017	D	T=48, Ctrl	T=48, 2 uM N	T=48, N + 0.5 nM Zn	T=48, N +0.5 nM Fe
5	7/24/2017	+Ni	T=24, Ctrl	T=24, + Ni		
	7/25/2017	Trich	T=24, Ctrl	T=24, + Ni		
	7/25/2017	D	T=0, Initial			
	7/27/2017	D	T=48, Ctrl	T=48, 0.4 nM Zn	T=48, 0.5 nM Fe	
6	7/28/2017	D_{Up}	T=0, Initial			
	8/2/2017	D_T	T=0, Initial			
	8/2/2017	D_T	T=12, Ctrl	T=12, 0.5 nM Zn	T=12, 0.5 nM Fe	
	8/3/2017	D_T	T=24, Ctrl	T=24, 0.5 nM Zn	T=24, 0.5 nM Fe	
	8/3/2017	D_T	T=36, Ctrl	T=36, 0.5 nM Zn	T=36, 0.5 nM Fe	
	8/4/2017	D_T	T=48, Ctrl	T=48, 0.5 nM Zn	T=48, 0.5 nM Fe	
	8/4/2017	D_T	T=60, Ctrl	T=60, 0.5 nM Zn	T=60, 0.5 nM Fe	
	8/5/2017	D_T	T=72, Ctrl	T=72, 0.5 nM Zn	T=72, 0.5 nM Fe	
7	8/5/2017	D	T=0, Initial			
	8/7/2017	D	T=48, Ctrl	T=48, 0.5 nM Zn	T=48, 0.5 nM Fe**	

* Station 3 was contaminated by Zn (probably through use of MasterFlex tubing when water was collected, this is the first station where switched from CTD to pump).

**The +Fe bottle in the third set (which was the 2nd bottle sampled) contained 1.0 nM Fe by mistake.

Results

Trace metal quota data will have to wait until SXRF analysis, but several points can be made about the grids using epifluorescence microscopy. Cells were collected on 193 grids, excluding most of the Zn contaminated Station 3 grids, 175 grids were examined by epifluorescence microscopy (10x and 40x) to determine grid quality. Roughly 14% of the grids examined were of low quality, generally because of tears in the formvar. These grids are probably not useful for SXRF analysis, unless individual cells of interest can be found in the grid squares where the film remains intact. 83% of the grids are suitable for SXRF analysis, with 56% of high quality and the remaining grids of medium quality (tears in formvar or gunk on grid, but at least 50% of grid squares are useable).

Target cells that will be in sufficient quantity for meaningful SXRF analysis and statistics (10 cells per treatment) include small round or rod shaped phytoplankton (probably *Synechococcus*), autotrophic flagellates, picoeukaryotes and putative dinoflagellates. Large eukaryotic cells can be also be distinguished on the grids, including pennate diatoms, probable coccolithophores and large dinoflagellates. These may not be present in sufficient quantities for SXRF analysis - with the exception of pennate diatoms in Station 7.

Trichodesmium filaments were relatively common and were present in 27% of the grids. In Noelle Held's *Trichodesmium* incubation only a few *Trichodesmium* were present on the grids, but long, very thin filaments with chlorophyll fluorescence and no evidence of internal structure were observed. These long, thin filaments were also observed associated with *Trichodesmium* colonies from the net tows. In one case (Station 6, T=60 hrs control, grid 167) a putative chlorophyll containing internal symbiont, with bulbous ends separated by four to five segments was found. These were also observed in photos of Station 7 and may be nitrogen-fixing organisms living inside a chain diatom.

Epifluorescence Microscopy

In addition to determining the location of target cells on specific grids (100x, using the macro GridAcq), photos were taken of representative cells from the bottle incubations, *Trichodesmium* net tows and filtered cells from three depths from a Station 7 CTD. For representative photos, see the PowerPoint file "JC150 Mann Cruise Report Photos", now as Supplementary Information S12.

Target	Station	Date	Type of Sample
Trichodesmium	5	7/24/2017	net tow
	6	7/30/2017	net tow
	7	8/04/2017	net tow
	7	8/07/2017	net tow
Cells > 2u	4	7/19/2017	filtered sample from ABC incubation
Cells > 10u	7	8/07/2017	filtered sample from CTD 053, 15m
	7	8/07/2017	filtered sample from CTD 053, 40m
	7	8/07/2017	filtered sample from CTD 053, 90m

One difficulty for filtered samples was that the filter pores themselves fluoresce, making it hard at times to find actual cells. This was definitely the case for the Station 4 filters, not enough water was processed to find any meaningful cell numbers and the attempt was basically abandoned. Filters from the Station 7 CTD were exposed to > 20L (an entire Nisken bottle) – this greater volume and the fact that larger cells were targeted improved the results – these photos are worth looking at.

Some observations from the photos include the presence of both tuft and puff-type *Trichodesmium* colonies, which were often found with *Rhizoselenia* (long pennate diatom, with needle like tapered ends and a pair of chloroplasts). There pennates were found associated with *Trichodesmium* at Stations 5 and 6, but not 7. Samples from the Station 7 vertical profile were different at each depth. At 15m *Trichodesmium* were present, along with some long, thin filaments which also contain chlorophyll. Several pairs of a probable internal symbiont with bulbous ends (see above) were also observed and radiolarian type protists were common. Pennate diatoms were present, along with some dinoflagellates, but these generally appeared to be empty shells – this may be due to a drying out filter under the intense light from the microscope, or possibly represent the end of a bloom. The sample at 40m was similar, but included fewer of the thin filaments and was generally less interesting than at 15m. The situation changed at the 90m DCM, where only a few *Trichodesmium* were observed and the sample was dominated by pennate and centric diatoms, with some *Chaetoceros* and larger dinoflagellates. Radiolarian type protists were also abundant, as was *Rhizoselenia* - although none were found associated with *Trichodesmium* at the shallower depths. It is likely that at least part of the DCM at Station 7 is composed of an increased amount of chlorophyll packaged in large phytoplankton, rather than an increase in chlorophyll fluorescence from smaller cells such as *Prochlorococcus*.

Reference
Twining, B. S. et al., 2003. Quantifying trace elements in individual aquatic protist cells with a synchrontron X-ray fluorescence microprobe. Anal. Chem. 75: 3806-3816.

Trichodesmium Associated Bacteria

In addition to the SXRF samples, *Trichodesmium* colonies were collected from several stations in order to look for the presence of a specific alpha Proteobacteria that has previously been found in colonies from the Pacific and the Atlantic. Both tuft and puff *Trichodesmium* colonies were picked from a net tow using a transfer pipet and placed in 0.2u filtered seawater (collected from the FISH). Colonies were washed five times in 0.2u filtered seawater to remove loosely associated organisms, except at Station 7 where the small colonies were only rinsed once. *Trichodesmium* were filtered down on either 2 or 8u PC filters using less than 5 psi vacuum pressure, the filter with biomass was placed in a cryovial and covered with a glycerol, tris and EDTA buffer. Cryovials containing *Trichodesmium* were flash frozen in liquid nitrogen and then stored at -80C. Many thanks to Elena, Despo, Annie, Steph and Claire for deploying and access to the net tows.

Station	Date	Net Tow	Times Washed	Filter Used	Notes
1	7/01/2017	Net 24, last diel net	5	8u	OK? Lost

Chapter 12: Cell quota

					sample
2	7/6/2017	Net 46	5	8u	thawed
5	7/24/2017	Net 153, 10am Noelle's Trich incubation net tow	5	2u	thawed
6	7/31/2017	Net 203, Noon, Claire Davis net	5	8u	thawed
7	8/4/2017	Net 218, ~Noon net tow	1	2u	OK

Trichodesmium nutrient incubations

Despo Polyviou, Elena Cerdan Garcia, Stephanie Sargeant, Joanna Harley (University of Southampton) in collaboration with S. Reynolds (University of Portsmouth)
PIs: Julie Robidart, Thomas S. Bibby (UoS)

Introduction: Photosynthetic cyanabacteria capable of nitrogen (N_2) fixation (diazotrophs) contribute to oceanic primary production and strongly influence ocean biogeochemical cycles. The abundant marine cyanobacterium *Trichodesmium*, found across the tropical and subtropical oligotrophic oceans, accounts for a significant proportion of the fixed N input (Capone et al. 1997; Westberry & Siegel 2006). However, the activity of *Trichodesmium* is constraint by the availability of nutrients such as phosphorus (P) and iron (Fe) (Moore et al. 2009; Snow et al. 2015).

Trichodesmium is polymorphic, found in filaments of ~100-200 cells that come together to form puff and tuft colonies. The colonies are referred to as consortia due to their function as microhabitats for an array of microorganisms clustered (at high densities compared to the surrounding water) in and around the colonies (Sheridan et al. 2002). These microorganisms include a diverse community of other cyanobacteria, heterotrophic bacteria, eukaryotes and phages (Hewson et al. 2009) which are distinct to the community of the surrounding environment (Hmelo et al. 2012) and vary according to the *Trichodesmium* colony morphology (Rouco et al. 2016). Interactions within the consortia community appear to be central to the controls of nutrient utilisation, with quorum sensing shown to stimulate the expression of genes involved in P utilisation (Van Mooy et al. 2012).

Genes stimulated by nutrient stress have been previously used as biomarkers for detecting nutrient limitation in the field (Erdner & Anderson 1999; Lindell & Post 2001; Chappell et al. 2012; Saito et al. 2014). This is a valuable technique as the bioavailable pools of nutrients are presently not clearly characterised. By complementing nutrient concentration measurements, the use of biomarkers allows direct sensing of the organisms' perception of nutrient availability. In addition, such information can be further incorporated into models used to predict the biogeography, activity and response of organisms to environmental changes (Reed et al. 2014; Mock et al. 2016).

Aims:

(1) Experiments are designed to investigate the response of *Trichodesmium* to nutrient additions across the cruise transect. The results will be used to understand the nature of nutrient limitation on the *Trichodesmium* community and characterise the expression of candidate genes with the potential to be used as biomarkers of nutrient limitations. Some of these targets include Fe and/or desert dust regulated genes like the interchangeable oxidoreductases plastocyanin (*Tery_2563*) and cytochrome c$_{553}$ (*Tery_2561*), fructose bisphosphate aldolase class I and class II genes (*Tery_1687, Tery_4099*), the *Tery_08xx* cluster genes, ferric uptake regulators (*Tery_1958, Tery_3404*), the *fhuD* homologue (*Tery_3943*) and genes annotated as 'haemolysin type calcium binding region domain' (*Tery_0419, Tery_0424 and Tery_2055*). Phosphorus limitation biomarkers will include components of the P transport system such as the phosphite ABC transporter *ptxABCD* (*Tery_0365-0368*) (Polyviou et al. 2015).

In parallel to the ZIPLOc experiments the alkaline phosphatase activity (APA) of the organisms is investigated in collaboration with C. Mahaffey and C. Davis (University of Liverpool) across

different treatments to better understand the effect of nutrients, and metals such as zinc (Zn) and Fe, on the enzyme and *Trichodesmium's* phosphorus acquisition response. The transcription of alkaline phosphatase homologues *phoX1* (*Tery_3845*), *phoX2* (*Tery_4464*) and *phoA* (*Tery_3467*) could be investigated in parallel to these data (subject to further discussion with the PSO).

(2) To identify possible differences in activity based on *Trichodesmium* colony morphology, colonies acquired were separated as puff or tuft colonies. Nucleic acid analysis will be used to provide a better understanding of the nutrient limitation of *Trichodesmium* distinctly for puffs and tufts and their response to additions of Fe and organic phosphorus moieties (orgP) based on the transcription of gene biomarkers (as previously). Difference in genes involved in N_2-fixation and photosynthesis will also be assessed. The question of the influence of a distinct epibiont community associated with each colony morphology will be addressed using 16S analysis. APA activity of puffs and tufts at t=0 is analysed in collaboration with C. Davis and C. Mahaffey.

Methods: The day prior to the experiment MQ and filtered seawater (collected with the Towfish by M. Lohan) was used to rinse incubation bottles stored with 1% HCl. The incubation bottles were filled (150 ml in 125ml bottles).

Plankton nets (200 μm mesh, 50 cm diameter) with nylon cord and eyelets (Duncan & Associates, UK) were deployed at 15 meters for 15 minutes. The cod end was emptied in a bucket in (both 1% HCl rinsed) and carried to the trace metal (TM) clean bubble. After the last deployment, the net was rinsed with fresh water and left to dry before storing. In the TM clean bubble *Trichodesmium* colonies were picked from the bucket through 3 wash steps (filtered TowFISH water) with disposable pipettes (rinsed with 3x 10% HCl, 3x pH 2 and 3x MQ water) and allocated to incubation bottles (in sets of 10 so that colonies picked at similar times are distributed across all bottles). Samples for t=0 were taken in triplicate from the first net. Colonies of mixed morphology (50 colonies/ 150 ml) were added to sets of triplicate bottles spiked with Fe, Zn, PO$_4$, Zn and PO$_4$, Fe and PO$_4$, NO$_3$ and NH$_4^+$ or organic phosphorus moieties (Table 1 and 2). Experiments on the effect of nutrients (Fe and orgP) on differential colony morphologies were set up in a similar fashion using 35 colonies per 150 ml. The bottles were parafilmed and left in on-deck incubators, screened to an equivalent light depth, with a continuous seawater flow to maintain surface temperatures. Bottles were incubated for 12 or 24 hours (Table 2). For overnight incubations the incubators were darkened with a black cloth.

Table 1: Nutrients used for incubation experiments

Nutrient	Chemical form	Final Concentration
Fe	FeCl$_3$ (provided by M. Lohan)	2 nM
Zn	ZnCl$_2$ (provided by M. Lohan)	1 nM
PO$_4$	NaH$_2$PO$_4$	0.2 μM
Organic P	Organic phosphorus moieties (provided by C. Mahaffey)	2 μM (stations 1 & 2), 0.5 μM (stations 3 − 7)
N	NO$_3$ and NH$_4^+$ (provided by C. Mahaffey)	2 μM NO$_3$ (stations 1 & 2), 1 μM NO$_3$ (stations 3 − 7), 2 μM NH$_4^+$ (stations 1 & 2), 1 μM NH$_4^+$ (stations 3 − 7)

For sampling, the contents of the incubation bottles were transferred to the respective sampling bottles in the TM clean bubble and 3-5 colonies were isolated in falcon tubes to be analysed on the

Fast Repetition Rate Fluorometre (FRRf) (Fast Ocean device MkIII, Chelsea Technologies Ltd, UK).

The remaining biomass was filtered on 0.2 μm Supor filters (Sigma-Aldrich) using peristaltic pumps and immediately frozen in liquid nitrogen before storing at -80 °C until subsequent DNA/RNA analysis.

Table 2: *Trichodesmium* nutrient incubation experiments

Date	Station	Day	Event #	Net #	Treatments	Incubation length (hours)
28/06/17	1	1	8-9	2-3	C, Fe, P, FeP	24
02/07/17	1	4	25-28	14-17	C, Zn, P, ZnP, orgP, N	24
06/07/17	2	2	41-44	18-21	C, Zn, Fe, P, FeP, ZnP, orgP, N	24
09/07/17	2	5	65, 66	35, 36	C, Zn, Fe, P, FeP, ZnP, orgP, N	12
12/07/17	3	1	82-85	46- 49	C, Zn, Fe, P, FeP, ZnP, orgP, N	12
14/07/17	3	3	90-92	50-52	C, Zn, Fe, P, FeP, ZnP, orgP, N	24
17/07/17	4	1	107-110	61-64	C, Zn, Fe, P, FeP, ZnP, orgP, N	12
19/07/17	4	3	117-121	67-71	C, Zn, Fe, P, FeP, ZnP, orgP, N	24
22/07/17	5	1	134-137	78-81	C, Zn, Fe, P, FeP, ZnP, orgP, N	12
24/07/17	5	3	145, 147-151	84, 86-90	C, Zn, Fe, P, FeP, ZnP, orgP, N	24
27/07/17	6	1	165-168	97-100	C, Zn, Fe, P, FeP, ZnP, orgP, N	12
29/07/17	6	3	176, 178-181	104, 106-109	C, Zn, Fe, P, FeP, ZnP, orgP, N	24
04/08/17	7	1	211-215	128-132	C, Fe, P, FeP	24
06/08/17	7	3	225, 226, 229-232	139, 140, 152-155	C, Zn, P, ZnP, orgP, N	24

Table 3: *Trichodesmium* puff and tuft morphology nutrient incubation experiments

Date	Station	Day	Event #	Net #	Treatments	Incubation length (hours)
31/07/17	6	5	194-199	118-123	C, Fe, orgP	24
07/08/17	7	4	249-253	170-174	C, Fe, orgP	24

Experiment D sampling

Elena Cerdan Garcia, Despo Polyviou, Joanna Harley

Introduction and Aims: As main experiment.

Nucleic acid analysis will specifically target the effect of nutrient additions on the community composition and activity as inferred by gene transcription.

Methods: Samples were filtered on 0.22 μm Sterivex filters using peristaltic pumps and frozen in liquid nitrogen before storing at -80 C until subsequent RNA/DNA analysis

References

Bergman, B. et al., 2013. Trichodesmium--a widespread marine cyanobacterium with unusual nitrogen fixation properties. *FEMS microbiology reviews*, 37(3), pp.286–302. Available at: http://www.ncbi.nlm.nih.gov/pubmed/22928644 [Accessed July 9, 2016].

Berman-Frank, I. et al., 2001. Segregation of nitrogen fixation and oxygenic photosynthesis in the marine cyanobacterium Trichodesmium. *Science (New York, N.Y.)*, 294(5546), pp.1534–7. Available at: http://www.ncbi.nlm.nih.gov/pubmed/11711677 [Accessed July 11, 2016].

Berman-Frank, I., Lundgren, P. & Falkowski, P., 2003. Nitrogen fixation and photosynthetic oxygen evolution in cyanobacteria. *Research in Microbiology*, 154, pp.157–164. Available at: www.elsevier.com/locate/resmic [Accessed August 10, 2016].

Capone, D.G. et al., 1997. Trichodesmium, a globally significant marine cyanobacterium. *Science*, 276(May), pp.1221–1229. Available at: http://www.sciencemag.org/content/276/5316/1221.short [Accessed August 4, 2012].

Chappell, P.D. et al., 2012. Molecular evidence of iron limitation and availability in the global diazotroph Trichodesmium. *The ISME journal*, pp.1–12. Available at: http://www.ncbi.nlm.nih.gov/pubmed/22402399 [Accessed August 2, 2012].

Erdner, D.L. & Anderson, D.M., 1999. Ferredoxin and flavodoxin as biochemical indicators of iron limitation during open-ocean iron enrichment. *Limnol. Oceanogr*, 44(7), pp.1609–1615.

Hewson, I. et al., 2009. Microbial community gene expression within colonies of the diazotroph, Trichodesmium, from the Southwest Pacific Ocean. *The ISME Journal*, 3(11), pp.1286–1300. Available at: http://www.nature.com/doifinder/10.1038/ismej.2009.75 [Accessed July 8, 2016].

Hmelo, L., Van Mooy, B. & Mincer, T., 2012. Characterization of bacterial epibionts on the cyanobacterium Trichodesmium. *Aquatic Microbial Ecology*, 67(1), pp.1–14. Available at: http://www.int-res.com/abstracts/ame/v67/n1/p1-14/ [Accessed July 8, 2016].

Kranz, S.A. et al., 2009. Carbon acquisition by Trichodesmium : The effect of pCO 2 and diurnal changes. *Limnology and Oceanography*, 54(2), pp.548–559.

Lindell, D. & Post, A.F., 2001. Ecological aspects of ntcA gene expression and its use as an indicator of the nitrogen status of marine Synechococcus spp. *Applied and environmental microbiology*, 67(8), pp.3340–9. Available at: http://www.ncbi.nlm.nih.gov/pubmed/11472902 [Accessed July 18, 2016].

Mock, T. et al., 2016. Bridging the gap between omics and earth system science to better understand how environmental change impacts marine microbes. *Global Change Biology*, 22(1), pp.61–75. Available at: http://dx.doi.org/10.1111/gcb.12983.

Moore, M.C. et al., 2009. Large-scale distribution of Atlantic nitrogen fixation controlled by iron availability. *Nature Geoscience*, 2(12), pp.867–871. Available at: http://www.nature.com/doifinder/10.1038/ngeo667 [Accessed July 26, 2012].

Van Mooy, B.A.S. et al., 2012. Quorum sensing control of phosphorus acquisition in Trichodesmium consortia. *The ISME journal*, 6(2), pp.422–9. Available at: http://www.ncbi.nlm.nih.gov/pubmed/21900966 [Accessed July 8, 2016].

Polyviou, D. et al., 2015. Phosphite utilization by the globally important marine diazotroph *T richodesmium*. *Environmental Microbiology Reports*, 7(6), pp.824–830. Available at: http://doi.wiley.com/10.1111/1758-2229.12308 [Accessed July 30, 2016].

Polyviou, D., 2016. Nutrient utilisation by Trichodesmium: characterisation of molecular and physiological processes (Doctoral dissertation, University of Southampton).

Reed, D.C. et al., 2014. Gene-centric approach to integrating environmental genomics and biogeochemical models. *Proceedings of the National Academy of Sciences*, 111(5), pp.1879–1884.

Rouco, M., Haley, S.T. & Dyhrman, S.T., 2016. Microbial diversity within the Trichodesmium holobiont. *Environmental Microbiology*, 18(12), pp.5151–5160. Available at: http://dx.doi.org/10.1111/1462-2920.13513.

Saito, M.A. et al., 2014. Multiple nutrient stresses at intersecting Pacific Ocean biomes detected by protein biomarkers. *Science (New York, N.Y.)*, 345(6201), pp.1173–7. Available at: http://www.ncbi.nlm.nih.gov/pubmed/25190794 [Accessed July 18, 2016].

Sandh, G., Xu, L. & Bergman, B., 2012. Diazocyte development in the marine diazotrophic cyanobacterium Trichodesmium. *Microbiology (Reading, England)*, 158(Pt 2), pp.345–52. Available at: http://www.ncbi.nlm.nih.gov/pubmed/22053003 [Accessed July 11, 2016].

Sheridan, C.C., Steinberg, D.K. & Kling, G.W., 2002. The microbial and metazoan community associated with colonies of Trichodesmium spp.: a quantitative survey. *Journal of Plankton Research*, 24(9), pp.913–922. Available at: http://www.plankt.oupjournals.org/cgi/doi/10.1093/plankt/24.9.913 [Accessed July 8, 2016].

Snow, J.T. et al., 2015. Environmental controls on the biogeography of diazotrophy and Trichodesmium in the Atlantic Ocean. *Global Biogeochemical Cycles*, 29(6), pp.865–884. Available at: http://dx.doi.org/10.1002/2015GB005090.

Westberry, T.K. & Siegel, D.A., 2006. Spatial and temporal distribution of Trichodesmium blooms in the world's oceans. *Global Biogeochemical Cycles*, 20(4). Available at: http://doi.wiley.com/10.1029/2005GB002673 [Accessed July 9, 2016].

Trichodesmium colony abundance
Despo Polyviou, Elena Cerdan Garcia, Joanna Harley

Aims: The abundance of *Trichodesmium* across the cruise transect is recorded to investigate relationships with *in-situ* nutrient concentrations and APA activity and accompany data collected as part of the main ZIPLOc experiments and *Trichodesmium* incubation experiments.

Methods: Water from 20L Niskin bottles (15 metres depth) was gravity filtered on 10 μm polycarbonate filters in duplicate (Table 5).

Preliminary data are presented on Fig. 2

Table 5: Colony abundance measurements

Date	Station	Day	Event #	CTD #	Depth (m)
29/06/17	1	1	11	CTD005S	15
05/07/17	2	1	36	CTD014S	15
12/07/17	3	1	81	CTD025S	15
17/07/17	4	1	106	CTD030T	15
19/07/17	4	3	126	CTD033S	15
22/07/17	5	1	132	CTD035S	15
24/07/17	5	3	156	CTD039T	15
27/07/17	6	1	164	CTD042T	15
29/07/17	6	3	186	CTD044S	15
04/08/17	7	1	210	CTD050S	15
07/08/17	7	4	243	CTD053S	15

Figure 2: Trichodesmium colony abundance across the cruise transect

Trichodesmium Diel cycle

Elena Cerdan Garcia, Despo Polyviou, Joanna Harley, Stephanie Sargeant

Introduction: Oxygen (O_2) released during N_2 fixation is detrimental to nitrogenase the central enzyme required for this process, therefore, diazotrophs have evolved mechanisms to segregate the two processes spatially or temporally (Berman-Frank et al. 2003). *Trichodesmium* employs a unique combination of both modes of segregation simultaneously with ~15 % of each filament developing specialised nitrogenase containing (Berman-Frank et al. 2001) (but not terminally differentiated) cells (diazocytes) with degraded gas vacuoles and glycogen granules (Sandh et al. 2012) arranged in zones of ~2-30 cells (Bergman et al. 2013). At the same time, and although both photosynthesis and N_2 fixation occur during the photoperiod, it possesses its own circadian clock synchronising a midday downregulation of photosynthesis (low or negative O_2 evolution) (Berman-Frank et al. 2001) with enhanced O_2 scavenging mechanisms (respiration and Mehler reaction) (Kranz et al. 2009) and a peak in nitrogenase activity (Berman-Frank et al. 2001).

Aim: Samples acquired will be used to provide better inside on the composition and activity of *Trichodesmium* consortia over a 24h diel cycle along the trans-meridional transect of the Atlantic. Analysis focuses on gene targets involved in photosynthesis and N_2 fixation particularly during pre-dawn to post-dawn shifts.

Methods: Nets (as described previously) were deployed from 2:30 am (local time) during a 12-hour period every 2-3 hours (Table 4). *Trichodesmium* colonies were isolated and analysed on the FRRf (as described previously), 30 colonies were then filtered in duplicate, frozen in liquid nitrogen and stored at -80 °C for subsequent molecular analysis. APA measurements were acquired in parallel to the 12h *in-situ* net sampling points for the last 3 stations. Please, refer to *"APA Trichodesmium"* section from C. Davis (University of Liverpool) within this report for further details.

In addition, incubations were set up (as described previously) from nets recovered between 2:30 – 3:30 am. Colonies were rinsed once before being added to incubation bottles (35 colonies/ 150 ml) that were kept in on-deck incubators for 24 hours. Duplicate bottles were sampled every 2-3 hours (to match *in-situ* net sampling points) (Table 4).F_v/F_m data from station 5 is presented in Fig. 1.

Figure 1: Diel changes in *Trichodesmium* photosynthetic efficiency. Photosynthetic efficiency was measured as F_v/F_m on a Fast Repetition Rare fluorimeter (FRRf) immediately after recovery of colonies from plankton nets (NETS) or from incubation bottles (INCUB) at station 5. Error bars represent standard deviations from the mean.

Table 4: *Trichodesmium* diel sampling and incubation experiments. Event Log numbers and Net (N) /Incubation (I) breakdown times (local time) are detailed for each station

Time	Station 1 (01/07/17 (-4UTC))		Station 2 (07/08/17 (-3UTC))		Station 2 (II) (10/07/17 (-3UTC))		Station 3 (14/07/17 (-3UTC))		Station 4 (19/07/17 (-2UTC))		Station 5 (24/07/17 (-2UTC))		Station 6 (29/07/17 (-1UTC))		Station 7 (06/08/17 (-1UTC))	
	N	I	N	I	N	I	N	I	N	I	N	I	N	I	N	I
2:00																
2:30					69,70,71											
3:00							90, 91, 92		115, 116, 117							
3:30	16,17										143, 144, 145					
4:00			51,52		72								173, 174, 175, 176			
5:30	18														221, 222, 223, 224, 225, 226	
6:00			53		73	X	95		119	X	147	X	178	X	229	X
8:00	19	X	54	X	74	X	98	X	122	X	151	X	182	X	233	X

Time																
10:00																X
12:00			56		75		99		124		153		183		235	
12:30	21	X	59		76		100		127		157		187		240	
13:30					77				128		159		190		242	
14:00			61	X		X	101	X		X		X		X		X
14:30	24	X														
15:00				X				X				X				X
16:00						X				X				X		
17:30		X				X		X		X		X		X		X
18:00				X		X		X		X		X		X		X
19:30		X				X				X				X		
20:00				X		X		X		X		X		X		X
21:00				X												
21:30																
22:00		X				X				X				X		X
23:00				X				X				X				X
00:00																X

1:00	1:30	2:00	3:00	4:00	5:00	5:30	6:00	8:00
			X					
	X					X		X
							X	X
X				X			X	
X				X			X	X
				X			X	
				X			X	
				X	X			X
X							X	X

Underway- Towfish sampling
Elena Cerdan Garcia, Despo Polyviou, Joanna Harley

Aims: To investigate community composition and activity across the cruise transect using seawater samples from the Towfish and the ship underway system. This will be paralleled to *in-situ* continuous measurements of fluorescence (ie. F_v/F_m, F_o, Rsigma) of the microbial community and nutrient concentrations (M. Lohan, M. Woodward).

Samples from the TowFISH are compared to that from the underway system to question the effect of contaminants in the ship underway system supply on the community composition and gene expression.

Methods: Seawater (3L) from the ship underway system, and the Towfish were sampled in triplicate in 4L polycarbonate bottles. Peristaltic pumps were used to filter the samples on Sterivex filters (maximum of 25 minutes filtering) which were subsequently flash frozen with liquid N_2 and stored at -80 ℃.

For fluorescence measurements a STAF (Single Turnover Active Fluorometry) software was used to run the FasBallast compliance monitor in flow through mode with a saturation phase pulse with relaxation phase pulse (*Chelsea Technologies Ltd*, UK). Settings (ie. LED combinations, auto-log, number of saturation pulses) were optimised at the beginning of the run, to adjust to the community. Filtered-seawater was used to run blank measurements, and the tubing was cleaned (bleach and MQ) between stations.

Table 6: Sampling for nucleic acid analysis along the cruise transect. The times (local time) and dates of sample recovery (listed as event numbers) from the towFISH (F) and underway system (UW) are recorded for each station.

Time	Station 1 03/07/17		Station 2 11/07/17		Station 3 16/07/17		Station 4 20/07/17		Station 5 25/07/17		Station 6 02/08/17		Station 7 08/08/17	
	UW	F	UW	F	UW	F	UW	F	UW	F	UW	F	UW	F
15:00	10	17	23	40	35	65	47	71	58	89			80	X
16:00														
17:00					36	66					69	110		
18:00	11	19	24	43										
19:00							48	73	59	91	70	111	81	

21:00			25	46	37	68					71	112	82	
22:00	12	21												
23:00							49	75						
23:30									60	93				

Underway Diel Sampling
Elena Cerdan Garcia, Despo Polyviou, Joanna Harley

Aim: To investigate diel cycles of community composition and transcription along the Atlantic trans-meridional transect.

Methods: Triplicate 4L polycarbonate bottles were used to sample seawater from the ship underway system every 2-3 hours (Table 7). Peristaltic pumps were used to filter the samples into Sterivex during 25 minutes and filtered volume was recorded. The filters were flash frozen with liquid N_2 and stored at -80 °C.

Table 7: Diel sampling from the ship underway system. The time (local time), date and event number at each sampling point is presented.

Time	Station 1 03/07/17	Station 2 11/07/17	Station 3 16/07/17	Station 4 20/07/17	Station 5 25/07/17	Station 6 02/08/17	Station 7 08/08/17
6:00	1		26				
8:00				38			
9:00	2		27		50	61	72
11:00				39			
12:00	3	13	28		51	62	73
13:00				40			
15:00	4	14	29		52	63	74
16:00				41			
18:00	5	15	30		53	64	75
19:00				42			
21:00	6	16	31		54	65	76
22:00				43			
00:00	7	17	32		55	66	77
1:00				44			
3:00		18	33		56	67	78
4:00	8			45			
6:00	9	19	34		57	68	79

7:00				46			
9:00		20					

Acknowledgements

References

Bergman, B. et al., 2013. Trichodesmium--a widespread marine cyanobacterium with unusual nitrogen fixation properties. *FEMS microbiology reviews*, 37(3), pp.286–302. Available at: http://www.ncbi.nlm.nih.gov/pubmed/22928644 [Accessed July 9, 2016].

Berman-Frank, I. et al., 2001. Segregation of nitrogen fixation and oxygenic photosynthesis in the marine cyanobacterium Trichodesmium. *Science (New York, N.Y.)*, 294(5546), pp.1534–7. Available at: http://www.ncbi.nlm.nih.gov/pubmed/11711677 [Accessed July 11, 2016].

Berman-Frank, I., Lundgren, P. & Falkowski, P., 2003. Nitrogen fixation and photosynthetic oxygen evolution in cyanobacteria. *Research in Microbiology*, 154, pp.157–164. Available at: www.elsevier.com/locate/resmic [Accessed August 10, 2016].

Capone, D.G. et al., 1997. Trichodesmium, a globally significant marine cyanobacterium. *Science*, 276(May), pp.1221–1229. Available at: http://www.sciencemag.org/content/276/5316/1221.short [Accessed August 4, 2012].

Chappell, P.D. et al., 2012. Molecular evidence of iron limitation and availability in the global diazotroph Trichodesmium. *The ISME journal*, pp.1–12. Available at: http://www.ncbi.nlm.nih.gov/pubmed/22402399 [Accessed August 2, 2012].

Erdner, D.L. & Anderson, D.M., 1999. Ferredoxin and flavodoxin as biochemical indicators of iron limitation during open-ocean iron enrichment. *Limnol. Oceanogr*, 44(7), pp.1609–1615.

Hewson, I. et al., 2009. Microbial community gene expression within colonies of the diazotroph, Trichodesmium, from the Southwest Pacific Ocean. *The ISME Journal*, 3(11), pp.1286–1300. Available at: http://www.nature.com/doifinder/10.1038/ismej.2009.75 [Accessed July 8, 2016].

Hmelo, L., Van Mooy, B. & Mincer, T., 2012. Characterization of bacterial epibionts on the cyanobacterium Trichodesmium. *Aquatic Microbial Ecology*, 67(1), pp.1–14. Available at: http://www.int-res.com/abstracts/ame/v67/n1/p1-14/ [Accessed July 8, 2016].

Kranz, S.A. et al., 2009. Carbon acquisition by Trichodesmium : The effect of pCO 2 and diurnal changes. *Limnology and Oceanography*, 54(2), pp.548–559.

Lindell, D. & Post, A.F., 2001. Ecological aspects of ntcA gene expression and its use as an indicator of the nitrogen status of marine Synechococcus spp. *Applied and environmental microbiology*, 67(8), pp.3340–9. Available at: http://www.ncbi.nlm.nih.gov/pubmed/11472902 [Accessed July 18, 2016].

Mock, T. et al., 2016. Bridging the gap between omics and earth system science to better understand how environmental change impacts marine microbes. *Global Change Biology*, 22(1), pp.61–75. Available at: http://dx.doi.org/10.1111/gcb.12983.

Moore, M.C. et al., 2009. Large-scale distribution of Atlantic nitrogen fixation controlled by iron availability. *Nature Geoscience*, 2(12), pp.867–871. Available at: http://www.nature.com/doifinder/10.1038/ngeo667 [Accessed July 26, 2012].

Van Mooy, B.A.S. et al., 2012. Quorum sensing control of phosphorus acquisition in Trichodesmium consortia. *The ISME journal*, 6(2), pp.422–9. Available at: http://www.ncbi.nlm.nih.gov/pubmed/21900966 [Accessed July 8, 2016].

Polyviou, D. et al., 2015. Phosphite utilization by the globally important marine diazotroph *T richodesmium*. *Environmental Microbiology Reports*, 7(6), pp.824–830. Available at:

http://doi.wiley.com/10.1111/1758-2229.12308 [Accessed July 30, 2016].

Polyviou, D., 2016. Nutrient utilisation by Trichodesmium: characterisation of molecular and physiological processes (Doctoral dissertation, University of Southampton).

Reed, D.C. et al., 2014. Gene-centric approach to integrating environmental genomics and biogeochemical models. *Proceedings of the National Academy of Sciences*, 111(5), pp.1879–1884.

Rouco, M., Haley, S.T. & Dyhrman, S.T., 2016. Microbial diversity within the Trichodesmium holobiont. *Environmental Microbiology*, 18(12), pp.5151–5160. Available at: http://dx.doi.org/10.1111/1462-2920.13513.

Saito, M.A. et al., 2014. Multiple nutrient stresses at intersecting Pacific Ocean biomes detected by protein biomarkers. *Science (New York, N.Y.)*, 345(6201), pp.1173–7. Available at: http://www.ncbi.nlm.nih.gov/pubmed/25190794 [Accessed July 18, 2016].

Sandh, G., Xu, L. & Bergman, B., 2012. Diazocyte development in the marine diazotrophic cyanobacterium Trichodesmium. *Microbiology (Reading, England)*, 158(Pt 2), pp.345–52. Available at: http://www.ncbi.nlm.nih.gov/pubmed/22053003 [Accessed July 11, 2016].

Sheridan, C.C., Steinberg, D.K. & Kling, G.W., 2002. The microbial and metazoan community associated with colonies of Trichodesmium spp.: a quantitative survey. *Journal of Plankton Research*, 24(9), pp.913–922. Available at: http://www.plankt.oupjournals.org/cgi/doi/10.1093/plankt/24.9.913 [Accessed July 8, 2016].

Snow, J.T. et al., 2015. Environmental controls on the biogeography of diazotrophy and Trichodesmium in the Atlantic Ocean. *Global Biogeochemical Cycles*, 29(6), pp.865–884. Available at: http://dx.doi.org/10.1002/2015GB005090.

Westberry, T.K. & Siegel, D.A., 2006. Spatial and temporal distribution of Trichodesmium blooms in the world's oceans. *Global Biogeochemical Cycles*, 20(4). Available at: http://doi.wiley.com/10.1029/2005GB002673 [Accessed July 9, 2016].

Influence of nutrient availability on phosphorus acquisition strategies of marine microbes.
Stephanie Sargeant (University of the West of England, UWE Bristol) & Sarah Reynolds
(University of Portsmouth)

Introduction

In the North subtropical Atlantic (sAtl) Ocean, PO_4 concentrations are chronically low, inducing P-stress in microbes resulting in limited growth and productivity (Sohm & Capone 2010). Survival is dependent upon the ability to meet cellular P demands by either competing for residual PO_4 (Zubkov et al 2007) or accessing dissolved organic phosphorus (DOP). Under P stress marine microorganisms have the ability to activate genes, which in turn produce enzymes and proteins, which are responsible for the transport pathways of both inorganic and organic P moieties. Metagenomic database analyses have demonstrated that both surface and deep water populations in oligotrophic oceans contain these genes and thus have the potential to scavenge PO_4 and utilise components of the organic phosphorus pool. In both laboratory and field studies, the activities of these genes has been identified and these genes are expressed to a greater degree under P limitation (Dhyrman et al 2006; Martiny et al 2006; Orchard et al, 2009; Sebastian & Ammerman, 2009). However, there has been little or no direct evidence from field data that demonstrate fully how the microbial community gain their P requirement, or if strategies are influenced by differing biogeochemical regimes.

OBJECTIVE To employ molecular techniques, including microarray, with nutrient manipulated incubations to explore the P acquisition strategies of the ecologically important microbes in the sub-tropical Atlantic Ocean.

Methods.

Experimental set up.

A suite of incubations was conducted at each of the seven process stations. A replicate experiment was conducted at station 1 (Community experiment 1A) to ensure that set up was completed before dawn. Seawater collected from 40m depth using the stainless steel CTD rosette was used to fill 18 x 4L acid washed (10% HCl) polycarbonate bottles. CTD water was pre-screened using 64μm mesh to remove predators. All incubations were conducted in duplicate along with controls to ensure experimental fairness and robustness. Non-manipulated samples were collected at time zero to assess the nutrient acquisition strategies of the natural community under natural biogeochemical conditions. Incubations were spiked with (i) nitrogen to induce phosphorus stress (+N); (ii) organic phosphorus moieties to examine response to organic phosphorus sources (+orgP) and (iii) phosphate (+P).

Incubations were sampled at time zero (pre-dawn), 12 hours (dusk) and 24 hours (the following dawn). Final concentrations of 2μM nitrate and 2μM ammonium were added to +N treatments using a combined stock for stations one and two. At stations three to seven final concentrations of 1μM nitrate and 1μM ammonium were added to +N incubations using separate stocks. For organic P incubations, additions of 2μM final concentration were made for stations one and two, at stations three to seven final additions of 0.5μM organic phosphorus moieties were added. A final concentration of 0.2μM phosphate was added to +P treatments at stations one to seven. Once spiked, bottles were inverted, lids were para-filmed and placed into on-deck incubators. Incubators were kept at *in situ* sea surface temperature by pumping surface seawater from the ship's underway system, screened to the equivalent light level and dark netting was used between dusk and dawn to reduce the impact of the ship's deck lights.

Sample analysis.

At each time point two 30ml samples were aliquoted for nutrient analysis, 2ml was removed for flow cytometry analysis (FCM) to gain bacterial cell counts and 200ml for chlorophyll analysis. Nutrient samples were given to Malcolm Woodward for analysis (see nutrient section for method details). For FCM analysis, 1.8ml of sample was added to 20µl of Glutaraldehyde in 2ml cryovials. Cyrovials were incubated in the fridge for 60 minutes before being flash frozen in liquid nitrogen and stored at $-80^{o}C$. FCM samples will be analysed at the University of Portsmouth by Dr Sarah Reynolds. Chloropyll samples were given to Luke Johnson and Claire Mahaffey for analysis (See Chapter 7 on chlorophyll analysis) Analytical replicates were collected for FCM, chlorophyll and nutrient analysis from one incubation bottle per experiment and single samples collected from the remaining bottles. The remaining volume was filtered (using Masterflex pumps) through 0.22µm sterivex filter cartridges for molecular analysis. Once filtered, samples were flash frozen in liquid nitrogen and stored at $-80^{o}C$. Molecular samples collected from the incubations will be extracted at the National Oceanography Centre, Southampton by Dr Sarah Reynolds and Dr Stephanie Sargeant in collaboration with Dr Julie Robidart and analysed using an environmental microarray technique as described by Shilova et al., (2014).

Table 1. List of CTD casts used for the setup of phosphorus acquisition community experiments.

Date	Station	Exp. #	JC150 event #	Log #	Latitude	Longitude	Time out (UTC)	Depth
29/06/2017	1	C1	11	CTD005S	22.0.00 N	58.0.00 W	09:31	40m
01/07/2017	1	C1A	15	CTD007S	22.0.00 N	58.0.00 W	07:10	40m
05/07/2017	2	C2	36	CTD014S	22.0.00 N	54.0.00 W	06:10	40m
12/07/2017	3	C3	81	CTD025S	22.0.00 N	50.0.00 W	07:06	40m
17/07/2017	4	C4	106	CTD0030S	23.22.00 N	44.57.00 W	06:28	40m
22/07/2017	5	C5	132	CTD035S	23.00.00 N	40.00.00 W	05:03	40m
27/07/2017	6	C6	164	CTD42S	22.19.80 N	35.52.30 W	04:11	40m
04/08/2017	7	C7	210	CTD050S	22.00.00 N	31.00.00 W	04:24	40m

with CTDs, Despo Polyviou for help with time points, NMF technicians for deploying the CTD and all members of JC150 for their support and advice throughout the cruise.

References

Dyhrman, S.T., Chappell, P.D., Haley, S.T., Moffett, J. W., Orchard, E. D., Waterbury, J. B. & Webb, E. A. (2006). Phosphonate utilization by the globally important marine diazotroph Trichodesmium. *Nature, 439,* doi:10.1038.

Martiny, A.C., Coleman, M.L. & Chisholm, S.W. (2016). Phosphate acquisition genes in Prochlorococcus ecotypes: Evidence for genome-wide adaptation. *PNAS, 103* (33), 12552–1255, doi:10.1073/pnas.0601301103.

Orchard, E.D., Webb, E.A. & Dyhrman, S.T. (2009). Molecular analysis of the phosphorus starvation response in Trichodesmium spp. *Environmental Microbiology, 11*(9), 2400-2411, doi:10.1111/j.1462-2920.2009.01968.x.

Sebastian, M. & Ammerman, J.W. (2009). The alkaline phosphatase PhoX is more widely distributed in marine bacteria than the classical PhoA. *The ISME Journal, 3*, 563–572.

Shilova, I.N., Robidart, J.C., Tripp, H.J., Turk-Kubo, K., Wawrik, B., Post, A.F., Thompson, A.W., Ward, B., Hollibaugh, J.T., Millard, A., Ostrowski, M., Scanlan, D.J., Paerl, R.W., Stuart, R. & Zehr, J.P. (2014). A microarray for assessing transcription from pelagic marine microbial taxa. *The ISME Journal, 8,* 1476–1491

Sohm, J. A. & Capone, D.G. (2010). Zonal differences in phosphorus pools, turnover and deficiency across the tropical North Atlantic Ocean. *Global Biogeochemical Cycles, 24*, GB2008, doi:10.1029/2008GB003414.

Zubkov, M.V., Mary, I., Woodward, E.M.S., Warwick, P.E., Fuchs, B.M., Scanlan, D.J. & Burkill, P.H. (2007). Microbial control of phosphate in the nutrient-depleted North Atlantic subtropical gyre. *Environmental Microbiology, 9*(8), 2079–2089, doi:10.1111/j.1462-2920.2007.01324.x.

Additional samples

OBJECTIVE 1 Collection of plankton samples for educational and outreach purposes.
OBJECTIVE 2 Trichodesmium colony biomass for additional opportunistic molecular analysis.
OBJECTIVE 3 Filtration of whole seawater for bacterial DNA analysis.

Methods

Trichodesmium biomass.
Trichodesmium biomass was collected from plankton net hauls using a 200μm deployed for 15 minutes at 15m. *Trichodesmium* colonies were picked using an acid washed (10% HCl) disposable pipette and deposited onto 0.4μm PC 25mm membranes. Membranes were folded with acid washed (10% HCl) tweezers and placed into 2ml cryovials before flash freezing with liquid nitrogen and storing at -80°C. DNA/RNA will be extracted for additional functional gene analysis to compliment *Trichodesmium* nutrient addition experiments.

Plankton samples.

Plankton biomass, primarily zooplankton, was collected from plankton net hauls using a 200µm deployed for 15 minutes at 15m. Biomass was concentrated into sterile 15ml centrifuge tubes using an acid washed (10% HCl) disposable pipette. Samples were fixed with 2% lugols iodine and wrapped in foil to keep them in the dark.

Bacterial DNA analysis.

20L of whole seawater from 40 collected using the stainless steel CTD was filtered onto a 0.2µm supor filter for the collection of bacterial DNA. Filters were folded with acid washed (10% HCl) tweezers and placed into 2ml cryovials before flash freezing with liquid nitrogen and storing at -80°C. DNA will be extracted for analysis of bacterial functional genes to support undergraduate research projects supervised by Stephanie Sargeant at the University of the West of England.

Table 2. List of NET deployments used to collect *Trichodesmium* biomass.

Date	Station	JC150 event #	Log #	Latitude	Longitude	Depth	Sample collection
14/07/2017	3	90 - 92	NET50 - NET52	22.0.00 N	50.0.00 W	15m	1 x 50 Trichodesmium colonies
19/07/2017	4	120 - 121	NET70 - NET71	23.22.00 N	44.57.00 W	15m	2 x 50 trichodesmium colonies.
24/07/2017	5	151	NET89	23.00.00 N	40.00.00 W	15m	2 x 50 Trichodesmium colonies.
29/07/2017	6	181	NET108	22.19.80 N	35.52.30 W	15m	1 x 50 Trichodesmium colinies.

Table 3. List of NET deployments used to collect plankton samples preserved in 2% lugols iodine for education and outreach.

Date	Station	JC150 event #	Log #	Latitude	Longitude	Depth	Sample collection
07/07/2017	2	54	NET29	22.0.00 N	54.0.00 W	15m	15ml plankton sample
10/07/2017	2	69, 70	NET37 - NET38	22.0.00 N	54.0.00 W	15m	2 x 15ml plankton sample
14/07/2017	3	90 - 92	NET50 - NET52	22.0.00 N	50.0.00 W	15m	15ml plankton sample, 2 x 1.8ml Trichodesmium samples (1 x puffs, 1 x tuffs).

19/07/2017	4	120 - 121	NET70 - NET71	23.22.00 N	44.57.00 W	15m	1 x 15ml plankton sample, 1 x 1.8ml Trichodesmium sample.
24/07/2017	5	151	NET89	23.00.00 N	40.00.00 W	15m	1 x 15ml plankton sample.
29/07/2017	6	177	NET104	22.19.80 N	35.52.30 W	200m	1 x 15ml plankton sample.
29/07/2017	6	181	NET108	22.19.80 N	35.52.30 W	15m	1 x 15ml plankton sample.
04/08/2017	7	215	NET131	22.0.00 N	31.0.00 W	15m	3 x 15ml plankton sample.

Table 4. List of CTD casts used to collect samples for bacterial DNA analysis.

Date	Station	JC150 event #	Log #	Latitude	Longitude	Depth	Sample collection
29/06/2017	1	11	CTD5S	22.0.00 N	58.0.00 W	40m	2 x20L whole seawater filtered
01/07/2017	1	15	CTD7S	22.0.00 N	58.0.00 W	40m	2 x20L whole seawater filtered
12/07/2017	3	81	CTD25S	22.0.00 N	50.0.00 W	40m	2 x20L whole seawater filtered
17/07/2017	4	106	CTD30S	23.22.00 N	44.57.00 W	40m	2 x20L whole seawater filtered
22/07/2017	5	132	CTD35S	23.00.00 N	40.00.00 W	40m	2 x20L whole seawater filtered
27/07/2017	6	164	CTD042S	22.19.80 N	35.52.30 W	40m	2 x20L whole seawater filtered
04/08/2017	7	210	CTD050S	22.0.00 N	31.0.00 W	40m	6 x whole seawater filtered (volumes 4L, 3L,

2.5L, 3L,
2L, 2L).

Supplementary Information S1: Event Log

Claire Mahaffey

Cruise	Station no.	Bridge Event no.	Gear Description	Event Description	Date	Start time	Latitude (N)	Longitude (W)	End Time	Depth (m)	Contact for event	Comments	NMF ID
JC150	FISH-IN	1	FISH	FISH IN	27/06/2017	08:36	28 0	60	14:02	5045	ML	Fish deployed starboard side	
JC150	TEST	2	CTD	SS	28/06/2017	13:19	20 52	58 17 83	15:35	5045	CM	bottle 1 not fire, water collected at 300m only	CTD001S
JC150	TEST	3	CTD	TI	28/06/2017	14:54	20 52 24	58 75	15:35	5045	ML	bottles fired at 300m for soak	CTD002T
JC150	TEST	4	NET	TRICHO	28/06/2017	18:43	20 52 21	58 18 64	19:02	5045	DP	lots of Tricho	NET01
JC150	TEST	5	MCLANE	x 2	28/06/2017	19:23	20 52 21	58 18 64	20:39	5045	NH	2 pumps, 40m and 100m	PUMP01
JC150	TEST	6	CTD	TI	28/06/2017	20:49	20 52 21	58 18 64	21:04	5091	DP	bottles fired at 40m for analysis	CTD003T
JC150	1	7	CTD	TI	29/06/2017	06:47	20 57 59	58 0 95	07:29	5388	ML	EXPT A,B,C setup, 40m	CTD004T
JC150	1	8	NET	TRICHO	29/06/2017	07:50	22 0	58 0 0	08:10	5388	DP	15m, 15 min, lots of Tricho	NET02
JC150	1	9	NET	TRICHO	29/06/2017	08:15	21 60	58 0 0	08:30	5388	DP	15m, 15 min, lots of Tricho	NET03
JC150	1	10	NET	TRICHO	29/06/2017	08:30	22 0	58 0 0	08:42	5388	DP	15m, 10 min, lots of Tricho	NET04
JC150	1	11	CTD	SS	29/06/2017	09:07	22 0	58 0 0	09:31	5388	SS	EXPT SARGENT/REYNOLDS, 40m	CTD005S
JC150	1	12	NET	ZOO	30/06/2017	06:36	22 0	58 0 0	06:49	5204	CD	Zoop net to 200m, aborted due to failed read out	NET05
JC150	1	13	NET	ZOO	30/06/2017	07:24	22 0	58 0 0	07:42	5204	CD	Zoop net to 200m, 10 m per min haul	NET06
JC150	1	14	CTD	TI	30/06/2017	08:49	22 0	58 0 0	14:20	5204	ML	Deep cast	CTD006T
JC150	1	15	CTD	SS	01/07/2017	06:32	22 60	58 0 0	07:10	5204	SS	Stainless to 500m, 22 x 40m, 2 x 15m	CTD007S
JC150	1	16	NET	TRICHO	01/07/2017	07:21	22 0	58 0 0	07:36	5204	EC	Tricho, 15m, 15 min	NET07
JC150	1	17	NET	TRICHO	01/07/2017	07:40	22 0	58 0 0	07:58	5204	EC	Tricho, 15m, 15 min	NET08
JC150	1	18	NET	TRICHO	01/07/2017	10:29	22 0	58 0 0	10:44	5204	EC	Tricho, 15m, 15 min	NET09
JC150	1	19	NET	TRICHO	01/07/2017	12:20	22 0	58 0 0	12:18	5204	EC	Tricho, 15m, 15 min	NET10
JC150	1	20	MCLANE	x 3	01/07/2017	16:47	22 0	58 0 0	17:04	5204	NH	15, 40, 70 m, 3 h pumping	PUMP02
JC150	1	21	NET	TRICHO	01/07/2017	17:13	22 0	58 0 0	16:31	5203	EC	Tricho, 15m, 15 min	NET11
JC150	1	22	NET	TRICHO	01/07/2017	18:10	22 0	58 0 0	17:48	5203	ML	Tricho, 15m, 15 min	NET12
JC150	1	23	CTD	TI	01/07/2017	18:30	22 0	58 0 0	18:25	5203	ML	4 bottles, soak for contaminated bottle	CTD008T
JC150	1	24	NET	TRICHO	02/07/2017	06:31	22 0	58 0 0	18:45	5204	DP	Trace metal clean, 15m, 15 min	NET13
JC150	1	25	NET	TRICHO	02/07/2017	06:52	22 0	58 0 0	06:50	5204	DP	Tricho, 15m, 15 min	NET14
JC150	1	26	NET	TRICHO	02/07/2017	07:12	22 0	58 0 0	07:09	5204	DP	Tricho, 15m, 15 min	NET15
JC150	1	27	NET	TRICHO	02/07/2017	07:32	22 0	58 0 0	07:27	5204	DP	Tricho, 15m, 15 min	NET16
JC150	1	28	NET	TRICHO	02/07/2017	08:15	22 0	58 0 0	07:48	5204	DP	Tricho, 15m, 15 min	NET17
JC150	1	29	CTD	TI	02/07/2017	09:58	22 0	58 0 0	09:46	5204	MH	HIGH REST TI CAST	CTD009T
JC150	1	30	MCLANE	x 3	03/07/2017	04:10	22 0	58 0 0	04:27	5204	NH	3 pumps, 15, 40, 200m	PUMP03
JC150	1	31	CTD	TI	03/07/2017	06:11	22 0	58 0 0	06:25	5204	ML	Experiment D	CTD010T
JC150	1	32	CTD	TI	03/07/2017	07:54	22 0	58 0 0	08:08	5204	ML	Experiment D	CTD011T
JC150	1	33	CTD	TI	03/07/2017	10:20	22 0	58 0 0	15:32	5204	ML	Experiment D	CTD012T
JC150	1	34	MCLANE	x 3	03/07/2017		22 0	56 32 141		5204	NH	Zn/Ester, 12 at 40m	PUMP04
JC150	1.5	35	CTD	TI	04/07/2017	06:45	22 0	56 32 141	06:39	5261	ML	3 pumps	CTD013T
JC150	2	36	CTD	SS	05/07/2017	05:35	22 0	58 0 0	06:10	5750	SS	22 x 40m, 2 x 15m Tricho	CTD014S
JC150	2	37	MCLANE	x 3	05/07/2017	06:35	22 0	54 0 0	11:15	5781	NH	x 3, 15, 40, 70m	PUMP05
JC150	2	38	CTD	SS	05/07/2017	11:24	22 0	54 0 0	12:28	5753	MW	1200m CRM, no water collected	CTD015S
JC150	2	39	MCLANE	x 3	05/07/2017	12:50	22 0	54 0 0	17:15	5753	NH	x 3, down, peak and up slope of DCM	PUMP06
JC150	2	40	CTD	TI	06/07/2017	05:50	22 0	54 0 0	06:00	5166	ML	all fired at 40m	CTD016T
JC150	2	41	NET	TRICHO	06/07/2017	06:19	22 0	54 0 0	06:34	5166	DP/EC/NH	15m for 15 min	NET18
JC150	2	42	NET	TRICHO	06/07/2017	06:38	22 0	54 0 0	06:52	5166	DP/EC/NH	15m for 15 min	NET19
JC150	2	43	NET	TRICHO	06/07/2017	06:57	22 0	54 0 0	07:12	5166	DP/EC/NH	15m for 15 min	NET20
JC150	2	44	NET	TRICHO	06/07/2017	07:16	22 0	54 0 0	07:31	5166	DP/EC/NH	15m for 15 min	NET21
JC150	2	45	NET	TRICHO	06/07/2017	07:34	22 0	54 0 0	07:50	5166	DP/EC/NH	15m for 15 min	NET22
JC150	2	46	NET	TRICHO	06/07/2017	07:53	22 0	54 0 0	08:07	5166	DP/EC/NH	15m for 15 min	NET23
JC150	2	47	MCLANE	x 3	06/07/2017	09:10	22 0	54 0 0	13:21	5166	NH	3 depths	PUMP07

Cruise	Station no.	Bridge Event no.	Gear Description	Event Description	Date	Start time	Latitude (N)			Longitude (W)			End Time	Depth (m)	Contact for event	Comments	NMF ID
JC150	2	48	CTD	TI	06/07/2017	13:45	22	0	0	54	0	0	15:11	5772	ML	1000m high res	CTD017T
JC150	2	49	NET	ZOO	07/07/2017	05:33	22	0	0	54	0	0	05:49	4512	CD/NH	200m, up at 10m per min	NET24
JC150	2	50	NET	TRICHO	07/07/2017	06:38	22	0	0	54	0	0	06:53	4512	DP/EC/NH	Tricho, 15m, 15 min	NET25
JC150	2	51	NET	TRICHO	07/07/2017	07:00	22	0	0	54	0	0	07:16	4512	DP/EC/NH	Tricho, 15m, 15 min	NET26
JC150	2	52	NET	TRICHO	07/07/2017	07:41	22	0	0	54	0	0	07:57	4512	DP/EC/NH	Tricho, 15m, 15 min	NET27
JC150	2	53	NET	TRICHO	07/07/2017	09:02	22	0	0	54	0	0	09:20	4512	DP/EC/NH	Tricho, 15m, 15 min	NET28
JC150	2	54	NET	TRICHO	07/07/2017	11:00	22	0	0	54	0	0	11:15	4512	DP/EC/NH	Tricho, 15m, 15 min	NET29
JC150	2	55	CTD	SS	07/07/2017	11:56	22	0	0	54	0	0	12:47	4512	MW	all bottles at 600m, CRM for Jamstec	CTD018S
JC150	2	56	NET	TRICHO	07/07/2017	13:00	22	0	0	54	0	0	13:19	4945	DP/EC/NH	Tricho, 15m, 15 min	NET30
JC150	2	57	MCLANE	x 1	07/07/2017	13:24	22	0	0	54	0	0	13:54	4945	NH	x 1 for troubleshooting	PUMP08
JC150	2	58	MCLANE	x 1	07/07/2017	14:20	22	0	0	54	0	0	14:53	4945	CD	x 1 for troubleshooting	PUMP09
JC150	2	59	NET	TRICHO	07/07/2017	15:00	22	0	0	54	0	0	15:22	4945	DP	Tricho, 15m, 15 min	NET31
JC150	2	60	NET	ZOO	07/07/2017	15:55	22	0	0	54	0	0	16:49	4945	CD/NH	Zoop, 200m, 10 m per min	NET32
JC150	2	61	NET	TRICHO	07/07/2017	16:51	22	0	0	54	0	0	17:15	5335	DP/EC/NH	Tricho, 15m, 15 min	NET33
JC150	2	62	CTD	TI	08/07/2017	06:43	22	0	0	54	0	0	11:45	5861	ML	Deep cast, full depth	CTD019T
JC150	2	63	MCLANE	x 3	08/07/2017	12:10	22	0	0	54	0	0	17:10	5861	NH	300, 180, 75	PUMP10
JC150	2	64	NET	ZOO	09/07/2017	05:30	22	0	0	54	0	0	06:15	6151	CD	Zoop to 200m, up at 10 m per min	NET34
JC150	2	65	NET	TRICHO	09/07/2017	06:25	22	0	0	54	0	0	06:40	6151	DP/EC/NH	Tricho, 15m, 15 min	NET35
JC150	2	66	NET	TRICHO	09/07/2017	06:45	22	0	0	54	0	0	07:00	5491	DP/EC/NH	Tricho, 15m, 15 min	NET36
JC150	2	67	CTD	TI	09/07/2017	07:28	22	0	0	54	0	0	07:38	5881	ML	all at 40m, experiment E	CTD020T
JC150	2	68	CTD	TI	10/07/2017	08:51	22	0	0	54	0	0	09:03	5881	ML	all at 40m, experiment E	CTD021T
JC150	2	69	NET	TRICHO	10/07/2017	05:00	22	0	0	54	0	0	05:15	5881	EC/DP/NH	Tricho, 15m, 15 min	NET37
JC150	2	70	NET	TRICHO	10/07/2017	05:20	22	0	0	54	0	0	05:36	5881	EC/DP/NH	Tricho, 15m, 15 min	NET38
JC150	2	71	NET	TRICHO	10/07/2017	05:41	22	0	0	54	0	0	05:57	5881	EC/DP/NH	Tricho, 15m, 15 min	NET39
JC150	2	72	NET	TRICHO	11/07/2017	06:59	22	0	0	54	0	0	07:16	5881	EC/DP/NH	Tricho, 15m, 15 min	NET40
JC150	2	73	CTD	TI	11/07/2017	09:00	22	0	0	54	0	0	09:16	5881	ML	all at 40m Experiment D	CTD022T
JC150	2	74	NET	TRICHO	11/07/2017	11:00	22	0	0	54	0	0	11:16	5881	ML	all at 40m Experiment D	NET41
JC150	2	75	NET	TRICHO	11/07/2017	13:00	22	0	0	54	0	0	13:16	5881	ML	all at 40m Experiment D	NET42
JC150	2	76	NET	TRICHO	11/07/2017	15:00	22	0	0	54	0	0	15:17	5881	EC/DP/NH	Tricho, 15m, 15 min	NET43
JC150	2	77	NET	TRICHO	11/07/2017	16:20	22	0	0	54	0	0	16:33	5881	EC/DP/NH	Tricho, 15m, 15 min	NET44
JC150	2	78	CTD	TI	11/07/2017	03:11	22	0	0	54	0	0	03:23	5775	DP/EC/NH	Tricho, 15m, 15 min	NET45
JC150	2	79	CTD	TI	11/07/2017	04:35	22	0	0	54	0	0	04:46	5785	DP/EC/NH	Tricho, 15m, 15 min	CTD023T
JC150	2	80	CTD	TI	11/07/2017	06:00	22	0	0	54	0	0	06:10	5752	ML	all at 40m Experiment D	CTD024T
JC150	3	81	CTD	SS	12/07/2017	06:40	22	0	0	50	0	0	07:06	4363	SS	22 x 40m, 2 x 15m Tricho	CTD025S
JC150	3	82	NET	TRICHO	12/07/2017	07:20	22	0	0	50	0	0	07:36	4363	DP/EC/NH	Tricho, 15m, 15 min	NET46
JC150	3	83	NET	TRICHO	12/07/2017	07:38	22	0	0	50	0	0	07:53	4363	DP/EC/NH	Tricho, 15m, 15 min	NET47
JC150	3	84	NET	TRICHO	12/07/2017	08:00	22	0	0	50	0	0	08:14	4363	DP/EC/NH	Tricho, 15m, 15 min	NET48
JC150	3	85	NET	TRICHO	12/07/2017	08:16	22	0	0	50	0	0	08:32	4363	DP/EC/NH	Tricho, 15m, 15 min	NET49
JC150	3	86	MCLANE	x 3	12/07/2017	08:32	22	0	0	50	0	0	13:15	4363	NH	x 3 pumps, 14, 40 and 100m	PUMP11
JC150	3	87	CTD	SS	13/07/2017	05:33	22	0	0	50	0	0	06:19	4372	CM	x 3 bottles for salinity, otherwise for DCM only	CTD026S
JC150	3	88	FISH PUMP	40m	13/07/2017	06:20	22	0	0	50	0	0	09:50	4372	ML	pump from 35 m, setup ABC	
JC150	3	89	MCLANE	3 x	13/07/2017	09:55	22	0	0	50	0	0	15:48	4372	NH	125, 150, 200m, 4 hours	PUMP12
JC150	3	90	NET	TRICHO	14/07/2017	05:30	22	0	0	50	0	0	05:49	4335	EC/DP	Tricho, 15m, 15 min	NET50
JC150	3	91	NET	TRICHO	14/07/2017	05:52	22	0	0	50	0	0	06:04	4335	EC/DP	Tricho, 15m, 15 min	NET51
JC150	3	92	NET	TRICHO	14/07/2017	06:06	22	0	0	50	0	0	06:23	4335	EC/DP	Tricho, 15m, 15 min	NET52
JC150	3	93	NET	ZOO	14/07/2017	06:29	22	0	0	50	0	0	07:05	4335	CD	zooplankton, 200m, up at 10m per min	NET53
JC150	3	94	CTD	TI	14/07/2017	07:14	22	0	0	50	0	0	08:45	4335	ML	1000m high res	CTD027T
JC150	3	95	NET	TRICHO	14/07/2017	08:50	22	0	0	50	0	0	09:12	4335	EC/DP	Tricho, 15m, 15 min	NET54

Cruise	Station no.	Bridge Event no.	Gear Description	Event Description	Date	Start time	Latitude (N)	Longitude (W)	End Time	Depth (m)	Contact for event	Comments	NMF ID
JC150	3	96	NET	TRICHO	14/07/2017	09:14	22 0	50 0 0	09:30	4335	EC/DP	Tricho, 15m, 15 min	NET55
JC150	3	97	NET	TRICHO	14/07/2017	09:34	22 0	50 0 0	09:49	4335	EC/DP	Tricho, 15m, 15 min	NET56
JC150	3	98	NET	TRICHO	14/07/2017	11:02	22 0	50 0 0	11:18	4335	EC/DP	Tricho, 15m, 15 min	NET57
JC150	3	99	NET	TRICHO	14/07/2017	13:00	22 0	50 0 0	13:20	4335	EC/DP	Tricho, 15m, 15 min	NET58
JC150	3	100	NET	TRICHO	14/07/2017	15:00	22 0	50 0 0	15:15	4335	EC/DP	Tricho, 15m, 15 min	NET59
JC150	3	101	NET	TRICHO	14/07/2017	16:30	22 0	50 0 0	16:47	4335	EC/DP	Tricho, 15m, 15 min	NET60
JC150	3	102	FISH PUMP	40m	15/07/2017	04:30	22 0	50 0 0	13:00	4335	ML	pump water for EXPT D	PUMP13
JC150	3	103	CTD	TI	15/07/2017	05:43	22 0	50 0 0	13:10	4335	ML	Deep cast	CTD028T
JC150	3	104	MCLANE	X3	15/07/2017	13:30	22 0	50 0 0	17:10	4335	NH	40, 300, 500	PUMP13
JC150	4	105	CTD	TI	17/07/2017	04:43	23 22 0	44 57 0	05:18	3482	SS	all at 40m, ABC setup at station 4	CTD029T
JC150	4	106	CTD	SS	17/07/2017	05:30	23 22 0	44 57 0	06:28	3482	SS	22 at 40m, 2 at 15m	CTD030T
JC150	4	107	NET	TRICHO	17/07/2017	06:45	23 22 0	44 57 0	07:00	3482	EC/DP	Tricho, 15m, 15 min	NET61
JC150	4	108	NET	TRICHO	17/07/2017	07:00	23 22 0	44 57 0	07:15	3482	EC/DP	Tricho, 15m, 15 min	NET62
JC150	4	109	NET	TRICHO	17/07/2017	07:15	23 22 0	44 57 0	07:30	3482	EC/DP	Tricho, 15m, 15 min	NET63
JC150	4	110	NET	TRICHO	17/07/2017	07:03	23 22 0	44 57 0	07:48	3482	EC/DP	Tricho, 15m, 15 min	NET64
JC150	4	111	MCLANE	X3	17/07/2017	07:53	23 22 0	44 57 0	08:00	3482	NH	x 3 15, 40, 100m	PUMP14
JC150	4	112	CTD	TI	18/07/2017	04:41	23 22 0	44 57 0	12:50	3482	ML	Deep cast over snake pit vent site	CTD031T
JC150	4	113	MCLANE	X3	18/07/2017	08:20	23 22 0	44 57 0	12:50	3482	NH	3 x 50, 140, 160m	PUMP15
JC150	4	114	CTD	TI	18/07/2017	13:10	23 22 0	44 57 0	14:37	3480	ML	1000m high res	CTD032T
JC150	4	115	NET	TI	19/07/2017	04:30	23 22 0	44 57 0	04:47	3491	EC/DP	Tricho, 15m, 15 min	NET65
JC150	4	116	NET	TRICHO	19/07/2017	04:50	23 22 0	44 57 0	05:05	3491	EC/DP	Tricho, 15m, 15 min	NET66
JC150	4	117	NET	TRICHO	19/07/2017	05:10	23 22 0	44 57 0	05:25	3491	EC/DP	Tricho, 15m, 15 min	NET67
JC150	4	118	NET	ZOO	19/07/2017	05:38	23 22 0	44 57 0	06:13	3491	CD	200m, up at 10m per min	NET68
JC150	4	119	NET	TRICHO	19/07/2017	08:02	23 22 0	44 57 0	08:17	3491	EC/DP	Tricho, 15m, 15 min	NET69
JC150	4	120	NET	TRICHO	19/07/2017	08:18	23 22 0	44 57 0	08:33	3491	EC/DP	Tricho, 15m, 15 min	NET70
JC150	4	121	NET	TRICHO	19/07/2017	08:35	23 22 0	44 57 0	08:50	3491	EC/DP	Tricho, 15m, 15 min	NET71
JC150	4	122	NET	TRICHO	19/07/2017	09:59	23 22 0	44 57 0	10:17	3491	EC/DP	Tricho, 15m, 15 min	NET72
JC150	4	123	MCLANE	x 1	19/07/2017	10:30	23 22 0	44 57 0	12:00	3491	NH	1000m high res	PUMP16
JC150	4	124	NET	TRICHO	19/07/2017	12:03	23 22 0	44 57 0	12:19	3491	EC/DP	Tricho, 15m, 15 min	NET73
JC150	4	125	NET	TRICHO	19/07/2017	12:21	23 22 0	44 57 0	12:37	3491	EC/DP	Tricho, 15m, 15 min	NET74
JC150	4	126	CTD	SS	19/07/2017	12:55	23 22 0	44 57 0	13:20	3491	EC	PAR, 2 at 15m	CTD033S
JC150	4	127	NET	TRICHO	19/07/2017	14:00	23 22 0	44 57 0	14:15	3491	EC/DP	Tricho, 15m, 15 min	NET75
JC150	4	128	NET	TRICHO	19/07/2017	15:30	23 22 0	44 57 0	15:45	3491	ML	Tricho, 15m, 15 min	NET76
JC150	4	129	FISH PUMP	40m	19/07/2017	03:27	23 22 0	44 57 0	11:20	3491	EC/DP	Setup D at station 4	PUMP17
JC150	4	130	CTD	SS	19/07/2017	10:50	23 22 0	44 57 0	11:45	3491	CM/EC	PAR, 2 at 15m	CTD034S
JC150	4	131	MCLANE	x3	19/07/2017	11:30	23 22 0	44 57 0	16:15	3491	NH	x3 pumps, 40, 16, 250m	PUMP17
JC150	5	132	CTD	SS	22/07/2017	04:31	23 0	40 0	05:03	5348	SS/DP	22 at 40m, 2 at 15m	CTD035S
JC150	5	133	CTD	TI	22/07/2017	05:40	23 0	40 0	06:03	5348	ML	SETUP APRIME	CTD036T
JC150	5	134	NET	TRICHO	22/07/2017	06:15	23 0	40 0	06:30	5348	EC/DP/SS	Tricho, 15m, 15 min	NET77
JC150	5	135	NET	TRICHO	22/07/2017	06:31	23 0	40 0	06:47	5348	EC/DP/SS	Tricho, 15m, 15 min	NET78
JC150	5	136	NET	TRICHO	22/07/2017	06:49	23 0	40 0	07:07	5348	EC/DP/SS	Tricho, 15m, 15 min	NET79
JC150	5	137	NET	TRICHO	22/07/2017	07:10	23 0	40 0	07:26	5348	EC/DP/SS	Tricho, 15m, 15 min	NET80
JC150	5	138	MCLANE	X3	22/07/2017	07:45	23 0	40 0	12:00	5348	NH	15, 40, 80m	PUMP18
JC150	5	139	FISH	REPAIR	22/07/2017	14:10	23 0	40 0	15:30	5348	ML	fish repair and redeployed	PUMP18
JC150	5	140	CTD	TI	23/07/2017	04:34	23 0	40 0	09:52	5348	ML	Deep cast	CTD037T
JC150	5	141	MCLANE	x3	23/07/2017	10:00	23 0	40 0	14:40	5348	NH	100, 125, 170m	PUMP19
JC150	5	142	CTD	TI	23/07/2017	14:58	23 0	40 0	16:10	5348	ML	1000m high res	CTD038T
JC150	5	143	NET	TRICHO	24/07/2017	04:30	23 0	40 0	04:45	5348	EC/DP/SS/NH	Tricho, 15m, 15 min	NET81

Cruise	Station no.	Bridge Event no.	Gear Description	Event Description	Date	Start time	Latitude (N)	Longitude (W)	End Time	Depth (m)	Contact for event	Comments	NMF ID
JC150	5	144	NET	TRICHO	24/07/2017	04:48	23 0 40	0 52 30	05:05	5348	EC/DP/SS/NH	Tricho, 15m, 15 min	NET82
JC150	5	145	NET	TRICHO	24/07/2017	05:08	23 0 40	0 52 30	05:18	5348	EC/DP/SS/NH	Tricho, 15m, 15 min	NET83
JC150	5	146	NET	ZOO	24/07/2017	05:21	23 0 40	0 52 30	05:55	5348	NH/CD	200m, up at 10m per min	NET84
JC150	5	147	NET	TRICHO	24/07/2017	08:00	23 0 40	0 52 30	08:16	5348	EC/DP/SS/NH	Tricho, 15m, 15 min	NET85
JC150	5	148	NET	TRICHO	24/07/2017	08:20	23 0 40	0 52 30	08:40	5348	EC/DP/SS/NH	Tricho, 15m, 15 min	NET86
JC150	5	149	NET	TRICHO	24/07/2017	08:41	23 0 40	0 52 30	08:55	5348	EC/DP/SS/NH	Tricho, 15m, 15 min	NET87
JC150	5	150	NET	TRICHO	24/07/2017	08:56	23 0 40	0 52 30	09:11	5348	EC/DP/SS/NH	Tricho, 15m, 15 min	NET88
JC150	5	151	NET	TRICHO	24/07/2017	10:04	23 0 40	0 52 30	10:20	5348	EC/DP/SS/NH	Tricho, 15m, 15 min	NET89
JC150	5	152	MCLANE	x 1	24/07/2017	10:15	23 0 40	0 52 30	11:50	5348	NH	25m	PUMP20
JC150	5	153	NET	TRICHO	24/07/2017	12:04	23 0 40	0 52 30	12:20	5348	EC/DP/SS/NH	Tricho, 15m, 15 min	NET90
JC150	5	154	NET	TRICHO	24/07/2017	12:22	23 0 40	0 52 30	12:38	5348	EC/DP/SS/NH	Tricho, 15m, 15 min	NET91
JC150	5	155	NET	TRICHO	24/07/2017	12:41	23 0 40	0 52 30	12:52	5348	EC/DP/SS/NH	Tricho, 15m, 15 min	NET92
JC150	5	156	CTD	TI	24/07/2017	13:11	23 0 40	0 52 30	13:38	5348	ML	PAR and low level TM DCM water	CTD039T
JC150	5	157	NET	TRICHO	24/07/2017	14:03	23 0 40	0 52 30	15:15	5348	EC/DP/SS/NH	Tricho, 15m, 15 min	NET93
JC150	5	158	NET	ZOO	24/07/2017	14:30	23 0 40	0 52 30	15:00	5348	CD/NH	200m, up at 10m per min	NET94
JC150	5	159	NET	TRICHO	24/07/2017	15:30	23 0 40	0 52 30	15:45	5348	EC/DP/SS/NH	Tricho, 15m, 15 min	NET95
JC150	5	160	CTD	TI	25/07/2017	03:39	23 0 40	0 52 30	03:48	5348	ML	Setup A*	CTD040T
JC150	5	161	FISH PUMP	40m	25/07/2017	04:30	23 0 40	0 52 30	11:10	5348	ML	Setup D at station 5	PIUMP21
JC150	5	162	CTD	SS	25/07/2017	10:13	23 0 40	0 52 30	11:00	5348	CM	PAR	CTD041S
JC150	5	163	MCLANE	x 3	25/07/2017	11:15	23 0 40	0 52 30	15:56	5348	NH	25, 40, 80	PUMP21
JC150	6	164	CTD	SS	27/07/2017	03:30	22 19 80	35 52 30	04:11	5470	SS/DP	40, 200, 300m	CTD042S
JC150	6	165	NET	TRICHO	27/07/2017	04:31	22 19 80	35 52 30	04:45	5470	EC/DP	22 at40m, 2 at 15m	NET96
JC150	6	166	NET	TRICHO	27/07/2017	04:47	22 19 80	35 52 30	05:02	5470	EC/DP	Tricho, 15m, 15 min	NET97
JC150	6	167	NET	TRICHO	27/07/2017	05:34	22 19 80	35 52 30	05:20	5470	EC/DP	Tricho, 15m, 15 min	NET98
JC150	6	168	NET	TRICHO	27/07/2017	05:21	22 19 80	35 52 30	05:37	5470	EC/DP	Tricho, 15m, 15 min	NET99
JC150	6	169	MCLANE	x 3	27/07/2017	06:00	22 19 80	35 52 30	10:30	5470	NH	25, 40, 80	PUMP22
JC150	6	170	CTD	TI	28/07/2017	02:40	22 19 80	35 52 30	02:52	5470	ML	Setup A-Up at station 6	CTD043T
JC150	6	171	FISH PUMP	40m	28/07/2017	03:17	22 19 80	35 52 30	11:25	5470	ML	Setup D-up at station 6	PIUMP22
JC150	6	172	MCLANE	x 3	28/07/2017	11:30	22 19 80	35 52 30	14:27	5470	NH	14, 50, 70m	PUMP23
JC150	6	173	NET	TRICHO	29/07/2017	04:00	22 19 80	35 52 30	04:15	5470	EC/DP	Tricho, 15m, 15 min	NET100
JC150	6	174	NET	TRICHO	29/07/2017	04:17	22 19 80	35 52 30	04:34	5470	EC/DP	Tricho, 15m, 15 min	NET101
JC150	6	175	NET	TRICHO	29/07/2017	04:35	22 19 80	35 52 30	04:46	5470	EC/DP	Tricho, 15m, 15 min	NET102
JC150	6	176	NET	TRICHO	29/07/2017	04:51	22 19 80	35 52 30	05:03	5470	EC/DP	Tricho, 15m, 15 min	NET103
JC150	6	177	NET	ZOO	29/07/2017	05:10	22 19 80	35 52 30	05:47	5470	CD/NH	200m, up at 10m per min	NET104
JC150	6	178	NET	TRICHO	29/07/2017	06:59	22 19 80	35 52 30	07:15	5470	EC/DP	Tricho, 15m, 15 min	NET105
JC150	6	179	NET	TRICHO	29/07/2017	07:16	22 19 80	35 52 30	07:34	5470	EC/DP	Tricho, 15m, 15 min	NET106
JC150	6	180	NET	TRICHO	29/07/2017	07:36	22 19 80	35 52 30	07:51	5470	EC/DP	Tricho, 15m, 15 min	NET107
JC150	6	181	NET	TRICHO	29/07/2017	07:53	22 19 80	35 52 30	08:19	5470	EC/DP	Tricho, 15m, 15 min	NET108
JC150	6	182	NET	TRICHO	29/07/2017	09:03	22 19 80	35 52 30	09:17	5470	EC/DP	Tricho, 15m, 15 min	NET109
JC150	6	183	NET	TRICHO	29/07/2017	11:00	22 19 80	35 52 30	11:16	5470	EC/DP	Tricho, 15m, 15 min	NET110
JC150	6	184	NET	TRICHO	29/07/2017	11:18	22 19 80	35 52 30	11:35	5470	EC/DP	Tricho, 15m, 15 min	NET111
JC150	6	185	NET	TRICHO	29/07/2017	11:36	22 19 80	35 52 30	11:52	5470	EC/DP	Tricho, 15m, 15 min	NET112
JC150	6	186	CTD	SS	29/07/2017	12:07	22 19 80	35 52 30	12:53	5470	NH	SS, salts, Tricho, 14, 40, DCM, 200	CTD044S
JC150	6	187	NET	TRICHO	29/07/2017	13:00	22 19 80	35 52 30	13:16	5470	EC/DP	Tricho, 15m, 15 min	NET113
JC150	6	188	NET	TRICHO	29/07/2017	13:18	22 19 80	35 52 30	13:32	5470	EC/DP	Tricho, 15m, 15 min	NET114
JC150	6	189	NET	ZOO	29/07/2017	13:33	22 19 80	35 52 30	14:00	5470	CD/NH	zooplankton, 200m, up at 10m per min	NET115
JC150	6	190	NET	TRICHO	29/07/2017	14:30	22 19 80	35 52 30	14:45	5470	EC/DP	Tricho, 15m, 15 min	NET116
JC150	6	191	CTD	SS	30/07/2017	03:32	22 19 80	35 52 30	04:11	5470	NH	Salts	CTD045S

Cruise	Station no.	Bridge Event no.	Gear Description	Event Description	Date	Start time	Latitude (N)	Longitude (W)	End Time	Depth (m)	Contact for event	Comments	NMF ID
JC150	6	192	MCLANE	x 3	30/07/2017	04:45	22 19 80	35 52 30	09:30	5470	NH	125, 150, 175m	PUMP24
JC150	6	193	MCLANE	x 3	30/07/2017	11:00	22 19 80	35 52 30	15:00	5470	NH	125,175, 250m	PUMP25
JC150	6	194	NET	TRICHO	31/07/2017	03:27	22 19 80	35 52 30	03:45	5470	EC/DP	Tricho, 15m, 15 min	NET117
JC150	6	195	NET	TRICHO	31/07/2017	03:47	22 19 80	35 52 30	04:03	5470	EC/DP	Tricho, 15m, 15 min	NET118
JC150	6	196	NET	TRICHO	31/07/2017	04:05	22 19 80	35 52 30	04:20	5470	EC/DP	Tricho, 15m, 15 min	NET119
JC150	6	197	NET	TRICHO	31/07/2017	04:21	22 19 80	35 52 30	04:36	5470	EC/DP	Tricho, 15m, 15 min	NET120
JC150	6	198	NET	TRICHO	31/07/2017	04:38	22 19 80	35 52 30	04:53	5470	EC/DP	Tricho, 15m, 15 min	NET121
JC150	6	199	NET	TRICHO	31/07/2017	04:55	22 19 80	35 52 30	05:10	5470	EC/DP	Tricho, 15m, 15 min	NET122
JC150	6	200	NET	ZOO	31/07/2017	05:32	22 19 80	35 52 30	06:00	5470	CD/NH		NET123
JC150	6	201	CTD	TT	31/07/2017	06:20	22 19 80	35 52 30	10:48	5840	CD/NH	Deep cast, full depth Geotraces crossover	CTD046T
JC150	6	202	NET	ZOO	31/07/2017	13:05	22 19 80	35 52 30	13:36	5840	ML		NET124
JC150	6	203	NET	TRICHO	31/07/2017	13:30	22 19 80	35 52 30	13:53	5502	CD/NH	Tricho, 15m, 15 min	NET125
JC150	6	204	CTD	SS	01/08/2017	03:35	22 19 80	35 52 30	05:23	5502	MW	JAMSTEC CRM collection 2500m	CTD047S
JC150	6	205	CTD	TT	01/08/2017	09:52	22 19 80	35 52 30	11:10	5820	ML	1000m high res	CTD048T
JC150	6	206	NET	TT	01/08/2017	11:30	22 19 80	35 52 30	11:45	5823	NH		NET126
JC150	6	207	FISH PUMP	40m	02/08/2017	02:30	22 19 80	35 52 30	13:15	5825	ML	Setup Experiment D, 40m	PUMP26
JC150	6	208	CTD	TT	02/08/2017	08:05	22 19 80	35 52 30	09:00	5825	CD/NH	200m, up at 10m per min	CTD049T
JC150	6	209	MCLANE	x 3	02/08/2017	08:45	19 80 35	52 30	13:48	5825	NH	3 x Mclane 40, 125, 200	PUMP27
JC150	6	210	CTD	SS	04/08/2017	03:29	22 0	31 0	04:24	4988	SS	500m, 2 at 15, 22 at 40m	CTD050S
JC150	6	211	NET	TRICHO	04/08/2017	04:32	22 0	31 0	04:37	4983	EC/DP	Tricho, 15m, 15 min	NET127
JC150	6	212	NET	TRICHO	04/08/2017	04:38	22 0	31 0	05:04	4983	EC/DP	Tricho, 15m, 15 min	NET128
JC150	6	213	NET	TRICHO	04/08/2017	05:05	22 0	31 0	05:20	4983	EC/DP	Tricho, 15m, 15 min	NET129
JC150	6	214	NET	TRICHO	04/08/2017	05:23	22 0	31 0	05:39	4983	EC/DP	Tricho, 15m, 15 min	NET130
JC150	6	215	NET	TRICHO	04/08/2017	05:40	22 0	31 0	05:56	4983	EC/DP	Tricho, 15m, 15 min	NET131
JC150	6	216	MCLANE	X 3	04/08/2017	06:05	22 0	31 0	10:40	4983	NH	X 3, 90, 110, 130 M	PUMP28
JC150	6	217	NET	TRICHO	04/08/2017	13:00	22 0	31 0	13:15	4983	EC/DP	Tricho, 15m, 15 min	NET132
JC150	6	218	NET	TRICHO	04/08/2017	13:15	22 0	31 0	13:30	4983	EC/DP	Tricho, 15m, 15 min	NET133
JC150	6	219	FISH PUMP	40m	05/08/2017	02:28	22 0	31 0	06:38	4983	ML	SETUP D AT STATION 7	PUMP29
JC150	6	220	MCLANE	X 3	05/08/2017	08:55	22 0	31 0	13:30	4983	NH	X 3 40, 50, 70 M	PUMP30
JC150	6	221	NET	TRICHO	06/08/2017	07:18	22 0	31 0	07:36	4985	CM	Tricho, 15m, 15 min	NET134
JC150	6	222	NET	TRICHO	06/08/2017	03:48	22 0	31 0	04:02	4985	EC/DP	Tricho, 15m, 15 min	NET135
JC150	6	223	NET	TRICHO	06/08/2017	04:05	22 0	31 0	04:20	4985	EC/DP	Tricho, 15m, 15 min	NET136
JC150	6	224	NET	TRICHO	06/08/2017	04:22	22 0	31 0	04:38	4985	EC/DP	Tricho, 15m, 15 min	NET137
JC150	6	225	NET	TRICHO	06/08/2017	04:40	22 0	31 0	04:55	4985	EC/DP	Tricho, 15m, 15 min	NET138
JC150	6	226	NET	TRICHO	06/08/2017	04:55	22 0	31 0	05:10	4985	EC/DP	Tricho, 15m, 15 min	NET139
JC150	6	227	NET	ZOO	06/08/2017	05:10	22 0	31 0	05:45	4985	CD	200m, up at 10m per min	NET140
JC150	7	228	CTD	TI	06/08/2017	06:05	22 0	31 0	06:17	4985	ML	60 m all at 40 m, setup stn 7 ABC	CTD051T
JC150	7	229	NET	TT	06/08/2017	07:00	22 0	31 0	06:17	4985	ML	Tricho, 15m, 15 min	NET141
JC150	7	230	NET	TRICHO	06/08/2017	07:18	22 0	31 0	07:16	4985	EC/DP	Tricho, 15m, 15 min	NET142
JC150	7	231	NET	TRICHO	06/08/2017	07:38	22 0	31 0	07:36	4985	EC/DP	Tricho, 15m, 15 min	NET143
JC150	7	232	NET	TRICHO	06/08/2017	07:55	22 0	31 0	07:53	4985	EC/DP	Tricho, 15m, 15 min	NET144
JC150	7	233	NET	TRICHO	06/08/2017	09:00	22 0	31 0	08:12	4985	EC/DP	Tricho, 15m, 15 min	NET145
JC150	7	234	NET	TRICHO	06/08/2017	09:15	22 0	31 0	09:15	4985	EC/DP	Tricho, 15m, 15 min	NET146
JC150	7	235	NET	TRICHO	06/08/2017	11:00	22 0	31 0	09:30	4985	EC/DP	Tricho, 15m, 15 min	NET147
JC150	7	236	NET	TRICHO	06/08/2017	11:16	22 0	31 0	11:15	4985	EC/DP	Tricho, 15m, 15 min	NET148
JC150	7	237	NET	TRICHO	06/08/2017	11:34	22 0	31 0	11:32	4985	EC/DP	Tricho, 15m, 15 min	NET149
JC150	7	238	NET	TRICHO	06/08/2017	11:52	22 0	31 0	11:49	4985	LW/LI	Go Pro	NET150
JC150	7	239	CTD	TI	06/08/2017	12:21	22 0	31 0	13:27	4985	ML	1000 m high rest	CTD052T

Cruise	Station no.	Bridge Event no.	Gear Description	Event Description	Date	Start time	Latitude (N)	Longitude (W)	End Time	Depth (m)	Contact for event	Comments	NMF ID
JC150	7	240	NET	TRICHO	06/08/2017	13:34	22 0 0	31 0 0	13:49	4985	EC/DP	Tricho, 15m, 15 min	NET151
JC150	7	241	NET	TRICHO	06/08/2017	13:52	22 0 0	31 0 0	14:00	4985	LW/LI	Go Pro	NET152
JC150	7	242	NET	TRICHO	06/08/2017	14:30	22 0 0	31 0 0	14:46	4985	EC/DP	Tricho, 15m, 15 min	NET153
JC150	7	243	CTD	SS	07/08/2017	03:42	22 0 0	31 0 0	04:13	4984	CM	bloom cast, FCM, chl, microscopy	CTD053S
JC150	7	244	NET	TRICHO	07/08/2017	04:28	22 0 0	31 0 0	04:42	4984	NH	15m	NET154
JC150	7	245	NET	TRICHO	07/08/2017	04:45	22 0 0	31 0 0	05:08	4984	NH	40m, hold for 15 min	NET155
JC150	7	246	NET	TRICHO	07/08/2017	05:09	22 0 0	31 0 0	05:40	4984	NH	90m, hold for 15 min	NET156
JC150	7	247	NET	TRICHO	07/08/2017	06:00	22 0 0	31 0 0	06:30	4984	NH	zooplankton, 200m, up at 10m per min	NET157
JC150	7	248	NET	TRICHO	07/08/2017	06:30	22 0 0	31 0 0	07:15	4984	NH	160m, hold for 15 min	NET158
JC150	7	249	NET	TRICHO	07/08/2017	07:15	22 0 0	31 0 0	07:30	4984	EC/DP	Tricho, 15m, 15 min	NET159
JC150	7	250	NET	TRICHO	07/08/2017	07:35	22 0 0	31 0 0	07:50	4984	EC/DP	Tricho, 15m, 15 min	NET160
JC150	7	251	NET	TRICHO	07/08/2017	07:55	22 0 0	31 0 0	08:10	4984	EC/DP	Tricho, 15m, 15 min	NET161
JC150	7	252	NET	TRICHO	07/08/2017	08:10	22 0 0	31 0 0	08:20	4984	EC/DP	Tricho, 15m, 15 min	NET162
JC150	7	253	NET	TRICHO	07/08/2017	08:50	22 0 0	31 0 0	09:05	4984	EC/DP	Tricho, 15m, 15 min	NET163
JC150	7	254	NET	TRICHO	07/08/2017	09:10	22 0 0	31 0 0	09:25	4984	CM	Tricho, 15m, 15 min	NET164
JC150	7	255	MCLANE	X 3	07/08/2017	10:00	22 0 0	31 0 0	14:00	4984	NH	40, 150, 200m	PUMP29
JC150	7	256	CTD	TI	08/08/2017	03:42	22 0 0	31 0 0	08:40	4984	ML	Full depth CTD	CTD054T
JC150	7	257	MCLANE	X 3	08/08/2017	09:00	22 0 0	31 0 0	13:45	4984	NH	210, 300, 400	PUMP30
JC150	7	258	FISH PUMP	40m	08/08/2017	13:50	22 0 0	31 0 0	15:55	4984	ML	Setup A* repeat at station 7	
JC150	7	259	Recover FISH		09/08/2014	09:04	23 15 54	28 0 57	09:31		ML	Recover Fish	

Supplementary Information S2: Station Schedules

Claire Mahaffey

JC150 STATION 1

DAY 1 (29th June 2017)
02:30   -   Titantium CTD to 500m, all bottles closed at 40m   **SETUP EXPT A,B,C**
                 -   Plankton nets (15m for 15 min), more than one net to be deployed   Tricho collection ALL
                 -   Stainless steel CTD to 500m, 22 bottles at 40m, 2 bottles at 15m   Stephanie Sargent

DAY 2 (30th June 2017)
02:30   -   Zooplankton nets x 3, 200m   Clare Davis
                 -   Titanium CTD to 20m above bottom (~ 6 hours)   TM and calibration
                 -   McLane pumps, 4 depths, pump for 4 hours   Noelle Held

DAY 3 (1st July 2017)
02:30   - Stainless steel CTD to 500m, 22 bottles at 40m, 2 bottles at 15m   Stephanie/Despo
03:30   - Plankton nets (15m for 15 min) x2   Tricho collection ALL
05:30   - Plankton net (15m for 15 min) x 1   Tricho collection ALL
08:00   - Plankton net (15m for 15 min) x 1   Tricho collection ALL
08:30   - McLane pumps, 3 deployed at 15, 40, 70 m, 3 hours pumping   Noelle Held
12:00   - Plankton net (15m for 15 min) x 1   Tricho collection ALL
14:30   - Plankton net (15m for 15 min) x 1   Tricho collection ALL

BREAKDOWN EXP A, B, C

DAY 4 (2nd July 2017)
02:30   - Plankton nets (15m for 15 min), followed by multiple nets   Tricho collection ALL
                 -   Titanium CTD to 1000m   TM and calibration
                 -   McLane pumps, 4 depths, pump for 4 hours   Noelle Held

DAY 5 (3rd July 2017)
02:30   - Titanium CTD to 500m x 3, all bottles fired a 40m,   **SETUP EXPT D**
                 -   McLane pumps, 4 depths, pump for 4 hours   Noelle Held

………then transit to station 2

JC150 STATION 2

DAY 1 Wednesday 5th July

02:30	: 1 x Stainless Steel CTD to 500m, 22 at 40m, 2 at 15m	Steph/Despo
	: McLane pumps, 3 depths, pump for 4 hours	Noelle
	: 1 x Stainless Steel CTD, 1000m (~ 1 hours),	Malcolm
	: McLane pumps, 3 depths, pump for 4 hours	Noelle

BREAKDOWN EXPERIMENT D at 06:00

DAY 2 Thursday 6th July

02:30   : 1 x Titanium CTD to 500m, 24 bottles at 40m

SETUP A,B,C

: 6 x Plankton nets (15m for 15 min)
Tricho
: McLane pumps, 3 depths, pump for 4 hours
    Noelle
: 1 x Titanium CTD to 1000m, high resolution profile
    Maeve

BREAKDOWN Zn/ester at 04:30

DAY 3 Friday 7th July

02:30	**:** Plankton nets (2 x 200m, up at 10m per min, 4 x 15m for 15 min)	Clare/Noelle
	: Then nets at dawn and every 1-2 hours until 2pm	
09:00	: 1 x Stainless Steel CTD to 1000m,	Malcolm
10:00	: McLane pump, 1 pump, 1 depth for test only,	
	may need to be repeated to troubleshoot	Noelle
	ongoing problem with one pump	
Noon	: Plankton net (2 x 200m, 4 x 15m for 15 min)	Clare/Noelle

DAY 4 Saturday 8th July

02:30	: 4 x Plankton nets (15m for 15 min)	Tricho
	: 1 x Titanium CTD, Full depth (~ 6 hours)	Maeve
	: McLane pumps, 3 depths, pump for 4 hours	Noelle

BREAKDOWN EXPERIMENT A,B, C

DAY 5 Sunday 9th July

Midnight	: 4 x Titanium CTD to 50m, 24 bottles at 40m	**SETUP D**
From ~00:30	**:** Plankton nets, 15m, 15 min in between CTD-Ti casts	Clare/Noelle
	: McLane pumps, 3 depths, pump for 4 hours	Noelle

………then transit to station 3

JC150 STATION 3

Day 1: Wednesday 12th July
Dawn is at 05:45

ETA 03:30-04:00	: Stainless Steel cast, 22 bottles at 40m, 2 bottles at 15m	Stephanie
	: 4 x Plankton nets, 15m for 15 min	Despo/Elena
	: McLane pumps, 3 depths 4 hours	Noelle

Day 2: Thursday 13th July

02:30	: 1 X Stainless steel cast to 500m, no bottles fired	Claire
03:30	: Pump from 40m using Kevlar wire, SAPS weight, FISH pump	**Setup A,B,C**
08:00	: 3 x McLane pumps, 4 hours	Noelle

08:00 BREAKDOWN EXPERIMENT D

Day 3: Friday 14th July

02:30	: Plankton nets (200m zoop net, 15m net)	Clare/Despo/Noelle/Elena
04:00	: 1 x Ti CTD to 1000m, high res sampling	Maeve and TM team
Then plankton nets every 2 hours to 14:00		Elena/Despo/Noelle

Day 4: Saturday 15th July

02:30	: 1 x Ti CTD, full depth ~ 5-6 hours	Maeve and TM team
03:00	: Pump from 40m using Kevlar wire, SAPS weight, FISH pump	**Setup D**
~ 10:00	: 3 x McLane pumps, 4 hours	Noelle

06:00 BREAKDOWN EXPERIMENT A,B,C

Then transit to station 4!....AND FISH

JC150 STATION 4
'Snake pit' on the Mid-Atlantic Ridge

Day 1: Monday 17th July

02:30	: 1 x Titanium CTD to 300m, all bottles at 40m	**SETUP ABC**
03:30	: 1 x stainless steel to 300m, 22 bottles at 40m, 2 bottles at 15m	Steph
04:30	: 4 x plankton nets	DP/EC
06:00	: 3 x McLane pumps	Noelle

10:00 BREAKDOWN D

Day 2: Tuesday 18th July

02:30	: 1 x Titanium CTD to 1000m, high res sampling	Maeve
04:00	: 3 x McLane pumps, 4 hours, 3 depths	Noelle
10:00	: 1 x Titanium CTD to full depth	Maeve

Day 3: Wednesday 19th July

02:30	: Plankton nets (200m, Tricho nets x 4), then nets at 06:00, 08:00, 10:00, noon and 13:30	D/E/C/N
After 08:00 net	: 1 x McLane pump to 15m, out by 10am net	Noelle
11:00	: 1 x stainless steel CTD to 300m with PAR sensor	Elena

06:00 BREAKDOWN ABC

Day 4: Thursday 20th July

01:30	: Fish pump at 50m	**SETUP D/Noelle**
When Kevlar wire free:	: 3 x McLane pumps, 4 hours 3 depths	
11:00	: 1 x stainless steel CTD to 300m with PAR sensor	Claire

JC150 STATION 5

Day 1: Saturday 22nd July

02:30	: 1 x stainless steel to 300m, 22 bottles at 40m, 2 bottles at 15m	Steph
03:30	: 1 x Titanium CTD to 300m, all bottles at 40m	**SETUP A+**
04:30	: 4 x plankton nets	DP/EC
06:00	: 3 x McLane pumps	Noelle
Noon	: Recover whole FISH and redeploy	Maeve

04:00 BREAKDOWN Experiment A   Claire/Clare
10:00 BREAKDOWN Experiment D

Day 2: Sunday 23rd July

02:30	: 1 x Titanium CTD to full depth	Maeve
Followed by	: 3 x McLane pumps, 4 hours, 3 depths	Noelle
Followed by	: 1 x Titanium CTD to 1000m, high res sampling	Maeve

Day 3: Monday 24th July

02:30	: Plankton nets (200m, Tricho nets x 4), then 1 or 2 nets at 06:00, 08:00, 10:00, noon and 13:30	D/E/C/N
After 08:00 net	: 1 x McLane pump to 15m, out by 10am net	Noelle
11:00	: 1 x stainless steel CTD to 300m, PAR, all at 15m	Elena/Malcolm

06:00: BREAKDOWN ABC

Day 4: Tuesday 25th July

01:30	: Fish pump at 50m	**SETUP D/Noelle**
10:00	: 1 x stainless steel CTD to 300m with PAR sensor	Claire
When Kevlar wire free:	: 3 x McLane pumps, 4 hours 3 depths	

JC150 STATION 6: GEOTRACES Crossover Station

Day 1: Thursday 27th July

Day 1: Thursday 27th July

02:30	: 1 x stainless steel CTD to 500m, 22 bottles at 40m, 2 bottles at 15m	Steph
03:30	: 4 x plankton nets	Elena/Despo
05:00	: 3 x McLane pumps (3 depths, 4 hours)	Noelle
04:00 BREAKDOWN Experiment A* from station 5		Claire/Clare/Maeve/Luke
08:00 BREAKDOWN Experiment D from station 5		All hands

Day 2: Friday 28th July

01:30	: 1 x Titanium CTD to 300m, all bottles at 40m	SETUP A-up
	Followed by deployment of FISH pump tubing to 40 m	SETUP D-up
Followed by	: 3 x McLane pumps, 4 hours, 3 depths	Noelle

Day 3: Saturday 29th July

02:30	: Lower FISH to 15-20m to pump on station	Maeve
03:00	: Plankton nets (200m, Tricho nets x 4), then nets at 06:00,	D/E/C/N
08:00, 10:00, noon and 13:30 (SEE DETAILED SCHEDULE)		
11:00	: 1 x stainless steel CTD to 500 m with PAR sensor (5 bottles at 15m then	
	3 bottles at each of the following depths (40, DCM, 200m)	Elena/Noelle
After net at 13:30, raise fish to 7-10m and transit at 4 knots around station 6 to collect water from FISH		Liz/Maeve

Day 4: Sunday 30th July

02:30	: 1 x Stainless steel CTD to 500m, no bottles fired	Noelle
Followed by	: 3 x McLane pumps, 4 hours, 3 depths	Noelle
Approx 09:30	: 3 x McLane pumps, 4 hours, 3 depths	Noelle
04:00 BREAKDOWN A-UP		Claire/Clare/Maeve/Luke
09:00 BREAKDOWN D-UP		ALL HANDS

Day 5: Monday 31st July

02:30	: Plankton nets (1 x 200m, 6 x 15m for 15 min)	Noelle/Clare/Despo
04:30	: 1 x Titanium CTD to full depth (6-7 hours)	Maeve
12:00	: Plankton nets (1 x 200m, 2 x 15m for 15 min)	Noelle/Clare

Day 6 Tuesday 1st August

02:30	:1 x stainless steel CTD to full depth, all bottles fired at depth TBD	Malcolm CRM
08:30	:1 x Titanium CTD to 1000m, high res sampling	Maeve

Day 7 Wednesday 2nd August

01:30	: 1 x Titanium CTD to 50m, all bottles at 40m	**SETUP A**
02:30	: Fish pump at 50m	**SETUP D**
When Kevlar wire free		
	: 3 x McLane pumps, 4 hours 3 depths	Noelle
08:00-09:00	: 1 x stainless steel CTD to 300m with PAR sensor	Claire

Transit from station 6 to 7 and JC150 STATION 7
(22N, 31W)

<div style="border: 1px solid black;">

DURING TRANSIT BETWEEN STATION 6 AND 7

Wednesday 2nd August   : Fish at 15:00, 17:00, 19:00, 21:00, 23:00

22:00   : Experiment D, T12 hour (x3 carboys)

Thursday 3rd August   : Fish at 01:00, 03:00, 05:00, 07:00, 09:00

10:00   : Experiment D, T24 hour (x 9 carboys)

                                             : Fish at 11:00, 13:00, 15:00, 17:00, 19:00, 21:00

22:00   : Experiment D, T36 hour (x 3 carboys)

                                             : Fish at 01:00, then arrive at station 7

</div>

Day 1: Friday 4th August:
02:30   : 1 x stainless steel CTD to 500m, 22 bottles at 40m, 2 bottles at 15m   Steph/Despo/Elena
03:30   : 4 x plankton nets (15 m, 15 min)   Elena/Despo
05:00   : 3 x McLane pumps (3 depths, 4 hours)   Noelle
11:00   : 2 x plankton nets (15m, 15 min)

10:00   : Experiment D, T48 hour (x 9 carboys)
Followed by   : Breakdown of Experiment A   Claire/Clare/Maeve/Luke
22:00   : Experiment D, T60 hour (x 3 carboys)

Day 2: Saturday 5th August
01:30   : deployment of FISH pump tubing to 40 m   Setup D
~ 08:00   : 3 x McLane pumps, 4 hours, 3 depths   Noelle

10:00   : Experiment D, T72 hour (x 9 carboys)

Day 3: Sunday 6th August
02:30   : Plankton nets (200m, Tricho nets x 4), then nets at 06:00,   D/E/C/N
08:00, 10:00, noon and 13:30
04:30   : 1 x Ti cast to 500m, all bottles at 40m   Setup A
10:00   : 1 x Titanium CTD to 500m, high res sampling with PAR sensor

Day 4: Monday 7th August
02:30   : 8 x Plankton nets (15m, 100, 140, 200m, tow for 15 min),   Clare/Noelle/Despo/Elena
07:00   : 3 x McLane pumps (3 depths, 4 hours)   Noelle

09:00   BREAKDOWN D   ALL HANDS

Day 5: Tuesday 8th August
02:30   : 1 x Titanium CTD to full depth (6-7 hours)   Maeve
09:00   : 3 x McLane pumps, 4 hours, 3 depths   Noelle
Followed by   : Recover FISH before transit to Tenerife

04:00   BREAKDOWN A   Clare/Claire/Maeve/Luke

Wednesday 9th August:
16:00   : Bow for a cruise photo and pre-dinner drink – ALL WELCOME
18:30   : Sunset – ALL WELCOME
19:30   : 'Life Aquatic' in the lounge (wear Ziploc merchandise or light blue T-shirt) – ALL WELCOME

Thursday 10th August: Transit

Friday 11th August: Transit
Saturday 12th August: Arrive Tenerife

Supplementary Information S3:
Trace Metal CTD log sheets

Maeve Lohan

Cruise JC150 Trace Metal CTD log sheet

Station	1 shallow cast	CTD No	009T	Date	02/07/2017		
Latitude	22.00.00	Event No	029	Time I/W (GMT)	08:15	CTD frame type:	
Longitude	58.00.00	Depth	5441	Time bottom (GMT)	08:36	Ti	
Filename		Cast Depth	700	Time O/W (GMT)	09:46		
Weather							

Fire Seq	Rosette Pos'n	Bot. No.	Depth (Pressure)	Time (GMT)	Label ID	O2	NUTS	TDTM	dFe	DZn	sFe	Fe spp	part	Co spp	Cr iso	Zn iso	Zn spp	Chla	DOP	SAL	Other
1	1	1T	650		049	x	x	x	x	x			x	x	x						174,175
2	2	2T	600		050		x	x	x	x					x						
3	3	3T	550		051		x	x	x	x	x	x								x	
4	4	4T	500		052		x	x	x	x	x										
5	5	5T	450		053	x	x		x	x	x	x			x	x					177, 168
6	6	6T	400		054		x	x	x	x						x					Koko Calib
7	7	7T	375		055		x	x	x		x								x		
8	8	8T	350		056		x	x	x	x	x	x			x				x		
9	9	9T	300		057		x	x	x	x	x	x				x			x	x	
10	10	10T	275		058		x	x	x	x	x	x	x								
11	11	11T	250		059		x		x	x		x			x						
12	12	12T	225		060		x	x	x	x	x	x								x	
13	13	13T	200		061		x		x	x	x	x	x	x			x	x	x		
14	14	14T	175		062		x	x	x	x	x	x	x				x	x	x		
15	15	15T	160		063		x		x	x	x	x	x		x		x	x	x		
16	16	16T	150		064		x	x	x	x	x	x	x	x	x		x	x	x		
17	17	17T	140		065	x	x	x	x	x	x	x	x			x	x	x	x		73,72
18	18	18T	120		066		x	x	x	x	x	x	x				x	x	x		
19	19	19T	100		067		x	x	x	x	x	x	x		x		x	x	x		
20	20	20T	80		068		x	x	x	x	x	x	x	x		x	x	x	x		
21	21	21T	60		069		x	x	x	x	x	x	x				x	x	x	×	
22	22	22T	40		070	x	x	x	x	x	x	x	x	x	x		x	x	x		
23	23	23T	25		071	x	x	x	x	x	x	x	x			x	x	x	x		54,56
24	24	24T	15		072			x	x	x	x	x	x	x		x	x		x		

Comments

Bottle 4 leaks from, front handle
Bottle 6 leaks from back handle

Cruise JC150 Trace Metal CTD log sheet

Station	1		
Latitude	21.59.99	CTD No	006T	Date	30/06/2017
Longitude	57.59.99	Event No	014	Time I/W (GMT)	08:48
Filename		Depth		Time bottom (GMT)	CTD frame type:
Weather		Cast Depth	5405	Time O/W (GMT)	Ti

Fire Seq	Rosette Pos^n	Bot. No.	Depth (Pressure)	Time (GMT)	Label ID	O2	NUTS	TDTM	dFe	DZn	sFe	Fe spp	part	Co spp	Cr iso	Zn iso	Zn spp	Chla	SAL	Other
1	1	1T	5405		025		x	x	x	x	x	x	x							x	
2	2	2T	5350		026				x	x	x	x	x	x							
3	3	3T	5000		027	30,28,37			x	x	x				x						
4	4	4T	4500		028				x	x	x		x	x	x						
5	5	5T	4000		029	23,24,26			x	x		x	x	x		x				x	
6	6	6T	3500		030				x	x										x	
7	7	7T	3000		031	20,22,21			x	x										x	
8	8	8T	2500		032				x	x		x								x	
9	9	9T	2250		033	53,54,43			x	x	x										
10	10	10T	2000		034	39,40,41			x	x	x			x	x	x	x			x	
11	11	11T	1750		035				x	x											
12	12	12T	1500		036	83,88,89			x	x	x									x	
13	13	13T	1250		037																
14	14	14T	1000		038	82,80,79			x	x	x	x	x		x	x	x		x		
15	15	15T	800		039				x	x	x	x	x								
16	16	16T	600		040	130,119,126			x	x	x		x	x							
17	17	17T	400		041				x	x			x	x							
18	18	18T	300		042				x	x				x							
19	19	19T	250		043	95,116,117			x	x	x										
20	20	20T	200		044				x	x	x		x	x							
21	21	21T	160		045	183,198,155			x	x	x										
22	22	22T	140		046				x	x	x		x	x							
23	23	23T	130		047	215,204,202			x	x	x	x	x								
24	24	24T	100		048				x	x	x	x	x	x						x	

Comments

Bottle 13: Tap fell off before deployment-changed and bottle dipped for soak
Bottles 16 and 17 were deployed the wrong way around so bottle 16 depth is 400 and 17 is 600m
Bottle 19 leaked from back under pressure
Bottle 22 leaks from the front handle and these will be replaced for next cast

Cruise JC150 Trace Metal CTD log sheet

Station	2 shallow cast	CTD No	017T	Date	06/07/2017
Latitude	22.00.00	Event No	048	Time I/W (GMT)	13:45
Longitude	53.99.99	Depth	5441	Time bottom (GMT)	
		Cast Depth	750	Time O/W (GMT)	15:11
Filename				CTD frame type:	Ti
Weather					

Fire Seq	Rosette Pos'n	Bot. No.	Depth (Pressure)	Time (GMT)	Label ID	O2	NUTS	TDTM	dFe	DZn	sFe	Fe spp	part	Co spp	Ni, Mn	Zn iso	Zn spp	Chla	DOP	SAL	Other
1	1	1T	700		073		x	x	x	x		x	x	x			x			x	
2	2	2T	600		074		x	x	x	x		x	x	x	x						
3	3	3T	550		075		x		x			x					x			x	
4	4	4T	500		076	X	x	x	x	x	X	x	x		x		x				218, 220
5	5	5T	450		077		x	x	x	x	x	x	x				x			x	Koko test
6	6	6T	400		078		x	x	x	x							x	x			
7	7	7T	350		079		x	x	x	x	x	x	x				x				No particulates-change o-ring as leaking near Tap
8	8	8T	325		080	x	x	x	x	x	x	x					x			x	149, 159
9	9	9T	300		081		x	x	x	x	x	x	x	x	x		x		x		
10	10	10T	275		082		x	x	x	x	x	x	x								
11	11	11T	250		083		x	x	x	x	x	x					x				
12	12	12T	225		084		x	x	x	x							x	x		x	
13	13	13T	200		085		x	x	x	x	x	x	x	x			x	x	x		
14	14	14T	180		086	x	x	x	x	x	x	x	x	x	x		x	x	x		85, 157
15	15	15T	160		087		x	x	x	x	x	x	x	x			x	x	x		
16	16	16T	150		088		x	x	x	x	x	x					x	x	x		Koko Test
17	17	17T	140		089	x	x	x	x	x	x	x					x	x	x		
18	18	18T	120		090		x	x	x	x	x	x	x	x	x		x	x	x		
19	19	30T	100		091		x	x	x	x	x	x					x	x		x	
20	20	20T	80		092	x	x	x	x	x	x	x	x	x	x		x	x	x		23, 155
21	21	21T	60		093		x	x	x	x	x			x			x	x	x	x	
22	22	25T	40		094		x	x	x	x	x		x		x		x	x	x		
23	23	23T	25		095		x	x	x	x	x	x	x	x	x		x	x	x		
24	24	24T	15		096		x		x	x			x		x		x	x	x	x	

Comments: **Change O ring on Bottle 7 near Tap**

Cruise JC150 Trace Metal CTD log sheet

Station	2 deep cast	CTD No	019T	Date	8/7/17
Latitude	21.59.999	Event No	062	Time I/W (GMT)	06:41
Longitude	53.59.999	Depth	5868	Time bottom (GMT)	
Filename		Cast Depth		Time O/W (GMT)	
Weather				CTD frame type:	Ti

Fire Seq	Rosette Pos'n	Bot. No.	Depth (Pressure)	Time (GMT)	Label ID	O2	NUTS	TDTM	dFe	DZn	sFe	Fe spp	part	Co spp	Cr iso	Zn iso	Zn spp	Chla	DOP	SAL	Other
1	1	1T	-20		097		x	x	X	X	x		X				X				
2	2	2T	-50		098	X	X	x	X	X	X		X	X			X				170,37,39
3	3	3T	5000		099	X	X	x	X	X			X				X			X	
4	4	4T	4500		100	X	X	x	X	X			X	X							54,60,119
5	5	5T	4000		101		X	x	X	X			X				X				
6	6	6T	3500		102	x	X	x	X	X			X	X			X			X	116,174, 215
7	7	7T	3000		103		X	x	X	X			X				X				
8	8	8T	2500		104	x	X	x	X	X	X		X				X				198,54,68
9	9	9T	2250		105		X	x	X	X							X			X	
10	10	10T	2000		106	x	X	x	X	X			X	X			X				75,77,79
11	11	11T	1750		107		X	x	X	X	X										
12	12	12T	1500		108	x	X	x	X	X			X	X			X			X	80,82,83
13	13	13T	1250		109		X	x	X	X	X		X								
14	14	14T	1100		110	x	X	x	X	X			X	X			X			X	22,28,30
15	15	15T	1000		111		X	x	X	X	X		X	X							
16	16	16T	900		112	x	X	x	X	X			X	X			X				20,26,21
17	17	17T	800		113	x	X	x	X	X	x		X	X			x			x	
18	18	18T	700		114	x	X	x	X	X											24,40,41
19	19	30T	600		115	x	X	x	X	X											
20	20	20T	300		116	x	X	x	X	X			x	x							1,11,18, Koko calibration water
21	21	21T	225		117		X	x	X	X											Koko calibration water
22	22	25T	160		118	x	X	x	X	X											84,16,85
23	23	23T	140		119		X	x	X	X											
24	24	24T	100		120	x	x	x	X	X											88,81,89

Comments

Cruise JC150 Trace Metal CTD log sheet

Station	3 shallow cast	CTD No	027T	Date	14/07/2017
Latitude	22.00.000	Event No	094	Time I/W (GMT)	07:25
Longitude	050.00.000	Depth	4325	Time bottom (GMT)	
Filename		Cast Depth	650	Time O/W (GMT)	
Weather				CTD frame type:	Ti

Fire Seq	Rosette Pos^n	Bot. No.	Depth (Pressure)	Time (GMT)	Label ID	O2	NUTS	TDTM	dFe	DZn	sFe	Fe spp	part	Co spp	Mn/Ni	APA	Zn spp	Chla	DOP	SAL	Other
1	1	1T	600		121	x	x	x	x	x										x	95,183,96
2	2	2T	550		122		x	x	x	x	x	x		x						x	
3	3	3T	500		123		x	x	x	x				x							
4	4	4T	450		124		x	x	x	x	x	x								x	
5	5	5T	425		125		x	x	x	x											
6	6	6T	400		126	x	x	x	x	x		x		x		x			x	x	101,48,91
7	7	7T	350		127		x	x	x	x						x					
8	8	8T	325		128		x	x	x	x	x	x		x					x	x	
9	9	9T	300		129		x	x	x	x								x	x		
10	10	10T	250		130		x	x	x	x			x	x							
11	11	11T	225		131		x	x	x	x											
12	12	12T	200		132		x	x	x	x	x	x	x					x	x	x	
13	13	13T	180		133		x	x	x	x	x			x		x		x	x	x	
14	14	14T	160		134		x	x	x	x	x	x	x		x	x		x	x	
15	15	15T	140		135		x	x	x	x	x	x	x			x		x	x	
16	16	16T	130		136	x	x	x	x	x	x	x	x	x	x	x		x	x		104,168
17	17	17T	125		137		x	x	x	x	x	x	x				x	x	x	
18	18	18T	120		138		x	x	x	x	x					x		x	x	
19	19	30T	100		139		x		x	x		x			x			x	x	
20	20	20T	80		140		x	x	x	x	x	x	x	x				x	x	
21	21	21T	60		141		x	x	x	x	x					x			x	
22	22	25T	40		142		x	x	x	x	x	x		x	x			x	x	
23	23	23T	25		143		x	x	x	x	x	x						x	x	x
24	24	24T	15		144	x	x	x	x	x	x	x	x	x	x			x	x		132,53,177

Comments

Cruise JC150 Trace Metal CTD log sheet

Station	3 deep cast	CTD No	028T	Date	15/07/2017	
Latitude	20.00.000	Event No	103	Time I/W (GMT)	05:44	CTD frame type:
Longitude	50.00.000	Depth	4390	Time bottom (GMT)	07:35	Ti
		Cast Depth	4370	Time O/W (GMT)	10:30	

Fire Seq	Rosette Pos^n	Bot. No.	Depth (Pressure)	Time (GMT)	Label ID	O2	NUTS	TDTM	dFe	DZn	sFe	Fe spp	part	Co spp	Mn/Ni	APA	Zn spp	Chla	DOP	SAL	Other
1	1	1T	-20		145		x		x	x							x			x	
2	2	2T	-50		146		x		x	x							x			x	
3	3	3T	4000		147		x		x	x				x			x				
4	4	4T	3500		148		x		x	x											
5	5	5T	3000		149		x		x	x				x			x			x	
6	6	6T	2750		150		x		x	x											
7	7	7T	2500		151		x		x	x							x				
8	8	8T	2250		152		x		x	x											
9	9	9T	2000		153		x		x	x				x			x			x	
10	10	10T	1750		154		x		x	x											
11	11	11T	1500		155		x		x	x	x			x			x				
12	12	12T	1250		156		x		x	x	x	x		x						x	
13	13	13T	1100		157		x		x	x	x										
14	14	14T	1000		158		x		x	x	x	x		x			x				
15	15	15T	900		159		x		x	x	x										
16	16	16T	800		160		x		x	x	x	x		x							
17	17	17T	750		161		x		x	x	x	x					x				
18	18	18T	700		162		x		x	x											
19	19	30T	650		163		x		x	x							x			x	
20	20	20T	600		164		x		x	x											
21	21	21T	400		165		x		x	x		x									Carboy for Neil and Koko
22	22	25T	140		166		x		x	x										x	Carboy for Neil and Koko
23	23	23T	140		167		x		x	x											
24	24	24T	100		168		x		x			x									

Weather

Comments

Bottle 15 bottom of tap missing-needs to be changed

Cruise JC150 Trace Metal CTD log sheet

Station	4 Shallow cast	
Latitude	23 21.999	CTD No 032T	Date 18/07/2017
Longitude	44 57.000	Event No 114	Time I/W (GMT) 13:10
Filename		Depth 3475	Time bottom (GMT) 13:36
Weather		Cast Depth 1000	Time O/W (GMT)

CTD frame type: Ti

Fire Seq	Rosette Pos^n	Bot. No.	Depth (Pressure)	Time (GMT)	Label ID	O2	NUTS	TDTM	dFe	DZn	sFe	Fe spp part	Co spp	Mn/Ni	Cr iso	Zn spp	Chla	DOP	APA	SAL	Other
1	1	1T	600		193		x	x	x	x					x	x	x	x	x		
2	2	2T	550		194		x	x	x	x											
3	3	3T	450		195		x	x	x	x	x	x									
4	4	4T	425		196		x	x	x	x					x			x			
5	5	5T	400		197		x	x	x	x						x					
6	6	6T	375		198		x	x	x	x		x				x		x			
7	7	7T	350		199		x	x	x	x	x							x			
8	8	8T	325		200		x	x	x	x											
9	9	9T	300		201		x	x	x	x	x	x	x		x	x		x	x		Zn iso
10	10	26T	275		202		x	x	x	x											Zn iso
11	11	11T	250		203		x	x	x	x						x		x			
12	12	12T	225		204		x	x	x	x							x				
13	13	13T	200		205		x	x	x	x	x	x	x		x	x	x	x	x		Zn iso
14	14	14T	180		206		x	x	x	x				x	x						
15	15	15T	160		207		x	x	x	x	x	x				x		x	x		Zn iso
16	16	16T	150		208		x	x	x	x	x	x	x			x		x	x		Zn iso
17	17	17T	140		209		x	x	x	x	x	x	x		x	x	x	x	x		
18	18	18T	130		210		x		x	x	x		x	x		x	x	x	x		
19	19	30T	120		211		x		x	x	x		x			x	x	x	x		
20	20	20T	100		212		x		x	x	x	x	x		x	x	x	x	x		
21	21	21T	60		213		x	x	x	x					x	x		x	x		
22	22	25T	40		214		x	x	x	x	x	x		x		x	x	x	x		Zn iso
23	23	23T	25		215		x	x	x	x					x			x	x		
24	24	24T	15		216		x	x	x	x		x	x	x		x	x	x	x		Zn iso

Comments

Cruise JC150 Trace Metal CTD log sheet

Station	4 deep cast	CTD No	031T	Date	18/07/2017
Latitude	23 2.000	Event No	112	Time I/W (GMT)	04:41	CTD frame type:
Longitude	044 57.000	Depth	3511	Time bottom (GMT)	06:01	
Filename		Cast Depth	3501	Time O/W (GMT)		Ti
Weather					

Fire Seq	Rosette Pos^n	Bot. No.	Depth (Pressure)	Time (GMT)	Label ID	O2	NUTS	TDTM	dFe	DZn	sFe	Fe spp	part	Co spp	Mn/Ni	Cr iso	Zn spp	Zn iso	DOP	SAL	Other
1	1	1T	3501		169	×	×	×	×	×	×	×	×			X					136,137,146
2	2	2T	3450		170	×	×	×	×	×	×					X					
3	3	3T	3400		171	×	×	×	×	×	X	×	×			×	×				135,145,139
4	4	4T	3350		172	X	X	X	X	X	×	×	×			×		×		×	144,138,148
5	5	5T	3350		173																Noelle sample for protomes
6	6	6T	3320		174		×	×	×	×	×	×	×				×				
7	7	7T	3200		175	×	×	×	×	×				×				×			5, 10, 169
8	8	8T	3000		176	×	×	×	×	×						×					
9	9	9T	2750		177	×	×	×	×	×	×					×					171,172,180
10	10	26T	2500		178	×	×	×	×	×						×					
11	11	11T	2250		179	×	×	×	×	×	×	×	×			×	×	×			74,176,178
12	12	12T	2000		180	×	×	×	×	×				×		×				×	
13	13	13T	1750		181	×	×	×	×	×						×					85,18,84
14	14	14T	1500		182	×	×	×	×	×						×				×	
15	15	15T	1250		183	×	×	×	×	×						×					11,41,155,
16	16	16T	1000		184	×	×	×	×	×		xx	X								Bottle pressure too high leaks
17	17	17T	900		185	×	×	×	×	×						×	×				134,140,142
18	18	18T	800		186	×	×	×	×	×											
19	19	30T	700		187	×	×	×	×	×				×		×					26,16,23
20	20	20T	650		188	×	×	×	×	×											
21	21	21T	600		189	×	×	×	×	×						×				×	1,21,24
22	22	25T	140		190	×	×	×	×	×											
23	23	23T	100		191	×	×	×	×	×											130, 56, 181 (lids for 56 and 181) wrong way around
24	24	24T	40		192		×	×	×	×										×	

Comments

Issues with bottles 13 through 20 where the pressure was very high and taps leaking. Think issues with the pressure valve controlling the gas pressure

Cruise JC150 Trace Metal CTD log sheet

Station	5 shallow cast	CTD No	38T	Date	23/07/2017
Latitude	22.59.999	Event No	142	Time I/W (GMT)	14:58	CTD frame type:
Longitude	40.00.000	Depth	5398	Time bottom (GMT)	15:19	Ti
Filename		Cast Depth		Time O/W (GMT)	
Weather					

Fire Seq	Rosette Pos^n	Bot. No.	Depth (Pressure)	Time (GMT)	Label ID	O2	NUTS	TDTM	dFe	DZn	sFe	Fe spp	part	Co spp	Mn/Ni	Chla	Zn spp	APA	DOP	SAL	Other
1	1	1T	600		240		x	x	x	x			x							x	
2	2	2T	550		241		x	x	x	x	x	x					x			x	
3	3	3T	500		242		x	x	x	x	x										
4	4	19T	450		243		x	x	x	x	X			x			x			x	
5	5	5T	400		244		x	x	x	x	x	x					x		x	x	
6	6	6T	350		245		x	x	x	x	x		x				x	x			
7	7	7T	325		246		x	x	x	x											
8	8	8T	300		247		x	x	x	x	x	x	x	x							
9	9	9T	275		248		x	x	x	x	x							x	x	x	
10	10	26T	250		249		x	x	x	x	x	x				x	x				
11	11	11T	225		250		x	x	x	x	x					x					
12	12	12T	200		251		x	x	x	x	x	x	x	x		x		x	x	x	
13	13	13T	180		252		x	x	x	x	x			x		x			x	x	
14	14	14T	160		253		x	x	x	x	x		x			x	x	x	x	x	
15	15	15T	150		254		x	x	x	x	x					x	x		x		
16	16	16T	140		255		x	x	x	x	x	x		x		x	x	x			
17	17	17T	125		256		x	x	x	x						x	x	x			
18	18	18T	120		257		x	x	x	x	x				X	x	x				
19	19	4T	100		257		x	x	x	x			x	x		x	x	x			
20	20	20T	80		259		x	x	x	x	x		x		X	x	x	x	x	x	
21	21	21T	60		260		x	x	x	x	x	x			X	x		x	x	x	
22	22	25T	40		261		x	x	x	x	x	x	x	x	X	x	x	x	x	x	
23	23	23T	25		262		x	x	x	x	x	x	x	x	X	x	x	x	x	x	
24	24	24T	15		263		x	x	x	x	x	x	x			x	x	x	x	x	

Comments

Cruise JC150 Trace Metal CTD log sheet

Station	5 deep cast	
Latitude	23 00.000	CTD No	37T
Longitude	40 00.000	Event No	140
		Depth	5399
		Cast Depth	5377

Date	23/07/2017	
Time I/W (GMT)	04:34	CTD frame type:
Time bottom (GMT)	06:36	Ti
Time O/W (GMT)		

Filename	
Weather	

Fire Seq	Rosette Posⁿ	Bot. No.	Depth (Pressure)	Time (GMT)	Label ID	O2	NUTS	TDTM	dFe	DZn	sFe	Fe spp	part	Co spp	Mn/Ni	Cr iso	Zn spp	APA	DOP	SAL	Other
1	1	1T	5377		216	x	x	x	x	x	x	x	x				x			x	173,157,79
2	2	2T	5355		217	x	x	x	x	x	x	x	x								
3	3	3T	5000		218	x	x	x	x	x											54,39,22
4	4	19T	4700		219	x	x	x	x	x	x	x									
5	5	5T	4500		220	x	x	x	x	x	x						x			x	209,215,52
6	6	6T	4000		221	x	x	x	x	x	x	x		x			x				
7	7	7T	3500		222	x	x	x	x	x	x		x				x			x	40,47,116
8	8	8T	3000		223	x	x	x	x	x	x						x				
9	9	9T	2500		224	x	x	x	x	x	x	x	x	x			x				170,80,30
10	10	26T	2250		225	x	x	x	x	x	x										
11	11	11T	2000		226	x	x	x	x	x	x	x	x	x			x			x	35,28,149
12	12	12T	1750		227	x	x	x	x	x	x		x				x				
13	13	13T	1500		228	x	x	x	x	x	x			x			x			x	31,25,207
14	14	14T	1250		229	x	x	x	x	x	x						x				
15	15	15T	1100		230	x	x	x	x	x	x	x	x	x						x	220,82,89
16	16	16T	1000		231	x	x	x	x	x	x	x	x	x			x			x	
17	17	17T	900		232	x	x	x	x	x	x						x				104,96,53
18	18	18T	800		233	x	x	x	x	x	x						x			x	
19	19	4T	700		234	x	x	x	x	x	x						x				106,174,158
20	20	20T	600		235		x	x	x	x	x		x							x	
21	21	21T	180		236	x	x	x	x	x	x							x			59,20,27
22	22	25T	125		237	x	x	x	x	x	x	x					x				3 x 2L, Neil
23	23	23T	125		238	x	x	x	x	x	x							x			95,13,193 x 1L, Neil
24	24	24T	60		239		x		x	x			x					x			

Comments

Cruise JC150 Trace Metal CTD log sheet

Station	6 shallow cast	CTD No	48T	Date	01/08/2017
Latitude	22.19.800	Event No	205	Time I/W (GMT)	09:52
Longitude	35.52.200	Depth	5825	Time bottom (GMT)	10:14
Filename		Cast Depth	1000	Time O/W (GMT)	
Weather					

CTD frame type: Ti

Fire Seq	Rosette Posⁿ	Bot. No.	Depth (Pressure)	Time (GMT)	Label ID	O2	NUTS	TDTM	dFe	DZn	sFe	TM spp	CHl a	Co spp	Mn/Ni	Cr iso	APA	Zn iso	DOP	SAL	Other
1	1	1T	650		288		x	x	x	x									x	951	
2	2	2T	600		289		x	x	x	x	x										
3	3	3T	550		290		x	x	x	x											
4	4	22T	500		291		x	x	x	x	x		x	x		x					
5	5	5T	450		292		x	x	x	x										952	
6	6	6T	400		293		x	x	x	x	x			x			x				
7	7	7T	350		294		x	x	x	x	x										
8	8	8T	325		295		x	x	x	x											
9	9	9T	300		296		x	x	x	x	x	x	x	x				x			
10	10	26T	275		297		x	x	x	x							x		x	957	
11	11	11T	250		298		x	x	x	x	x										
12	12	12T	225		299		x	x	x	x		x	x								
13	13	13T	200		300		x	x	x	x	x			x		x					
14	14	14T	180		301		x	x	x	x						x					
15	15	15T	160		302		x	x	x	x		x					x		x		
16	16	16T	140		303		x	x	x	x		x	x				x	x	x	954	
17	17	17T	130		304		x	x	x	x		x	x	x	x		x	x			
18	18	18T	120		305		x	x	x	x	x	x		x	x		x	x	x		
19	19	19T	100		306		x	x	x	x	x	x	x	x	x		x		x		
20	20	20T	80		307		x	x	x	x	x					x	x		x		
21	21	21T	60		308		x	x	x	x	x		x				x	x	x		
22	22	25T	40		309		x	x	x	x	x	x	x	x	x		x	x			
23	23	23T	25		310		x	x	x	x	x	x	x	x	x		x	x	x	955	
24	24	24T	15		311		x	x	x	x	x	x			x	x		x	x		

Comments

Cruise JC150 Trace Metal CTD log sheet

Station	6 deep cast	CTD No	46T	Date	31/07/2017
Latitude	22 19.799	Event No	201	Time I/W (GMT)	06:30
Longitude	35 52.200	Depth	5820	Time bottom (GMT)	
Filename		Cast Depth	5802	Time O/W (GMT)	
Weather					

CTD frame type: Ti

Fire Seq	Rosette Posn	Bot. No.	Depth (Pressure)	Time (GMT)	Label ID	O2	NUTS	TDTM	dFe	DZn	sFe	Fe spp	part	Co spp	Mn/Ni	Cr iso	tm spp	Zn iso	DOP	SAL	Other
1	1	1T	5802		264	X	X		X	X	X		X			X	X			945	82,215,106
2	2	2T	5773		265		X	X	X	X											
3	3	3T	5600		266	X	X	X	X	X	X			X				X			
4	4	19T	5400		267	X	X	X	X	X	X			X		X	X				96,54,113
5	5	5T	5250		268	X	X	X	X	X	X		X								174,157,28
6	6	6T	5000		269	X	X	X	X	X	X				X						
7	7	7T	4700		270	X	X	X	X	X	X										89,79,53
8	8	8T	4500		271	X	X	X	X	X	X		X	X		X	X	X		946	
9	9	9T	4000		272	X	X	X	X	X	X		X	X							130,5,26
10	10	26T	3500		273	X	X	X	X	X	X			X							
11	11	11T	3000		274	X	X	X	X	X	X										74,155,144
12	12	12T	2500		275		X	X	X	X	X		X	X		X	X	X			
13	13	13T	2250		276	X	X	X	X	X	X										56,138,139
14	14	14T	2000		277		X	X	X	X	X		X	X	X			X		947	
15	15	15T	1750		278	X	X	X	X	X	X		X								181,169,83
16	16	16T	1500		279	X	X	X	X	X	X		X	X							
17	17	17T	1250		280		X	X	X	X				X			X				84,24,11
18	18	18T	1100		281	X	X	X	X	X										948	
19	19	4T	1000		282	X	X	X	X	X			X	X				X		949	41,16,21
20	20	20T	900		283	X	X	X	X	X						X					
21	21	21T	800		284	X	X	X	X	X											23,178,171
22	22	25T	700		285	X	X	X	X	X	X		X	X				X			
23	23	23T	140		286	X	X	X	X	X	X									950	18,172,176
24	24	24T	40		287		X	X	X	X											

Comments

Bottle 4 leaking from tap handle needs to be replaced.

Cruise JC150 Trace Metal CTD log sheet

Station	7 shallow cast
Latitude	21.59.997
Longitude	30.59.999
Filename	
Weather	

CTD No	52T
Event No	239
Depth	5000
Cast Depth	500

Date	06/08/2017
Time I/W (GMT)	12:21
Time bottom (GMT)	
Time O/W (GMT)	

CTD frame type: Ti

Fire Seq	Rosette Pos^n	Bot. No.	Depth (Pressure)	Time (GMT)	Label ID	O2	NUTS	TDTM	dFe	DZn	sFe	TM spp	CHl a	Co spp	Mn/Ni	pTM	APA	Zn iso	DOP	SAL	Other
1	1	1T	500		312		x	x	x	x	x	x	x	x		x			x	980	
2	2	2T	450		313		x	x	x	x											
3	3	3T	425		314		x	x	x	x											
4	4	4T	400		315		x	x	x	x			x						x		
5	5	5T	350		316		x	x	x	x										981	
6	6	6T	325		317		x	x	x	x	x	x									
7	7	7T	300		318		x	x	x	x	x	x	x	x		x			x	982	
8	8	8T	275		319		x	x	x	x											
9	9	9T	250		320		x	x	x	x									x		
10	10	26T	225		321		x	x	x	x										983	
11	11	11T	200		322		x	x	x	x	x	x	x	x	x	x					
12	12 / 12	12T	180		323		x	x	x	x											
13	13	13T	160		324		x	x	x	x			x						x	984	
14	14	14T	140		325		x	x	x	x								x			
15	15	15T	120		326		x	x	x	x	x	x	x	x				x	x		
16	16	16T	110		327		x	x	x	x								x			
17	17	17T	100		328		x	x	x	x			x				x	x	x	985	
18	18	18T	90		329		x	x	x	x			x	x			x	x			
19	19	19T	84		330		x	x	x	x	x	x	x	x	x		x	x	x		
20	20	20T	80		331		x	x	x	x		x	x	x			x		x		
21	21	21T	60		332		x	x	x	x			x	x	x	x	x		x	986	
22	22	25T	40		333		x	x	x	x		x	x	x	x	x			x		
23	23	23T	30		334		x	x	x	x	x	x				x			x		
24	24	24T	15		335		x	x	x	x	x	x	x	x	x				x		

Comments

Cruise JC150 Trace Metal CTD log sheet

Station	7 deep cast	CTD No	54T	Date	08/08/2017
Latitude	22.00.000	Event No	256	Time I/W (GMT)	03:42
Longitude	31.00.000	Depth	5020	Time bottom (GMT)	
		Cast Depth	5015	Time O/W (GMT)	
Filename				CTD frame type:	Ti
Weather					

Fire Seq	Rosette Pos'n	Bot. No.	Depth (Pressure)	Time (GMT)	Label ID	O2	NUTS	TDTM	dFe	DZn	sFe	TM spp	CHl a	Co spp	Mn/Ni	pTM	APA	Zn iso	DOP	SAL	Other
1	1	1T	5015		336	×	×	×	×	×	×	×		×		×				987	30,220,31
2	2	2T	5000		337	×	×	×	×	×											
3	3	3T	4750		338	×	×	×	×	×				×							215,16,96
4	4	22T	4500		339	×	×	×	×	×											
5	5	5T	4000		340	×	×	×	×	×				×							113,28,181
6	6	6T	3500		341	×	×	×	×	×	×	×				×				988	
7	7	7T	3000		342	×	×	×	×	×				×							52,20,95
8	8	8T	2750		343	×	×	×	×	×											
9	9	9T	2500		344	×	×	×	×	×				×							170,116,27
10	10	26T	2250		345	×	×	×	×	×											
11	11	11T	2000		346	×	×	×	×	×	×	×		×		×					80,22,149
12	12	12T	1750		347		×	×	×	×											
13	13	13T	1500		348	×	×	×	×	×				×							79,53,176
14	14	14T	1250		349		×	×	×	×						×				984	
15	15	15T	1100		350	×	×	×	×	×	×			×							144,11,74
16	16	16T	1000		351		×	×	×	×	×			×		×					
17	17	17T	900		352	×	×	×	×	×	×	×		×		×				990	82,169,139
18	18	18T	800		353		×	×	×	×	×			×		×					
19	19	19T	700		354	×	×	×	×	×	×			×							89,26,54
20	20	20T	600		355		×	×	×	×				×		×					
21	21	21T	550		356		×	×	×	×											84,155,56
22	22	25T	500		357	×	×	×	×	×										991	
23	23	23T	110		358	×	×	×	×	×											130,41,18
24	24	24T	40		359		×	×	×	×						×				992	

Comments

Supplementary Information S4: Stainless Steel CTD log sheets

Claire Mahaffey

Cruise JC150 Stainless Steel CTD log sheet

Station	1	CTD No	005	Date	29/06/17

Station	1	CTD No	005	Date	29/06/17
Latitude	22° 0.00 N	Event No	11	Time I/W (GMT)	
Longitude	58° 0.00 W	Depth	5388	Time bottom (GMT)	CTD frame type:
Filename	/	Cast Depth	300m	Time O/W (GMT)	SS
Weather	pre dawn. - too close to dawn. Sun rising can see horizon.				

Fire Seq	Rosette Pos^n	Bot. No.	Depth (Pressure)	Time (GMT)	Label ID														
1	1		40		Steph Sargeant														
2	2		40		Rinsing Whole														
3	3		40		Rinsing														
4	4		40		Comm. intextics														
5	5		40																
6	6		40																
7	7		40																
8	8		40																
9	9		40																
10	10		40																
11	11		40																
12	12		40																
13	13		40			←													
14	14		40																
15	15		40																
16	16		40																
17	17		40																
18	18		40																
19	19		40																
20	20		40																
21	21		40																
22	22		40																
23	23		15			cont abundace of mccrol													
24	24		15																

Comments

JC150 DAILY EVENT LOG

Fish 22 0836 17° 28 N
Deploy.
60° 17.83

CRUISE CODE	STN	BRIDGE EV	GEAR	EVENT	DATE START	TIME START	LAT START	LONG START	DATE END	TIME END	LAT END	LONG END	DEPTH	CONTACT	COMMENTS	NMF ID
JC150	1	7	CTD	Ti	29/06/17	0647	22 003	57 59.995	29/06/17	0729	22 000N	57 60.00	5388	ML	A,B,C from	CTD 004T
JC150	1	8	net	Tow	29/06/17	0750	22 000N	57 60.00	29/06/17	0810	22 000N	57 60 W	5388	DP	100 t bnd	net 02
JC150	1	9	net	Tow	"	0815	21 60	58 W	29/06	0830	22 N	57.6 W	5388	DP	130 t bnd	net 03
JC150	1	10	net	Tow	29/06/17	0830	22 00 N	58 W	29/06	0842	22 N	58 W	5388	DP	160 t bnd o	net 02
JC150	1	11	CTD	SS	29/06/17	0907	22 N	58 W	29/06	0931	22 N 58 W	SS	Expt	osc CTD s 003
JC150	1	12	net	200	30/06/17	0638	22 N	58 W	30/06	0649	22 N 58 W	5203	CD	200m	net 05
JC150	1	13	net	200	30/06/17	07.24	22 N	58 W	30/06	0742	22 N 58 W	5247	CD	disturbed grape o/w	net up at 10m compl
JC150	1	14	CTD	Ti	30/06/17	0849	22 N	58 W	30/06	1420	22 N 57 60W	ML	ML	DEEP CAST	CTD 006T
JC150																
JC150																
JC150																
JC150																
JC150																
JC150																
JC150																
JC150																

SS
Ti

Cruise JC150 Stainless Steel CTD log sheet

Station	Z	CTD No	001|45	Date	05/07/17	
Latitude	21° 59.54° N	Event No	36	Time I/W (GMT)	0535	CTD frame type:
Longitude	53° 59.99° W	Depth	5750	Time bottom (GMT)		
Filename	1	Cast Depth	500	Time O/W (GMT)	0610	SS
Weather						

Fire Seq	Rosette Pos"	Bot. No.	Depth (Pressure)	Time (GMT)	Label ID		
1	1				Steph Trible Expt Mini		
2	2						
3	3						
4	4						
5	5						
6	6						
7	7		40		X	℥	
8	8				X		
9	9				X		
10	10				X X		
11	11				X		
12	12				X		
13	13				X		
14	14				X X		
15	15				X		
16	16				X		
17	17				X		
18	18				X X		
19	19				X		
20	20				X		
21	21				X		
22	22		15		X		
23	23		15				
24	24		15			X	
Comments							

Cruise JC150 Stainless Steel CTD log sheet

Station	2			
Latitude	22°N	CTD No	018S	Date	07/07/17
Longitude	54°W	Event No	55	Time I/W (GMT)	11.56
Filename	1	Depth	45,2	Time bottom (GMT)	~~...~~
Weather	1	Cast Depth	700	Time O/W (GMT)	12.47
				CTD frame type:	SS

Fire Seq	Rosette Pos^n	Bot. No.	Depth (Pressure)	Time (GMT)	Label ID
1	1		600		
2	2				
3	3				
4	4				
5	5				
6	6				
7	7				
8	8				
9	9				
10	10				
11	11				
12	12				
13	13				
14	14				
15	15				
16	16				
17	17				
18	18				
19	19				
20	20				
21	21				
22	22				
23	23				
24	24				

Comments

CTD shallow subtract for JAMSTEC reference standards Maximum Mark natural

Cruise JC150 Stainless Steel CTD log sheet

	Date	12/07/17	
CTD No	255		
Station	3	Date	12/07/17
Latitude	22°N	Event No	83	Time I/W (GMT)	0640	CTD frame type:
Longitude	50°W	Depth	4357	Time bottom (GMT)	0651	SS
Filename	–	Cast Depth	300m	Time O/W (GMT)	0706	
Weather	clear				

Fire Seq	Rosette Pos^n	Bot. No.	Depth (Pressure)	Time (GMT)	Label ID		
1	1				Steph Tnku		
2	2				Erpt clmn		
3	3				X		
4	4				X		
5	5				X		
6	6				X		
7	7		40m		X		
8	8				X		
9	9				X		
10	10				X		
11	11				X		
12	12				X		
13	13				X		
14	14				X		
15	15				X		
16	16				X		
17	17				X		
18	18				X		
19	19				X		
20	20				X		
21	21				X		
22	22		(5m		X		
23	23		15m		X		
24	24						

Comments

Cruise JC150 Stainless Steel CTD log sheet

Station	3	CTD No	026S	Date	13/07/17	
Latitude	22	Event No	87	Time I/W (GMT)	0533	CTD frame type:
Longitude	50	Depth	4392	Time bottom (GMT)		
Filename		Cast Depth	500m	Time O/W (GMT)	0554	SS
Weather						

Fire Seq	Rosette Pos^n	Bot. No.	Depth (Pressure)	Time (GMT)	Label ID														
1	1		500		SALTS														
2	2		500			X													
3	3		500			X													
4	4		500			X													
5	5																		
6	6																		
7	7																		
8	8																		
9	9																		
10	10																		
11	11																		
12	12																		
13	13																		
14	14																		
15	15																		
16	16																		
17	17																		
18	18																		
19	19																		
20	20																		
21	21																		
22	22																		
23	23																		
24	24																		

Comments

Broad DCM, peak @ 150m

To fmg
DCM

Cruise JC150 Stainless Steel CTD log sheet

Station		4	CTD No	030	Date	17/07	
Latitude		23° 22'N	Event No	106	Time I/W (GMT)	0530	CTD frame type:
Longitude		46° 56.9'W	Depth	2433	Time bottom (GMT)		
Filename		1	Cast Depth	300	Time O/W (GMT)	0628	SS
Weather							

Fire Seq	Rosette Pos^n	Bot. No.	Depth (Pressure)	Time (GMT)	Label ID																	
1	1		40																			
2	2																					
3	3																					
4	4																					
5	5																					
6	6																					
7	7				X																	
8	8				X																	
9	9				X																	
10	10				X																	
11	11				X																	
12	12				X																	
13	13				X																	
14	14				X																	
15	15				X																	
16	16				X																	
17	17				X																	
18	18				X																	
19	19				X																	
20	20				X																	
21	21				X																	
22	22		15		Steph chlar																	
23	23		15		X Trub																	
24	24				X																	

Comments

Cruise JC150 Stainless Steel CTD log sheet

Station	4	CTD No	0335	Date	14/07/17
Latitude	23° 22' N	Event No	127	Time I/W (GMT)	1255
Longitude	44° 57.?W	Depth	3514	Time bottom (GMT)	
Filename	/	Cast Depth	300	Time O/W (GMT)	1320
Weather				CTD frame type:	SS

Fire Seq	Rosette Pos^n	Bot. No.	Depth (Pressure)	Time (GMT)	Label ID				
1	1		300		Salt	Fresh Salt	3,2		
2	2								
3	3								
4	4		300		Salt	3,3			
5	5								
6	6								
7	7		300		Salt	3,4			
8	8								
9	9								
10	10								
11	11								
12	12		300		Salt	3,5			
13	13								
14	14								
15	15								
16	16		15			X			
17	17								
18	18								
19	19								
20	20		15			X			
21	21								
22	22								
23	23								
24	24								

Comments

PAR for ELENA

Cruise JC159 Stainless Steel CTD log Sheet

Station	4	CTD No	034S	Date	20/07/2017	
Latitude	23° 21.99'N	Event No	130	Time I/W (GMT)	10:50	CTD frame type:
Longitude	44° 57W	Depth	3509	Time bottom (GMT)		
Filename		Cast Depth	300	Time O/W (GMT)	11:45	SS
Weather						

Fire Seq	Rosette Posⁿ	Bot. No.	Depth (Pressure)	Time (GMT)	Label ID	salts													
1	1					x													
2	2																		
3	3																		
4	4																		
5	5																		
6	6																		
7	7																		
8	8					x													
9	9																		
10	10																		
11	11																		
12	12																		
13	13																		
14	14																		
15	15		15			x													
16	16																		
17	17																		
18	18																		
19	19																		
20	20																		
21	21																		
22	22		15			x													
23	23																		
24	24																		

Comments

PAR and DCM

Cruise JC150 Stainless Steel CTD log sheet

Station	5	CTD No	035S	Date	22/07/2017
Latitude	23 N	Event No	132	Time I/W (GMT)	04:31	CTD frame type:
Longitude	40 W	Depth	5345	Time bottom (GMT)	
Filename		Cast Depth	300	Time O/W (GMT)	05:03	SS
Weather			

Fire Seq	Rosette Posⁿ	Bot. No.	Depth (Pressure)	Time (GMT)	Label ID	Steph expt	Tricho no.											
1	1		40			x												
2	2		40			x												
3	3		40			x												
4	4		40			x												
5	5		40			x												
6	6		40			x												
7	7		40			x												
8	8		40			x												
9	9		40			x												
10	10		40			x												
11	11		40			x												
12	12		40			x												
13	13		40			x												
14	14		40			x												
15	15		40			x												
16	16		40			x												
17	17		40			x												
18	18		40			x												
19	19		40			x												
20	20		40			x												
21	21		40			x												
22	22		40			x	x											
23	23		15				x											
24	24		15															

Comments

Cruise JC159 Stainless Steel CTD log Sheet

Station	5	
Latitude	23N	CTD No	041S	Date	25/07/2017
Longitude	40W	Event No	162	Time I/W (GMT)	10:13
Filename		Depth	5348	Time bottom (GMT)	
Weather		Cast Depth	300	Time O/W (GMT)	11:00

CTD frame type: SS

Fire Seq	Rosette Posⁿ	Bot. No.	Depth (Pressure)	Time (GMT)	Label ID
1	1				
2	2				
3	3				
4	4				
5	5				
6	6				
7	7				
8	8				
9	9				
10	10				
11	11				
12	12				
13	13				
14	14				
15	15				
16	16				
17	17				
18	18				
19	19				
20	20				
21	21				
22	22				
23	23				
24	24				

Comments

PAR only

Cruise JC159 Stainless Steel CTD log sheet

Station	6	CTD No	042S	Date	27/07/2017	
Latitude	22° 19.79N	Event No	164	Time I/W (GMT)	03:30	CTD frame type:
Longitude	35° 52.20W	Depth	5530	Time bottom (GMT)		SS
Filename		Cast Depth	500	Time O/W (GMT)	04:11	
Weather						

Fire Seq	Rosette Pos^n	Bot. No.	Depth (Pressure)	Time (GMT)	Label ID	Steph expt	Tricho no.											
1	1		40			x												
2	2		40			x												
3	3		40			x												
4	4		40			x												
5	5		40			x												
6	6		40			x												
7	7		40			x									Leak			
8	8		40			x												
9	9		40			x												
10	10		40			x												
11	11		40			x												
12	12		40			x												
13	13		40			x												
14	14		40			x												
15	15		40			x												
16	16		40			x												
17	17		40			x												
18	18		40			x												
19	19		40			x												
20	20		40			x												
21	21		40			x												
22	22		40			x												
23	23		15				x											
24	24		15				x											

Comments

Cruise JC150 Stainless Steel CTD log Sheet

Station	6	CTD No	44S	Date	29/07/2017	
Latitude	22° 19.80N	Event No	186	Time I/W (GMT)	12:07	CTD frame type:
Longitude	35° 52.20 W	Depth	5826	Time bottom (GMT)		
Filename		Cast Depth	200	Time O/W (GMT)	12:53	SS
Weather	23 knots, partly cloudy					

Fire Seq	Rosette Pos^n	Bot. No.	Depth (Pressure)	Time (GMT)	Label ID	Noelle Tricho	Despo Tricho
1	1		1		×		
2	2		2		×		
3	3		3		×		
4	4		4		×		
5	5		5		×		
6	6		6		×		
7	7		7			×	
8	8		8			×	
9	9		9			×	
10	10		10			×	
11	11		11			×	
12	12		12			×	
13	13		13				×
14	14		14				×
15	15						
16	16						
17	17						
18	18						
19	19						
20	20						
21	21						
22	22						
23	23						
24	24						

Comments

Cruise JC159 Stainless Steel CTD log Sheet

Station	6	CTD No	45S	Date	30/07/2017	
Latitude	22° 119 79N	Event No	191	Time I/W (GMT)	03:32	CTD frame type:
Longitude	35° 52 19W	Depth	5834	Time bottom (GMT)		SS
Filename		Cast Depth	500	Time O/W (GMT)	04:11	
Weather						

Fire Seq	Rosette Posⁿ	Bot. No.	Depth (Pressure)	Time (GMT)	Label ID	salts														
1	1					x														
2	2																			
3	3																			
4	4					x														
5	5																			
6	6																			
7	7					x														
8	8																			
9	9																			
10	10					x														
11	11																			
12	12																			
13	13					x														
14	14																			
15	15																			
16	16					x														
17	17																			
18	18																			
19	19					x														
20	20																			
21	21																			
22	22					x														
23	23																			
24	24																			

Comments

Cruise JC150 Stainless Steel CTD log sheet

Station	6	CTD No	047S	Date	01/08/2017
Latitude	22° 19 80N	Event No	204	Time I/W (GMT)	03:35	CTD frame type:
Longitude	35° 52 19W	Depth	5820	Time bottom (GMT)		
Filename		Cast Depth	2750	Time O/W (GMT)	05:23	SS
Weather						

Fire Seq	Rosette Pos^n	Bot. No.	Depth (Pressure)	Time (GMT)	Label ID	Jamstec CRM									
1	1		2500			x									
2	2		2500			x									
3	3		2500			x									
4	4		2500			x									
5	5		2500			x									
6	6		2500			x									
7	7		2500			x									
8	8		2500			x									
9	9		2500			x									
10	10		2500			x									
11	11		2500			x									
12	12		2500			x									
13	13		2500			x									
14	14		2500			x									
15	15		2500			x									
16	16		2500			x									
17	17		2500			x									
18	18		2500			x									
19	19		2500			x									
20	20		2500			x									
21	21		2500			x									
22	22		2500			x									
23	23		2500			x									
24	24		2500			x									

Comments

Collection of water from 2500 for Jamstec CRM

Cruise JC150 Stainless Steel CTD log sheet

Station	7	CTD No	0050S	Date	04/08/2017
Latitude	22 N	Event No	210	Time I/W (GMT)	03:29
Longitude	31 W	Depth	4988	Time bottom (GMT)	
Filename		Cast Depth	500	Time O/W (GMT)	04:24
Weather				CTD frame type:	SS

Fire Seq	Rosette Posⁿ	Bot. No.	Depth (Pressure)	Time (GMT)	Label ID	Steph expt	Tricho no.
1	1		40			x	
2	2		40			x	
3	3		40			x	
4	4		40			x	
5	5		40			x	
6	6		40			x	
7	7		40			x	
8	8		40			x	
9	9		40			x	
10	10		40			x	
11	11		40			x	
12	12		40			x	
13	13		40			x	
14	14		40			x	
15	15		40			x	
16	16		40			x	
17	17		40			x	
18	18		40			x	
19	19		40			x	
20	20		40			x	
21	21		40			x	
22	22		40				x
23	23		15				x
24	24		15				

Comments

Cruise JC150 Stainless Steel CTD log Sheet

Station	7	CTD No	053S	Date	07/08/2017	
Latitude	22N	Event No	243	Time I/W (GMT)	03:29	CTD frame type:
Longitude	31W	Depth	4984	Time bottom (GMT)		
Filename		Cast Depth	250	Time O/W (GMT)	04:24	SS
Weather						

Fire Seq	Rosette Posⁿ	Bot. No.	Depth (Pressure)	Time (GMT)	Label ID	chl	tricho	Microscope	FCM	nuts
1	1		180			x			x	x
2	2		180					x	x	x
3	3		160			x		x	x	x
4	4		160					x	x	x
5	5		100			x			x	x
6	6		100					x	x	x
7	7		90			x		x	x	x
8	8		90					x	x	x
9	9		80			x			x	x
10	10		80					x	x	x
11	11		60			x		x	x	x
12	12		60					x	x	x
13	13		60				x			
14	14		40			x		x	x	x
15	15		40					x	x	x
16	16		40					x		
17	17		40							
18	18		15			x			x	x
19	19		15							
20	20		15							
21	21		15					x		
22	22		15				x	x		
23	23		15				x			
24	24		15							

Comments

Supplementary Information S5:
TM FISH underway log sheets

Maeve Lohan

Cruise JC150 TM Fish Underway Log

All fish samples are filtered through 0.2 acropak unless stated. RNA, Chla, DOP, APA, Flow cytometry are always unfiltered (uf).

Date	Time range (GMT)	FISH No.	DFe	DZn	Co spp	TDFe/Zn	DOP	Chla	Nuts	Trico water	Flow Cyto	RNA	APA	Comments
27/06/2017	16:00	0001	x	x		xx		x	x					New filter 27/06/2017
27/06/2017	18:00	0002	x	x					xx					Samples thrown away cleaning decks
27/06/2017	18:48	0003						x	x					
27/06/2017	20:00	0004	x	x					xx					Water for Neil
27/06/2017	22:10	0005	x	x					xx					
28/06/2017	00:00	0006	x	x					xx					
28/06/2017	02:00	0007	x	x					xx					2L for Neil
28/06/2017	08:00	0008	x	x		x			xx					
28/06/2017	10:00	0009	x	x					xx					
28/06/2017	12:30	0010	x	x					xx					Despo samples
29/06/2017	22:30	0011	x	x		x			xx					
29/06/2017	00:00	0012	x	x		x			xx					APA for Clare
29/06/2017	01:52	0013	x	x		x			xx					Noelle x3, Liz, Elena 8L
29/06/2017	21:00	0014	x	x					xx					
01/07/2017	19:54	0015												New Filter, Carboy for Neil, Elena
01/07/2017	21:14	0016												Noelle 2 x 4L
03/07/2017	18:00	0017	x	x		x	x	x	xx		x		x	N fix, Elena x3
03/07/2017	20:00	0018	x	x		x	x	x	xx		x			
03/07/2017	22:00	0019	x	x			x	x	xx		x		x	3 x 3L Noelle
04/07/2017	00:00	0020	x	x			x	x	xx		x			
04/07/2017	02:00	0021	x	x		x	x	x	xx		x		x	3 x 3L Noelle
04/07/2017	04:00	0022	x	x		x	x	x	xx		x		x	
04/07/2017	05:00	0023	x	x			x	x	xx		x		x	
04/07/2017	09:00	0024	x	x		x	x	x	xx		x			2L Neil
04/07/2017	11:05	0025	x	x			x	x	xx		x		x	

Cruise JC150 TM Fish Underway Log

All fish samples are filtered through 0.2 acropak unless stated. RNA, Chla, DOP, APA, Flow cytometry are always unfiltered (uf).

Date	Time range (GMT)	FISH No.	DFe	DZn	Co spp	TDFe/Zn	DOP	Chla	Nuts	N fix	Flow Cyto	RNA	APA	Comments
4/7/17	12:45	0026	x	x		x	x	x	x		x			
4/7/17	15:00	0027	x	x			x	x	x		x			
4/7/17	17:15	0028	x	x		x	x	x	x	x	x			
4/7/17	19:00	0029	x	x			x	x	x		x		x	
4/7/17	21:05	0030	x	x		x	x	x	x		x			
4/7/17	23:00	031	x	x			x	x	x		x		x	
4/7/17	01:00	0032	x	x		x	x	x	x		x			
5/7/17	03:30	033	x	x			x	x	x		x		x	Noelle 4 x 4L
5/7/17	18:00	0034		x							x		x	Water bio
11/7/17	10:00	0035	x	x			x	x	x					New filter transit to Stn 3
11/7/17	14:00	0036	x	x		x	x	x	x		x		x	Fish taken out and put back in
11/7/17	15:00	0037	x	x			x	x	x		x			
11/7/17	16:00	0038	x	x			x	x	x		x		x	
11/7/17	17:00	0039	x	x			x	x	x		x			
11/7/17	18:00	0040	x	x		x	x	x	x		x		x	20L for N fix
11/7/17	19:00	041	x	x			x	x	x		x			
11/7/17	20:00	042	x	x		x	x	x	x		x		x	
11/7/17	21:00	043	x	x			x	x	x		x			3 x 3L for Elena
11/7/17	22:00	044	x	x		x	x	x	x		x		x	
11/7/17	23:00	045	x	x			x	x	x		x			
12/7/17	00:00	046	x	x		x	x	x	x		x		x	9L unfiltered Elena
12/7/17	01:00	047	x	x			x	x	x		x			
12/7/17	02:00	048	x	x		x	x	x	x		x		x	
12/7/17	03:00	049	x	x			x	x	x		x			
12/7/17	04:00	050	x	x		x	x	x	x		x		x	

Cruise JC150 TM Fish Underway Log

All fish samples are filtered through 0.2 acropak unless stated. RNA, Chla, DOP, APA, Flow cytometry are always unfiltered (uf).

Date	Time range (GMT)	FISH No.	DFe	DZn	Co spp	TDFe/Zn	DOP	Chla	Nuts	Trico water	Flow Cyto	RNA	APA	Comments
12/7/17	05:30	051	x	x										
15/7/17	18:30	053	x	x			x							New filter transit to Stn 4
15/7/17	20:00	054	x	x		X	x	x	x		x			
15/7/17	22:00	055	x	x			x	x	x		x			
15/7/17	00:00	056	x	x			x	x	x		x			
16/7/17	02:00	057	x	x			x	x	x		x			
16/7/17	03:00	058	x	x			x	x	x		x			
16/7/17	05:00	059	x	x			x	x	x		x			
16/7/17	07:00	060	x	x			x	x	x		x			
16/7/17	09:00	061	x	x			x	x	x		x			
16/7/17	11:00	062	x	x			x	x	x		x			
16/7/17	13:00	063	x	x			x	x	x		x			
16/7/17	15:00	064	x	x			x	x	x		x			15 L collected for N2 Fix
16/7/17	17:00	065	x	x			x	x	x		x			3 x 3L Elena
16/7/17	19:00	066	x	x			x	x	x		x			3 x 3L Elena
16/7/17	21:00	067	x	x			x	x	x		x			
16/7/17	23:00	068	x	x			x	x	x		x			3 x 3L Elena
17/7/17	01:00	069	x	x			x	x	x		x			
17/7/17	03:00	070	x	x			x	x	x		x			Despo & Noelle Stn 4
20/7/17	17:30	071	x	x			x	x	x		x			Transit to Stn 5
20/7/17	19:00	072	x	x			x	x	x		x			
20/7/17	21:00	073	x	x			x	x	x		x			
20/7/17	23:00	074	x	x			x	x	x		x			
21/7/17	01:00	075	x	x			x	x	x		x			

Cruise JC150 TM Fish Underway Log

All fish samples are filtered through 0.2 acropak unless stated. RNA, Chla, DOP, APA, Flow cytometry are always unfiltered (uf).

Date	Time range (GMT)	FISH No.	DFe	DZn	Co spp	TDFe/Zn	DOP	Chla	Nuts	Trico water	Flow Cyto	RNA	APA	Comments
21/07/2017	03:00	076	x	x		x	x	x	x				x	
21/07/2017	05:00	077	x	x			x	x	x					
21/07/2017	07:00	078	x	x		x	x	x	x					New filter
21/07/2017	09:00	079	x	x		x	x	x	x					
21/07/2017	11:00	080	x	x			x	x	x					
21/07/2017	13:00	081	x	x		x	x	x	x					
21/07/2017	15:00	082	x	x		x	x	x	x		x		x	20 L N2 Fix Lewis
21/07/2017	17:00	083	x	x		x	x	x	x		x		x	125 ml Koko
21/07/2017	19:00	084	x	x			x	x	x		x		x	
21/07/2017	21:00	085	x	x		x	x	x	x		x		x	
21/07/2017	23:00	086	x	x			x	x	x		x		x	
22/07/2017	01:00	087	x	x		x	x	x	x		x		x	
22/07/2017	03:00	088	x	x		x	x	x	x		x		x	Noelle & Despo- Stn 5
25/07/2017	17:00	089	x	x		x	x	x	x		x		x	3 x 3 L Elena
25/07/2017	19:00	090	x	x			x	x	x		x		x	
25/07/2017	21:00	091	x	x		x	x	x	x		x		x	3 x 3 L Elena
25/07/2017	23:00	092	x	x			x	x	x		x		x	
26/07/2017	01:10	093	x	x		x	x	x	x		x		x	3 x 3 L Elena
26/07/2017	02:00	094	x	x			x	x	x		x		x	
26/07/2017	04:00	095	x	x		x	x	x	x		x		x	
26/07/2017	06:00	096	x	x			x	x	x		x		x	
26/07/2017	08:00	097	x	x		x	x	x	x		x		x	
26/07/2017	10:00	098	x	x			x	x	x		x		x	
26/07/2017	12:00	099	x	x		x	x	x	x		x		x	
26/07/2017	14:00	100	x	x		x	x	x	x		x		x	20 L N2 fix Lewis

Cruise JC150 TM Fish Underway Log

All fish samples are filtered through 0.2 acropak unless stated. RNA, Chla, DOP, APA, Flow cytometry are always unfiltered (uf).

Date	Time range (GMT)	FISH No.	DFe	DZn	Co spp	TDFe/Zn	DOP	Chla	Nuts	Trico water	Flow Cyto	RNA	APA	Comments
26/7/2017	16:00	101	x	x		x	x	x	x				x	
26/7/2017	18:00	102	x	x			x	x	x				x	
26/7/2017	20:00	103	x	x		x	x	x	x				x	
26/7/2017	22:00	104	x	x			x	x	x				x	
27/07/2017	00:16	105	x	x		x	x	x	x				x	
27/07/2017	02:00	106	x	x		x	x	x	x				x	
29/7/2017	13:00	107													3 x FCM, 3 x Tubes for Claire
2/8/2017	14:30	108	x	x			x	x	x					Left station early next time point 3 pm local time
2/8/2017	16:00	109	x	x		x	x	x	x				x	
2/8/2017	18:00	110	x	x		x	x	x	x				x	3 x 3 L Elena
2/8/2017	20:00	111	x	x		x	x	x	x				x	3 x 3 L Elena New Filter
2/8/2017	22:00	112	x	x			x	x	x				x	3 x 3 L Elena
3/8/2017	00:00	113	x	x		x	x	x	x				x	
3/8/2017	02:00	114	x	x			x	x	x				x	
3/8/2017	04:00	115	x	x		x	x	x	x				x	
3/8/2017	06:00	116	x	x		x	x	x	x				x	
3/8/2017	08:00	117	x	x		x	x	x	x				x	
3/8/2017	10:00	118	x	x			x	x	x				x	
3/8/2017	12:00	119	x	x		x	x	x	x				x	
3/8/2017	14:00	120	x	x			x	x	x				x	
3/8/2017	16:00	121	x	x		x	x	x	x				x	
3/8/2017	18:00	122	x	x		x	x	x	x				x	20 L for N2 fix
3/8/2017	20:00	123	x	x			x	x	x				x	
3/8/2017	22:00	124	x	x		x	x	x	x				x	
4/8/2017	00:00	125	x	x		x	x	x	x				x	
4/8/2017	02:00	126	x	x			x	x	x				x	Arrive Stn 7, Despo & Noelle

Cruise JC150 TM Fish Underway Log

All fish samples are filtered through 0.2 acropak unless stated. RNA, Chla, DOP, APA, Flow cytometry are always unfiltered (uf).

Date	Time range (GMT)	FISH No.	DFe	DZn	Co spp	TDFe/Zn	DOP	Chla	Nuts	Trico water	Flow Cyto	RNA	APA	Comments
08/08/2017	16:20	127	x	x			x	x	x		x	x	x	
08/08/2017	17:10	128	x	x			x	x	x		x	x	x	
08/08/2017	18:10	129	x	x			x	x	x		x	x	x	
08/08/2017	19:10	130	x	x			x	x	x		x	x	x	

Supplementary Information S6: Experimental setup and labelling for Experiments ABC (including A*, A prime, A up, A star)

Maeve Lohan

Stations and Experiment type

Station	Exp A	Exp B	Exp C	Zn Ester	A' prime	A* star	A up	Exp E
1	✓	✓	✓					✓
1.5				✓				
2	✓	✓	✓					
3	✓	✓	✓					
4	✓✓	✓	✓					
5					✓	✓		
6						✓	✓	
7						✓✓		

Exp A: Added Zn and Fe
Exp B: Added N with either Zn or Fe
Exp C: Added Ester with either Zn or Fe
A' prime: Added Zn and Fe (more concentrations)
A* star: Added Zn, Fe and Co
A up: Added Zn, Fe and Co
Exp E: Added, N, Esters with both zinc and iron and sub-sampled over 72 hours

Station 1: CTD 004 40m (29/06/2017)

Exp A: Zinc

Control	+0.2 nM	+0.5 nM	+1nM	+1.5 nM	+2 nM
1	3	5	7	9	11
2	4	6	8	10	12

Exp A: Fe

Control	+0.5 nM	+0.75 nM	+1nM	+1.5 nM	+2 nM
13	15	17	19	21	23
14	16	18	20	22	24

Exp B: Zn + 2 µM N

+2 µN	N+0.2 nM	N+0.5 nM	N+1nM	N+1.5 nM	N+2 nM
25	27	29	31	33	35
26	28	30	32	34	36

Exp B: Fe + 2 µM N

+2 µN	N+0.5 nM	N+0.75 nM	N+1nM	N+1.5 nM	N+2 nM
37	39	41	43	45	47
38	40	42	44	46	48

Exp C: Zn + 2 µM Ester

+2 µM Ester	E+0.2 nM	E+0.5 nM	E+1nM	E+1.5 nM	E+2 nM
49	51	53	55	57	59
50	52	54	56	58	60

Exp C: Fe + 2 µM Ester

+2 µM Ester	E+0.5 nM	E+0.75 nM	E+1nM	E+1.5 nM	E+2 nM
61	63	65	67	69	71
62	64	66	68	70	72

Station 1.5: Zinc Ester experiment CTD 013 40m (04/07/2017)

AA	BB	Control
CC	DD	+ 1nM Zn + 100 nM Ester
EE	FF	+ 1nM Zn + 200 nM Ester
GG	HH	+ 1nM Zn + 500 nM Ester
II	JJ	+ 1nM Zn + 1000 nM Ester
KK	LL	+ 1nM Zn + 2000 nM Ester

Station 2: CTD 016 40m (06/07/2017)

Station 3: Pump ~ 40 m (13/07/2017)

Changed Ester concentration to 0.5µM
Added in Treatments to examine N, Ester and metals

Exp A: Zinc

Control	+0.2 nM	+0.5 nM	+0.75 nM	+1nM	+1.5 nM	+2 nM
1	3	5	7	9	11	
2	4	6	8	10	12	

Exp A: Fe

Control	+0.2 nM	+0.5 nM	+0.75 nM	+1nM	+1.5 nM	+2 nM
13	15	17	19	21	23	
14	16	18	20	22	24	

Exp B: Zn + 2 µM N

+2 µN	N+0.2 nM	N+0.5 nM	N+0.75 nM	N+1nM	N+1.5 nM	N+2 nM
25	27	29	31	33	35	
26	28	30	32	34	36	

Exp B: Fe + 2 µM N

+2 µN	N+0.5 nM	N+0.75 nM	N+1nM	N+1.5 nM	N+2 nM
37	39	41	43	45	47
38	40	42	44	46	48

Exp C: Zn + 0.5 µM Ester

+0.5 µM Ester	E+0.2 nM	E+0.5 nM	E+1nM	E+1.5 nM	E+2 nM
49	51	53	55	57	59
50	52	54	56	58	60

Exp C: Fe + 0.5 µM Ester

+0.5 µM Ester	E+0.5 nM	E+0.75 nM	E+1nM	E+1.5 nM	E+2 nM
61	63	65	67	69	71
62	64	66	68	70	72

2 µM N + 0.5 µM ester Ester
| 73 |

2 µM N + 0.5 µM ester + 1 nM Zn
| 74 |

2 µM N + 0.5 µM ester + 1 nM Zn
| 75 |

Station 4: CTD 029T 40 m (17/07/2017)

Also repeated Station A at the end of Station 4 (19/07/2017) using the pump

Exp A: Zinc

Control	+0.2 nM	+0.5 nM	+1nM	+1.5 nM	+2 nM
1	3	5	7	9	11
2	4	6	8	10	12

Exp A: Fe

Control	+0.5 nM	+0.75 nM	+1nM	+1.5 nM	+2 nM
13	15	17	19	21	23
14	16	18	20	22	24

Exp B: Zn + 2 μM N

+ 2 μN	N + 0.2 nM	N + 0.5 nM	N + 1nM	N + 1.5 nM	N + 2 nM
25	27	29	31	33	35
26	28	30	32	34	36

Exp B: Fe + 2 μM N

+ 2 μN	N + 0.5 nM	N + 0.75 nM	N + 1nM	N + 1.5 nM	N + 2 nM
37	39	41	43	45	47
38	40	42	44	46	48

Exp C: Zn + 0.5 μM Ester

+ 0.5 μM Ester	E + 0.2 nM	E + 0.5 nM	E + 1nM	E + 1.5 nM	E + 2 nM
49	51	53	55	57	59
50	52	54	56	58	60

Exp C: Fe + 0.5 μM Ester

+ 0.5 μM Ester	E + 0.5 nM	E + 0.75 nM	E + 1nM	E + 1.5 nM	E + 2 nM
61	63	65	67	69	71
62	64	66	68	70	72

Station 5: A' prime CTD 036T 40 m (22/07/2017)

Control	+ 0.2 nM Zn	+ 0.3 nM Zn	+ 0.4 nM Zn	+ 0.5 nM Zn	+ 0.6 nM Zn	+ 0.7 nM Zn	+ 0.8 nM Zn	+ 0.9 nM Zn	+ 1 nM Zn
25	28	31	34	37	40	43	46	49	52
26	29	32	35	38	41	44	47	50	53
27	30	33	36	39	42	45	48	51	54

Control	+ 0.2 nM Fe	+ 0.3 nM Fe	+ 0.4 nM Fe	+ 0.5 nM Fe	+ 0.6 nM Fe	+ 0.7 nM Fe	+ 0.8 nM Fe	+ 0.9 nM Fe	+ 1 nM Fe
55	58	61	64	67	70	AC	DC	GC	JC
56	59	62	65	68	71	ABC	EC	HC	KC
57	60	63	66	69	72	CC	FC	IC	LC

Station 5: A* star CTD 040T 40 m (25/07/2017)

	Control	+ 0.2 nM Zn	+ 0.3 nM Zn	+ 0.4 nM Zn	+ 0.5 nM Zn	+ 0.6 nM Zn	+ 0.7 nM Zn	+ 0.8 nM Zn	+ 0.9 nM Zn	+ 1 nM Zn
	25	28	31	34	37	40	43	46	49	52
	26	29	32	35	38	41	44	47	50	53
	27	30	33	36	39	42	45	48	51	54

Control	+ 0.2 nM Fe	+ 0.3 nM Fe	+ 0.4 nM Fe	+ 0.5 nM Fe	+ 1 nM Fe
55	58	61	64	67	70
56	59	62	65	68	71
57	60	63	66	69	72

Control	+ 20 pM Co	+ 30 pM Co	+ 40 pM Co	+ 50 pM Co	+ 100 pM Co
13	16	19	22	N1	N4
14	17	20	23	N2	N5
15	18	21	24	N3	N6

Station 6: A up CTD 043T 40 m (28/07/2017)

Control	+ 0.2 nM Zn	+ 0.3 nM Zn	+ 0.4 nM Zn	+ 0.5 nM Zn	+ 0.6 nM Zn	+ 0.7 nM Zn	+ 0.8 nM Zn	+ 0.9 nM Zn	+ 1 nM Zn
25	28	31	34	37	40	43	46	49	52
26	29	32	35	38	41	44	47	50	53
27	30	33	36	39	42	45	48	51	54

Control	+ 0.2 nM Fe	+ 0.3 nM Fe	+ 0.4 nM Fe	+ 0.5 nM Fe	+ 1 nM Fe
55	58	61	64	67	70
56	59	62	65	68	71
57	60	63	66	69	72

Control	+ 20 pM Co	+ 30 pM Co	+ 50 pM Co	+ 75 pM Co	+ 200 pM Co
1	4	7	10	13	16
2	5	8	11	14	17
3	6	9	12	15	18

Station 6: A* star CTD 049T 40 m (02/08/2017)

+ 1 nM Zn	+ 0.9 nM Zn	+ 0.8 nM Zn	+ 0.7 nM Zn	+ 0.6 nM Zn	+ 0.5 nM Zn	+ 0.4 nM Zn	+ 0.3 nM Zn	+ 0.2 nM Zn	Control	
52	49	46	43	40	37	34	31	28	25	
53	50	47	44	41	38	35	32	29	26	
54	51	48	45	42	39	36	33	30	27	

+ 1 nM Fe	+ 0.5 nM Fe	+ 0.4 nM Fe	+ 0.3 nM Fe	+ 0.2 nM Fe	Control
70	67	64	61	58	55
71	68	65	62	59	56
72	69	66	63	60	57

+ 200 pM Co	+ 75 pM Co	+ 50 pM Co	+ 30 pM Co	+ 20 pM Co	Control
16	13	10	7	4	1
17	14	11	8	5	2
18	15	12	9	6	3

Station 7: A* star CTD 051T 40 m (06/08/2017)

Control	+ 0.2 nM Zn	+ 0.3 nM Zn	+ 0.4 nM Zn	+ 0.5 nM Zn	+ 0.6 nM Zn	+ 0.7 nM Zn	+ 0.8 nM Zn	+ 0.9 nM Zn	+ 1 nM Zn
25	28	31	34	37	40	43	46	49	52
26	29	32	35	38	41	44	47	50	53
27	30	33	36	39	42	45	48	51	54

Control	+ 0.2 nM Fe	+ 0.3 nM Fe	+ 0.4 nM Fe	+ 0.5 nM Fe	+ 1 nM Fe
55	58	61	64	67	70
56	59	62	65	68	71
57	60	63	66	69	72

Control	+ 20 pM Co	+ 30 pM Co	+ 50 pM Co	+ 75 pM Co	+ 200 pM Co
1	4	7	10	13	16
2	5	8	11	14	17
3	6	9	12	15	18

Station 7: A* star Pump 40 m (08/08/2017)

Control	+ 0.2 nM Zn	+ 0.3 nM Zn	+ 0.4 nM Zn	+ 0.5 nM Zn	+ 0.6 nM Zn	+ 0.7 nM Zn	+ 0.8 nM Zn	+ 0.9 nM Zn	+ 1 nM Zn
25	28	31	34	37	40	43	46	49	52
26	29	32	35	38	41	44	47	50	53
27	30	33	36	39	42	45	48	51	54

Control	+ 0.2 nM Fe	+ 0.3 nM Fe	+ 0.4 nM Fe	+ 0.5 nM Fe	+ 0.6 nM Fe	+ 0.7 nM Fe	+ 0.8 nM Fe	+ 0.9 nM Fe	+ 1 nM Fe
55	58	61	64	67	70	1	4	7	10
56	59	62	65	68	71	2	5	8	11
57	60	63	66	69	72	3	6	9	12

Control	+ 20 pM Co	+ 30 pM Co	+ 40 pM Co	+ 50 pM Co	+ 75 pM Co	+ 200 pM Co	+ 0.5 nM Zn + 0.5 µM Ester
1	4	7	10	13	16	16	16
2	5	8	11	14	17	17	17
3	6	9	12	15	18	18	18

+ 0.5 µM Ester

AC	DC
BC	EC
CC	KO KO

Supplementary Information S7: Experimental setup and labelling scheme for Experiment D

Maeve Lohan

	Stn 1	Stn 2	Stn 3	Stn 4	Stn 5	Stn 6	Stn 7
Control	✓	✓	✓	✓	✓	✓	✓
+ Zn (nM)	0.2	1	1	0.2	0.4	0.5	0.5
+ Zn (nM)	1			0.5	0.8		1
+ Fe (nM)	2			1	0.3	0.5	0.5
+ Fe (nM)	1	1	1	0.5	0.5		1
+ Co (pM)	50			50	20		20
+ Co (pM)	500	50	50	50	50		75
+ N (µM)		2	2	2			
+ N + Zn		2 + 1	2 + 1	2 + 0.2			
+ N + Zn				2 + 0.5			
+ N + Co		2 + 50	2 + 50	2 + 50			
+ N + Co							
+ N + Fe		2 + 1	2 + 1	2 + 0.5 / 2 + 1			
+ N + Co + Zn		2 + 50 + 1	2 + 50 + 1	2 + 50			
+ Ester (µM)		0.5	0.5				
+ Est + Zn		0.5 + 1	0.5 + 1				
+ Est + Fe		0.5 + 1	0.5 + 1				
+Est +Co		0.5 + 50	0.5 + 50				

	Control	Zn	Fe	Co
Control	✓			
Zn		0.5		
Fe			0.5	
Co				50
+Zn+Fe		0.2	0.5	
+Zn+Fe		0.4	0.5	
+Zn+Fe		0.8	0.5	
+Fe+Zn		0.4	0.2	
+Fe+Zn		0.4	1	
+Zn+Co		0.2		20
+Zn+Co		0.2		200
+Zn+Co		0.2		50
+Zn+Co		0.4		50
+Zn+Co		0.8		50

Station 1: CTD's 010-012T 40m (03/07/2017)

Control A	B	C
+ 0.2 nM Zn D	E	F
+ 1 nM Zn G	H	I
+ 1 nM Fe J	K	L
+ 2 nM Fe M	N	O
+50 pM Co P	Q	R
+ 500 pM Co S	T	U

Station 2: CTD's 022-024T 40m (11/07/2017)

Control

+ 1 nM Zn

+ 1 nM Fe

+ 1 nM Zn + 2 µM N

+ 1 nM Fe + 2 µM N

+ 1 nM Zn + 0.5 µM Ester

+ 1 nM Fe + 0.5 µM Ester

+50 pM Co

+50 pM Co + 2 µM N

+ 1 nM Zn +50 pM Co + 2 µM N

C replicates are 2Lbottles
D replicates are 4L for genes

AA	BA	CA	DA	EA	FA	GA	HA	IA	JA
AB	BB	CB	DB	EB	FB	GB	HB	IB	JB
AC	BC	CC	DC	EC	FC	GC	HC	IC	JC
AD	BD	CD	DD	ED	FD	GD	HD	ID	JD

+ 0.5 µM Ester

+ 2 µM N

KA	LA
KB	LB
KC	LC
DC	LD

Station 3: Pump- Masterflex tubing 40m (15/07/2017)

C replicates are 2Lbottles
D replicates are 4L for genes

Treatment	A	B	C	D
Control	AA	AB	AC	AD
+ 1 nM Zn	BA	BB	BC	BD
+ 1 nM Fe	CA	CB	CC	CD
+ 1 nM Zn + 2 µM N	DA	DB	DC	DD
+ 1 nM Fe + 2 µM N	EA	EB	EC	ED
+ 1 nM Zn + 0.5 µM Ester	FA	FB	FC	FD
+ 1 nM Fe + 0.5 µM Ester	GA	GB	GC	GD
+50 pM Co	HA	HB	HC	HD
+50 pM Co + 2 µM N	IA	IB	IC	ID
+ 1 nM Zn +50 pM Co + 2 µM N	JA	JB	JC	JD
+ 2 µM N	KA	KB	KC	DC
+ 0.5 µM Ester	LA	LB	LC	LD

Station 4: Pump ~ 40m
(19/07/2017)

☐ 2 Concentrations of Zn and Fe with and
without addition of N
☐ 1 concentration of Co with and without
the addition of N

Control	A1	A2	A3
+ 0.2 nM Zn	B1	B2	B3
+ 0.5 nM Zn	C1	C2	C3
+ 0.5 nM Fe	D1	D2	D3
+ 0.5 nM Fe	E1	E2	E3
+ 1 nM Fe	F1	F2	F3
+ 50 pM Co	G1	G2	G3
+ 2 µM N	H1	H2	H3
+ 0.2 nM Zn + 2 µM N	I1	I2	I3
+ 0.5 nM Zn + 2 µM N	J1	J2	J3
+ 0.5 nM Fe + 2 µM N	K1	K2	K3
+ 1 nM Fe + 2 µM N	L1	L2	L3
+ 50 pM Co + 2 µM N			

Station 5: Pump ~ 40m (03/07/2017)

☐ Concentrations chosen based on results from Exp A*

Treatment			
Control	A1	A2	A3
+ 0.4 nM Zn	B1	B2	B3
+ 0.8 nM Zn	C1	C2	C3
+ 0.3 nM Fe	D1	D2	D3
+ 0.5 nM Fe	E1	E2	E3
+ 20 pM Co	F1	F2	F3
+ 50 pM Co	G1	G2	G3

Station 6: D up Pump ~ 40m (28/07/2017)

☐ Clare and Neil experiment
☐ Varying concentrations of metals

Control

+ 0.2 nM Zn + 0.5 nM Fe

+ 0.4 nM Zn + 0.5 nM Fe

+ 0.4 nM Zn + 0.5 nM Fe

+ 0.8 nM Zn + 0.5 nM Fe

+ 0.4 nM Zn + 0.2 nM Fe

+ 0.4 nM Zn + 1 nM Fe

+ 0.2 nM Zn + 20 pM Co

+ 0.2 nM Zn + 200 pM Co

+ 0.2 nM Zn + 50 pM Co

+ 0.2 nM Zn + 50 pM Co

+ 0.4 nM Zn + 50 pM Co

+ 0.8 nM Zn + 50 pM Co

A1	A2	A3
B1	B2	B3
C1	C2	C3
D1	D2	D3
E1	E2	E3
F1	F2	F3
G1	G2	G3
H1	H2	H3
I1	I2	I3
J1	J2	J3
K1	K2	K3

+ 0.5 nM Fe

+ 0.5 nM Zn

+ 50 pM Co

L1	L2	L3
M1	M2	M3
N1	N2	N3

Station 7: Pump ~ 40m (05/08/2017)

□ Carried out at same time as exp A*

	1	2	3
Control	B1	B2	B3
+ 0.5 nM Zn	K1	K2	K3
+ 1 nM Zn	L1	L2	L3
+ 0.5 nM Fe	D1	D2	D3
+ 1 nM Fe	E1	E2	E3
+ 20 pM Co	G1	G2	G3
+ 75 pM Co	A2	H1	H2

Supplementary Information S9:

Time course experiments

Maeve Lohan

Station 2: Experiment E time course exp
CTD's 20 & 21T 40m (09/07/2017)

Label	Treatment
A1, A2, A3	Control
B1, B2, B3	1 µM N
C1, C2, C3	2 µM N
D1, D2, D3	4 µM N
E1, E2, E3	0.5 µM Ester
F1, F2, F3	1µM Ester
G1, G2, G3	2µM Ester
H1, H2, H3	1 µM N + 1 nM Zn
I1, I2, I3	1 µM N + 1 nM Fe
J1, J2, J3	1µM Ester + 1 nM Zn
K1, K2, K3	1µM Ester + 1 nM Fe

- Sub-sampled every 6 hours for 72 hours
- Investigate time response in nutrients and APA and Chla

Station 6: Time course exp: Pump ~ 40m (02/08/2017)

Control	A1	A2	A3
Control	B1	B2	B3
Control	G1	G2	G3
+ 0.5 nM Fe	D1	D2	D3
+ 0.5 nM Fe	C1	C2	C3
+ 0.5 nM Fe	F1	F2	F3
+ 0.5 nM Zn	I1	I2	I3
+ 0.5 nM Zn	K1	K2	K3
+ 0.5 nM Zn	L1	L2	L3

➢ Sub-sampled every 12 hours (10 am and 10 pm local time) for 72 hrs

➢ T12 3 x carboys: Chla, APA, FCM, DOP

➢ T24 9 x carboys : Chla, APA, FCM, DOP, dFe, dZn, nutrients N_2 fix, cell quota, genes, proteomics

➢ T36 3 x carboys: Chla, APA, FCM, DOP

➢ T48 9 x carboys : Chla, APA, FCM, DOP, dFe, dZn, nutrients N_2 fix, cell quota, genes, proteomics

➢ T60 3 x carboys: Chla, APA, FCM, DOP

➢ T72 9 x carboys : 9 x carboys : Chla, APA, FCM, DOP, dFe, dZn, nutrients N_2 fix, cell quota, genes, proteomics

Supplementary Information S8:

Nutrient sample inventory

Malcolm Woodward

SAMPLES ANALYSED:

CTD Samples Analysed by AAIII Micromolar analysis, and Nanomolar analysis where concentrations required it:

Date	CTD	Position	CTD bottle numbers analysed, and depths
30/06/17	CTD_006T	$22^0$00.00'N $58^0$00.00'W	24,23,22,21,20,19,18,17,16,15,14,12,11,10,9,8,7,6,5,4,3,2,1 (depths:100,130,140,160,200,250,300,400,600,800,1000,1500,1750,2000,2250,2500,3000,3500,4000,4500,5000,5350,5400)
02/07/17	CTD_009T	$22^0$00.00'N $58^0$00.00'W	24,23,22,21,20,19,18,17,16,15,14,13,12,11,10,9,8,7,6,5,4,3,2,1(depths:15,25,40,60,80,100,120,140,150,160,175,200,225,250,275,300,350,375,400,450,500,550,600,650)
05/07/17	CTD_015S	$22^0$00.00'N $54^0$00.00'W	24,23,22,21,20,19,18,17,16,15,14,13,12,11,10,9,8,7,6,5,4,3,2,1(depths:all at 1200m)
06/07/17	CTD_017T	$22^0$00.00'N $53^0$59.99'W	24,23,22,21,20,19,18,17,16,15,14,13,12,11,10,9,8,7,6,5,4,3,2,1(depths:15,25,40,60,80,100,120,140,150,160,180,200,225,250,275,300,325,350,400,450,500,550,600,700)
07/07/17	CTD_018S	$22^0$00.00'N $54^0$00.00'W	24,23,22,21,20,19,18,17,16,15,14,13,12,11,10,9,8,7,6,5,4,3,2,1(depths:all at 600m) (Mid depth CRM water)
08/07/17	CTD_019T	$21^0$59.99'N $53^0$59.99'W	24,23,22,21,20,19,18,17,16,15,14,13,12,11,10,9,8,7,6,5,4,3,2,1(depths:100,140,160,225,300,600,700,800,900,1000, 1100,1250,1500,1750,2000,2250,2500,3000,3500,4000,4500,5000,5815,5865)
14/07/17	CTD_027T	$22^0$00.00'N $50^0$00.00'W	24,23,22,21,20,19,18,17,16,15,14,13,12,11,10,9,8,7,6,5,4,3,2,1(depths:15,25,40,60,80,100,120,125,130,140,160,180,200,225,250,300,325,350,400,425,450,500,550,600)
15/07/17	CTD_028T	$22^0$00.00'N $50^0$00.00'W	24,23,22,21,20,19,18,17,16,15,14,13,12,11,10,9,8,7,6,5,4,3,2,1(depths:100,140,140,400,600,650,700,750,800,900,1000,1100,1250,1500,1750,2000,2250,2500,2750,3000,3500,4000,4320,4370)
18/07/17	CTD_031T	$23^0$22.00'N $44^0$57.00'W	24,23,22,21,20,19,18,17,16,15,14,13,12,11,10,9,8,7,6,5,4,3,2,1(depths:40,100,140,600,650,700,800,900,1000,1250,1500,1750,2000,2250,2500,2750,3000,3200,3320,3340,3400,3450,3501)
18/07/17	CTD_032T	$23^0$21.99'N $44^0$56.99'W	24,23,22,21,20,19,18,17,16,15,14,13,12,11,10,9,8,7,6,5,4,3,2,1(depths:15,25,40,60,100,120,130,140,150,160,180,200,225,250,275,300,325,350,400,425,450,500,550,600)
23/07/17	CTD_037T	$23^0$00.00'N $40^0$00.00'W	24,23,22,21,20,19,18,17,16,15,14,13,12,11,10,9,8,7,6,5,4,3,2,1(depths:60,125,125,180,600,700,800,900,1000,1100,1250,1500,1750,2000,2250,2500,3000,3500,4000,4500,4700,5000,5355,5377)
23/07/17	CTD_038T	$22^0$59.00'N $40^0$00.00'W	24,23,22,21,20,19,18,17,16,15,14,13,12,11,10,9,8,7,6,5,4,3,2,1(depths:15,25,40,60,80,100,120,125,140,150,160,180,200,225,250,275,300,325,350,400,450,500,550,600)
31/07/17	CTD_046T	$22^0$19.799'N $35^0$52.199'W	24,23,22,21,20,19,18,17,16,15,14,13,12,11,10,9,8,7,6,5,4,3,2,1(depths:40,140,700,800,900,1000,1100,1250,1500,1750,2000,2250,2500,3000,3500,4000,4500,4700,5000,5250, 5400,5600,5802)
01/08/17	CTD_047S	$22^0$19.80'N $35^0$52.199'W	24,23,22,21,20,19,18,17,16,15,14,13,12,11,10,9,8,7,6,5,4,3,2,1(depths:all at 2500m) (Deep Atlantic CRM water)
01/08/17	CTD_048T	$22^0$19.80'N $35^0$52.20'W	24,23,22,21,20,19,18,17,16,15,14,13,12,11,10,9,8,7,6,5,4,3,2,1(depths:15,25,40,60,80,100,120,130,140,160,180,200,225,250,275,300,325,350,400,450,500,550,600,650)
06/08/17	CTD_052T	$22^0$00.00'N $30^0$59.99'W	24,23,22,21,20,19,18,17,16,15,14,13,12,11,10,9,8,7,6,5,4,3,2,1(depths:15,30,40,60,80,84,90,100,110,120,140,160,180,200,225,250,275,300,325,350,400,425,450,500)
07/08/17	CTD_053S	$22^0$00.00'N $31^0$00.00'W	18,14,11,9,7,5,3,1(depths:15,40,60,80,90,100,160,180)

8/08/17	CTD_054T	$22^0$00.00'N $30^0$59.999' W	24,23,22,21,20,19,18,17,16,15,14,13,12,11,10,9,8,7,6,5,4,3,2,1(depths:40,110,500,550,600,700,800,900,1000,1100,1250,1500,1750,2000,2250,2500,2750,3000,3500,4000,4500,4750,5000,5015)

Underway Trace metal 'Fish' samples analysed by ammonium and waveguide nanomolar analytical systems:

Numbers	Dates	Comments
Fish 003	27.6.17	AAIII
001, 005, 006, 007, 008, 009, 010	28.6.17	Waveguide
011, 012, 013	29.6.17	Waveguide and Ammonium
014,	01.7.17	Waveguide
017, 018,019, 020, 021, 022, 023, 024, 025, 026, 027, 028	04.7.17	Waveguide and Ammonium
029, 030, 031, 032, 033	04.7.17	Waveguide and Ammonium
035, 036, 037, 038, 039, 040, 041, 042, 043, 044	11.7.17	Waveguide and Ammonium
045, 046, 047, 048, 049, 050	12.7.17	Waveguide and Ammonium
053, 054, 055, 056, 057, 058, 059, 060, 061, 062, 063, 064, 065, 066, 067, 068, 069, 070	16.7.17	Waveguide and Ammonium
071, 072, 073, 074, 075, 076, 077, 078, 079, 080, 081, 082	21.7.17	Waveguide and Ammonium
083, 084, 085, 086, 087, 088	22.7.17	Waveguide and Ammonium
089, 090, 091, 092, 093, 094, 095, 096, 097, 098, 099	26.7.17	Waveguide and Ammonium
100, 101, 102, 103, 104, 105, 106	27.7.17	Waveguide and Ammonium
108, 109, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121	3.8.17	Waveguide and Ammonium
122, 123, 124, 125, 126	4.8.17	Waveguide and Ammonium
127,128,129,130	8.8.17	Waveguide and Ammonium

Nutrient Analysis of Experimental samples:

1. **Incubation Experiments**

29.6.17: Expt: A,B,C: T0 Stn 1, Rosette 5,11,16: (Waveguide and Ammonium)

01.7.17: Phosphate Experiment, B1-B9: Waveguide and AAIII

01.7.17: Breakdown Expts A,B,C Stn1: Sample ID 001-072: (AAIII, Waveguide and Nanoammonium)

Expt A Stn1: Zn Control, a,b; 0.2nM Zn a,b; 0.5nM Zn a,b; 1nM Zn a,b; 1.5nM Zn a,b; 2nM Zn a,b; Fe Control a,b; 0.5nM Fe a,b; 0.75nM Fe a,b; 1nM Fe a,b; 1.5nM Fe a,b; 2nM Fe a,b.

Expt B Stn1: Zn+N Control, a,b; 0.2nM Zn+N a,b; 0.5nM Zn+N a,b; 1nM Zn+N a,b; 1.5nM Zn+N a,b; 2nM Zn+N a,b; Fe Control+N a,b; 0.5nM Fe+N a,b; 0.75nM Fe+N a,b; 1nM Fe+N a,b; 1.5nM Fe+N a,b; 2nM Fe+N a,b

Expt C Stn1: Zn Control+P, a,b; 0.2nM Zn+P a,b; 0.5nM Zn+P a,b; 1nM Zn+P a,b; 1.5nM Zn+P a,b; 2nM Zn+P a,b; Fe Control+P a,b; 0.5nM Fe+P a,b; 0.75nM Fe+P a,b; 1nM Fe+P a,b; 1.5nM Fe+P a,b; 2nM Fe+P a,b.

3.7.17: Exp D Stn 1 T0 Cast 1, 2, 3: (Waveguide and Ammonium)

4.7.17: Zn Esters T0 1,2,3: (Waveguide and Ammonium)

5.7.17: Exp D Stn 1: A,D,G,J,M,P,S; B,E,H,K,N,Q,T; C,F,I,L,O,R,U: (Waveguide and Ammonium)

6.7.17: Expt: A,B,C T0 Stn 2, Rosette 6,12,17: (Waveguide and Ammonium)
Zinc Esters; AA,BB,CC,DD,EE,FF,GG,HH,II,JJ,KK,LL: (AAIII)

8.7.17: Breakdown Expts A,B,C Stn 2: Sample ID 001-072; (AAIII, Waveguide and Nanoammonium)

Expt A Stn2: Zn Control, a,b; 0.2nM Zn a,b; 0.5nM Zn a,b; 1nM Zn a,b; 1.5nM Zn a,b; 2nM Zn a,b; Fe Control a,b; 0.5nM Fe a,b; 0.75nM Fe a,b; 1nM Fe a,b; 1.5nM Fe a,b; 2nM Fe a,b.

Expt B Stn2: Zn+N Control, a,b; 0.2nM Zn+N a,b; 0.5nM Zn+N a,b; 1nM Zn+N a,b; 1.5nM Zn+N a,b; 2nM Zn+N a,b; Fe Control+N a,b; 0.5nM Fe+N a,b; 0.75nM Fe+N a,b; 1nM Fe+N a,b; 1.5nM Fe+N a,b; 2nM Fe+N a,b

Expt C Stn2: Zn Control+P, a,b; 0.2nM Zn+P a,b; 0.5nM Zn+P a,b; 1nM Zn+P a,b; 1.5nM Zn+P a,b; 2nM Zn+P a,b; Fe Control+P a,b; 0.5nM Fe+P a,b; 0.75nM Fe+P a,b; 1nM Fe+P a,b; 1.5nM Fe+P a,b; 2nM Fe+P a,b.

9.7.17: Expt E, T0: Control a,b,c; Sam ID A,B,C,D,E,F,G,H,I,J,K: (AAIII, Waveguide and Nanoammonium)

Expt E, T6: Sam ID A,B,C,D,E,F,G,H,I,J,K: (AAIII, Waveguide and Nanoammonium)

Expt E, T12: Sam ID A,B,C,D,E,F,G,H,I,J,K: (AAIII, Waveguide and Nanoammonium)

10.7.17: Expt E, T18: Sam ID A,B,C,D,E,F,G,H,I,J,K: (AAIII, Waveguide and Nanoammonium)

Expt E, T24: Sam ID A,B,C,D,E,F,G,H,I,J,K: (AAIII, Waveguide and Nanoammonium)

Expt E, T30: Sam ID A,B,C,D,E,F,G,H,I,J,K: (AAIII, Waveguide and Nanoammonium)

Expt E, T36: Sam ID A,B,C,D,E,F,G,H,I,J,K: (AAIII, Waveguide and Nanoammonium)

Expt E, T40: Sam ID A,B,C,D,E,F,G,H,I,J,K: (AAIII, Waveguide and Nanoammonium)

11.7.17: Expt E, T48: Sam ID A,B,C,D,E,F,G,H,I,J,K: (AAIII, Waveguide and Nanoammonium.)

Expt D: Stn 2 T0 Control 1,2,3; (Waveguide and Nanoammonium)

Expt E, T54: Sam ID A,B,C,D,E,F,G,H,I,J,K: (AAIII, Waveguide and Nanoammonium)

Expt E, T60: Sam ID A,B,C,D,E,F,G,H,I,J,K: (AAIII, Nanoammonium)

12.7.17: Expt E, T66: Sam ID A,B,C,D,E,F,G,H,I,J,K: (AAIII, Waveguide and Nanoammonium.)

Expt E, T72: Sam ID A,B,C,D,E,F,G,H,I,J,K: (AAIII, Waveguide and Nanoammonium)

13.7.17: Fish Pump Blanks: T0 A,B, C. Stn 2 Experiment D breakdown: AA,BA,CA,DC,EA,FA,GA,HA,IA,JA,KA,LA,AB,BB,CB,DB,EB,FB,GB,HB,IB,JB,KB,LB, (AAIII, Waveguide and Nanoammonium (no nanoammonium on ester additions))

15.7.17: Expt D Stn 3, T0,a,b,c. (Waveguide and Nanoammonium)

17.7.17: Expt D Stn 4, T0,a,b. (Waveguide and Nanoammonium)

Expt A,B,C Stn4: 2nMFe+N b,a; 1.5nMFe+N b,a, 1nMFe+N b,a; 0.75nMFe+N b,a; 0.5nMFe+N b,a; Fe+N Control b,a; 2nMZn+N b,a; 1.5nMZn+N b,a, 1nMZn+N b,a; 0.5nMZn+N b,a; 0.2nMZn+N b,a; Zn+N Control b,a. : (ID 025-048: AAIII)

Expt D Breakdown: Control, AA; 1nM Zn, BA; 1nM Fe, CA; 2uMN+1nM Zn, DA; 2uMN+1nM Fe, EA; 0.5uMP+1nM Zn, FA; 0.5uMP+1nM Fe, GA; 50Pm Co, HA; 50pM Co+2uM N, IA; N+Co+Zn, JA; 2uM N, KA; 0.5uM P, LA;

Control, AB; 1nM Zn, BB; 1nM Fe, CB; 2uMN+1nM Zn, DB; 2uMN+1nM Fe, EB; 0.5uMP+1nM Zn, FB; 0.5uMP+1nM Fe, GB; 50Pm Co, HB; 50pM Co+2uM N, IB; N+Co+Zn, JB; 2uM N, KB; 0.5uM P, LB. (AAIII, Waveguide and Nanoammonium). No esters or Cobalt in reduction column. Esters no phosphate waveguide, No N in waveguide or Ammonium.

19.7.17: Expt A,B,C breakdown (48 Hours) Stn4: 2nMFe+N b,a; 1.5nMFe+N b,a, 1nMFe+N b,a; 0.75nMFe+N b,a; 0.5nMFe+N b,a; Fe+N Control b,a; 2nMZn+N b,a; 1.5nMZn+N b,a, 1nMZn+N b,a; 0.5nMZn+N b,a; 0.2nMZn+N b,a; Zn+N Control b,a. : (ID 025-048: AAIII).

20.7.17: Expt D N additions: 2uM N (G1,2,3); 0.2 nM Zn+N (H1,2,3); 0.5 nM Zn+N (I1,2,3); 0.5 nM Fe+N (J1,2,3); 1nM Fe+N (K1,2,3); 50pM Co+N (L1,2,3). (AAIII). Expt D T0 Stn 4, a,b,c,d. (Waveguide and Nanoammonium).

22.7.17: Expt ABC Stn 5, T0,a,b,c. (Waveguide and Nanoammonium)

Expt D Stn 4; Control (A); 0.2nM Zn (B); 0.5nM Zn (C); 0.5nM Fe (D); 1.0nM Fe (E); 50pM Co (F); (Waveguide).

Expt D N additions: 2uM N (G1,2,3); 0.2 nM Zn+N (H1,2,3); 0.5 nM Zn+N (I1,2,3); 0.5 nM Fe+N (J1,2,3); 1nM Fe+N (K1,2,3); 50pM Co+N (L1,2,3). (All duplicates), (AAIII).

24.7.17. Expt A* Breakdown: Bottle ID's 25-72, A-L (Nanoammonium+Waveguide phosphate only)

25.7.17: Expt A* Stn 5 T0 a,b,c.

Expt D Stn 5 T0 a,b,c

26.7.17: Claire Experiment Samples: 1,2,3,4,5,6,7,8,9,10,11,12 (Waveguide)

27.7.17: Expt A* Breakdown: Bottle ID's 25-72, (Nanoammonium+Waveguide)

Expt D Breakdown, Expt D Stn 5; Control (A1,2,3); 0.4nM Zn (B1,2,3); 0.8nM Zn (C1,2,3); 0.3nM Zn (D1,2,3); 0.5nM Fe (E1,2,3); 20pM Co (F1,2,3); 50pM Co (G1,2,3); Noelle1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24, (Waveguide+ Nanoammonium).

28.7.17: Expt A-UP T0 Stn 6; Expt D-UP T0, 1,2,3.(Waveguide+ Nanoammonium).

30.7.17: Expt D-UP Breakdown Stn 6: Control (A1,2,3); 0.2 Zn+0.5 Fe (B1,2,3), 0.4 Zn+0.5 Fe (C1,2,3), 0.8 Zn+0.5 Fe (D1,2,3), 0.4 Zn+0.2 Fe (E1,2,3), 0.4 Zn+1.0 Fe (F1,2,3), 0.2 Zn+20Co (G1,2,3), 0.2 Zn+100Co (H1,2,3), 0.2 Zn+50Co (I1,2,3), 0.4 Zn+50Co (J1,2,3), 0.8 Zn+50Co (K1,2,3). (Waveguide+ Nanoammonium).

2.8.17: Expt D Stn 6 T0 #1,#2,#3. Expt A Stn 6 T0 #1,#2. (Waveguide+ Nanoammonium).

3.8.17. Expt D. Stn 6, T12: Control, 0.5nM Zn, 0.5nM Fe. (Waveguide+ Nanoammonium).

Expt D. Stn 6, T24: Control(A2,B1,G2), 0.5nM Zn(J2,K3,L2), 0.5nM Fe(C1,C3,F1) (Waveguide+ Nanoammonium).

4.8.17. Expt D. Stn 6, T36: Control(D1), 0.5nM Zn (G3), 0.5nM Fe(I3). (Waveguide+ Nanoammonium).

Expt D. Stn 6, T24: Control(B2,B3,H2), 0.5nM Fe(D2,E2,E3),0.5nM Zn(I1,K2,L1). (Waveguide+ Nanoammonium).

5.8.17. Expt D. Stn 6, T60: Control(G1), 0.5nM Zn (E1), 0.5nM Fe(L3). (Waveguide+ Nanoammonium).

Expt D. Stn 6, T72: Control(A1,A3,H3), 0.5nM Zn(I2,J1,J3),0.5nM Fe(C2,F2,F3).

6.8.17. Stn 7 Expt A T0. (Waveguide+ Nanoammonium).

7.8.17. Expt D. Stn 7 Breakdown: (Control, A2,H1,H2), (0.5nM Zn, K1,K2,K3), (1.0nM Zn, L1,L2,L3), (0.5nM Fe, D1,D2,D3), (1.0nM Fe, E1,E2,E3), (20pM Co, G1,G2,G3),(75pM Co, A2,H1,H2). (Waveguide+ Nanoammonium).

2. **Steph Sargeant:**

| Steph 1/2, 3/4 | 29.6.17 | Waveguide and Ammonium |

Steph,5,6,7,8,9,10,11,12,13,14,15,16, 17,18,19,20,	30.6.17	AAIII Nutrient autoanalyser and Ammonium
Steph 21A, 21B, 21C, 22, 23, 24, 25, 26, 27, 28, 29, 30,31 32, 33, 34, 35, 36, 37, 38 (All duplicates)	02.7.17	AAIII Nutrient autoanalyser
Steph 39A, 39B, 39C, 40	05.7.17	Waveguide and Ammonium
41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56	06.7.17	AAIII Nutrient autoanalyser
Steph 57A, 57B, 57C, 58 (All duplicates)	12.7.17	AAIII Nutrient autoanalyser
Steph 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74	13.7.17	AAIII Nutrient autoanalyser
Steph 75A, 75B, 75C, 76 (duplicates)	17.7.17	AAIII Nutrient autoanalyser
Steph 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92 (duplicates)	18.7.17	AAIII Nutrient autoanalyser
Steph, 75A, 75B, 75C, 76, 77, 78, 79, 80, 81, 82 (duplicates)	22.7.17	AAIII Nutrient autoanalyser
Steph, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, (duplicates)	23.7.17	AAIII Nutrient autoanalyser
Steph, 99A, 99B, 99C, 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, (duplicates)	28.7.17	AAIII Nutrient autoanalyser
123A, 123B, 123C, 124, 125, 126, 127, 128, 129, 130, 131, 132, 133, 134, 135, 136, 137, 138, 139, 140, 141, 142, 143, 144, 145, 146 (duplicates)	5.8.17	AAIII Nutrient autoanalyser

3. **Koko Kunde:**
   (^{59}Fe 0.5nM Fe)

Stn3 Sam ID t0-1	15.7.17	Waveguide and Ammonium
Stn3 Sam ID t1-1 – t2-1	15.7.17	AAIII Nutrient autoanalyser
Stn3 Sam ID t3-1 – t4-1	16.7.17	AAIII Nutrient autoanalyser
Stn3 Sam ID t6-1	17.7.17	AAIII Nutrient autoanalyser
Stn4 Sam ID t0	26.7.17	Waveguide and Ammonium
Stn4 Sam ID t1-1- t4-1	21.7.17	AAIII Nutrient autoanalyser
Stn4 Sam ID t5-1- t6-1	22.7.17	AAIII Nutrient autoanalyser
Stn5 Sam ID t1-1- t5-1	26.7.17	Waveguide and Ammonium
Stn5 Sam ID t6-1	27.7.17	Waveguide and Ammonium
Stn7 Sam ID t1-1- t3-1	5.8.17	Waveguide and Ammonium
Stn7 Sam ID t4-1, t5-1	6.8.17	Waveguide and Ammonium
Stn7 Sam ID t6-1	7.8.17	Waveguide and Ammonium

Supplementary Information S10: McLane Pump sample log

Noelle Held

Barcode (on_pump_sample)	Station	Deploy #	Approx Lat	Approx Long	Pump #	Depth	Start pump (GMT)	Volume filtered	Filter size	Filter fraction	Sample type	Freezer bag #	max filter size (uM)	min filter size (uM)
St1A_P1_1	1	A	22	58	1	15	13:30	89.2	0.2	0.25	protein	M5	3	0.2
St1A_P1_2	1	A	22	58	1	15	13:30	89.2	0.2	0.25	hosphoprotei	M5	3	0.2
St1A_P1_3	1	A	22	58	1	15	13:30	89.2	0.2	0.25	metallome	M5	3	0.2
St1A_P1_4	1	A	22	58	1	15	13:30	89.2	0.2	0.125	metals	M2	3	0.2
St1A_P1_5	1	A	22	58	1	15	13:30	89.2	0.2	0.0625	DNA_julie	M3	3	0.2
St1A_P1_6	1	A	22	58	1	15	13:30	89.2	0.2	0.0625	DNA_liz	M2	3	0.2
St1A_P1_7	1	A	22	58	1	15	13:30	89.2	3	0.25	protein	M5	51	3
St1A_P1_8	1	A	22	58	1	15	13:30	89.2	3	0.25	hosphoprotei	M5	51	3
St1A_P1_9	1	A	22	58	1	15	13:30	89.2	3	0.25	metallome	M5	51	3
St1A_P1_10	1	A	22	58	1	15	13:30	89.2	3	0.125	metals	M2	51	3
St1A_P1_11	1	A	22	58	1	15	13:30	89.2	3	0.0625	DNA_julie	M3	51	3
St1A_P1_12	1	A	22	58	1	15	13:30	89.2	3	0.0625	DNA_liz	M2	51	3
St1A_P1_13	1	A	22	58	1	15	13:30	89.2	52	0.5	protein	M5	51	51
St1A_P1_14	1	A	22	58	1	15	13:30	89.2	52	0.5	hosphoprotei	M5	51	51
St1A_P4_14	1	A	22	58	4	70	13:30	96.4	52	0.5	hosphoprotei	M5	51	51
St1A_P4_13	1	A	22	58	4	70	13:30	96.4	52	0.5	protein	M5	51	51
St1A_P4_12	1	A	22	58	4	70	13:30	96.4	3	0.0625	DNA_liz	M2	51	3
St1A_P4_11	1	A	22	58	4	70	13:30	96.4	3	0.0625	DNA_julie	M3	51	3
St1A_P4_10	1	A	22	58	4	70	13:30	96.4	3	0.125	metals	M2	51	3
St1A_P4_9	1	A	22	58	4	70	13:30	96.4	3	0.25	metallome	M5	51	3
St1A_P4_8	1	A	22	58	4	70	13:30	96.4	3	0.25	hosphoprotei	M5	51	3
St1A_P4_7	1	A	22	58	4	70	13:30	96.4	3	0.25	protein	M5	51	3
St1A_P4_6	1	A	22	58	4	70	13:30	96.4	0.2	0.0625	DNA_liz	M2	3	0.2
St1A_P4_5	1	A	22	58	4	70	13:30	96.4	0.2	0.0625	DNA_julie	M3	3	0.2
St1A_P4_4	1	A	22	58	4	70	13:30	96.4	0.2	0.125	metals	M2	3	0.2
St1A_P4_3	1	A	22	58	4	70	13:30	96.4	0.2	0.25	metallome	M5	3	0.2
St1A_P4_2	1	A	22	58	4	70	13:30	96.4	0.2	0.25	hosphoprotei	M5	3	0.2
St1A_P4_1	1	A	22	58	4	70	13:30	96.4	0.2	0.25	protein	M5	3	0.2
St1B_P1_14	1	B	22	58	1	40	10:30	72.4	52	0.5	hosphoprotei	M5	51	51
St1B_P1_13	1	B	22	58	1	40	10:30	72.4	52	0.5	protein	M5	51	51
St1B_P1_12	1	B	22	58	1	40	10:30	72.4	3	0.0625	DNA_liz	M2	51	3
St1B_P1_11	1	B	22	58	1	40	10:30	72.4	3	0.0625	DNA_julie	M3	51	3
St1B_P1_10	1	B	22	58	1	40	10:30	72.4	3	0.125	metals	M2	51	3
St1B_P1_9	1	B	22	58	1	40	10:30	72.4	3	0.25	metallome	M5	51	3
St1B_P1_8	1	B	22	58	1	40	10:30	72.4	3	0.25	hosphoprotei	M5	51	3
St1B_P1_7	1	B	22	58	1	40	10:30	72.4	3	0.25	protein	M5	51	3
St1B_P1_6	1	B	22	58	1	40	10:30	72.4	0.2	0.0625	DNA_liz	M2	3	0.2
St1B_P1_5	1	B	22	58	1	40	10:30	72.4	0.2	0.0625	DNA_julie	M3	3	0.2
St1B_P1_4	1	B	22	58	1	40	10:30	72.4	0.2	0.125	metals	M2	3	0.2
St1B_P1_3	1	B	22	58	1	40	10:30	72.4	0.2	0.25	metallome	M5	3	0.2
St1B_P1_2	1	B	22	58	1	40	10:30	72.4	0.2	0.25	hosphoprotei	M5	3	0.2
St1B_P1_1	1	B	22	58	1	40	10:30	72.4	0.2	0.25	protein	M5	3	0.2
St1B_P3_6	1	B	22	58	3	140	10:30	28.7	0.2	0.0625	DNA_liz	M2	3	0.2
St1B_P3_5	1	B	22	58	3	140	10:30	28.7	0.2	0.0625	DNA_julie	M3	3	0.2
St1B_P3_4	1	B	22	58	3	140	10:30	28.7	0.2	0.125	metals	M2	3	0.2
St1B_P3_3	1	B	22	58	3	140	10:30	28.7	0.2	0.25	metallome	M5	3	0.2
St1B_P3_2	1	B	22	58	3	140	10:30	28.7	0.2	0.25	hosphoprotei	M5	3	0.2
St1B_P3_1	1	B	22	58	3	140	10:30	28.7	0.2	0.0625	DNA_julie	M3	3	0.2

Barcode	on_pump_sample Station	Deploy #	Approx Lat	Approx Long	Pump #	Depth	Start pump (GMT)	Volume filtered	Filter size	Filter fraction	Sample type	Freezer bag #	max filter size (uM)	min filter size (uM)
St1B_P3_7	1	B	22	58	3	140	10:30	28.7	3	0.25	protein	M5	51	3
St1B_P3_8	1	B	22	58	3	140	10:30	28.7	3	0.25	hosphoprote	M5	51	3
St1B_P3_9	1	B	22	58	3	140	10:30	28.7	3	0.25	metallome	M2	51	3
St1B_P3_10	1	B	22	58	3	140	10:30	28.7	0.2	0.125	metals	M2	3	0.2
St1B_P3_11	1	B	22	58	3	140	10:30	28.7	3	0.0625	DNA_julie	M3	51	3
St1B_P3_12	1	B	22	58	3	140	10:30	28.7	0.2	0.0625	DNA_liz	M2	3	0.2
St1B_P3_13	1	B	22	58	3	140	10:30	28.7	52	0.5	protein	M5	51	51
St1B_P3_14	1	B	22	58	3	140	10:30	28.7	52	0.5	hosphoprote	M5	51	51
St1B_P4_1	1	B	22	58	4	200	10:30	12.3	3	0.25	protein	M5	51	3
St1B_P4_2	1	B	22	58	4	200	10:30	12.3	0.2	0.0625	DNA_liz	M2	3	0.2
St1B_P4_3	1	B	22	58	4	200	10:30	12.3	0.2	0.125	metals	M2	3	0.2
St1B_P4_4	1	B	22	58	4	200	10:30	12.3	3	0.25	metallome	M2	51	3
St1B_P4_5	1	B	22	58	4	200	10:30	12.3	3	0.0625	DNA_julie	M3	51	3
St1B_P4_6	1	B	22	58	4	200	10:30	12.3	3	0.25	protein	M1	51	3
St1B_P4_7	1	B	22	58	4	200	10:30	12.3	3	0.25	protein	M1	51	3
St1B_P4_8	1	B	22	58	4	200	10:30	12.3	3	0.25	hosphoprote	M1	51	3
St1B_P4_9	1	B	22	58	4	200	10:30	12.3	3	0.25	metallome	M2	51	3
St1B_P4_10	1	B	22	58	4	200	10:30	12.3	0.2	0.125	metals	M2	3	0.2
St1B_P4_11	1	B	22	58	4	200	10:30	12.3	3	0.0625	DNA_julie	M3	51	3
St1B_P4_12	1	B	22	58	4	200	10:30	12.3	0.2	0.0625	DNA_liz	M2	3	0.2
St1B_P4_13	1	B	22	58	4	200	10:30	12.3	52	0.5	protein	M5	51	51
St1B_P4_14	1	B	22	58	4	200	10:30	12.3	52	0.5	hosphoprote	M5	51	51
St1C_P1_1	1	C	22	58	1	40	11:30	241.9	52	0.5	hosphoprote	M1	51	51
St1C_P1_2	1	C	22	58	1	40	11:30	241.9	52	0.5	protein	M1	51	51
St1C_P1_3	1	C	22	58	1	40	11:30	241.9	3	0.25	protein	M1	51	3
St1C_P1_4	1	C	22	58	1	40	11:30	241.9	0.2	0.125	metals	M2	3	0.2
St1C_P1_5	1	C	22	58	1	40	11:30	241.9	3	0.25	metallome	M2	51	3
St1C_P1_6	1	C	22	58	1	40	11:30	241.9	3	0.0625	hosphoprote	M1	51	3
St1C_P1_7	1	C	22	58	1	40	11:30	241.9	3	0.25	protein	M1	51	3
St1C_P1_8	1	C	22	58	1	40	11:30	241.9	3	0.25	protein	M1	51	3
St1C_P1_9	1	C	22	58	1	40	11:30	241.9	3	0.25	hosphoprote	M1	51	3
St1C_P1_10	1	C	22	58	1	40	11:30	241.9	3	0.25	metallome	M2	51	3
St1C_P1_11	1	C	22	58	1	40	11:30	241.9	0.2	0.125	metals	M2	3	0.2
St1C_P1_12	1	C	22	58	1	40	11:30	241.9	3	0.0625	DNA_julie	M4	51	3
St1C_P1_13	1	C	22	58	1	40	11:30	241.9	0.2	0.0625	DNA_liz	M3	3	0.2
St1C_P1_14	1	C	22	58	1	40	11:30	241.9	52	0.5	hosphoprote	M2	51	51
St1C_P3_1	1	C	22	58	3	15	11:30	358.9	52	0.5	protein	M1	51	51
St1C_P3_2	1	C	22	58	3	15	11:30	358.9	3	0.25	protein	M1	51	3
St1C_P3_3	1	C	22	58	3	15	11:30	358.9	0.2	0.125	metallome	M2	3	0.2
St1C_P3_4	1	C	22	58	3	15	11:30	358.9	0.2	0.0625	metals	M2	3	0.2
St1C_P3_5	1	C	22	58	3	15	11:30	358.9	0.2	0.0625	DNA_julie	M4	3	0.2
St1C_P3_6	1	C	22	58	3	15	11:30	358.9	0.2	0.0625	protein	M3	3	0.2
St1C_P3_7	1	C	22	58	3	15	11:30	358.9	0.2	0.125	DNA_liz	M4	3	0.2
St1C_P3_8	1	C	22	58	3	15	11:30	358.9	3	0.25	protein	M1	51	3
St1C_P3_9	1	C	22	58	3	15	11:30	358.9	3	0.25	metals	M2	51	3
St1C_P3_10	1	C	22	58	3	15	11:30	358.9	0.2	0.125	metallome	M2	51	3
St1C_P3_11	1	C	22	58	3	15	11:30	358.9	3	0.0625	metals	M3	51	3
St1C_P3_12	1	C	22	58	3	15	11:30	358.9	3	0.0625	DNA_julie	M4	51	3

Barcode / on_pump_sample	Station	Deploy #	Approx Lat	Approx Long	Pump #	Depth	Start pump (GMT)	Volume filtered	Filter size	Filter fraction	Sample type	Freezer bag #	max filter size (uM)	min filter size (uM)
St1C_P3_13	1	C	58	58	3	15	11:30	358.9	52	0.5	protein	M1	51	51
St1C_P3_14	1	C	58	58	3	15	11:30	358.9	52	0.5	hosphoprotei	M1	51	51
St1C_P3_13	1	C	22	22	3	15	11:30	358.9	52	0.5	protein	M1	51	51
St2A_P1_1	2	A	21.6	54	3	40	10:05	343	0.2	0.0625	DNA_liz	M4	3	0.2
St2A_P1_2	2	A	21.6	54	3	40	10:06	343	0.2	0.125	DNA_julie	M3	3	0.2
St2A_P1_3	2	A	21.6	54	3	40	10:07	343	3	0.25	metals	M6	51	3
St2A_P1_4	2	A	21.6	54	3	40	10:08	343	0.2	0.25	metallome	M6	3	0.2
St2A_P1_5	2	A	21.6	54	3	40	10:09	343	0.2	0.25	protein	M1	3	0.2
St2A_P1_6	2	A	21.6	54	3	40	10:10	343	0.2	0.25	hosphoprotei	M1	3	0.2
St2A_P1_7	2	A	21.6	54	3	40	10:11	343	0.2	0.0625	DNA_liz	M4	3	0.2
St2A_P1_8	2	A	21.6	54	3	40	10:12	343	0.2	0.125	DNA_julie	M3	3	0.2
St2A_P1_9	2	A	21.6	54	3	40	10:13	343	3	0.25	metals	M6	51	3
St2A_P1_10	2	A	21.6	54	3	40	10:14	343	0.2	0.25	metallome	M6	3	0.2
St2A_P1_11	2	A	21.6	54	3	40	10:15	343	0.2	0.125	protein	M1	3	0.2
St2A_P1_12	2	A	21.6	54	3	40	10:16	343	3	0.25	hosphoprotei	M1	51	3
St2A_P1_13	2	A	21.6	54	3	40	10:17	343	52	0.5	protein	M1	51	51
St2A_P1_14	2	A	21.6	54	3	40	10:18	343	52	0.5	protein	M1	51	51
St2A_P3_1	2	A	21.6	54	3	15	10:05	195	3	0.25	hosphoprotei	M6	51	3
St2A_P3_2	2	A	21.6	54	3	15	10:06	195	0.2	0.0625	DNA_liz	M3	3	0.2
St2A_P3_3	2	A	21.6	54	3	15	10:07	195	0.2	0.125	DNA_julie	M6	3	0.2
St2A_P3_4	2	A	21.6	54	3	15	10:08	195	0.2	0.0625	metals	M4	3	0.2
St2A_P3_5	2	A	21.6	54	3	15	10:09	195	0.2	0.0625	metallome	M1	3	0.2
St2A_P3_6	2	A	21.6	54	3	15	10:10	195	0.2	0.0625	protein	M1	3	0.2
St2A_P3_7	2	A	21.6	54	3	15	10:11	195	3	0.25	hosphoprotei	M7	51	3
St2A_P3_8	2	A	21.6	54	3	15	10:12	195	3	0.25	protein	M1	51	3
St2A_P3_9	2	A	21.6	54	3	15	10:13	195	3	0.25	metals	M6	51	3
St2A_P3_10	2	A	21.6	54	3	15	10:14	195	0.2	0.125	DNA_liz	M4	3	0.2
St2A_P3_11	2	A	21.6	54	3	15	10:15	195	3	0.0625	DNA_julie	M3	51	3
St2A_P3_12	2	A	21.6	54	3	15	10:16	195	3	0.0625	metallome	M6	51	3
St2A_P3_13	2	A	21.6	54	3	15	10:17	195	52	0.5	protein	M1	51	51
St2A_P3_14	2	A	21.6	54	3	15	10:18	195	52	0.5	protein	M1	51	51
St2B_P3_1	2	B	21.6	54	3	160	13:05	488.6	0.2	0.25	hosphoprotei	M7	3	0.2
St2B_P3_2	2	B	21.6	54	3	160	13:05	488.6	0.2	0.25	protein	M7	3	0.2
St2B_P3_3	2	B	21.6	54	3	160	13:05	488.6	3	0.125	metals	M6	51	3
St2B_P3_4	2	B	21.6	54	3	160	13:05	488.6	3	0.0625	DNA_julie	M3	51	3
St2B_P3_5	2	B	21.6	54	3	160	13:05	488.6	0.2	0.0625	metallome	M6	51	3
St2B_P3_6	2	B	21.6	54	3	160	13:05	488.6	0.2	0.0625	DNA_liz	M4	3	0.2
St2B_P3_7	2	B	21.6	54	3	160	13:05	488.6	0.2	0.25	protein	M1	3	0.2
St2B_P3_8	2	B	21.6	54	3	160	13:05	488.6	0.2	0.25	hosphoprotei	M1	3	0.2
St2B_P3_9	2	B	21.6	54	3	160	13:05	488.6	3	0.25	protein	M7	51	3
St2B_P3_10	2	B	21.6	54	3	160	13:05	488.6	3	0.125	metallome	M6	51	3
St2B_P3_11	2	B	21.6	54	3	160	13:05	488.6	3	0.0625	metals	M6	51	3
St2B_P3_12	2	B	21.6	54	3	160	13:05	488.6	0.0625	0.0625	DNA_julie	M4	51	3
St2B_P3_13	2	B	21.6	54	3	160	13:05	488.6	52	0.5	protein	M7	51	51
St2B_P3_14	2	B	21.6	54	3	160	13:05	488.6	52	0.5	hosphoprotei	M7	51	51
St2B_P1_1	2	B	21.6	54	3	110	13:05	467.5	0.2	0.25	protein	M7	3	0.2
St2B_P1_2	2	B	21.6	54	3	110	13:05	467.5	0.2	0.25	protein	M7	3	0.2
St2B_P1_3	2	B	21.6	54	3	110	13:05	467.5	0.2	0.25	metallome	M6	3	0.2
St2B_P1_4	2	B	21.6	54	3	110	13:05	467.5	0.2	0.125	metals	M6	3	0.2

Barcode	Station on_pump_sample	Deploy #	Approx Lat	Approx Long	Pump #	Depth	Start pump (GMT)	Volume filtered	Filter size	Filter fraction	Sample type	Freezer bag #	max filter size (uM)	min filter size (uM)
St2B_P1_5	2	B	21.6	54	3	110	13:05	467.5	52	0.5	phosphoprotein	M7		51
St2B_P1_6	2	B	21.6	54	3	110	13:05	467.5	52	0.5	protein	M7		51
St2B_P1_7	2	B	21.6	54	3	110	13:05	467.5	3	0.0625	DNA_liz	M4	51	3
St2B_P1_8	2	B	21.6	54	3	110	13:05	467.5	3	0.0625	DNA_julie	M3	51	3
St2B_P1_9	2	B	21.6	54	3	110	13:05	467.5	3	0.125	metals	M6	51	3
St2B_P1_10	2	B	21.6	54	3	110	13:05	467.5	3	0.25	metallome	M6	51	3
St2B_P1_11	2	B	21.6	54	3	110	13:05	467.5	0.2	0.25	phosphoprotein	M7	3	0.2
St2B_P1_12	2	B	21.6	54	3	110	13:05	467.5	0.2	0.25	protein	M7	3	0.2
St2B_P1_13	2	B	21.6	54	3	110	13:05	467.5	0.2	0.0625	DNA_liz	M4	3	0.2
St2B_P1_14	2	B	21.6	54	3	110	13:05	467.5	0.2	0.0625	DNA_julie	M3	3	0.2
St2C_P1_1	2	C	21.6	54	1	40	09:10	347.2	52	0.5	phosphoprotein	M7		51
St2C_P1_2	2	C	21.6	54	1	40	09:10	347.2	52	0.5	protein	M7		51
St2C_P1_3	2	C	21.6	54	1	40	09:10	347.2	3	0.0625	DNA_liz	M4	51	3
St2C_P1_4	2	C	21.6	54	1	40	09:10	347.2	3	0.0625	DNA_julie	M3	51	3
St2C_P1_5	2	C	21.6	54	1	40	09:10	347.2	3	0.125	metals	M6	51	3
St2C_P1_6	2	C	21.6	54	1	40	09:10	347.2	3	0.25	metallome	M6	51	3
St2C_P1_7	2	C	21.6	54	1	40	09:10	347.2	3	0.25	phosphoprotein	M7	51	3
St2C_P1_8	2	C	21.6	54	1	40	09:10	347.2	3	0.25	protein	M7	51	3
St2C_P1_9	2	C	21.6	54	1	40	09:10	347.2	0.2	0.25	phosphoprotein	M7	3	0.2
St2C_P1_10	2	C	21.6	54	1	40	09:10	347.2	0.2	0.25	protein	M7	3	0.2
St2C_P1_11	2	C	21.6	54	1	40	09:10	347.2	0.2	0.0625	DNA_liz	M4	3	0.2
St2C_P1_12	2	C	21.6	54	1	40	09:10	347.2	0.2	0.0625	DNA_julie	M3	3	0.2
St2C_P1_13	2	C	21.6	54	1	40	09:10	347.2	0.2	0.125	metals	M6	3	0.2
St2C_P1_14	2	C	21.6	54	1	40	09:10	347.2	0.2	0.25	metallome	M6	3	0.2
St2C_P1_15	2	C	21.6	54	1	40	09:10	306.5	51second	0.5	sandbox	M7		51
St2C_P1_16	2	C	21.6	54	1	40	09:10	306.5	51second	0.5	sandbox	M7		51
St2C_P1_17	2	C	21.6	54	1	40	09:10	306.5	3second	0.5	sandbox	M7	51	3
St2C_P1_18	2	C	21.6	54	1	40	09:10	306.5	3second	0.5	sandbox	M7	51	3
St2C_P1_19	2	C	21.6	54	1	40	09:10	306.5	0.2second	0.5	sandbox	M7	3	0.2
St2C_P1_20	2	C	21.6	54	1	40	09:10	306.5	0.2second	0.5	sandbox	M7	3	0.2
St2C_P1_21	2	C	21.6	54	1	40	09:10	347.2	0.2	0.25	protein	M7	3	0.2
St2C_P1_22	2	C	21.6	54	1	40	09:10	347.2	0.2	0.25	phosphoprotein	M7	3	0.2
St2C_P3_1	2	C	21.6	54	3	250	09:10	413.8	0.2	0.25	phosphoprotein	M7	3	0.2
St2C_P3_2	2	C	21.6	54	3	250	09:10	413.8	0.2	0.25	protein	M7	3	0.2
St2C_P3_3	2	C	21.6	54	3	250	09:10	413.8	0.2	0.0625	DNA_liz	M4	3	0.2
St2C_P3_4	2	C	21.6	54	3	250	09:10	413.8	0.2	0.125	metals	M6	3	0.2
St2C_P3_5	2	C	21.6	54	3	250	09:10	413.8	0.2	0.0625	DNA_julie	M3	3	0.2
St2C_P3_6	2	C	21.6	54	3	250	09:10	413.8	0.2	0.5	sandbox	M7	3	0.2
St2C_P3_7	2	C	21.6	54	3	250	09:10	413.8	3	0.25	phosphoprotein	M7	51	3
St2C_P3_8	2	C	21.6	54	3	250	09:10	413.8	3	0.25	sandbox	M7	51	3
St2C_P3_9	2	C	21.6	54	3	250	09:10	413.8	3	0.25	metallome	M6	51	3
St2C_P3_10	2	C	21.6	54	3	250	09:10	413.8	3	0.125	metals	M6	51	3
St2C_P3_11	2	C	21.6	54	3	250	09:10	413.8	3	0.0625	DNA_julie	M3	51	3
St2C_P3_12	2	C	21.6	54	3	250	09:10	413.8	3	0.0625	DNA_liz	M4	51	3
St2C_P3_13	2	C	21.6	54	3	250	09:10	413.8	52	0.5	protein	M7	51	51
St2C_P3_14	2	C	21.6	54	3	250	09:10	413.8	52	0.5	phosphoprotein	M7	51	51
St2C_P3_15	2	C	21.6	54	3	250	09:10	409.1	0.2second	0.25	sandbox	M7	3	0.2
St2C_P3_16	2	C	21.6	54	3	250	09:10	409.1	0.2second	0.25	sandbox	M7	3	0.2

Barcode (on_pump_sample)	Station	Deploy #	Approx Lat	Approx Long	Pump #	Depth	Start pump (GMT)	Volume filtered	Filter size	Filter fraction	Sample type	Freezer bag #	max filter size (uM)	min filter size (uM)
St2C_P3_17	2	C	21.6	54	3	250	09:10	409.1	0.2second	0.25	sandbox	M7	3	0.2
St2C_P3_18	2	C	21.6	54	3	250	09:10	409.1	0.2second	0.25	sandbox	M7	3	0.2
St2C_P3_19	2	C	21.6	54	3	250	09:10	409.1	3second	0.5	sandbox	M7	51	3
St2C_P3_20	2	C	21.6	54	3	250	09:10	409.1	3second	0.5	sandbox	M7	51	3
St2C_P3_21	2	C	21.6	54	3	250	09:10	409.1	51second	0.5	sandbox	M7	51	51
St2C_P3_22	2	C	21.6	54	3	250	09:10	409.1	51second	0.5	sandbox	M7	51	51
St2D_P1_1	2	D	21.6	54	1	70	13:05	255.7	0.2	0.25	protein	M8	3	0.2
St2D_P1_2	2	D	21.6	54	1	70	13:05	255.7	0.2	0.25	hosphoprotei	M8	3	0.2
St2D_P1_3	2	D	21.6	54	1	70	13:05	255.7	0.2	0.25	sandbox	M8	3	0.2
St2D_P1_4	2	D	21.6	54	1	70	13:05	255.7	0.125	0.125	metallome	M6	51	51
St2D_P1_5	2	D	21.6	54	1	70	13:05	255.7	0.2	0.0625	DNA_julie	M3	3	0.2
St2D_P1_6	2	D	21.6	54	1	70	13:05	255.7	0.2	0.0625	DNA_liz	M4	3	0.2
St2D_P1_7	2	D	21.6	54	1	70	13:05	260.6	0.2	0.25	protein	M8	3	0.2
St2D_P1_8	2	D	21.6	54	1	70	13:05	260.6	0.2	0.25	hosphoprotei	M8	3	0.2
St2D_P1_9	2	D	21.6	54	1	70	13:05	260.6	3	0.25	metallome	M6	3	3
St2D_P1_10	2	D	21.6	54	1	70	13:05	260.6	3	0.125	metals	M6	3	3
St2D_P1_11	2	D	21.6	54	1	70	13:05	260.6	3	0.0625	DNA_julie	M3	51	3
St2D_P1_12	2	D	21.6	54	1	70	13:05	260.6	3	0.0625	DNA_liz	M4	3	0.2
St2D_P1_13	2	D	21.6	54	1	70	13:05	260.6	52	0.5	protein	M8	51	51
St2D_P1_14	2	D	21.6	54	1	70	13:05	260.6	52	0.5	hosphoprotei	M8	51	51
St2D_P1_15	2	D	21.6	54	1	70	13:05	260.6	3	0.25	sandbox	M8	51	3
St2D_P1_16	2	D	21.6	54	1	70	13:05	255.7	3	0.25	sandbox	M8	51	3
St2D_P1_17	2	D	21.6	54	1	70	13:05	255.7	3	0.25	sandbox	M8	51	3
St2D_P1_18	2	D	21.6	54	1	70	13:05	255.7	0.2	0.25	sandbox	M8	3	0.2
St2D_P1_19	2	D	21.6	54	1	70	13:05	255.7	0.2	0.25	sandbox	M8	3	0.2
St2D_P1_20	2	D	21.6	54	1	70	13:05	255.7	0.2	0.25	sandbox	M8	3	0.2
St2D_P1_21	2	D	21.6	54	1	70	13:05	255.7	0.2	0.5	sandbox	M8	3	0.2
St2D_P1_22	2	D	21.6	54	1	70	13:05	255.7	51second	0.5	sandbox	M8	51	51
St2D_P3_1	2	D	21.6	54	3	180	13:05	379.3	0.2	0.5	sandbox	M8	51	3
St2D_P3_2	2	D	21.6	54	3	180	13:05	379.3	0.2	0.25	protein	M8	3	0.2
St2D_P3_3	2	D	21.6	54	3	180	13:05	379.3	0.2	0.25	hosphoprotei	M8	3	0.2
St2D_P3_4	2	D	21.6	54	3	180	13:05	379.3	0.125	0.125	metallome	M6	51	51
St2D_P3_5	2	D	21.6	54	3	180	13:05	379.3	0.2	0.25	metals	M6	3	0.2
St2D_P3_6	2	D	21.6	54	3	180	13:05	379.3	0.2	0.0625	DNA_liz	M4	3	0.2
St2D_P3_7	2	D	21.6	54	3	180	13:05	379.3	0.2	0.25	protein	M8	3	0.2
St2D_P3_8	2	D	21.6	54	3	180	13:05	379.3	0.2	0.25	hosphoprotei	M8	3	0.2
St2D_P3_9	2	D	21.6	54	3	180	13:05	379.3	0.2	0.25	protein	M8	3	0.2
St2D_P3_10	2	D	21.6	54	3	180	13:05	379.3	0.2	0.25	metallome	M6	3	0.2
St2D_P3_11	2	D	21.6	54	3	180	13:05	379.3	3	0.0625	DNA_julie	M3	51	3
St2D_P3_12	2	D	21.6	54	3	180	13:05	379.3	3	0.0625	DNA_liz	M4	3	0.2
St2D_P3_13	2	D	21.6	54	3	180	13:05	379.3	52	0.5	protein	M8	51	51
St2D_P3_14	2	D	21.6	54	3	180	13:05	379.3	52	0.5	sandbox	M8	51	51
St2D_P3_15	2	D	21.6	54	3	180	13:05	379.3	3	0.25	sandbox	M8	51	3
St2D_P3_16	2	D	21.6	54	3	180	13:05	374.8	3	0.25	sandbox	M8	51	3
St2D_P3_17	2	D	21.6	54	3	180	13:05	374.8	0.25second	0.25	sandbox	M8	3	0.2
St2D_P3_18	2	D	21.6	54	3	180	13:05	374.8	0.25second	0.25	sandbox	M8	3	0.2
St2D_P3_19	2	D	21.6	54	3	180	13:05	374.8	3second	0.5	sandbox	M8	51	3
St2D_P3_20	2	D	21.6	54	3	180	13:05	374.8	3second	0.5	sandbox	M8	3	3

Barcode (on_pump_sample)	Station	Deploy #	Approx Lat	Approx Long	Pump #	Depth	Start pump (GMT)	Volume filtered	Filter size	Filter fraction	Sample type	Freezer bag #	max filter size (uM)	min filter size (uM)
St2D_P3_21	2	D	21.6	54	3	180	13:05	374.8	51second	0.5	sandbox	M8	51	51
St2D_P3_22	2	D	21.6	54	3	180	13:05	374.8	51second	0.5	protein	M8	51	51
St2D_P4_1	2	D	21.6	54	3	350	13:05	460.1	0.2	0.25	protein	M8	3	0.2
St2D_P4_2	2	D	21.6	54	3	350	13:05	460.1	0.2	0.25	metallome	M8	3	0.2
St2D_P4_3	2	D	21.6	54	3	350	13:05	460.1	0.2	0.25	sandbox	M8	3	0.2
St2D_P4_4	2	D	21.6	54	3	350	13:05	460.1	0.2	0.25	sandbox	M8	3	0.2
St2D_P4_5	2	D	21.6	54	3	350	13:05	460.1	0.2	0.25	sandbox	M8	3	0.2
St2D_P4_6	2	D	21.6	54	3	350	13:05	460.1	3	0.0625	DNA_liz	M4	3	0.2
St2D_P4_7	2	D	21.6	54	3	350	13:05	460.1	3	0.125	metals	M8	3	0.2
St2D_P4_8	2	D	21.6	54	3	350	13:05	460.1	52	0.5	protein	M8	51	51
St2D_P4_9	2	D	21.6	54	3	350	13:05	460.1	52	0.5	hosphoprotei	M8	51	51
St2D_P4_10	2	D	21.6	54	3	350	13:05	460.1	51second	0.5	metallome	M8	51	51
St2D_P4_11	2	D	21.6	54	3	350	13:05	460.1	3	0.0625	DNA_liz	M8	3	0.2
St2D_P4_12	2	D	21.6	54	3	350	13:05	460.1	3	0.25	metals	M8	3	3
St2D_P4_13	2	D	21.6	54	3	350	13:05	460.1	3	0.125	hosphoprotei	M8	3	0.2
St2D_P4_14	2	D	21.6	54	3	350	13:05	460.1	3	0.25	protein	M8	3	0.2
St2D_P4_15	2	D	21.6	54	3	350	13:05	460.1	0.2	0.25	DNA_liz	M8	3	0.2
St2D_P4_16	2	D	21.6	54	3	350	13:05	460.1	0.2	0.25	sandbox	M8	3	0.2
St2D_P4_17	2	D	21.6	54	3	350	13:05	460.1	0.2	0.25	sandbox	M8	3	0.2
St2D_P4_18	2	D	21.6	54	3	350	13:05	460.1	0.2	0.25	sandbox	M8	3	0.2
St2D_P4_19	2	D	21.6	54	3	350	13:05	460.1	0.2	0.25	sandbox	M8	3	0.2
St2D_P4_20	2	D	21.6	54	3	350	13:05	418.1	0.2	0.0625	protein	M8	51	51
St2D_P4_21	2	D	21.6	54	3	350	13:05	418.1	3	0.0625	sandbox	M8	3	3
St2D_P4_22	2	D	21.6	54	3	350	13:05	418.1	51second	0.5	sandbox	M8	51	51
St3A_P1_1	3	a	22	50	1	15	10:15	358.5	52	0.5	hosphoprotei	M10	51	51
St3A_P1_2	3	a	22	50	1	15	10:15	358.5	52	0.5	protein	M10	51	51
St3A_P1_3	3	a	22	50	1	15	10:15	358.5	0.0625	0.0625	DNA_liz	M4	3	3
St3A_P1_4	3	a	22	50	1	15	10:15	358.5	0.0625	0.125	metals	M10	3	3
St3A_P1_5	3	a	22	50	1	15	10:15	358.5	0.2	0.25	metallome	M10	3	3
St3A_P1_6	3	a	22	50	1	15	10:15	358.5	3	0.25	hosphoprotei	M9	3	3
St3A_P1_7	3	a	22	50	1	15	10:15	358.5	3	0.25	protein	M9	3	3
St3A_P1_8	3	a	22	50	1	15	10:15	358.5	3	0.25	DNA_liz	M4	3	3
St3A_P1_9	3	a	22	50	1	15	10:15	358.5	3	0.25	metallome	M10	3	3
St3A_P1_10	3	a	22	50	1	15	10:15	358.5	3	0.125	metals	M10	3	3
St3A_P1_11	3	a	22	50	1	15	10:15	358.5	0.0625	0.0625	DNA_julie	M3	3	3
St3A_P1_12	3	a	22	50	1	15	10:15	358.5	3	0.0625	DNA_liz	M3	3	3
St3A_P1_13	3	a	22	50	1	15	10:15	358.5	52	0.5	protein	M10	51	51
St3A_P1_14	3	a	22	50	1	15	10:15	358.5	52	0.5	hosphoprotei	M10	51	51
St3A_P1_15	3	a	22	50	1	15	10:15	329	0.2	0.25	sandbox	M10	3	0.2
St3A_P1_16	3	a	22	50	1	15	10:15	329	0.2	0.25	sandbox	M10	3	0.2
St3A_P1_17	3	a	22	50	1	15	10:15	329	0.2	0.25	sandbox	M10	3	0.2
St3A_P1_18	3	a	22	50	1	15	10:15	329	0.2	0.25	sandbox	M10	3	0.2
St3A_P1_19	3	a	22	50	1	15	10:15	329	3second	0.5	sandbox	M10	3	3
St3A_P1_20	3	a	22	50	1	15	10:15	329	0.2second	0.5	protein	M9	3	0.2
St3A_P3_1	3	a	22	50	1	40	10:15	315.4	0.2second	0.25	protein	M9	3	0.2
St3A_P3_2	3	a	22	50	1	40	10:15	315.4	0.2second	0.25	hosphoprotei	M9	3	0.2
St3A_P3_3	3	a	22	50	1	40	10:15	315.4	0.2	0.25	metallome	M10	3	0.2
St3A_P3_4	3	a	22	50	1	40	10:15	315.4	0.2	0.125	metals	M10	3	0.2

Barcode (on_pump_sample)	Station	Deploy #	Approx Lat	Approx Long	Pump #	Depth	Start pump (GMT)	Volume filtered	Filter size	Filter fraction	Sample type	Freezer bag #	max filter size (uM)	min filter size (uM)
St3A_P3_5	3	a	22	50	1	40	10:15	315.4	0.2	0.0625	DNA_julie	M3	3	0.2
St3A_P3_6	3	a	22	50	1	40	10:15	315.4	0.0625	0.0625	DNA_liz	M4	3	0.2
St3A_P3_7	3	a	22	50	1	40	10:15	315.4	0.2	0.25	protein	M9	51	3
St3A_P3_8	3	a	22	50	1	40	10:15	315.4	3	0.25	metallome	M10	51	3
St3A_P3_9	3	a	22	50	1	40	10:15	315.4	3	0.25	metals	M10	51	3
St3A_P3_10	3	a	22	50	1	40	10:15	315.4	0.2	0.125	metallome	M10	51	3
St3A_P3_11	3	a	22	50	1	40	10:15	315.4	3	0.0625	metals	M10	3	3
St3A_P3_12	3	a	22	50	1	40	10:15	315.4	3	0.0625	DNA_liz	M4	51	3
St3A_P3_13	3	a	22	50	1	40	10:15	315.4	0.5	0.5	protein	M10	51	3
St3A_P3_14	3	a	22	50	1	40	10:15	315.4	0.5	0.5	hosphoprotei	M10	51	51
St3A_P3_15	3	a	22	50	1	40	10:15	315.4	52	0.5	protein	M10	51	51
St3A_P3_16	3	a	22	50	1	40	10:15	278.2	52	0.5	sandbox	M10	3	3
St3A_P3_17	3	a	22	50	1	40	10:15	278.2	3	0.25	sandbox	M10	3	3
St3A_P3_18	3	a	22	50	1	40	10:15	278.2	0.25	0.25	sandbox	M10	3	3
St3A_P3_19	3	a	22	50	1	40	10:15	278.2	3second	0.5	sandbox	M10	3	3
St3A_P3_20	3	a	22	50	1	40	10:15	278.2	3second	0.5	sandbox	M10	3	3
St3A_P1_1	3	a	22	50	1	100	10:15	367.9	0.2	0.25	protein	M9	51	3
St3A_P1_2	3	a	22	50	1	100	10:15	367.9	0.2	0.25	hosphoprotei	M9	51	3
St3A_P1_3	3	a	22	50	1	100	10:15	367.9	0.2	0.25	protein	M9	51	3
St3A_P1_4	3	a	22	50	1	100	10:15	367.9	0.0625	0.0625	DNA_liz	M4	3	0.2
St3A_P1_5	3	a	22	50	1	100	10:15	367.9	3	0.125	metallome	M10	51	3
St3A_P1_6	3	a	22	50	1	100	10:15	367.9	0.2	0.25	metals	M10	51	3
St3A_P1_7	3	a	22	50	1	100	10:15	367.9	0.2	0.0625	DNA_liz	M3	51	3
St3A_P1_8	3	a	22	50	1	100	10:15	367.9	0.2	0.25	protein	M10	51	3
St3A_P1_9	3	a	22	50	1	100	10:15	367.9	3	0.25	metals	M10	51	3
St3A_P1_10	3	a	22	50	1	100	10:15	367.9	3	0.125	metallome	M10	51	3
St3A_P1_11	3	a	22	50	1	100	10:15	367.9	0.0625	0.0625	DNA_julie	M3	51	3
St3A_P1_12	3	a	22	50	1	100	10:15	367.9	3	0.0625	DNA_liz	M4	3	3
St3A_P1_13	3	a	22	50	1	100	10:15	367.9	52	0.5	protein	M10	51	51
St3A_P1_14	3	a	22	50	1	100	10:15	367.9	0.5	0.5	hosphoprotei	M10	51	51
St3A_P1_15	3	a	22	50	1	100	10:15	341	0.5	0.5	sandbox	M10	3	3
St3A_P1_16	3	a	22	50	1	100	10:15	341	0.2second	0.25	sandbox	M10	3	3
St3A_P1_17	3	a	22	50	1	100	10:15	341	0.2second	0.25	sandbox	M10	3	3
St3A_P1_18	3	a	22	50	1	100	10:15	341	0.2second	0.25	sandbox	M10	3	0.2
St3A_P1_19	3	a	22	50	1	100	10:15	341	0.5	0.5	sandbox	M10	3	3
St3A_P1_20	3	a	22	50	1	100	10:15	341	3second	0.5	sandbox	M10	3	3
St3B_P1_1	3	b	22	50	2	125	11:00	437.6	0.2	0.25	protein	M11	51	0.2
St3B_P1_2	3	b	22	50	2	125	11:00	437.6	0.2	0.25	hosphoprotei	M11	3	0.2
St3B_P1_3	3	b	22	50	2	125	11:00	437.6	0.2	0.125	metallome	M11	3	0.2
St3B_P1_4	3	b	22	50	2	125	11:00	437.6	0.2	0.125	metals	M10	3	0.2
St3B_P1_5	3	b	22	50	2	125	11:00	437.6	0.0625	0.0625	DNA_julie	M3	3	0.2
St3B_P1_6	3	b	22	50	2	125	11:00	437.6	0.2	0.0625	protein	M4	3	0.2
St3B_P1_7	3	b	22	50	2	125	11:00	437.6	0.2	0.25	hosphoprotei	M11	3	0.2
St3B_P1_8	3	b	22	50	2	125	11:00	437.6	3	0.25	metallome	M11	3	0.2
St3B_P1_9	3	b	22	50	2	125	11:00	437.6	0.2	0.25	metals	M10	51	3
St3B_P1_10	3	b	22	50	2	125	11:00	437.6	0.2	0.125	metallome	M10	51	3
St3B_P1_11	3	b	22	50	2	125	11:00	437.6	3	0.0625	DNA_julie	M3	51	3
St3B_P1_12	3	b	22	50	2	125	11:00	437.6	3	0.0625	DNA_liz	M4	51	3

Barcode / on_pump_sample	Station	Deploy #	Approx Lat	Approx Long	Pump #	Depth	Start pump (GMT)	Volume filtered	Filter size	Filter fraction	Sample type	Freezer bag #	max filter size (uM)	min filter size (uM)
St3B_P1_13	3	b	22	50	2	125	11:00	437.6	52	0.5	protein	M11	51	51
St3B_P1_14	3	b	22	50	2	125	11:00	437.6	52	0.5	hosphoprotei	M11	51	51
St3B_P1_15	3	b	22	50	2	125	11:00	435.9	0.2	0.25	sandbox	M11	3	0.2
St3B_P1_16	3	b	22	50	2	125	11:00	435.9	0.2	0.25	sandbox	M11	3	0.2
St3B_P1_17	3	b	22	50	2	125	11:00	435.9	0.2	0.25	sandbox	M11	3	0.2
St3B_P1_18	3	b	22	50	2	125	11:00	435.9	0.2	0.25	sandbox	M11	3	0.2
St3B_P1_19	3	b	22	50	2	125	11:00	435.9	0.2	0.25	sandbox	M11	3	0.2
St3B_P1_20	3	b	22	50	2	125	11:00	435.9	3	0.5	sandbox	M11		51
St3B_P1_21	3	b	22	50	2	125	11:00	435.9	3	0.5	sandbox	M11	51	3
St3B_P1_22	3	b	22	50	2	125	11:00	435.9	51second	0.5	sandbox	M11	51	51
St3B_P3_1	3	b	22	50	2	150	11:00	379.3	52	0.5	protein	M11	51	51
St3B_P3_2	3	b	22	50	2	150	11:00	379.3	3	0.25	sandbox	M11	3	0.2
St3B_P3_3	3	b	22	50	2	150	11:00	379.3	3	0.25	sandbox	M11	3	0.2
St3B_P3_4	3	b	22	50	2	150	11:00	379.3	0.2	0.25	sandbox	M11	3	0.2
St3B_P3_5	3	b	22	50	2	150	11:00	379.3	0.2	0.25	sandbox	M11	3	0.2
St3B_P3_6	3	b	22	50	2	150	11:00	379.3	0.2	0.0625	DNA_liz	M4	51	3
St3B_P3_7	3	b	22	50	2	150	11:00	379.3	3	0.25	DNA_julie	M3	3	3
St3B_P3_8	3	b	22	50	2	150	11:00	379.3	3	0.25	protein	M11	3	0.2
St3B_P3_9	3	b	22	50	2	150	11:00	379.3	3	0.25	hosphoprotei	M11	3	0.2
St3B_P3_10	3	b	22	50	2	150	11:00	379.3	3	0.125	metals	M10	51	3
St3B_P3_11	3	b	22	50	2	150	11:00	379.3	3	0.0625	DNA_julie	M3	51	3
St3B_P3_12	3	b	22	50	2	150	11:00	379.3	0.0625	0.0625	DNA_liz	M4	3	3
St3B_P3_13	3	b	22	50	2	150	11:00	382.4	52	0.5	protein	M11		51
St3B_P3_14	3	b	22	50	2	150	11:00	382.4	51second	0.5	hosphoprotei	M11	3	51
St3B_P3_15	3	b	22	50	2	150	11:00	382.4	51second	0.5	sandbox	M11	51	51
St3B_P3_16	3	b	22	50	2	150	11:00	382.4	3second	0.25	sandbox	M11	3	0.2
St3B_P3_17	3	b	22	50	2	150	11:00	382.4	0.2second	0.25	sandbox	M11	3	0.2
St3B_P3_18	3	b	22	50	2	150	11:00	382.4	0.2second	0.25	sandbox	M11	3	0.2
St3B_P3_19	3	b	22	50	2	150	11:00	382.4	3	0.25	sandbox	M11	3	0.2
St3B_P3_20	3	b	22	50	2	150	11:00	382.4	3	0.5	sandbox	M11	51	51
St3B_P3_21	3	b	22	50	2	150	11:00	382.4	3second	0.5	sandbox	M11	51	51
St3B_P3_22	3	b	22	50	2	150	11:00	382.4	51second	0.5	sandbox	M11		51
St3B_P4_1	3	b	22	50	2	200	11:00	431.9	0.2	0.25	protein	M11	3	0.2
St3B_P4_2	3	b	22	50	2	200	11:00	431.9	0.2	0.25	sandbox	M11	3	0.2
St3B_P4_3	3	b	22	50	2	200	11:00	431.9	0.2	0.25	metals	M10	3	0.2
St3B_P4_4	3	b	22	50	2	200	11:00	431.9	0.2	0.125	metals	M10	3	0.2
St3B_P4_5	3	b	22	50	2	200	11:00	431.9	0.2	0.0625	DNA_julie	M3	51	0.2
St3B_P4_6	3	b	22	50	2	200	11:00	431.9	0.2	0.0625	DNA_liz	M4	3	0.2
St3B_P4_7	3	b	22	50	2	200	11:00	431.9	3	0.25	protein	M11	3	3
St3B_P4_8	3	b	22	50	2	200	11:00	431.9	3	0.25	hosphoprotei	M11	3	3
St3B_P4_9	3	b	22	50	2	200	11:00	431.9	3	0.25	metallome	M10	51	3
St3B_P4_10	3	b	22	50	2	200	11:00	431.9	3	0.125	metals	M10	51	3
St3B_P4_11	3	b	22	50	2	200	11:00	431.9	3	0.0625	DNA_julie	M3	51	3
St3B_P4_12	3	b	22	50	2	200	11:00	431.9	3	0.0625	DNA_liz	M4	51	3
St3B_P4_13	3	b	22	50	2	200	11:00	431.9	52	0.5	protein	M11		51
St3B_P4_14	3	b	22	50	2	200	11:00	433.5	52	0.5	hosphoprotei	M11	3	51
St3B_P4_15	3	b	22	50	2	200	11:00	433.5	0.2second	0.25	sandbox	M11	3	0.2
St3B_P4_16	3	b	22	50	2	200	11:00	433.5	0.2second	0.25	sandbox	M11	3	0.2

Barcode on_pump_sample	Station	Deploy #	Approx Lat	Approx Long	Pump #	Depth	Start pump (GMT)	Volume filtered	Filter size	Filter fraction	Sample type	Freezer bag #	max filter size (uM)	min filter size (uM)
St3B_P4_17	3	b	22	50	2	200	11:00	433.5	0.2second	0.25	sandbox	M11		0.2
St3B_P4_18	3	b	22	50	2	200	11:00	433.5	0.2second	0.25	sandbox	M11	3	0.2
St3B_P4_19	3	b	22	50	2	200	11:00	433.5	3second	0.5	sandbox	M11	51	3
St3B_P4_20	3	b	22	50	2	200	11:00	433.5	3second	0.5	sandbox	M11	51	3
St3B_P4_21	3	b	22	50	2	200	11:00	433.5	51second	0.5	sandbox	M11	51	51
St3B_P4_22	3	b	22	50	2	200	11:00	433.5	51second	0.5	sandbox	M11	51	51
St3C_P1_1	3	c	22	50	3	40	13:45	159.7	52	0.5	protein	M12	3	51
St3C_P1_2	3	c	22	50	3	40	13:45	159.7	0.2	0.5	sandbox	M12	51	3
St3C_P1_3	3	c	22	50	3	40	13:45	159.7	0.2	0.25	sandbox	M12	3	0.2
St3C_P1_4	3	c	22	50	3	40	13:45	159.7	0.2	0.125	metals	M10	3	0.2
St3C_P1_5	3	c	22	50	3	40	13:45	159.7	0.2	0.0625	DNA_julie	M13	3	0.2
St3C_P1_6	3	c	22	50	3	40	13:45	159.7	0.2	0.0625	DNA_liz	M14	3	0.2
St3C_P1_7	3	c	22	50	3	40	13:45	159.7	3	0.25	protein	M12	51	3
St3C_P1_8	3	c	22	50	3	40	13:45	159.7	3	0.25	sandbox	M12	51	3
St3C_P1_9	3	c	22	50	3	40	13:45	159.7	3	0.25	hosphoprotei	M12	51	3
St3C_P1_10	3	c	22	50	3	40	13:45	159.7	3	0.25	metallome	M10	51	3
St3C_P1_11	3	c	22	50	3	40	13:45	159.7	3	0.0625	DNA_liz	M13	51	3
St3C_P1_12	3	c	22	50	3	40	13:45	159.7	0.2	0.0625	DNA_liz	M14	3	0.2
St3C_P1_13	3	c	22	50	3	40	13:45	159.7	52	0.5	protein	M12	51	51
St3C_P1_14	3	c	22	50	3	40	13:45	159.7	52	0.5	hosphoprotei	M12	51	51
St3C_P1_15	3	c	22	50	3	40	13:45	148.1	3	0.25	sandbox	M12	3	51
St3C_P1_16	3	c	22	50	3	40	13:45	148.1	3	0.25	sandbox	M12	3	3
St3C_P1_17	3	c	22	50	3	40	13:45	148.1	3	0.25	metals	M12	3	3
St3C_P1_18	3	c	22	50	3	40	13:45	148.1	3	0.25	metals	M12	3	3
St3C_P1_19	3	c	22	50	3	40	13:45	148.1	3	0.5	sandbox	M12	3	3
St3C_P1_20	3	c	22	50	3	40	13:45	148.1	3	0.5	sandbox	M12	3	3
St3C_P1_21	3	c	22	50	3	40	13:45	148.1	3	0.5	sandbox	M12	3	3
St3C_P1_22	3	c	22	50	3	40	13:45	148.1	51second	0.5	sandbox	M12	51	51
St3C_P3_1	3	c	22	50	3	300	13:45	324.7	0.2	0.25	protein	M12	3	0.2
St3C_P3_2	3	c	22	50	3	300	13:45	324.7	0.2	0.25	hosphoprotei	M12	3	0.2
St3C_P3_3	3	c	22	50	3	300	13:45	324.7	0.2	0.25	sandbox	M12	3	0.2
St3C_P3_4	3	c	22	50	3	300	13:45	324.7	0.2	0.125	metals	M10	3	0.2
St3C_P3_5	3	c	22	50	3	300	13:45	324.7	0.2	0.0625	DNA_julie	M13	3	0.2
St3C_P3_6	3	c	22	50	3	300	13:45	324.7	0.2	0.0625	DNA_liz	M14	3	0.2
St3C_P3_7	3	c	22	50	3	300	13:45	324.7	3	0.25	protein	M12	3	3
St3C_P3_8	3	c	22	50	3	300	13:45	324.7	0.2	0.25	DNA_liz	M14	3	0.2
St3C_P3_9	3	c	22	50	3	300	13:45	324.7	3	0.25	hosphoprotei	M12	51	3
St3C_P3_10	3	c	22	50	3	300	13:45	324.7	3	0.125	metallome	M10	51	3
St3C_P3_11	3	c	22	50	3	300	13:45	324.7	3	0.25	metals	M10	51	3
St3C_P3_12	3	c	22	50	3	300	13:45	324.7	0.2	0.0625	DNA_julie	M13	3	0.2
St3C_P3_13	3	c	22	50	3	300	13:45	324.7	3	0.0625	metals	M10	51	3
St3C_P3_14	3	c	22	50	3	300	13:45	324.7	52	0.5	protein	M12	51	51
St3C_P3_15	3	c	22	50	3	300	13:45	320.3	0.25	0.25	sandbox	M12	3	0.2
St3C_P3_16	3	c	22	50	3	300	13:45	320.3	0.25	0.25	sandbox	M12	3	0.2
St3C_P3_17	3	c	22	50	3	300	13:45	320.3	0.25	0.25	sandbox	M12	3	0.2
St3C_P3_18	3	c	22	50	3	300	13:45	320.3	0.25	0.25	sandbox	M12	3	0.2
St3C_P3_19	3	c	22	50	3	300	13:45	320.3	0.5	0.5	sandbox	M12	51	3
St3C_P3_20	3	c	22	50	3	300	13:45	320.3	3second	0.5	sandbox	M12	51	3

Barcode	on_pump_sample Station	Deploy #	Approx Lat	Approx Long	Pump #	Depth	Start pump (GMT)	Volume filtered	Filter size	Filter fraction	Sample type	Freezer bag #	max filter size (uM)	min filter size (uM)
St3C_P3_21	3	c	22	50	3	300	13:45	320.3	51second	0.5	sandbox	M12	51	51
St3C_P3_22	3	c	22	50	3	300	13:45	320.3	51second	0.5	sandbox	M12	51	51
St4A_P4_1	3	c	22	50	3	400	13:45	360.6	0.2	0.25	protein	M12	3	0.2
St4A_P4_2	3	c	22	50	3	400	13:45	360.6	3	0.25	metals	M10	3	3
St4A_P4_3	3	c	22	50	3	400	13:45	360.6	0.0625	0.0625	DNA_julie	M13	3	0.2
St4A_P4_4	3	c	22	50	3	400	13:45	360.6	3	0.25	metallome	M10	3	3
St3C_P4_5	3	c	22	50	3	400	13:45	360.6	0.2	0.25	metallome	M10	3	0.2
St3C_P4_6	3	c	22	50	3	400	13:45	360.6	0.2	0.25	protein	M12	3	0.2
St3C_P4_7	3	c	22	50	3	400	13:45	360.6	0.0625	0.0625	DNA_liz	M14	3	0.2
St3C_P4_8	3	c	22	50	3	400	13:45	360.6	3	0.25	metals	M10	3	3
St3C_P4_9	3	c	22	50	3	400	13:45	360.6	3	0.25	metallome	M10	3	3
St3C_P4_10	3	c	22	50	3	400	13:45	360.6	0.125	0.125	phosphoproteome	M15	51	0.2
St3C_P4_11	3	c	22	50	3	400	13:45	360.6	3	0.0625	DNA_liz	M14	3	3
St3C_P4_12	3	c	22	50	3	400	13:45	360.6	3	0.0625	DNA_liz	M14	3	3
St3C_P4_13	3	c	22	50	3	400	13:45	360.6	0.25	0.0625	DNA_julie	M13	3	0.2
St3C_P4_14	3	c	22	50	3	400	13:45	360.6	3	0.25	metallome	M10	3	3
St3C_P4_15	3	c	22	50	3	400	13:45	360.6	3	0.25	metals	M10	3	3
St3C_P4_16	3	c	22	50	3	400	13:45	360.6	0.2	0.25	protein	M12	3	0.2
St3C_P4_17	3	c	22	50	3	400	13:45	360.6	0.0625	0.0625	DNA_julie	M13	3	0.2
St3C_P4_18	3	c	22	50	3	400	13:45	360.6	0.125	0.125	metals	M10	3	3
St3C_P4_19	3	c	22	50	3	400	13:45	360.6	0.2	0.25	hosphoproteome	M12	51	51
St3C_P4_20	3	c	22	50	3	400	13:45	360.6	52	0.5	protein	M12	51	51
St3C_P4_21	3	c	50	50	3	400	13:45	335.4	0.5	0.5	sandbox	M12	3	3
St3C_P4_22	3	c	50	50	3	400	13:45	335.4	0.5	0.5	sandbox	M12	51	51
St4A_P4_22	3	c	50	50	3	400	13:45	335.4	51second	0.5	sandbox	M12	51	51
St4A_P1_13	4	a	23.22	44.47	1	15	08:35	17	0.0625	0.0625	DNA_liz	M14	3	3
St4A_P1_12	4	a	23.22	44.47	1	15	08:35	17	3	0.0625	DNA_julie	M13	3	0.2
St4A_P1_11	4	a	23.22	44.47	1	15	08:35	17	0.125	0.125	metals	M10	51	3
St4A_P1_10	4	a	23.22	44.47	1	15	08:35	17	3	0.25	metallome	M10	51	3
St4A_P1_9	4	a	23.22	44.47	1	15	08:35	17	3	0.25	hosphoproteome	M15	51	3
St4A_P1_8	4	a	23.22	44.47	1	15	08:35	17	3	0.25	protein	M15	51	3
St4A_P1_7	4	a	23.22	44.47	1	15	08:35	17	3	0.25	protein	M15	3	3
St4A_P1_6	4	a	23.22	44.47	1	15	08:35	17	0.0625	0.0625	DNA_liz	M14	3	0.2
St4A_P1_5	4	a	23.22	44.47	1	15	08:35	17	0.2	0.25	sandbox	M12	51	0.2
St4A_P1_4	4	a	23.22	44.47	1	15	08:35	17	0.2	0.25	sandbox	M12	51	0.2
St4A_P1_3	4	a	23.22	44.47	1	15	08:35	17	0.2	0.125	metals	M10	51	0.2
St4A_P1_2	4	a	23.22	44.47	1	15	08:35	17	0.2	0.25	hosphoproteome	M15	51	0.2
St4A_P1_1	4	a	23.22	44.47	1	15	08:35	17	0.2	0.25	protein	M15	51	0.2
St4A_P1_14	4	a	23.22	44.47	1	15	08:35	17	52	0.5	hosphoproteome	M15	51	51
St4A_P3_1	4	a	23.22	44.47	1	40	08:35	285.9	0.2	0.25	hosphoproteome	M15	3	0.2
St4A_P3_2	4	a	23.22	44.47	1	40	08:35	285.9	0.2	0.25	protein	M15	3	0.2
St4A_P3_3	4	a	23.22	44.47	1	40	08:35	285.9	0.2	0.25	metallome	M10	3	0.2
St4A_P3_4	4	a	23.22	44.47	1	40	08:35	285.9	0.2	0.125	metals	M10	3	0.2
St4A_P3_5	4	a	23.22	44.47	1	40	08:35	285.9	0.2	0.0625	DNA_julie	M13	3	0.2
St4A_P3_6	4	a	23.22	44.47	1	40	08:35	285.9	0.2	0.0625	DNA_liz	M14	3	0.2
St4A_P3_7	4	a	23.22	44.47	1	40	08:35	285.9	0.2	0.25	protein	M15	3	0.2
St4A_P3_8	4	a	23.22	44.47	1	40	08:35	285.9	0.2	0.25	protein	M15	3	0.2
St4A_P3_9	4	a	23.22	44.47	1	40	08:35	285.9	3	0.25	metallome	M10	51	3
St4A_P3_10	4	a	23.22	44.47	1	40	08:35	285.9	3	0.125	metals	M10	51	3

Barcode on_pump_sample	Station	Deploy #	Approx Lat	Approx Long	Pump #	Depth	Start pump (GMT)	Volume filtered	Filter size	Filter fraction	Sample type	Freezer bag #	max filter size (uM)	min filter size (uM)
St4A_P3_11	4	a	23.22	44.47	1	40	08:35	285.9	52	0.5	hosphoprotei	M15	51	3
St4A_P3_12	4	a	23.22	44.47	1	40	08:35	285.9	3	0.0625	DNA_liz	M14	3	3
St4A_P3_13	4	a	23.22	44.47	1	40	08:35	285.9	52	0.5	protein	M15	51	3
St4A_P3_14	4	a	23.22	44.47	1	40	08:35	285.9	52	0.5	hosphoprotei	M15	51	51
St4A_P3_15	4	a	23.22	44.47	1	40	08:35	300	51second	0.5	sandbox	M15	51	51
St4A_P3_16	4	a	23.22	44.47	1	40	08:35	300	51second	0.5	sandbox	M15	51	51
St4A_P3_17	4	a	23.22	44.47	1	40	08:35	300	3second	0.5	sandbox	M15	3	51
St4A_P3_18	4	a	23.22	44.47	1	40	08:35	300	3second	0.5	sandbox	M15	3	51
St4A_P3_19	4	a	23.22	44.47	1	40	08:35	300	0.2second	0.25	sandbox	M15	3	0.2
St4A_P3_20	4	a	23.22	44.47	1	40	08:35	300	0.2second	0.25	sandbox	M15	3	0.2
St4A_P3_21	4	a	23.22	44.47	1	40	08:35	300	0.2second	0.25	metallome	M10	3	0.2
St4A_P3_22	4	a	23.22	44.47	1	40	08:35	300	51second	0.5	sandbox	M15	51	51
St4A_P4_1	4	a	23.22	44.47	1	100	08:35	375.1	52	0.5	protein	M15	51	51
St4A_P4_2	4	a	23.22	44.47	1	100	08:35	375.1	3	0.0625	DNA_liz	M14	3	3
St4A_P4_3	4	a	23.22	44.47	1	100	08:35	375.1	3	0.0625	DNA_julie	M13	3	3
St4A_P4_4	4	a	23.22	44.47	1	100	08:35	375.1	0.125	0.125	metals	M10	3	0.2
St4A_P4_5	4	a	23.22	44.47	1	100	08:35	375.1	0.2	0.0625	DNA_julie	M13	3	0.2
St4A_P4_6	4	a	23.22	44.47	1	100	08:35	375.1	0.2	0.0625	DNA_liz	M14	3	0.2
St4A_P4_7	4	a	23.22	44.47	1	100	08:35	375.1	0.25	0.25	protein	M15	3	0.2
St4A_P4_8	4	a	23.22	44.47	1	100	08:35	375.1	0.25	0.0625	hosphoprotei	M15	3	0.2
St4A_P4_9	4	a	23.22	44.47	1	100	08:35	375.1	0.25	0.25	metallome	M10	3	0.2
St4A_P4_10	4	a	23.22	44.47	1	100	08:35	375.1	3	0.125	metals	M10	3	3
St4A_P4_11	4	a	23.22	44.47	1	100	08:35	375.1	0.0625	0.0625	DNA_liz	M13	51	3
St4A_P4_12	4	a	23.22	44.47	1	100	08:35	375.1	3	0.0625	DNA_liz	M14	51	3
St4A_P4_13	4	a	23.22	44.47	1	100	08:35	375.1	52	0.5	protein	M15	51	51
St4A_P4_14	4	a	23.22	44.47	1	100	08:35	375.1	52	0.5	hosphoprotei	M15	51	51
St4A_P4_15	4	a	23.22	44.47	1	100	08:35	372.8	0.2	0.25	sandbox	M15	3	0.2
St4A_P4_16	4	a	23.22	44.47	1	100	08:35	372.8	0.2	0.25	sandbox	M15	3	0.2
St4A_P4_17	4	a	23.22	44.47	1	100	08:35	372.8	0.25	0.25	sandbox	M15	3	0.2
St4A_P4_18	4	a	23.22	44.47	1	100	08:35	372.8	0.25	0.25	sandbox	M15	3	0.2
St4A_P4_19	4	a	23.22	44.47	1	100	08:35	372.8	0.25	0.5	sandbox	M15	3	0.2
St4A_P4_20	4	a	23.22	44.47	1	100	08:35	372.8	3second	0.5	sandbox	M15	3	0.2
St4A_P4_21	4	a	23.22	44.47	1	100	08:35	372.8	3second	0.5	sandbox	M15	51	0.2
St4A_P4_22	4	a	23.22	44.47	1	100	08:35	372.8	51second	0.5	sandbox	M15	51	51
St4B_P1_1	4	b	23.22	44.47	1	100	08:35	372.8	51second	0.5	sandbox	M15	51	51
St4B_P1_2	4	b	23.22	44.47	2	15	08:35	20.2	0.2	0.25	protein	M15	3	0.2
St4B_P1_3	4	b	23.22	44.47	2	15	08:35	20.2	0.2	0.25	hosphoprotein	M15	3	0.2
St4B_P1_4	4	b	23.22	44.47	2	15	08:35	20.2	0.2	0.125	metals		3	0.2
St4B_P1_5	4	b	23.22	44.47	2	15	08:35	20.2	0.2	0.0625	DNA_julie	M15	3	0.2
St4B_P1_6	4	b	23.22	44.47	2	15	08:35	20.2	0.2	0.0625	DNA_liz	M15	3	0.2
St4B_P1_7	4	b	23.22	44.47	2	15	08:35	20.2	3	0.25	protein	M15	3	3
St4B_P1_8	4	b	23.22	44.47	2	15	08:35	20.2	3	0.25	hosphoprotein	M15	3	3
St4B_P1_9	4	b	23.22	44.47	2	15	08:35	20.2	3	0.25	metallome	M15	3	3
St4B_P1_10	4	b	23.22	44.47	2	15	08:35	20.2	3	0.125	metals	M15	3	3
St4B_P1_11	4	b	23.22	44.47	2	15	08:35	20.2	3	0.0625	DNA_julie	M15	3	3
St4B_P1_12	4	b	23.22	44.47	2	15	08:35	20.2	3	0.0625	DNA_liz	M15	51	3
St4B_P1_13	4	b	23.22	44.47	2	15	08:35	20.2	52	0.5	protein	M15	51	51
St4B_P1_14	4	b	23.22	44.47	2	15	08:35	20.2	52	0.5	hosphoprotein	M15	51	51

Barcode (on_pump_sample)	Station	Deploy #	Approx Lat	Approx Long	Pump #	Depth	Start pump (GMT)	Volume filtered	Filter size	Filter fraction	Sample type	Freezer bag #	max filter size (uM)	min filter size (uM)
St4B_P3_1	4	b	23.22	44.47	2	140	08:35	365.9	0.2	0.25	protein		3	0.2
St4B_P3_2	4	b	23.22	44.47	2	140	08:35	365.9	0.2	0.25	hosphoprotein		3	0.2
St4B_P3_3	4	b	23.22	44.47	2	140	08:35	365.9	0.2	0.25	metallome		3	0.2
St4B_P3_4	4	b	23.22	44.47	2	140	08:35	365.9	0.2	0.125	metals		3	0.2
St4B_P3_5	4	b	23.22	44.47	2	140	08:35	365.9	0.2	0.0625	DNA_julie		3	0.2
St4B_P3_6	4	b	23.22	44.47	2	140	08:35	365.9	0.2	0.0625	DNA_liz		3	0.2
St4B_P3_7	4	b	23.22	44.47	2	140	08:35	365.9	3	0.25	protein		51	3
St4B_P3_8	4	b	23.22	44.47	2	140	08:35	365.9	3	0.25	hosphoprotein		51	3
St4B_P3_9	4	b	23.22	44.47	2	140	08:35	365.9	3	0.25	metallome		51	3
St4B_P3_10	4	b	23.22	44.47	2	140	08:35	365.9	3	0.125	metals		51	3
St4B_P3_11	4	b	23.22	44.47	2	140	08:35	365.9	3	0.0625	DNA_julie		51	3
St4B_P3_12	4	b	23.22	44.47	2	140	08:35	365.9	3	0.0625	DNA_liz		51	3
St4B_P3_13	4	b	23.22	44.47	2	140	08:35	365.9	52	0.5	protein		51	51
St4B_P3_14	4	b	23.22	44.47	2	140	08:35	365.9	52	0.5	hosphoprotein		51	51
St4B_P3_15	4	b	23.22	44.47	2	140	08:35	370.8	0.2	0.25	sandbox		3	0.2
St4B_P3_16	4	b	23.22	44.47	2	140	08:35	370.8	0.2	0.25	sandbox		3	0.2
St4B_P3_17	4	b	23.22	44.47	2	140	08:35	370.8	0.2second	0.25	sandbox		3	0.2
St4B_P3_18	4	b	23.22	44.47	2	140	08:35	370.8	0.2second	0.25	sandbox		3	0.2
St4B_P3_19	4	b	23.22	44.47	2	140	08:35	370.8	3	0.5	sandbox		3	3
St4B_P3_20	4	b	23.22	44.47	2	140	08:35	370.8	3second	0.5	sandbox		3	3
St4B_P4_1	4	b	23.22	44.47	2	160	08:35	41.2	0.2	0.25	protein		3	0.2
St4B_P4_2	4	b	23.22	44.47	2	160	08:35	41.2	0.2	0.25	hosphoprotein		3	0.2
St4B_P4_3	4	b	23.22	44.47	2	160	08:35	41.2	0.2	0.25	metallome		3	0.2
St4B_P4_4	4	b	23.22	44.47	2	160	08:35	41.2	0.2	0.125	metals		3	0.2
St4B_P4_5	4	b	23.22	44.47	2	160	08:35	41.2	0.2	0.0625	DNA_julie		3	0.2
St4B_P4_6	4	b	23.22	44.47	2	160	08:35	41.2	0.2	0.0625	DNA_liz		3	0.2
St4B_P4_7	4	b	23.22	44.47	2	160	08:35	41.2	3	0.25	protein		51	3
St4B_P4_8	4	b	23.22	44.47	2	160	08:35	41.2	3	0.25	hosphoprotein		51	3
St4B_P4_9	4	b	23.22	44.47	2	160	08:35	41.2	3	0.25	metallome		51	3
St4B_P4_10	4	b	23.22	44.47	2	160	08:35	41.2	3	0.125	metals		51	3
St4B_P4_11	4	b	23.22	44.47	2	160	08:35	41.2	3	0.0625	DNA_julie		51	3
St4B_P4_12	4	b	23.22	44.47	2	160	08:35	41.2	3	0.0625	DNA_liz		51	3
St4B_P4_13	4	b	23.22	44.47	2	160	08:35	41.2	52	0.5	protein		51	51
St4B_P4_14	4	b	23.22	44.47	2	160	08:35	41.2	52	0.5	hosphoprotein		51	51
St4B_P4_15	4	b	23.22	44.47	2	160	08:35	40.8	0.2	0.25	sandbox		3	0.2
St4B_P4_16	4	b	23.22	44.47	2	160	08:35	40.8	0.2	0.25	sandbox		3	0.2
St4B_P4_17	4	b	23.22	44.47	2	160	08:35	40.8	0.2second	0.25	sandbox		3	0.2
St4B_P4_18	4	b	23.22	44.47	2	160	08:35	40.8	0.2second	0.25	sandbox		3	0.2
St4B_P4_19	4	b	23.22	44.47	2	160	08:35	40.8	3	0.5	sandbox		3	3
St4B_P4_20	4	b	23.22	44.47	2	160	08:35	40.8	3second	0.5	sandbox		3	3
St4C_P4_1	4	c	23.22	44.47	3	15	10:30	95.4	0.2	0.25	protein		3	0.2
St4C_P4_2	4	c	23.22	44.47	3	15	10:30	95.4	0.2	0.25	hosphoprotein		3	0.2
St4C_P4_3	4	c	23.22	44.47	3	15	10:30	95.4	0.2	0.25	metallome		3	0.2
St4C_P4_4	4	c	23.22	44.47	3	15	10:30	95.4	0.2	0.125	metals		3	0.2
St4C_P4_5	4	c	23.22	44.47	3	15	10:30	95.4	0.2	0.0625	DNA_julie		3	0.2
St4C_P4_6	4	c	23.22	44.47	3	15	10:30	95.4	0.2	0.0625	DNA_liz		3	0.2
St4C_P4_7	4	c	23.22	44.47	3	15	10:30	95.4	3	0.25	protein		51	3
St4C_P4_8	4	c	23.22	44.47	3	15	10:30	95.4	3	0.25	hosphoprotein		51	3

Barcode on_pump_sample	Station	Deploy #	Approx Lat	Approx Long	Pump #	Depth	Start pump (GMT)	Volume filtered	Filter size	Filter fraction	Sample type	Freezer bag #	max filter size (uM)	min filter size (uM)
St4C_P4_9	4	c	23.22	44.47	3	15	10:30	95.4	3	0.25	metallome		3	3
St4C_P4_10	4	c	23.22	44.47	3	15	10:30	95.4	3	0.125	metals	51	3	0.2
St4C_P4_11	4	c	23.22	44.47	3	15	10:30	95.4	0.0625	0.0625	DNA_julie	51	3	0.2
St4C_P4_12	4	c	23.22	44.47	3	15	10:30	95.4	3	0.0625	DNA_liz	51	51	3
St4C_P4_13	4	c	23.22	44.47	3	15	10:30	95.4	52	0.5	protein		51	51
St4C_P4_14	4	c	23.22	44.47	3	15	10:30	95.4	52	0.5	hosphoprotein		51	51
St4C_P4_15	4	c	23.22	44.47	3	15	10:30	104	0.2	0.25	sandbox	3	3	0.2
St4C_P4_16	4	c	23.22	44.47	3	15	10:30	104	0.2	0.25	sandbox	3	3	0.2
St4C_P4_17	4	c	23.22	44.47	3	15	10:30	104	0.2	0.25	sandbox	3	3	0.2
St4C_P4_18	4	c	23.22	44.47	3	15	10:30	104	0.25second	0.25	sandbox	3	3	3
St4C_P4_19	4	c	23.22	44.47	3	15	10:30	104	3second	0.5	sandbox			3
St4C_P4_20	4	c	23.22	44.47	3	15	10:30	104	3second	0.5	sandbox		3	3
St4D_P1_1	4	d	23.22	44.47	4	40	12:15	56.9	3second	0.5	sandbox		3	3
St4D_P1_2	4	d	23.22	44.47	4	40	12:15	56.9	3second	0.5	sandbox		3	3
St4D_P1_3	4	d	23.22	44.47	4	40	12:15	56.9	0.2	0.5	sandbox		3	0.2
St4D_P1_4	4	d	23.22	44.47	4	40	12:15	56.9	0.2	0.0625	DNA_liz	3	3	0.2
St4D_P1_5	4	d	23.22	44.47	4	40	12:15	56.9	0.2	0.0625	DNA_julie	51	3	0.2
St4D_P1_6	4	d	23.22	44.47	4	40	12:15	56.9	0.2	0.25	protein	3	3	0.2
St4D_P1_7	4	d	23.22	44.47	4	40	12:15	56.9	0.2	0.25	hosphoprotein	51	3	0.2
St4D_P1_8	4	d	23.22	44.47	4	40	12:15	56.9	0.2	0.25	metallome	51	3	0.2
St4D_P1_9	4	d	23.22	44.47	4	40	12:15	56.9	0.2	0.25	protein	51	3	0.2
St4D_P1_10	4	d	23.22	44.47	4	40	12:15	56.9	0.2	0.25	sandbox	3	3	0.2
St4D_P1_11	4	d	23.22	44.47	4	40	12:15	56.9	0.0625	0.0625	DNA_julie	51	3	0.2
St4D_P1_12	4	d	23.22	44.47	4	40	12:15	56.9	3	0.125	metallome	51	3	0.2
St4D_P1_13	4	d	23.22	44.47	4	40	12:15	56.9	3	0.25	protein	51	51	51
St4D_P1_14	4	d	23.22	44.47	4	40	12:15	48.1	52	0.5	protein	51	51	3
St4D_P1_15	4	d	23.22	44.47	4	40	12:15	48.1	0.2	0.25	sandbox	3	3	0.2
St4D_P1_16	4	d	23.22	44.47	4	40	12:15	48.1	0.2	0.25	sandbox	3	3	0.2
St4D_P1_17	4	d	23.22	44.47	4	40	12:15	48.1	0.2	0.25	sandbox	3	3	0.2
St4D_P1_18	4	d	23.22	44.47	4	40	12:15	48.1	0.2	0.25	sandbox	3	3	0.2
St4D_P1_19	4	d	23.22	44.47	4	40	12:15	48.1	3second	0.5	sandbox	3	3	0.2
St4D_P1_20	4	d	23.22	44.47	4	40	12:15	48.1	3second	0.5	sandbox	3	3	3
St4D_P2_1	4	d	23.22	44.47	4	160	12:15	222.7	0.2	0.25	protein	3	3	0.2
St4D_P2_2	4	d	23.22	44.47	4	160	12:15	222.7	0.2	0.25	sandbox	3	3	0.2
St4D_P2_3	4	d	23.22	44.47	4	160	12:15	222.7	0.2	0.25	sandbox	3	3	0.2
St4D_P2_4	4	d	23.22	44.47	4	160	12:15	222.7	0.2	0.25	sandbox	3	3	0.2
St4D_P2_5	4	d	23.22	44.47	4	160	12:15	222.7	0.2	0.25	metals	3	3	0.2
St4D_P2_6	4	d	23.22	44.47	4	160	12:15	222.7	0.2	0.125	metallome	51	3	0.2
St4D_P2_7	4	d	23.22	44.47	4	160	12:15	222.7	0.2	0.25	hosphoprotein	3	3	0.2
St4D_P2_8	4	d	23.22	44.47	4	160	12:15	222.7	0.2	0.25	protein	3	3	0.2
St4D_P2_9	4	d	23.22	44.47	4	160	12:15	222.7	0.2	0.25	hosphoprotein	3	3	0.2
St4D_P2_10	4	d	23.22	44.47	4	160	12:15	222.7	0.2	0.125	metallome	51	3	0.2
St4D_P2_11	4	d	23.22	44.47	4	160	12:15	222.7	0.2	0.25	sandbox	3	3	0.2
St4D_P2_12	4	d	23.22	44.47	4	160	12:15	222.7	0.2	0.0625	DNA_liz	3	3	0.2
St4D_P2_13	4	d	23.22	44.47	4	160	12:15	222.7	0.0625	0.0625	DNA_julie	51	3	0.2
St4D_P2_14	4	d	23.22	44.47	4	160	12:15	222.7	0.2	0.125	metals	51	3	0.2
St4D_P2_15	4	d	23.22	44.47	4	160	12:15	222.7	3	0.25	sandbox	3	3	0.2
St4D_P2_16	4	d	23.22	44.47	4	160	12:15	222.7	3	0.25	sandbox	3	3	0.2
St4D_P2_17	4	d	23.22	44.47	4	160	12:15	222.7	3	0.25	sandbox	3	3	0.2
St4D_P2_18	4	d	23.22	44.47	4	160	12:15	222.7	0.0625	0.0625	DNA_julie	51	51	3
St4D_P2_19	4	d	23.22	44.47	4	160	12:15	222.7	0.2	0.125	metals	3	3	3
St4D_P2_20	4	d	23.22	44.47	4	160	12:15	222.7	3	0.25	hosphoprotein	3	3	0.2
St4D_P3_9	4	d	23.22	44.47	4	160	12:15	222.7	0.25second	0.25	hosphoprotein	51	3	3
St4D_P3_10	4	d	23.22	44.47	4	160	12:15	222.7	0.25second	0.125	metallome	51	3	3
St4D_P3_11	4	d	23.22	44.47	4	160	12:15	222.7	3	0.0625	metals	51	3	3
St4D_P3_12	4	d	23.22	44.47	4	160	12:15	222.7	3	0.0625	DNA_julie	51	51	3
St4D_P3_13	4	d	23.22	44.47	4	160	12:15	222.7	52	0.5	protein	52	51	51
St4D_P3_14	4	d	23.22	44.47	4	160	12:15	222.7	52	0.5	hosphoprotein	52		51
St4D_P3_15	4	d	23.22	44.47	4	160	12:15	269.5	0.25second	0.25	sandbox	3	3	0.2
St4D_P3_16	4	d	23.22	44.47	4	160	12:15	269.5	0.25second	0.25	sandbox	3	3	0.2

Barcode on_pump_sample	Station	Deploy #	Approx Lat	Approx Long	Pump #	Depth	Start pump (GMT)	Volume filtered	Filter size	Filter fraction	Sample type	Freezer bag #	max filter size (uM)	min filter size (uM)
St4D_P3_17	4	d	23.22	44.47	4	160	12:15	269.5	0.2second	0.25	sandbox		3	0.2
St4D_P3_18	4	d	23.22	44.47	4	160	12:15	269.5	0.2second	0.25	sandbox		3	0.2
St4D_P3_19	4	d	23.22	44.47	4	160	12:15	269.5	3second	0.5	sandbox		3	3
St4D_P3_20	4	d	23.22	44.47	4	160	12:15	269.5	3second	0.5	sandbox		3	3
St4D_P4_1	4	d	23.22	44.47	4	250	12:15	407.7	0.2	0.25	protein		3	0.2
St4D_P4_2	4	d	23.22	44.47	4	250	12:15	407.7	0.0625	0.0625	DNA_liz		51	3
St4D_P4_3	4	d	23.22	44.47	4	250	12:15	407.7	3	0.25	metallome		3	3
St4D_P4_4	4	d	23.22	44.47	4	250	12:15	407.7	0.125	0.125	metals		3	0.2
St4D_P4_5	4	d	23.22	44.47	4	250	12:15	407.7	0.2	0.25	protein		3	0.2
St4D_P4_6	4	d	23.22	44.47	4	250	12:15	407.7	0.0625	0.0625	DNA_julie		51	3
St4D_P4_7	4	d	23.22	44.47	4	250	12:15	407.7	0.2	0.25	protein		3	0.2
St4D_P4_8	4	d	23.22	44.47	4	250	12:15	407.7	3	0.25	hosphoprotein		3	3
St4D_P4_9	4	d	23.22	44.47	4	250	12:15	407.7	3	0.25	metallome		3	3
St4D_P4_10	4	d	23.22	44.47	4	250	12:15	407.7	0.2	0.25	metals		3	3
St4D_P4_11	4	d	23.22	44.47	4	250	12:15	407.7	0.0625	0.0625	DNA_julie		51	3
St4D_P4_12	4	d	23.22	44.47	4	250	12:15	407.7	0.0625	0.0625	DNA_liz		51	3
St4D_P4_13	4	d	23.22	44.47	4	250	12:15	407.7	3	0.25	protein		3	3
St4D_P4_14	4	d	23.22	44.47	4	250	12:15	363.1	3	0.25	metals		3	3
St4D_P4_15	4	d	23.22	44.47	4	250	12:15	363.1	0.2	0.25	sandbox		3	0.2
St4D_P4_16	4	d	23.22	44.47	4	250	12:15	363.1	0.2	0.25	sandbox		3	0.2
St4D_P4_17	4	d	23.22	44.47	4	250	12:15	363.1	0.2	0.25	sandbox		3	0.2
St4D_P4_18	4	d	23.22	44.47	4	250	12:15	363.1	0.2	0.25	sandbox		3	0.2
St4D_P4_19	4	d	23.22	44.47	4	250	12:15	363.1	3second	0.5	sandbox		3	3
St4D_P4_20	4	d	23.22	44.47	4	250	12:15	363.1	3second	0.5	sandbox		3	3
St5A_P1_1	5	a	39.6	23	5	15	08:00	40.1	52	0.5	protein		51	51
St5A_P1_2	5	a	39.6	23	5	15	08:00	40.1	3	0.5	hosphoprotein		51	3
St5A_P1_3	5	a	39.6	23	5	15	08:00	40.1	0.2second	0.25	sandbox		3	0.2
St5A_P1_4	5	a	39.6	23	5	15	08:00	40.1	0.2	0.25	sandbox		3	0.2
St5A_P1_5	5	a	39.6	23	5	15	08:00	40.1	0.2	0.25	sandbox		3	0.2
St5A_P1_6	5	a	39.6	23	5	15	08:00	40.1	0.2	0.0625	DNA_liz		3	0.2
St5A_P1_7	5	a	39.6	23	5	15	08:00	40.1	3	0.25	protein		3	3
St5A_P1_8	5	a	39.6	23	5	15	08:00	40.1	3	0.25	hosphoprotein		3	3
St5A_P1_9	5	a	39.6	23	5	15	08:00	40.1	3	0.25	metallome		3	3
St5A_P1_10	5	a	39.6	23	5	15	08:00	40.1	3	0.0625	metals		51	3
St5A_P1_11	5	a	39.6	23	5	15	08:00	40.1	3	0.0625	DNA_julie		51	3
St5A_P1_12	5	a	39.6	23	5	15	08:00	40.1	0.0625	0.0625	DNA_liz		51	3
St5A_P1_13	5	a	39.6	23	5	15	08:00	40.1	0.2	0.5	protein		51	51
St5A_P1_14	5	a	39.6	23	5	15	08:00	40.1	52	0.5	protein		51	51
St5A_P1_15	5	a	39.6	23	5	15	08:00	40.1	52	0.5	hosphoprotein		51	51
St5A_P1_16	5	a	39.6	23	5	15	08:00	10.1	0.2second	0.25	sandbox		3	0.2
St5A_P1_17	5	a	39.6	23	5	15	08:00	10.1	0.2second	0.25	sandbox		3	0.2
St5A_P1_18	5	a	39.6	23	5	15	08:00	10.1	0.2second	0.25	sandbox		3	0.2
St5A_P1_19	5	a	39.6	23	5	15	08:00	10.1	3second	0.5	sandbox		3	3
St5A_P1_20	5	a	39.6	23	5	15	08:00	10.1	3second	0.5	sandbox		3	3
St5A_P3_1	5	a	39.6	23	5	40	08:00	217.9	0.2	0.25	protein		3	0.2
St5A_P3_2	5	a	39.6	23	5	40	08:00	217.9	0.2	0.25	hosphoprotein		3	0.2
St5A_P3_3	5	a	39.6	23	5	40	08:00	217.9	0.2	0.25	metallome		3	0.2
St5A_P3_4	5	a	39.6	23	5	40	08:00	217.9	0.2	0.125	metals		3	0.2

Barcode on_pump_sample	Station	Deploy #	Approx Lat	Approx Long	Pump #	Depth	Start pump (GMT)	Volume filtered	Filter size	Filter fraction	Sample type	Freezer bag #	max filter size (uM)	min filter size (uM)
St5A_P3_5	5	a	39.6	23	5	40	08:00	217.9	0.2	0.0625	DNA_julie		3	0.2
St5A_P3_6	5	a	39.6	23	5	40	08:00	217.9	0.2	0.0625	DNA_liz		3	0.2
St5A_P3_7	5	a	39.6	23	5	40	08:00	217.9	0.2	0.25	protein		3	0.2
St5A_P3_8	5	a	39.6	23	5	40	08:00	217.9	3	0.25	hosphoprotein		51	3
St5A_P3_9	5	a	39.6	23	5	40	08:00	217.9	0.2	0.25	metallome		3	0.2
St5A_P3_10	5	a	39.6	23	5	40	08:00	217.9	0.2	0.125	metals		3	0.2
St5A_P3_11	5	a	39.6	23	5	40	08:00	217.9	3	0.25	DNA_julie		51	3
St5A_P3_12	5	a	39.6	23	5	40	08:00	217.9	3	0.0625	DNA_liz		51	3
St5A_P3_13	5	a	39.6	23	5	40	08:00	217.9	3	0.25	protein		51	3
St5A_P3_14	5	a	39.6	23	5	40	08:00	217.9	3	0.25	hosphoprotein		51	3
St5A_P3_15	5	a	39.6	23	5	40	08:00	219.7	52	0.5	sandbox			51
St5A_P3_16	5	a	39.6	23	5	40	08:00	219.7	52	0.5	sandbox			51
St5A_P3_17	5	a	39.6	23	5	40	08:00	219.7	52	0.5	sandbox			51
St5A_P3_18	5	a	39.6	23	5	40	08:00	219.7	52	0.5	sandbox			51
St5A_P3_19	5	a	39.6	23	5	40	08:00	219.7	0.2	0.5	DNA_liz		3	0.2
St5A_P3_20	5	a	39.6	23	5	40	08:00	219.7	0.2	0.5	DNA_julie		3	0.2
St5A_P4_1	5	a	39.6	23	5	80	08:00	244.1	0.2	0.25	protein		3	0.2
St5A_P4_2	5	a	39.6	23	5	80	08:00	244.1	3	0.25	hosphoprotein		51	3
St5A_P4_3	5	a	39.6	23	5	80	08:00	244.1	0.2	0.25	metallome		3	0.2
St5A_P4_4	5	a	39.6	23	5	80	08:00	244.1	0.2	0.125	metals		3	0.2
St5A_P4_5	5	a	39.6	23	5	80	08:00	244.1	0.2	0.0625	DNA_julie		3	0.2
St5A_P4_6	5	a	39.6	23	5	80	08:00	244.1	0.2	0.0625	DNA_liz		3	0.2
St5A_P4_7	5	a	39.6	23	5	80	08:00	244.1	3	0.25	protein		51	3
St5A_P4_8	5	a	39.6	23	5	80	08:00	244.1	3	0.25	hosphoprotein		51	3
St5A_P4_9	5	a	39.6	23	5	80	08:00	244.1	0.2	0.125	metallome		3	0.2
St5A_P4_10	5	a	39.6	23	5	80	08:00	244.1	0.2	0.0625	metals		3	0.2
St5A_P4_11	5	a	39.6	23	5	80	08:00	244.1	3	0.0625	DNA_julie		51	3
St5A_P4_12	5	a	39.6	23	5	80	08:00	244.1	0.2	0.25	DNA_liz		3	0.2
St5A_P4_13	5	a	39.6	23	5	80	08:00	252.9	3	0.5	protein		51	3
St5A_P4_14	5	a	39.6	23	5	80	08:00	252.9	3	0.5	hosphoprotein		51	3
St5A_P4_15	5	a	39.6	23	5	80	08:00	252.9	52	0.25	sandbox			51
St5A_P4_16	5	a	39.6	23	5	80	08:00	252.9	52	0.25	sandbox			51
St5A_P4_17	5	a	39.6	23	5	80	08:00	252.9	52	0.25	sandbox			51
St5A_P4_18	5	a	39.6	23	5	80	08:00	252.9	52	0.25	sandbox			51
St5A_P4_19	5	a	39.6	23	5	80	08:00	252.9	52	0.5	sandbox			51
St5A_P4_20	5	a	39.6	23	5	80	08:00	252.9	52	0.5	sandbox			51
St5B_P1_1	5	b	39.6	23	1	100	10:35	19.7	0.2	0.25	protein		3	0.2
St5B_P1_2	5	b	39.6	23	1	100	10:35	19.7	0.2	0.25	phosphoprotein		3	0.2
St5B_P1_3	5	b	39.6	23	1	100	10:35	19.7	0.2	0.25	metallome		3	0.2
St5B_P1_4	5	b	39.6	23	1	100	10:35	19.7	0.2	0.125	metals		3	0.2
St5B_P1_5	5	b	39.6	23	1	100	10:35	19.7	0.2	0.0625	DNA_julie		3	0.2
St5B_P1_6	5	b	39.6	23	1	100	10:35	19.7	0.2	0.0625	DNA_liz		3	0.2
St5B_P1_7	5	b	39.6	23	1	100	10:35	19.7	3	0.25	protein		51	3
St5B_P1_8	5	b	39.6	23	1	100	10:35	19.7	3	0.25	phosphoprotein		51	3
St5B_P1_9	5	b	39.6	23	1	100	10:35	19.7	3	0.125	metallome		51	3
St5B_P1_10	5	b	39.6	23	1	100	10:35	19.7	3	0.25	metals		51	3
St5B_P1_11	5	b	39.6	23	1	100	10:35	19.7	3	0.0625	DNA_julie		51	3
St5B_P1_12	5	b	39.6	23	1	100	10:35	19.7	3	0.0625	DNA_liz		51	3

Barcode on_pump_sample	Station	Deploy #	Approx Lat	Approx Long	Pump #	Depth	Start pump (GMT)	Volume filtered	Filter size	Filter fraction	Sample type	Freezer bag #	max filter size (uM)	min filter size (uM)
St5B_P1_13	5	b	39.6	23	1	100	10:35	19.7	52	0.5	protein		51	51
St5B_P1_14	5	b	39.6	23	1	100	10:35	19.7	52	0.5	hosphoprotein			51
St5B_P1_15	5	b	39.6	23	1	100	10:35	29.2	0.2second	0.25	sandbox		3	0.2
St5B_P1_16	5	b	39.6	23	1	100	10:35	29.2	0.2second	0.25	sandbox		3	0.2
St5B_P1_17	5	b	39.6	23	1	100	10:35	29.2	0.2second	0.25	sandbox		3	0.2
St5B_P1_18	5	b	39.6	23	1	100	10:35	29.2	0.2second	0.25	sandbox		3	0.2
St5B_P1_19	5	b	39.6	23	1	100	10:35	29.2	3second	0.5	sandbox			3
St5B_P1_20	5	b	39.6	23	1	100	10:35	29.2	3second	0.5	sandbox			3
St5B_P3_1	5	b	39.6	23	3	125	10:35	268	0.2	0.25	protein		3	0.2
St5B_P3_2	5	b	39.6	23	3	125	10:35	268	0.2	0.25	hosphoprotein		3	0.2
St5B_P3_3	5	b	39.6	23	3	125	10:35	268	0.2	0.25	metallome		3	0.2
St5B_P3_4	5	b	39.6	23	3	125	10:35	268	0.2	0.125	metals		3	0.2
St5B_P3_5	5	b	39.6	23	3	125	10:35	268	0.2	0.0625	DNA_julie		3	0.2
St5B_P3_6	5	b	39.6	23	3	125	10:35	268	0.2	0.0625	DNA_liz		3	0.2
St5B_P3_7	5	b	39.6	23	3	125	10:35	268	3	0.25	protein		51	3
St5B_P3_8	5	b	39.6	23	3	125	10:35	268	3	0.25	hosphoprotein		51	3
St5B_P3_9	5	b	39.6	23	3	125	10:35	268	3	0.25	metallome		51	3
St5B_P3_10	5	b	39.6	23	3	125	10:35	268	3	0.125	metals		51	3
St5B_P3_11	5	b	39.6	23	3	125	10:35	268	0.0625	0.0625	DNA_julie		51	3
St5B_P3_12	5	b	39.6	23	3	125	10:35	268	3	0.0625	DNA_liz		51	3
St5B_P3_13	5	b	39.6	23	3	125	10:35	268	52	0.5	protein			51
St5B_P3_14	5	b	39.6	23	3	125	10:35	319.3	52	0.5	hosphoprotein			51
St5B_P3_15	5	b	39.6	23	3	125	10:35	319.3	0.25second	0.25	sandbox		3	0.2
St5B_P3_16	5	b	39.6	23	3	125	10:35	319.3	0.25second	0.25	sandbox		3	0.2
St5B_P3_17	5	b	39.6	23	3	125	10:35	319.3	0.25second	0.25	sandbox		3	0.2
St5B_P3_18	5	b	39.6	23	3	125	10:35	319.3	0.25second	0.25	sandbox		3	0.2
St5B_P3_19	5	b	39.6	23	3	125	10:35	319.3	3second	0.5	sandbox			3
St5B_P3_20	5	b	39.6	23	3	125	10:35	319.3	3second	0.5	sandbox			3
St5B_P4_1	5	b	39.6	23	4	170	10:35	331.7	0.2	0.25	protein		3	0.2
St5B_P4_2	5	b	39.6	23	4	170	10:35	331.7	0.2	0.25	hosphoprotein		3	0.2
St5B_P4_3	5	b	39.6	23	4	170	10:35	331.7	0.2	0.25	metallome		3	0.2
St5B_P4_4	5	b	39.6	23	4	170	10:35	331.7	0.2	0.125	metals		3	0.2
St5B_P4_5	5	b	39.6	23	4	170	10:35	331.7	0.2	0.0625	DNA_julie		3	0.2
St5B_P4_6	5	b	39.6	23	4	170	10:35	331.7	0.2	0.0625	DNA_liz		3	0.2
St5B_P4_7	5	b	39.6	23	4	170	10:35	331.7	3	0.25	protein		51	3
St5B_P4_8	5	b	39.6	23	4	170	10:35	331.7	3	0.25	hosphoprotein		51	3
St5B_P4_9	5	b	39.6	23	4	170	10:35	331.7	3	0.25	metallome		51	3
St5B_P4_10	5	b	39.6	23	4	170	10:35	331.7	3	0.125	metals		51	3
St5B_P4_11	5	b	39.6	23	4	170	10:35	331.7	0.0625	0.0625	DNA_julie		51	3
St5B_P4_12	5	b	39.6	23	4	170	10:35	331.7	3	0.0625	DNA_liz		51	3
St5B_P4_13	5	b	39.6	23	4	170	10:35	331.7	52	0.5	protein			51
St5B_P4_14	5	b	39.6	23	4	170	10:35	309.2	52	0.5	hosphoprotein			51
St5B_P4_15	5	b	39.6	23	4	170	10:35	309.2	0.25second	0.25	sandbox		3	0.2
St5B_P4_16	5	b	39.6	23	4	170	10:35	309.2	0.25second	0.25	sandbox		3	0.2
St5B_P4_17	5	b	39.6	23	4	170	10:35	309.2	0.25second	0.25	sandbox		3	0.2
St5B_P4_18	5	b	39.6	23	4	170	10:35	309.2	0.25second	0.25	sandbox		3	0.2
St5B_P4_19	5	b	39.6	23	4	170	10:35	309.2	3second	0.5	sandbox			3
St5B_P4_20	5	b	39.6	23	4	170	10:35	309.2	3second	0.5	sandbox			3

Barcode on_pump_sample	Station	Deploy #	Approx Lat	Approx Long	Pump #	Depth	Start pump (GMT)	Volume filtered	Filter size	Filter fraction	Sample type	Freezer bag #	max filter size (uM)	min filter size (uM)
St5C_P1_1	5	c	39.6	23	1	25	10:30	95.4	0.2	0.25	protein		3	0.2
St5C_P1_2	5	c	39.6	23	1	25	10:30	95.4	0.2	0.25	hosphoprotein		3	0.2
St5C_P1_3	5	c	39.6	23	1	25	10:30	95.4	0.2	0.25	metallome		3	0.2
St5C_P1_4	5	c	39.6	23	1	25	10:30	95.4	0.2	0.125	metals		3	0.2
St5C_P1_5	5	c	39.6	23	1	25	10:30	95.4	0.2	0.0625	DNA_julie		3	0.2
St5C_P1_6	5	c	39.6	23	1	25	10:30	95.4	0.2	0.0625	DNA_liz		3	0.2
St5C_P1_7	5	c	39.6	23	1	25	10:30	95.4	0.2	0.25	protein		3	0.2
St5C_P1_8	5	c	39.6	23	1	25	10:30	95.4	0.2	0.25	hosphoprotein		3	0.2
St5C_P1_9	5	c	39.6	23	1	25	10:30	95.4	3	0.25	sandbox		3	0.2
St5C_P1_10	5	c	39.6	23	1	25	10:30	95.4	3	0.25	sandbox		3	0.2
St5C_P1_11	5	c	39.6	23	1	25	10:30	95.4	3	0.25	sandbox		3	0.2
St5C_P1_12	5	c	39.6	23	1	25	10:30	95.4	3	0.0625	DNA_liz		3	0.2
St5C_P1_13	5	c	39.6	23	1	25	10:30	95.4	52	0.5	protein	51	51	51
St5C_P1_14	5	c	39.6	23	1	25	10:30	95.4	52	0.5	hosphoprotein	51	51	51
St5C_P1_15	5	c	39.6	23	1	25	10:30	95.4	52	0.5	protein	51	51	51
St5C_P1_16	5	c	39.6	23	1	25	10:30	95.4	3	0.25	sandbox		3	0.2
St5C_P1_17	5	c	39.6	23	1	25	10:30	95.4	3	0.25	sandbox		3	0.2
St5C_P1_18	5	c	39.6	23	1	25	10:30	104	3second	0.5	sandbox		3	3
St5C_P1_19	5	c	39.6	23	1	25	10:30	104	3second	0.5	sandbox		3	3
St5C_P1_20	5	c	39.6	23	1	25	10:30	104	0.2second	0.5	sandbox	3	3	3
St5D_P3_1	5	d	39.6	23	3	40	13:45	278.1	0.2second	0.5	protein	51	51	51
St5D_P3_2	5	d	39.6	23	3	40	13:45	278.1	0.2second	0.25	sandbox		3	0.2
St5D_P3_3	5	d	39.6	23	3	40	13:45	278.1	0.2second	0.25	sandbox		3	0.2
St5D_P3_4	5	d	39.6	23	3	40	13:45	278.1	0.2	0.25	metals		3	0.2
St5D_P3_5	5	d	39.6	23	3	40	13:45	278.1	0.2	0.125	metals		3	0.2
St5D_P3_6	5	d	39.6	23	3	40	13:45	278.1	0.0625	0.0625	DNA_julie	51	3	0.2
St5D_P3_7	5	d	39.6	23	3	40	13:45	278.1	0.2	0.25	protein		3	0.2
St5D_P3_8	5	d	39.6	23	3	40	13:45	278.1	0.2	0.25	DNA_liz		3	0.2
St5D_P3_9	5	d	39.6	23	3	40	13:45	278.1	3	0.25	hosphoprotein		3	0.2
St5D_P3_10	5	d	39.6	23	3	40	13:45	278.1	3	0.25	metals		3	0.2
St5D_P3_11	5	d	39.6	23	3	40	13:45	278.1	0.0625	0.0625	DNA_julie	51	51	3
St5D_P3_12	5	d	39.6	23	3	40	13:45	278.1	3	0.0625	DNA_liz		3	0.2
St5D_P3_13	5	d	39.6	23	3	40	13:45	278.1	3	0.5	protein	51	51	51
St5D_P3_14	5	d	39.6	23	3	40	13:45	278.1	52	0.5	hosphoprotein	51	51	51
St5D_P3_15	5	d	39.6	23	3	40	13:45	278.1	0.2	0.25	protein		3	0.2
St5D_P3_16	5	d	39.6	23	3	40	13:45	341.4	0.25	0.25	sandbox		3	0.2
St5D_P3_17	5	d	39.6	23	3	40	13:45	341.4	0.25	0.25	sandbox		3	0.2
St5D_P3_18	5	d	39.6	23	3	40	13:45	341.4	0.25second	0.25	sandbox	3	3	0.2
St5D_P3_19	5	d	39.6	23	3	40	13:45	341.4	0.25second	0.5	sandbox	3	3	0.2
St5D_P3_20	5	d	39.6	23	3	40	13:45	341.4	3second	0.5	sandbox	3	3	3
St5D_P4_1	5	d	39.6	23	4	300	13:45	425.7	0.2	0.25	hosphoprotein	3	3	0.2
St5D_P4_2	5	d	39.6	23	4	300	13:45	425.7	0.2	0.25	protein	3	3	0.2
St5D_P4_3	5	d	39.6	23	4	300	13:45	425.7	0.2	0.25	metallome	3	3	0.2
St5D_P4_4	5	d	39.6	23	4	300	13:45	425.7	0.2	0.125	metals	3	3	0.2
St5D_P4_5	5	d	39.6	23	4	300	13:45	425.7	0.2	0.0625	DNA_julie	3	3	0.2
St5D_P4_6	5	d	39.6	23	4	300	13:45	425.7	0.2	0.0625	DNA_liz	3	3	0.2
St5D_P4_7	5	d	39.6	23	4	300	13:45	425.7	0.2	0.25	protein	51	51	3
St5D_P4_8	5	d	39.6	23	4	300	13:45	425.7	3	0.25	hosphoprotein		3	3

Barcode / on_pump_sample	Station	Deploy #	Approx Lat	Approx Long	Pump #	Depth	Start pump (GMT)	Volume filtered	Filter size	Filter fraction	Sample type	Freezer bag #	max filter size (uM)	min filter size (uM)
St5D_P4_9	5	d	39.6	23	4	300	13:45	425.7	3	0.25	metallome		51	3
St5D_P4_10	5	d	39.6	23	4	300	13:45	425.7	3	0.125	metals		3	3
St5D_P4_11	5	d	39.6	23	4	300	13:45	425.7	3	0.0625	DNA_julie		51	3
St5D_P4_12	5	d	39.6	23	4	300	13:45	425.7	0.2	0.0625	DNA_liz		3	0.2
St5D_P4_13	5	d	39.6	23	4	300	13:45	425.7	52	0.5	protein		51	51
St5D_P4_14	5	d	39.6	23	4	300	13:45	425.7	52	0.5	hosphoprotein		51	51
St5D_P4_15	5	d	39.6	23	4	300	13:45	404.2	3second	0.5	sandbox		3	3
St5D_P4_16	5	d	39.6	23	4	300	13:45	404.2	0.2second	0.25	sandbox		3	0.2
St5D_P4_17	5	d	39.6	23	4	300	13:45	404.2	0.2second	0.25	sandbox		3	0.2
St5D_P4_18	5	d	39.6	23	4	300	13:45	404.2	0.2second	0.25	sandbox		3	0.2
St5D_P4_19	5	d	39.6	23	4	300	13:45	404.2	3second	0.5	sandbox		3	3
St5D_P4_20	5	d	39.6	23	4	300	13:45	404.2	3second	0.5	sandbox		3	3
St6A_P1_1	6	a	35.53	22.19	1	25	06:30	131.8	52	0.5	hosphoprotein		51	51
St6A_P1_2	6	a	35.53	22.19	1	25	06:30	131.8	52	0.5	protein		51	51
St6A_P1_3	6	a	35.53	22.19	1	25	06:30	131.8	0.2	0.0625	DNA_liz		3	0.2
St6A_P1_4	6	a	35.53	22.19	1	25	06:30	131.8	3	0.0625	DNA_julie		51	3
St6A_P1_5	6	a	35.53	22.19	1	25	06:30	131.8	3	0.125	metals		3	3
St6A_P1_6	6	a	35.53	22.19	1	25	06:30	131.8	3	0.25	metallome		51	3
St6A_P1_7	6	a	35.53	22.19	1	25	06:30	131.8	52	0.5	hosphoprotein	may not be accurate	51	51
St6A_P1_8	6	a	35.53	22.19	1	25	06:30	131.8	52	0.25	protein	may not be accurate	51	3
St6A_P1_9	6	a	35.53	22.19	1	25	06:30	131.8	0.2	0.0625	DNA_liz	may not be accurate	3	0.2
St6A_P1_10	6	a	35.53	22.19	1	25	06:30	131.8	3	0.0625	DNA_julie	may not be accurate	51	3
St6A_P1_11	6	a	35.53	22.19	1	25	06:30	131.8	3	0.25	metals	may not be accurate	3	3
St6A_P1_12	6	a	35.53	22.19	1	25	06:30	131.8	3	0.25	metallome	may not be accurate	51	3
St6A_P1_13	6	a	35.53	22.19	1	25	06:30	131.8	0.2	0.25	protein	may not be accurate	51	0.2
St6A_P1_14	6	a	35.53	22.19	1	25	06:30	131.8	0.2	0.5	hosphoprotein	may not be accurate	51	51
St6A_P3_1	6	a	35.53	22.19	1	40	06:30	811.2	0.2	0.25	hosphoprotein	may not be accurate	51	3
St6A_P3_2	6	a	35.53	22.19	1	40	06:30	811.2	0.2	0.25	protein	may not be accurate	51	0.2
St6A_P3_3	6	a	35.53	22.19	1	40	06:30	811.2	0.2	0.0625	DNA_liz	may not be accurate	3	0.2
St6A_P3_4	6	a	35.53	22.19	1	40	06:30	811.2	0.2	0.125	DNA_julie	may not be accurate	3	0.2
St6A_P3_5	6	a	35.53	22.19	1	40	06:30	811.2	0.2	0.25	metals	may not be accurate	3	0.2
St6A_P3_6	6	a	35.53	22.19	1	40	06:30	811.2	0.2	0.25	metallome	may not be accurate	51	0.2
St6A_P3_7	6	a	35.53	22.19	1	40	06:30	811.2	0.2	0.25	protein	may not be accurate	51	0.2
St6A_P3_8	6	a	35.53	22.19	1	40	06:30	811.2	0.2	0.0625	DNA_liz	may not be accurate	3	0.2
St6A_P3_9	6	a	35.53	22.19	1	40	06:30	811.2	0.2	0.0625	DNA_julie	may not be accurate	3	0.2
St6A_P3_10	6	a	35.53	22.19	1	40	06:30	811.2	3	0.25	metals	may not be accurate	3	3
St6A_P3_11	6	a	35.53	22.19	1	40	06:30	811.2	3	0.25	metallome	may not be accurate	3	3
St6A_P3_12	6	a	35.53	22.19	1	40	06:30	811.2	3	0.0625	DNA_liz	may not be accurate	51	3
St6A_P3_13	6	a	35.53	22.19	1	40	06:30	811.2	52	0.5	protein	may not be accurate	51	51
St6A_P3_14	6	a	35.53	22.19	1	40	06:30	811.2	52	0.5	hosphoprotein may not be accurate		51	51
St6A_P4_1	6	a	35.53	22.19	1	80	06:30	273.5	0.2	0.5	hosphoprotein may not be accurate		3	0.2
St6A_P4_2	6	a	35.53	22.19	1	80	06:30	273.5	0.2	0.25	protein		3	0.2
St6A_P4_3	6	a	35.53	22.19	1	80	06:30	273.5	0.2	0.25	hosphoprotein		3	0.2
St6A_P4_4	6	a	35.53	22.19	1	80	06:30	273.5	0.2	0.125	metallome		3	0.2
St6A_P4_5	6	a	35.53	22.19	1	80	06:30	273.5	0.2	0.0625	metals		3	0.2
St6A_P4_6	6	a	35.53	22.19	1	80	06:30	273.5	0.2	0.0625	DNA_julie		3	0.2
St6A_P4_7	6	a	35.53	22.19	1	80	06:30	273.5	3	0.25	protein		51	3
St6A_P4_8	6	a	35.53	22.19	1	80	06:30	273.5	3	0.25	hosphoprotein		3	3

Barcode on_pump_sample	Station	Deploy #	Approx Lat	Approx Long	Pump #	Depth	Start pump (GMT)	Volume filtered	Filter size	Filter fraction	Sample type	Freezer bag #	max filter size (uM)	min filter size (uM)
St6A_P4_9	6	a	35.53	22.19	1	80	06:30	273.5	3	0.25	metallome		51	3
St6A_P4_10	6	a	35.53	22.19	1	80	06:30	273.5	3	0.125	metals		51	3
St6A_P4_11	6	a	35.53	22.19	1	80	06:30	273.5	0.0625	0.0625	DNA_julie		51	3
St6A_P4_12	6	a	35.53	22.19	1	80	06:30	273.5	3	0.125	metals		51	3
St6A_P4_13	6	a	35.53	22.19	1	80	06:30	273.5	52	0.5	protein	51	51	51
St6A_P4_14	6	a	35.53	22.19	1	80	06:30	273.5	52	0.5	protein	51	51	51
St6A_P4_15	6	a	35.53	22.19	1	80	06:30	273.5	3second	0.5	hosphoprotein		51	3
St6A_P4_16	6	a	35.53	22.19	1	80	06:30	273.5	0.2second	0.25	sandbox		3	0.2
St6A_P4_17	6	a	35.53	22.19	1	80	06:30	273.5	0.2second	0.25	sandbox		3	0.2
St6A_P4_18	6	a	35.53	22.19	1	80	06:30	273.5	0.2second	0.25	sandbox		3	0.2
St6A_P4_19	6	a	35.53	22.19	1	80	06:30	273.5	3second	0.5	sandbox		51	3
St6A_P4_20	6	a	35.53	22.19	1	80	06:30	273.5	3second	0.5	sandbox		51	3
St6B_P1_1	6	b	35.53	22.19	2	25	10:30	74.425	0.2	0.25	protein	may not be a	3	0.2
St6B_P1_2	6	b	35.53	22.19	2	25	10:30	74.425	0.2	0.25	sandbox	may not be a	3	0.2
St6B_P1_3	6	b	35.53	22.19	2	25	10:30	74.425	0.2	0.25	sandbox	may not be a	3	0.2
St6B_P1_4	6	b	35.53	22.19	2	25	10:30	74.425	0.2	0.25	sandbox	may not be a	3	0.2
St6B_P1_5	6	b	35.53	22.19	2	25	10:30	74.425	0.2	0.0625	DNA_liz	may not be a	3	0.2
St6B_P1_6	6	b	35.53	22.19	2	25	10:30	74.425	0.2	0.0625	DNA_liz	may not be a	3	0.2
St6B_P1_7	6	b	35.53	22.19	2	25	10:30	74.425	0.2	0.25	protein	may not be a	3	0.2
St6B_P1_8	6	b	35.53	22.19	2	25	10:30	74.425	0.2	0.25	hosphoprotein	may not be a	3	0.2
St6B_P1_9	6	b	35.53	22.19	2	25	10:30	74.425	0.2	0.25	protein	may not be a	3	0.2
St6B_P1_10	6	b	35.53	22.19	2	25	10:30	74.425	3	0.25	metals	may not be a	3	0.2
St6B_P1_11	6	b	35.53	22.19	2	25	10:30	74.425	3	0.0625	DNA_liz	may not be a	150	3
St6B_P1_12	6	b	35.53	22.19	2	25	10:30	74.425	3	0.0625	sandbox	may not be a	150	3
St6B_P1_15	6	b	35.53	22.19	2	25	10:30	74.425	0.2	0.125	sandbox	may not be a	3	0.2
St6B_P1_16	6	b	35.53	22.19	2	25	10:30	74.425	0.2	0.25	sandbox	may not be a	3	0.2
St6B_P1_17	6	b	35.53	22.19	2	25	10:30	74.425	0.2	0.0625	sandbox	may not be a	3	0.2
St6B_P1_18	6	b	35.53	22.19	2	25	10:30	74.425	0.2	0.0625	metals	may not be a	3	0.2
St6B_P1_19	6	b	35.53	22.19	2	25	10:30	74.425	0.2	0.25	DNA_liz	may not be a	3	0.2
St6B_P1_20	6	b	35.53	22.19	2	25	10:30	74.425	0.2	0.25	sandbox	may not be a	3	0.2
St6B_P3_1	6	b	35.53	22.19	2	15	10:30	328.48	3second	0.25	sandbox	may not be a	150	3
St6B_P3_2	6	b	35.53	22.19	2	15	10:30	328.48	0.2	0.25	protein	may not be a	3	0.2
St6B_P3_3	6	b	35.53	22.19	2	15	10:30	328.48	0.2	0.25	metals	may not be a	3	0.2
St6B_P3_4	6	b	35.53	22.19	2	15	10:30	328.48	0.2	0.25	metals	may not be a	3	0.2
St6B_P3_5	6	b	35.53	22.19	2	15	10:30	328.48	0.2	0.25	sandbox	may not be a	3	0.2
St6B_P3_6	6	b	35.53	22.19	2	15	10:30	328.48	0.2	0.0625	DNA_liz	may not be a	3	0.2
St6B_P3_7	6	b	35.53	22.19	2	15	10:30	328.48	0.2	0.25	protein	may not be a	3	0.2
St6B_P3_8	6	b	35.53	22.19	2	15	10:30	328.48	3	0.25	metallome	may not be a	3	0.2
St6B_P3_9	6	b	35.53	22.19	2	15	10:30	328.48	3	0.125	DNA_julie	may not be a	150	3
St6B_P3_10	6	b	35.53	22.19	2	15	10:30	328.48	3	0.25	metallome	may not be a	150	3
St6B_P3_11	6	b	35.53	22.19	2	15	10:30	328.48	3	0.0625	DNA_julie	may not be a	150	3
St6B_P3_12	6	b	35.53	22.19	2	15	10:30	328.48	3	0.0625	sandbox	may not be a	150	3
St6B_P3_15	6	b	35.53	22.19	2	15	10:30	328.48	0.25	0.25	sandbox	may not be a	3	0.2
St6B_P3_16	6	b	35.53	22.19	2	15	10:30	328.48	0.25	0.25	sandbox	may not be a	3	0.2
St6B_P3_17	6	b	35.53	22.19	2	15	10:30	328.48	0.25	0.25	sandbox	may not be a	3	0.2
St6B_P3_18	6	b	35.53	22.19	2	15	10:30	328.48	3second	0.25	sandbox	may not be a	150	3
St6B_P3_19	6	b	35.53	22.19	2	15	10:30	328.48	3second	0.5	sandbox	may not be a	150	3
St6B_P3_20	6	b	35.53	22.19	2	15	10:30	328.48	3second	0.5	sandbox	may not be a	150	3

Barcode on_pump_sample	Station	Deploy #	Approx Lat	Approx Long	Pump #	Depth	Start pump (GMT)	Volume filtered	Filter size	Filter fraction	Sample type	Freezer bag #	max filter size (uM)	min filter size (uM)
St6B_P4_1	6	b	35.53	22.19	2	40	10:30	328.48	0.2	0.25	protein	may not be a	3	0.2
St6B_P4_2	6	b	35.53	22.19	2	40	10:30	328.48	0.2	0.25	hosphoprotei	may not be a	3	0.2
St6B_P4_3	6	b	35.53	22.19	2	40	10:30	328.48	0.2	0.25	metallome	may not be a	3	0.2
St6B_P4_4	6	b	35.53	22.19	2	40	10:30	328.48	0.2	0.125	metals	may not be a	3	0.2
St6B_P4_5	6	b	35.53	22.19	2	40	10:30	328.48	0.2	0.0625	DNA_julie	may not be a	3	0.2
St6B_P4_6	6	b	35.53	22.19	2	40	10:30	328.48	0.0625	0.0625	DNA_liz	may not be a	3	0.2
St6B_P4_7	6	b	35.53	22.19	2	40	10:30	328.48	3	0.25	protein	may not be a	150	3
St6B_P4_8	6	b	35.53	22.19	2	40	10:30	328.48	3	0.25	hosphoprotein	may not be a	150	3
St6B_P4_9	6	b	35.53	22.19	2	40	10:30	328.48	3	0.25	metallome	may not be a	150	3
St6B_P4_10	6	b	35.53	22.19	2	40	10:30	328.48	3	0.125	metals	may not be a	150	3
St6B_P4_11	6	b	35.53	22.19	2	40	10:30	328.48	3	0.0625	DNA_julie	may not be a	150	3
St6B_P4_12	6	b	35.53	22.19	2	40	10:30	328.48	0.0625	0.0625	DNA_liz	may not be a	150	3
St6B_P4_15	6	b	35.53	22.19	2	40	10:30	328.48	0.2	0.25	sandbox	may not be a	3	0.2
St6B_P4_16	6	b	35.53	22.19	2	40	10:30	328.48	0.2	0.25	sandbox	may not be a	3	0.2
St6B_P4_17	6	b	35.53	22.19	2	40	10:30	328.48	0.2	0.25	sandbox	may not be a	3	0.2
St6B_P4_18	6	b	35.53	22.19	2	40	10:30	328.48	0.2	0.25	sandbox	may not be a	3	0.2
St6B_P4_19	6	b	35.53	22.19	2	40	10:30	328.48	3second	0.5	sandbox	may not be a	150	3
St6B_P4_20	6	b	35.53	22.19	2	40	10:30	328.48	3second	0.5	sandbox	may not be a	150	3
St6C_P1_1	6	c	35.53	22.19	3	125	04:45	27.3	0.2	0.25	protein	volume but c	3	0.2
St6C_P1_2	6	c	35.53	22.19	3	125	04:45	27.3	0.2	0.25	hosphoprotein	volume but c	3	0.2
St6C_P1_3	6	c	35.53	22.19	3	125	04:45	27.3	0.2	0.25	metallome	volume but c	3	0.2
St6C_P1_4	6	c	35.53	22.19	3	125	04:45	27.3	0.2	0.125	metals	volume but c	3	0.2
St6C_P1_5	6	c	35.53	22.19	3	125	04:45	27.3	0.2	0.0625	DNA_julie	volume but c	3	0.2
St6C_P1_6	6	c	35.53	22.19	3	125	04:45	27.3	0.2	0.0625	DNA_liz	volume but c	3	0.2
St6C_P1_7	6	c	35.53	22.19	3	125	04:45	325.4	3	0.25	protein	volume but c	150	3
St6C_P1_8	6	c	35.53	22.19	3	125	04:45	325.4	3	0.25	hosphoprotein	volume but c	150	3
St6C_P1_9	6	c	35.53	22.19	3	125	04:45	325.4	3	0.25	metallome	volume but c	150	3
St6C_P1_10	6	c	35.53	22.19	3	125	04:45	325.4	3	0.125	metals	volume but c	150	3
St6C_P1_11	6	c	35.53	22.19	3	125	04:45	325.4	3	0.0625	DNA_julie	volume but c	150	3
St6C_P1_12	6	c	35.53	22.19	3	125	04:45	325.4	3	0.0625	DNA_liz	volume but c	150	3
St6C_P3_1	6	c	35.53	22.19	3	150	04:45	325.4	0.2	0.25	protein	may not be a	3	0.2
St6C_P3_2	6	c	35.53	22.19	3	150	04:45	325.4	0.2	0.25	hosphoprotein	may not be a	3	0.2
St6C_P3_3	6	c	35.53	22.19	3	150	04:45	325.4	0.2	0.25	metallome	may not be a	3	0.2
St6C_P3_4	6	c	35.53	22.19	3	150	04:45	325.4	0.2	0.125	metals	may not be a	3	0.2
St6C_P3_5	6	c	35.53	22.19	3	150	04:45	325.4	0.2	0.0625	DNA_julie	may not be a	3	0.2
St6C_P3_6	6	c	35.53	22.19	3	150	04:45	325.4	0.2	0.0625	DNA_liz	may not be a	3	0.2
St6C_P3_7	6	c	35.53	22.19	3	150	04:45	325.4	3	0.25	protein	may not be a	3	0.2
St6C_P3_8	6	c	35.53	22.19	3	150	04:45	325.4	3	0.25	protein	may not be a	150	3
St6C_P3_9	6	c	35.53	22.19	3	150	04:45	325.4	3	0.25	hosphoprotein	may not be a	150	3
St6C_P3_10	6	c	35.53	22.19	3	150	04:45	325.4	3	0.25	metallome	may not be a	150	3
St6C_P3_11	6	c	35.53	22.19	3	150	04:45	325.4	3	0.0625	DNA_julie	may not be a	150	3
St6C_P3_12	6	c	35.53	22.19	3	150	04:45	325.4	3	0.0625	DNA_liz	may not be a	150	3
St6C_P3_15	6	c	35.53	22.19	3	150	04:45	325.4	3	0.0625	sandbox	may not be a	3	0.2
St6C_P3_16	6	c	35.53	22.19	3	150	04:45	325.4	3	0.25	sandbox	may not be a	3	0.2
St6C_P3_17	6	c	35.53	22.19	3	150	04:45	484.1	0.25	0.25	sandbox	may not be a	3	0.2
St6C_P3_18	6	c	35.53	22.19	3	150	04:45	484.1	0.2	0.25	sandbox	may not be a	3	0.2
St6C_P3_19	6	c	35.53	22.19	3	150	04:45	484.1	3second	0.5	sandbox	may not be a	150	3
St6C_P3_20	6	c	35.53	22.19	3	150	04:45	484.1	3second	0.5	sandbox	may not be a	150	3

Barcode on_pump_sample	Station	Deploy #	Approx Lat	Approx Long	Pump #	Depth	Start pump (GMT)	Volume filtered	Filter size	Filter fraction	Sample type	Freezer bag #	max filter size (uM)	min filter size (uM)
St6D_P1_1	6	d	35.53	22.19	4	125	11:00	68.8	0.2	0.25	protein		3	0.2
St6D_P1_2	6	d	35.53	22.19	4	125	11:00	68.8	0.2	0.25	hosphoprotein		3	0.2
St6D_P1_3	6	d	35.53	22.19	4	125	11:00	68.8	0.2	0.25	metallome		3	0.2
St6D_P1_4	6	d	35.53	22.19	4	125	11:00	68.8	0.2	0.25	metals		3	0.2
St6D_P1_5	6	d	35.53	22.19	4	125	11:00	68.8	0.2	0.0625	DNA_julie		3	0.2
St6D_P1_6	6	d	35.53	22.19	4	125	11:00	68.8	0.2	0.0625	DNA_liz		3	0.2
St6D_P1_7	6	d	35.53	22.19	4	125	11:00	68.8	3	0.25	sandbox		150	3
St6D_P1_8	6	d	35.53	22.19	4	125	11:00	68.8	3	0.25	sandbox		150	3
St6D_P1_9	6	d	35.53	22.19	4	125	11:00	68.8	3	0.25	sandbox		150	3
St6D_P1_10	6	d	35.53	22.19	4	125	11:00	68.8	3	0.125	sandbox		150	3
St6D_P1_11	6	d	35.53	22.19	4	125	11:00	68.8	3	0.0625	sandbox		150	3
St6D_P1_12	6	d	35.53	22.19	4	125	11:00	68.8	3	0.0625	DNA_liz		150	3
St6D_P1_15	6	d	35.53	22.19	4	125	11:00	116.5	3	0.25	DNA_julie		150	3
St6D_P1_16	6	d	35.53	22.19	4	125	11:00	116.5	3	0.25	metals		150	3
St6D_P1_17	6	d	35.53	22.19	4	125	11:00	116.5	3	0.25	metallome		150	3
St6D_P1_18	6	d	35.53	22.19	4	125	11:00	116.5	3	0.25	protein		150	3
St6D_P1_19	6	d	35.53	22.19	4	125	11:00	116.5	3	0.25	hosphoprotein		150	3
St6D_P1_20	6	d	35.53	22.19	4	125	11:00	116.5	3	0.25	protein		150	3
St6D_P3_20	6	d	35.53	22.19	4	175	11:00	426.7	3second	0.5	sandbox		150	3
St6D_P3_19	6	d	35.53	22.19	4	175	11:00	426.7	3second	0.5	sandbox		150	3
St6D_P3_18	6	d	35.53	22.19	4	175	11:00	426.7	0.2second	0.25	sandbox		150	3
St6D_P3_17	6	d	35.53	22.19	4	175	11:00	426.7	0.2second	0.25	sandbox		150	3
St6D_P3_16	6	d	35.53	22.19	4	175	11:00	426.7	0.2second	0.25	sandbox		150	3
St6D_P3_15	6	d	35.53	22.19	4	175	11:00	399.1	3	0.0625	DNA_liz		150	3
St6D_P3_12	6	d	35.53	22.19	4	175	11:00	399.1	3	0.0625	DNA_julie		150	3
St6D_P3_11	6	d	35.53	22.19	4	175	11:00	399.1	0.2	0.25	metals		3	0.2
St6D_P3_10	6	d	35.53	22.19	4	175	11:00	399.1	0.2	0.25	metallome		3	0.2
St6D_P3_9	6	d	35.53	22.19	4	175	11:00	399.1	0.2	0.25	protein		3	0.2
St6D_P3_8	6	d	35.53	22.19	4	175	11:00	399.1	0.2	0.25	hosphoprotein		3	0.2
St6D_P3_7	6	d	35.53	22.19	4	175	11:00	399.1	0.2	0.25	protein		3	0.2
St6D_P3_6	6	d	35.53	22.19	4	175	11:00	399.1	0.2	0.25	hosphoprotein		3	0.2
St6D_P3_5	6	d	35.53	22.19	4	175	11:00	399.1	0.2	0.25	metallome		3	0.2
St6D_P3_4	6	d	35.53	22.19	4	175	11:00	399.1	0.2	0.25	metals		3	0.2
St6D_P3_3	6	d	35.53	22.19	4	125	11:00	116.5	0.2	0.0625	DNA_julie		3	0.2
St6D_P3_2	6	d	35.53	22.19	4	125	11:00	116.5	0.2	0.0625	DNA_liz		3	0.2
St6D_P3_1	6	d	35.53	22.19	4	125	11:00	116.5	3	0.125	metals		150	3
St6D_P4_1	6	d	35.53	22.19	4	175	11:00	426.7	0.2	0.25	hosphoprotein		3	0.2
St6D_P4_2	6	d	35.53	22.19	4	175	11:00	426.7	0.2	0.25	protein		3	0.2
St6D_P4_3	6	d	35.53	22.19	4	175	11:00	426.7	0.2second	0.25	sandbox		3	0.2
St6D_P4_4	6	d	35.53	22.19	4	250	11:00	426.7	0.2second	0.25	sandbox		3	0.2
St6D_P4_5	6	d	35.53	22.19	4	250	11:00	426.7	0.2second	0.25	sandbox		3	0.2
St6D_P4_6	6	d	35.53	22.19	4	250	11:00	426.7	0.2	0.5	sandbox		3	0.2
St6D_P4_7	6	d	35.53	22.19	4	250	11:00	426.7	0.2	0.25	DNA_julie		3	0.2
St6D_P4_8	6	d	35.53	22.19	4	250	11:00	426.7	0.2	0.25	protein		3	0.2
St6D_P4_9	6	d	35.53	22.19	4	250	11:00	426.7	0.2	0.25	metallome		3	0.2
St6D_P4_10	6	d	35.53	22.19	4	250	11:00	35.6	3	0.125	metals		150	3
St6D_P4_11	6	d	35.53	22.19	4	250	11:00	35.6	3	0.0625	DNA_julie		150	3
St6D_P4_12	6	d	35.53	22.19	4	250	11:00	35.6	3	0.0625	DNA_liz		150	3

Barcode	on_pump_sample	Station	Deploy #	Approx Lat	Approx Long	Pump #	Depth	Start pump (GMT)	Volume filtered	Filter size	Filter fraction	Sample type	Freezer bag #	max filter size (uM)	min filter size (uM)
St6D_P4_15		6	d	35.53	22.19	4	250	11:00	35.4	0.2second	0.25	sandbox		3	0.2
St6D_P4_16		6	d	35.53	22.19	4	250	11:00	35.4	0.2second	0.25	sandbox		3	0.2
St6D_P4_17		6	d	35.53	22.19	4	250	11:00	35.4	0.2second	0.25	sandbox		3	0.2
St6D_P4_18		6	d	35.53	22.19	4	250	11:00	35.4	0.2second	0.25	sandbox		3	0.2
St6D_P4_19		6	d	35.53	22.19	4	250	11:00	35.4	3second	0.5	sandbox		150	3
St6D_P4_20		6	d	35.53	22.19	4	250	11:00	35.4	3second	0.5	sandbox		150	3
St6E_P1		6	e	35.53	22.19	5	40	09:45	4.6	0.2uM	0.5				
St6E_P1		6	e	35.53	22.19	5	40	09:45	4.6	0.2uM	0.5				
St6E_P1		6	e	35.53	22.19	5	40	09:45	4.6	3uM	1	protein		3	0.2
St6D_P4_20		6	d	35.53	22.19	4	250	11:00	35.4	3second	0.5	sandbox		150	3
St6E_P3_1		6	e	35.53	22.19	5	110	09:45	355.6	0.2second	0.25	protein		3	0.2
St6E_P3_2		6	e	35.53	22.19	5	110	09:45	355.6	0.2second	0.25	sandbox		3	0.2
St6E_P3_3		6	e	35.53	22.19	5	110	09:45	355.6	0.2second	0.25	metallome		3	0.2
St6E_P3_4		6	e	35.53	22.19	5	110	09:45	355.6	0.2	0.125	metals		3	0.2
St6E_P3_5		6	e	35.53	22.19	5	110	09:45	355.6	0.2	0.0625	DNA_julie		3	0.2
St6E_P3_6		6	e	35.53	22.19	5	110	09:45	355.6	0.2	0.0625	DNA_liz		3	0.2
St6E_P3_7		6	e	35.53	22.19	5	110	09:45	355.6	0.2second	0.25	protein		3	0.2
St6E_P3_8		6	e	35.53	22.19	5	110	09:45	355.6	0.2second	0.25	hosphoprotein		3	0.2
St6E_P3_9		6	e	35.53	22.19	5	110	09:45	355.6	0.2second	0.25	metallome		3	0.2
St6E_P3_10		6	e	35.53	22.19	5	110	09:45	355.6	0.2	0.125	metals		3	0.2
St6E_P3_11		6	e	35.53	22.19	5	110	09:45	355.6	0.2	0.0625	DNA_liz		3	0.2
St6E_P3_12		6	e	35.53	22.19	5	110	09:45	355.6	0.2	0.0625	DNA_julie		3	0.2
St6E_P3_15		6	e	35.53	22.19	5	110	09:45	371.7	0.2second	0.25	sandbox		3	0.2
St6E_P3_16		6	e	35.53	22.19	5	110	09:45	371.7	0.2second	0.25	sandbox		3	0.2
St6E_P3_17		6	e	35.53	22.19	5	110	09:45	371.7	0.2second	0.25	sandbox		3	0.2
St6E_P3_18		6	e	35.53	22.19	5	110	09:45	371.7	0.2second	0.25	sandbox		3	0.2
St6E_P3_19		6	e	35.53	22.19	5	110	09:45	371.7	3second	0.5	sandbox		150	3
St6E_P3_20		6	e	35.53	22.19	5	110	09:45	371.7	3second	0.5	sandbox		150	3
St6E_P4_1		6	e	35.53	22.19	5	250	09:45	617.9	0.2second	0.25	protein		3	0.2
St6E_P4_2		6	e	35.53	22.19	5	250	09:45	617.9	0.2second	0.25	sandbox		3	0.2
St6E_P4_3		6	e	35.53	22.19	5	250	09:45	617.9	0.2second	0.25	metallome		3	0.2
St6E_P4_4		6	e	35.53	22.19	5	250	09:45	617.9	0.2	0.125	metals		3	0.2
St6E_P4_5		6	e	35.53	22.19	5	250	09:45	617.9	0.2	0.0625	DNA_julie		3	0.2
St6E_P4_6		6	e	35.53	22.19	5	250	09:45	617.9	0.2	0.0625	DNA_liz		3	0.2
St6E_P4_7		6	e	35.53	22.19	5	250	09:45	617.9	0.2second	0.25	protein		3	0.2
St6E_P4_8		6	e	35.53	22.19	5	250	09:45	617.9	0.2second	0.25	hosphoprotein		3	0.2
St6E_P4_9		6	e	35.53	22.19	5	250	09:45	617.9	0.2second	0.25	metallome		3	0.2
St6E_P4_10		6	e	35.53	22.19	5	250	09:45	617.9	3	0.125	metals		150	3
St6E_P4_11		6	e	35.53	22.19	5	250	09:45	617.9	3	0.0625	DNA_julie		150	3
St6E_P4_12		6	e	35.53	22.19	5	250	09:45	617.9	0.0625	0.0625	DNA_liz		150	3
St6E_P4_15		6	e	35.53	22.19	5	250	09:45	575	0.2second	0.25	sandbox		3	0.2
St6E_P4_16		6	e	35.53	22.19	5	250	09:45	575	0.2second	0.25	sandbox		3	0.2
St6E_P4_17		6	e	35.53	22.19	5	250	09:45	575	0.2second	0.25	sandbox		3	0.2
St6E_P4_18		6	e	35.53	22.19	5	250	09:45	575	0.2second	0.25	sandbox		3	0.2
St6E_P4_19		6	e	35.53	22.19	5	250	09:45	575	3second	0.5	sandbox		150	3
St6E_P4_20		6	e	35.53	22.19	5	250	09:45	575	3second	0.5	sandbox	150	3	3
St7A_P1_1		7	a	31	22	1	90	06:35	465	0.2	0.25	protein		3	0.2
St7A_P1_2		7	a	31	22	1	90	06:35	465	0.2	0.25	hosphoprotein		3	0.2
St7A_P1_3		7	a	31	22	1	90	06:35	465	0.2	0.25	metallome		3	0.2

Barcode on_pump_sample	Station	Deploy #	Approx Lat	Approx Long	Pump #	Depth	Start pump (GMT)	Volume filtered	Filter size	Filter fraction	Sample type	Freezer bag #	max filter size (uM)	min filter size (uM)
St7A_P1_4	7	a	31	22	1	90	06:35	465	0.2	0.125	metals		3	0.2
St7A_P1_5	7	a	31	22	1	90	06:35	465	0.2	0.0625	DNA_julie		3	0.2
St7A_P1_6	7	a	31	22	1	90	06:35	465	0.2	0.0625	DNA_liz		3	0.2
St7A_P1_7	7	a	31	22	1	90	06:35	493.2	3	0.25	protein		150	3
St7A_P1_8	7	a	31	22	1	90	06:35	493.2	3	0.25	hosphoprotein		150	3
St7A_P1_9	7	a	31	22	1	90	06:35	493.2	3	0.0625	DNA_liz		150	3
St7A_P1_10	7	a	31	22	1	90	06:35	493.2	3	0.125	metallome		150	3
St7A_P1_11	7	a	31	22	1	90	06:35	493.2	3	0.0625	metals		150	3
St7A_P1_12	7	a	31	22	1	90	06:35	493.2	3	0.0625	DNA_julie		150	3
St7A_P1_15	7	a	31	22	1	90	06:35	388	0.2second	0.25	sandbox		3	0.2
St7A_P1_16	7	a	31	22	1	90	06:35	388	0.2second	0.25	sandbox		3	0.2
St7A_P1_17	7	a	31	22	1	90	06:35	388	0.2second	0.25	sandbox		3	0.2
St7A_P1_18	7	a	31	22	1	90	06:35	388	3second	0.5	sandbox		150	3
St7A_P1_19	7	a	31	22	1	90	06:35	388	3second	0.5	sandbox		150	3
St7A_P1_20	7	a	31	22	1	90	06:35	388	3second	0.5	sandbox		150	3
St7A_P3_1	7	a	31	22	1	110	06:35	388	0.2	0.25	protein		3	0.2
St7A_P3_2	7	a	31	22	1	110	06:35	388	0.2	0.25	sandbox		3	0.2
St7A_P3_3	7	a	31	22	1	110	06:35	388	0.2	0.25	metallome		3	0.2
St7A_P3_4	7	a	31	22	1	110	06:35	388	0.2	0.125	metals		3	0.2
St7A_P3_5	7	a	31	22	1	110	06:35	388	0.2	0.0625	DNA_julie		3	0.2
St7A_P3_6	7	a	31	22	1	110	06:35	388	0.2	0.0625	DNA_liz		3	0.2
St7A_P3_7	7	a	31	22	1	110	06:35	428.3	3	0.25	protein		150	3
St7A_P3_8	7	a	31	22	1	110	06:35	428.3	3	0.25	hosphoprotein		150	3
St7A_P3_9	7	a	31	22	1	110	06:35	428.3	3	0.0625	DNA_liz		150	3
St7A_P3_10	7	a	31	22	1	110	06:35	428.3	3	0.125	metallome		150	3
St7A_P3_11	7	a	31	22	1	110	06:35	428.3	3	0.0625	metals		150	3
St7A_P3_12	7	a	31	22	1	110	06:35	428.3	3	0.0625	DNA_julie		150	3
St7A_P3_15	7	a	31	22	1	110	06:35	474.3	0.2second	0.25	sandbox		3	0.2
St7A_P3_16	7	a	31	22	1	110	06:35	474.3	0.2second	0.25	sandbox		3	0.2
St7A_P3_17	7	a	31	22	1	110	06:35	474.3	0.2second	0.25	sandbox		3	0.2
St7A_P3_18	7	a	31	22	1	110	06:35	474.3	3second	0.5	sandbox		150	3
St7A_P3_19	7	a	31	22	1	110	06:35	474.3	3second	0.5	sandbox		150	3
St7A_P3_20	7	a	31	22	1	110	06:35	428.3	3second	0.5	sandbox		150	3
St7A_P4_1	7	a	31	22	1	130	06:35	474.3	0.2	0.25	protein		3	0.2
St7A_P4_2	7	a	31	22	1	130	06:35	474.3	0.2	0.25	sandbox		3	0.2
St7A_P4_3	7	a	31	22	1	130	06:35	474.3	0.2	0.25	metallome		3	0.2
St7A_P4_4	7	a	31	22	1	130	06:35	474.3	3	0.125	metals		3	3
St7A_P4_5	7	a	31	22	1	130	06:35	474.3	0.2	0.0625	DNA_julie		3	0.2
St7A_P4_6	7	a	31	22	1	130	06:35	474.3	0.2	0.0625	DNA_liz		3	0.2
St7A_P4_7	7	a	31	22	1	130	06:35	474.3	3	0.25	protein		3	3
St7A_P4_8	7	a	31	22	1	130	06:35	474.3	3	0.25	hosphoprotein		3	3
St7A_P4_9	7	a	31	22	1	130	06:35	474.3	3	0.25	hosphoprotein		3	3
St7A_P4_10	7	a	31	22	1	130	06:35	474.3	3	0.125	metallome		3	3
St7A_P4_11	7	a	31	22	1	130	06:35	474.3	3	0.0625	metals		3	3
St7A_P4_12	7	a	31	22	1	130	06:35	474.3		0.0625	DNA_julie		3	3
St7A_P4_15	7	a	31	22	1	130	06:35	467.3	0.2second	0.25	sandbox		3	0.2
St7A_P4_16	7	a	31	22	1	130	06:35	467.3	0.2second	0.25	sandbox		3	0.2
St7A_P4_17	7	a	31	22	1	130	06:35	467.3	0.2second	0.25	sandbox		3	0.2

Barcode on_pump_sample	Station	Deploy #	Approx Lat	Approx Long	Pump #	Depth	Start pump (GMT)	Volume filtered	Filter size	Filter fraction	Sample type	Freezer bag #	max filter size (uM)	min filter size (uM)
St7A_P4_18	7	a	31	22	1	130	06:35	467.3	0.2second	0.25	sandbox		3	0.2
St7A_P4_19	7	a	31	22	1	130	06:35	467.3	3second	0.5	sandbox	150	150	3
St7A_P4_20	7	a	31	22	1	130	06:35	467.3	3second	0.5	sandbox		150	3
St7B_P1_1	7	b	31	22	2	15	09:30	128.4	0.2	0.25	protein	3	3	0.2
St7B_P1_2	7	b	31	22	2	15	09:30	128.4	0.2	0.25	hosphoprotein	3	3	0.2
St7B_P1_3	7	b	31	22	2	15	09:30	128.4	0.2	0.25	metallome	3	3	0.2
St7B_P1_4	7	b	31	22	2	15	09:30	128.4	0.2	0.25	metals	3	3	0.2
St7B_P1_5	7	b	31	22	2	15	09:30	128.4	0.2	0.0625	DNA_julie	3	3	0.2
St7B_P1_6	7	b	31	22	2	15	09:30	128.4	0.2	0.0625	DNA_liz	3	3	0.2
St7B_P1_7	7	b	31	22	2	15	09:30	128.4	0.2	0.25	protein	150	150	3
St7B_P1_8	7	b	31	22	2	15	09:30	128.4	0.2	0.25	hosphoprotein	150	150	3
St7B_P1_9	7	b	31	22	2	15	09:30	128.4	0.2	0.25	metallome	150	150	3
St7B_P1_10	7	b	31	22	2	15	09:30	128.4	0.2	0.0625	DNA_liz	150	150	3
St7B_P1_11	7	b	31	22	2	15	09:30	128.4	3	0.125	metals	150	150	3
St7B_P1_12	7	b	31	22	2	15	09:30	128.4	3	0.0625	sandbox	150	150	3
St7B_P1_15	7	b	31	22	2	15	09:30	162.3	0.2	0.25	sandbox	150	150	3
St7B_P1_16	7	b	31	22	2	15	09:30	162.3	0.2	0.25	sandbox	150	150	3
St7B_P1_17	7	b	31	22	2	15	09:30	162.3	0.2	0.25	sandbox	150	150	3
St7B_P1_18	7	b	31	22	2	15	09:30	162.3	0.2	0.25	DNA_liz	3	3	0.2
St7B_P1_19	7	b	31	22	2	15	09:30	162.3	3	0.125	metals	3	3	0.2
St7B_P1_20	7	b	31	22	2	15	09:30	162.3	3	0.25	hosphoprotein	150	150	3
_P1_handwr	7	b	31	22	3	150	10:00	128.4	150uM	0.5	protein	150	150	150
_P1_handwr	7	c	31	22	3	150	10:00	128.4	150uM	0.5	tricho	150	150	150
St7B_P3_20	7	b	31	22	2	40	09:30	339.3	3second	0.5	sandbox	3	3	0.2
St7B_P3_19	7	b	31	22	2	40	09:30	339.3	3second	0.5	sandbox	3	3	0.2
St7B_P3_18	7	b	31	22	2	40	09:30	339.3	0.2second	0.25	sandbox	3	3	0.2
St7B_P3_17	7	b	31	22	2	40	09:30	339.3	0.2second	0.25	sandbox	3	3	0.2
St7B_P3_16	7	b	31	22	2	40	09:30	339.3	0.2second	0.25	sandbox	3	3	0.2
St7B_P3_15	7	b	31	22	2	40	09:30	339.3	0.2second	0.25	sandbox	3	3	0.2
St7B_P3_12	7	b	31	22	2	40	09:30	295.8	3	0.0625	DNA_liz	3	3	0.2
St7B_P3_11	7	b	31	22	2	40	09:30	295.8	3	0.125	metals	150	150	3
St7B_P3_10	7	b	31	22	2	40	09:30	295.8	3	0.25	metallome	150	150	3
St7B_P3_9	7	b	31	22	2	40	09:30	295.8	3	0.25	hosphoprotein	150	150	3
St7B_P3_8	7	b	31	22	2	40	09:30	295.8	3	0.25	protein	150	150	3
St7B_P3_7	7	b	31	22	2	40	09:30	295.8	0.2second	0.25	DNA_liz	3	3	0.2
St7B_P3_6	7	b	31	22	2	40	09:30	295.8	0.2second	0.0625	DNA_julie	3	3	0.2
St7B_P3_5	7	b	31	22	2	40	09:30	295.8	0.2second	0.0625	DNA_julie	3	3	0.2
St7B_P3_4	7	b	31	22	2	40	09:30	295.8	0.2second	0.125	metals	3	3	0.2
St7B_P3_3	7	b	31	22	2	40	09:30	295.8	0.2	0.25	sandbox	3	3	0.2
St7B_P3_2	7	b	31	22	2	40	09:30	295.8	0.2	0.25	sandbox	3	3	0.2
St7B_P3_1	7	b	31	22	2	40	09:30	295.8	0.2	0.25	sandbox	3	3	0.2
_P3_handwr	7	c	31	22	3	150	10:00	295.8	150uM	0.5	tricho	150	150	150
_P3_handwr	7	c	31	22	3	40	10:00	295.8	150uM	0.5	hosphoprotein	150	150	150
St7B_P4_1	7	b	31	22	2	70	09:30	340	0.2	0.25	protein	3	3	0.2
St7B_P4_2	7	b	31	22	2	70	09:30	340	0.2	0.25	hosphoprotein	3	3	0.2
St7B_P4_3	7	b	31	22	2	70	09:30	340	0.2	0.25	metallome	3	3	0.2
St7B_P4_4	7	b	31	22	2	70	09:30	340	0.2	0.125	metals	3	3	0.2
St7B_P4_5	7	b	31	22	2	70	09:30	340	0.2	0.0625	DNA_julie	3	3	0.2

Barcode on_pump_sample	Station	Deploy #	Approx Lat	Approx Long	Pump #	Depth	Start pump (GMT)	Volume filtered	Filter size	Filter fraction	Sample type	Freezer bag #	max filter size (uM)	min filter size (uM)
St7B_P4_6	7	b	31	22	2	70	09:30	340	0.2	0.0625	DNA_liz		3	0.2
St7B_P4_7	7	b	31	22	2	70	09:30	340	3	0.25	protein		150	3
St7B_P4_8	7	b	31	22	2	70	09:30	340	3	0.25	hosphoprotein		150	3
St7B_P4_9	7	b	31	22	2	70	09:30	340	3	0.25	metallome		150	3
St7B_P4_10	7	b	31	22	2	70	09:30	340	3	0.125	metals		150	3
St7B_P4_11	7	b	31	22	2	70	09:30	340	3	0.25	DNA_Julie		150	3
St7B_P4_12	7	b	31	22	2	70	09:30	340	0.2	0.0625	DNA_liz		3	0.2
St7B_P4_15	7	b	31	22	2	70	09:30	341.3	0.2second	0.25	sandbox		3	0.2
St7B_P4_16	7	b	31	22	2	70	09:30	341.3	0.2second	0.25	sandbox		3	0.2
St7B_P4_17	7	b	31	22	2	70	09:30	341.3	0.2second	0.25	sandbox		3	0.2
St7B_P4_18	7	b	31	22	2	70	09:30	341.3	0.2second	0.25	sandbox		3	0.2
St7B_P4_19	7	b	31	22	2	70	09:30	341.3	3second	0.5	sandbox		150	3
St7B_P4_20	7	b	31	22	2	70	09:30	341.3	3second	0.5	sandbox		150	3
_P4_handwr	7	b	31	22	2	70	10:00	340	150uM	0.5	tricho		150	150
_P4_handwr	7	b	31	22	2	70	10:00	340	150uM	0.5	tricho		150	150
St7C_P3_1	7	c	31	22	3	150	10:00	422	0.2second	0.25	protein		3	0.2
St7C_P3_2	7	c	31	22	3	150	10:00	422	3	0.5	tricho		150	3
_P3_handwr	7	c	31	22	3	150	10:00	412.1	150uM	0.5	tricho		150	150
_P3_handwr	7	c	31	22	3	150	10:00	412.1	150uM	0.5	metallome		150	150
St7C_P3_20	7	c	31	22	3	150	10:00	422	3second	0.5	sandbox		150	3
St7C_P3_19	7	c	31	22	3	150	10:00	422	3second	0.5	sandbox		150	3
St7C_P3_18	7	c	31	22	3	150	10:00	422	0.2second	0.25	sandbox		3	0.2
St7C_P3_17	7	c	31	22	3	150	10:00	422	0.2second	0.25	sandbox		3	0.2
St7C_P3_16	7	c	31	22	3	150	10:00	422	0.2second	0.25	sandbox		3	0.2
St7C_P3_15	7	c	31	22	3	150	10:00	422	3	0.0625	DNA_liz		150	3
St7C_P3_12	7	c	31	22	3	150	10:00	412.1	3	0.0625	metals		150	3
St7C_P3_11	7	c	31	22	3	150	10:00	412.1	3	0.25	DNA_liz		150	3
St7C_P3_10	7	c	31	22	3	150	10:00	412.1	0.2	0.25	sandbox		3	0.2
St7C_P3_9	7	c	31	22	3	150	10:00	412.1	0.2	0.25	sandbox		3	0.2
St7C_P3_8	7	c	31	22	3	150	10:00	412.1	0.2	0.25	sandbox		3	0.2
St7C_P3_7	7	c	31	22	3	150	10:00	412.1	0.2	0.25	protein		3	0.2
St7C_P3_6	7	c	31	22	3	150	10:00	412.1	0.2	0.0625	DNA_liz		3	0.2
St7C_P3_5	7	c	31	22	3	150	10:00	412.1	0.2	0.25	sandbox		3	0.2
St7C_P3_4	7	c	31	22	3	150	10:00	412.1	0.2	0.25	sandbox		3	0.2
St7C_P3_3	7	c	31	22	3	150	10:00	412.1	0.2	0.25	sandbox		3	0.2
St7C_P3_2	7	c	31	22	3	150	10:00	412.1	0.2	0.25	sandbox		3	0.2
St7C_P3_1	7	c	31	22	3	150	10:00	412.1	0.2	0.25	DNA_liz		3	0.2
St7C_P4_1	7	c	31	22	3	200	10:00	415.7	0.2	0.25	DNA_liz		3	0.2
St7C_P4_2	7	c	31	22	3	200	10:00	415.7	0.2	0.25	protein		3	0.2
St7C_P4_3	7	c	31	22	3	200	10:00	415.7	0.2	0.25	metallome		3	0.2
St7C_P4_4	7	c	31	22	3	200	10:00	415.7	0.2	0.125	metals		3	0.2
St7C_P4_5	7	c	31	22	3	200	10:00	415.7	0.2	0.125	DNA_julie		3	0.2
St7C_P4_6	7	c	31	22	3	200	10:00	415.7	0.2	0.25	DNA_liz		3	0.2
St7C_P4_7	7	c	31	22	3	200	10:00	415.7	3	0.25	protein		150	3
St7C_P4_8	7	c	31	22	3	200	10:00	415.7	3	0.25	hosphoprotein		150	3
St7C_P4_9	7	c	31	22	3	200	10:00	415.7	3	0.25	metallome		150	3
St7C_P4_10	7	c	31	22	3	200	10:00	415.7	3	0.125	metals		150	3
St7C_P4_11	7	c	31	22	3	200	10:00	415.7	3	0.0625	DNA_julie		150	3
St7C_P4_12	7	c	31	22	3	200	10:00	415.7	3	0.0625	DNA_liz		150	3
St7C_P4_15	7	c	31	22	3	200	10:00	409.8	0.2second	0.25	sandbox		3	0.2

Barcode on_pump_sample	Station	Deploy #	Approx Lat	Approx Long	Pump #	Depth	Start pump (GMT)	Volume filtered	Filter size	Filter fraction	Sample type	Freezer bag #	max filter size (uM)	min filter size (uM)
St7C_P4_16	7	c	31	22	3	200	10:00	409.8	0.2second	0.25	sandbox	3	3	0.2
St7C_P4_17	7	c	31	22	3	200	10:00	409.8	0.2second	0.25	sandbox	3	3	0.2
St7C_P4_18	7	c	31	22	3	200	10:00	409.8	0.2second	0.25	sandbox	3	3	0.2
St7C_P4_19	7	c	31	22	3	200	10:00	409.8	3second	0.5	sandbox	3		3
St7C_P4_20	7	c	31	22	3	200	10:00	409.8	3second	0.5	sandbox	3		3
P4_handwr	7	c	31	22	3	200	10:00	409.8	0.2second	0.25	sandbox	3	3	0.2
P4_handwr	7	c	31	22	3	200	10:00	409.8	0.2second	0.25	sandbox	3	3	0.2
P4_handwr	7	c	31	22	3	200	10:00	409.8	3second	0.5	sandbox	3		3
P4_handwr	7	c	31	22	3	200	10:00	415.7	150uM	0.5	tricho		150	150
P4_handwr	7	c	31	22	3	200	10:00	415.7	150uM	0.5	tricho		150	150
P1_handwr	7	c	31	22	3	40	10:00	21.88	0.2uM	0.5	sandbox	3	3	0.2
P1_handwr	7	c	31	22	3	40	10:00	21.88	0.2uM	0.5	sandbox	3	3	0.2
P1_handwr	7	c	31	22	3	40	10:00	21.88	0.2uM	0.5	sandbox	3	3	0.2
P1_handwr	7	c	31	22	3	40	10:00	21.88	0.2uM	0.5	sandbox	3	3	0.2
P1_handwr	7	c	31	22	3	40	10:00	21.88	3uM	1	sandbox	150	150	3
St7D_P3_1	7	d	31	22	4	300	09:35	243.2	0.2	0.25	protein	3	3	0.2
St7D_P3_2	8	d	31	22	4	300	09:35	243.2	0.2	0.25	hosphoprotein	3	3	0.2
St7D_P3_3	9	d	31	22	4	300	09:35	243.2	3	0.0625	DNA_liz	3	150	3
St7D_P3_4	10	d	31	22	4	300	09:35	243.2	3	0.125	metals	3	150	3
St7D_P3_5	11	d	31	22	4	300	09:35	243.2	0.2	0.0625	DNA_julie	3	3	0.2
St7D_P3_6	12	d	31	22	4	300	09:35	243.2	0.2	0.2	DNA_liz	3	3	0.2
St7D_P3_7	13	d	31	22	4	300	09:35	243.2	0.2	0.25	protein	3	150	3
St7D_P3_8	14	d	31	22	4	300	09:35	243.2	0.2	0.25	hosphoprotein	3	150	3
St7D_P3_9	15	d	31	22	4	300	09:35	243.2	0.2	0.25	metallome	3	150	3
St7D_P3_10	16	d	31	22	4	300	09:35	243.2	0.2	0.25	protein	3	150	3
St7D_P3_11	17	d	31	22	4	300	09:35	243.2	0.0625	0.0625	hosphoprotein	3	150	3
St7D_P3_12	18	d	31	22	4	300	09:35	243.2	0.0625	0.0625	DNA_liz	3	150	3
St7D_P3_15	19	d	31	22	4	300	09:35	755	3	0.125	metals	3	3	3
St7D_P3_16	20	d	31	22	4	300	09:35	755	3	0.25	sandbox	3	3	3
St7D_P3_17	21	d	31	22	4	300	09:35	755	0.2	0.25	sandbox	3	3	0.2
St7D_P3_18	22	d	31	22	4	300	09:35	755	0.2	0.25	sandbox	3	3	0.2
St7D_P3_19	23	d	31	22	4	300	09:35	755	3second	0.5	sandbox	3		3
St7D_P3_20	24	d	31	22	4	300	09:35	755	3second	0.5	sandbox	3		3
St7D_P4_1	25	d	31	22	4	400	09:35	403.7	0.2	0.25	protein	3	150	3
St7D_P4_2	26	d	31	22	4	400	09:35	403.7	0.2	0.25	hosphoprotein	3	3	0.2
St7D_P4_3	27	d	31	22	4	400	09:35	403.7	0.2	0.25	metallome	3	150	3
St7D_P4_4	28	d	31	22	4	400	09:35	403.7	0.2	0.125	metals	3	3	0.2
St7D_P4_5	29	d	31	22	4	400	09:35	403.7	0.2	0.0625	DNA_julie	3	3	0.2
St7D_P4_6	30	d	31	22	4	400	09:35	403.7	0.2	0.0625	DNA_liz	3	3	0.2
St7D_P4_7	31	d	31	22	4	400	09:35	403.7	3	0.25	protein	3	150	3
St7D_P4_8	32	d	31	22	4	400	09:35	403.7	3	0.25	hosphoprotein	3	150	3
St7D_P4_9	33	d	31	22	4	400	09:35	403.7	3	0.25	metallome	3	150	3
St7D_P4_10	34	d	31	22	4	400	09:35	403.7	3	0.25	metallome	3	150	3
St7D_P4_11	35	d	31	22	4	400	09:35	403.7	3	0.0625	metals	3	150	3
St7D_P4_12	36	d	31	22	4	400	09:35	403.7	3	0.0625	DNA_julie	3	150	3
St7D_P4_15	37	d	31	22	4	400	09:35	392	0.2second	0.25	sandbox	3	3	0.2
St7D_P4_16	38	d	31	22	4	400	09:35	392	0.2second	0.25	sandbox	3	3	0.2
St7D_P4_17	39	d	31	22	4	400	09:35	392	0.2second	0.25	sandbox	3	3	0.2
St7D_P4_18	40	d	31	22	4	400	09:35	392	0.2second	0.25	sandbox	3	3	0.2
St7D_P4_19	41	d	31	22	4	400	09:35	392	3second	0.5	sandbox	3	3	3
St7D_P4_20	42	d	31	22	4	400	09:35	392	3second	0.5	sandbox	3	3	3

Supplementary Information S11:

Cell quota grid log

Elizabeth Mann

JC150 Grid Log

Grid #	Date	Station	Incubation	Timepoint	Treatment	File Name	Grid Quality	Stick Name
1	03/07/2017	1	D	T=0	Ctrl, Initial	JC150_1	High	JC150 Sta 1 D, T=0 #1
2							High	JC150 Sta 1 D, T=0 #2
3	03/07/2017	1	D	T=0	Ctrl, Initial		Low	
4							Low	JC150 Sta 1 D, T=0 #2A
5	03/07/2017	1	D	T=0	Ctrl, Initial		Med	
6	03/07/2017	1	D	T=0	Ctrl, Initial		Low	JC150 Sta 1 D, T=0 #3
7							Low	
8	05/07/2017	1	D	T=48, End	Ctrl	JC150_8	High	JC150 Sta 1 D, End Ctrl A
9							High	
10	05/07/2017	1	D	T=48, End	+ Zn	JC150_10	High	JC150 Sta 1 D, End Zn G
11							High	
12	05/07/2017	1	D	T=48, End	+ Fe		High	JC150 Sta 1 D, End Fe M
13							High	
14	05/07/2017	1	D	T=48, End	Ctrl		High	JC150 Sta 1 D, End Ctrl B
15							Med	
16	05/07/2017	1	D	T=48, End	+ Zn		High	JC150 Sta 1 D, End Zn H
17							High	
18	05/07/2017	1	D	T=48, End	+ Fe		Med	JC150 Sta 1 D, End Fe N
19							High	
20	05/07/2017	1	D	T=48, End	Ctrl		Low	JC150 Sta 1 D, End Ctrl C
21							Med	
22	05/07/2017	1	D	T=48, End	+ Zn		High	JC150 Sta 1 D, End Zn I
23							Med	

Grid #	Date	Station	Incubation	Timepoint	Treatment	File Name	Grid Quality	**Should be labeled O, for 3rd set**	Stick Name
24	05/07/2017	1	D	T=48, End	+ Fe		Low		JC150 Sta 1 D, End Fe N
25							Med		
26	09/07/2017	2	E	T=0	Ctrl, Initial		Med		JC150 T=0 Extra Exp, Sta 2
27							High		
28	11/07/2017	2	D	T=0	Ctrl, Initial	JC150_29	Med		JC150 Exp D, T=0 7/11/17 Sta 2 A
29							High		
30	11/07/2017	2	D	T=0	Ctrl, Initial		Low		JC150 Exp D, T=0 7/11/17 Sta 2 B
31							High		
32	13/07/2017	2	D	T=48	Ctrl		High		JC150 7/13/17 Sta 2, D T=48 Ctrl
33							High		
34	13/07/2017	2	D	T=48	+N		Med		JC150 7/13/17 Sta 2, D T=48 +Nitrog
35							High		
36	13/07/2017	2	D	T=48	+N, +Zn		High		JC150 7/13/17 Sta 2, T=48 N,Zn
37							High		
38	13/07/2017	2	D	T=48	+N, + Fe		Low		JC150 7/13/17 Sta 2 D, T=48 Fe,N
39							High		
40	13/07/2017	2	D	T=48	Ctrl		High		JC150 7/13/17 Sta 2, D T=48 Ctrl
41							High		
42	13/07/2017	2	D	T=48	+N		Med		JC150 7/13/17 Sta 2, D T=48 +N B
43							Med		
44	13/07/2017	2	D	T=48	+N, + Zn		High		JC150 7/13/17 Sta 2, T=48 N,Zn B
45							High		
46	13/07/2017	2	D	T=48	+N, + Fe		High		JC150 7/13/17 Sta 2 D, T=48 Fe,N B
47							Med		

Grid #	Date	Station	Incubation	Timepoint	Treatment	File Name	Grid Quality	Stick Name
48	15/07/2017	3	D	T=0	Ctrl, Initial		High	JC150 7/15/17 Sta 3 T=0, D A Ctrl
49							Med	
50	15/07/2017	3	D	T=0	Ctrl, Initial		High	JC150 7/15/17 Sta 3 T=0, D Control B
51							Med	
52	17/07/2017	3	D	T=48	Ctrl			JC150 7/15/17 Sta 3 D, T=48 Ctrl A
53								
54	17/07/2017	3	D	T=48	+N			JC150 7/15/17 Sta 3 D, T=48 +N A
55								
56	17/07/2017	3	D	T=48	+N, +Zn			JC150 7/15/17 Sta 3 D, T=48 +Zn A
57								
58	17/07/2017	3	D	T=48	+N, +Fe			JC150 7/15/17 Sta 3 D, T=48 +Fe A
59								
60	17/07/2017	3	D	T=48	Ctrl			JC150 7/15/17 Sta 3 D, T=48 Ctrl B
61								
62	17/07/2017	3	D	T=48	+N			JC150 7/15/17 Sta 3 D, T=48 +N B
63								
64	17/07/2017	3	D	T=48	+N, +Zn			JC150 7/15/17 Sta 3 D, T=48 +Zn B
65								
66	17/07/2017	3	D	T=48	+N, +Fe			JC150 7/15/17 Sta 3 D, T=48 +Fe B
67								
68	20/07/2017	4	D	T=0	Ctrl, Initial		High	JC150 7/20/17 Sta 4, D T=0 Ctrl A
69							High	
70	20/07/2017	4	D	T=0	Ctrl, Initial		High	JC150 7/20/17 Sta 4, D T=0 Ctrl B
71							Med	

Note - if grid in "+N" series, all samples had N except for Ctrl

Grid #	Date	Station	Incubation	Timepoint	Treatment	File Name	Grid Quality	Stick Name
72	22/07/2017	4	D	T=48	Ctrl		Low	JC150 7/20/17 Sta 4, D T=48 Ctrl A
73							Med	
74	22/07/2017	4	D	T=48	Ctrl		High	JC150 7/20/17 Sta 4, D T=48 Ctrl A xtra
75	22/07/2017	4	D	T=48	+N		Med	JC150 7/20/17 Sta 4, D T=48 +N A
76							Low	
77	22/07/2017	4	D	T=48	+N, +Zn		Low to Med	JC150 7/20/17 Sta 4, D T=48 +Zn A
78							Low to Med	Note – if grid in "+N" series, all samples had N except for Ctrl
79	22/07/2017	4	D	T=48	+N, +Zn		High	JC150 7/20/17 Sta 4, D T=48 +Zn xtra
80	22/07/2017	4	D	T=48	+N, +Fe		High	JC150 7/20/17 Sta 4, D T=48 +Fe A
81							Med	
82	22/07/2017	4	D	T=48	Ctrl		High	JC150 7/20/17 Sta 4, D T=48 Ctrl B
83							High	
84	22/07/2017	4	D	T=48	Ctrl		High	JC150 7/20/17 Sta 4, D T=48 Ctrl B xtra
85	22/07/2017	4	D	T=48	+N		High	JC150 7/20/17 Sta 4, D T=48 +N B
86							High	
87	22/07/2017	4	D	T=48	+N		High	JC150 7/20/17 Sta 4, D T=48 +N B xtra
88	22/07/2017	4	D	T=48	+N, +Zn		High	JC150 7/20/17 Sta 4, D T=48 +Zn B
89							High	
90	22/07/2017	4	D	T=48	+N, +Zn		Med	JC150 7/20/17 Sta 4, D T=48 +Zn extra B
91	22/07/2017	4	D	T=48	+N, +Fe		Low	JC150 7/20/17 Sta 4, D T=48 +Fe B
92							Med	
93	22/07/2017	4	D	T=48	+N, +Fe		High	JC150 7/20/17 Sta 4, D T=48 +Fe xtra

Grid #	Date	Station	Incubation	Timepoint	Treatment	File Name	Grid Quality	Stick Name
94, 95	25/07/2017	5	D	T=0	Ctrl, Initial		High, Med	JC150 7/25/17 Sta 5, D T=0 Ctrl A1
96, 97	25/07/2017	5	D	T=0	Ctrl, Initial		Med, High	JC150 7/25/17 Sta 5, D T=0 Ctrl A2
98, 99	27/07/2017	5	D	T=48	Ctrl		Low, Low	JC150 7/27/17 Sta 5, D T=48 Ctrl A1
100	27/07/2017	5	D	T=48	Ctrl		Med	JC150 7/27/17 Sta 5, D T=48 Ctrl A1 xtra
101, 102	27/07/2017	5	D	T=48	+Zn		Med, High	JC150 7/27/17 Sta 5, D T=48 +Zn B1
103	27/07/2017	5	D	T=48	+Zn		Low	JC150 7/27/17 Sta 5, D T=48 +Zn B1 xtra
104, 105	27/07/2017	5	D	T=48	+Fe		Med, Med	JC150 7/27/17 Sta 5, D T=48 +Fe E1
106	27/07/2017	5	D	T=48	+Fe		Low	JC150 7/27/17 Sta 5, D T=48 +Zn B1 xtra
107, 108	27/07/2017	5	D	T=48	Ctrl		Med, High	JC150 7/27/17 Sta 5, D T=48 Ctrl A3
109	27/07/2017	5	D	T=48	Ctrl		High	JC150 7/27/17 Sta 5, D T=48 Ctrl A3 xtra
110, 111	27/07/2017	5	D	T=48	+Zn		Low, Low	JC150 7/27/17 Sta 5, D T=48 +Zn B3
112	27/07/2017	5	D	T=48	+Zn		Med	JC150 7/27/17 Sta 5, D T=48 +Zn B3 xtra
113, 114	27/07/2017	5	D	T=48	+Fe		Low, High	JC150 7/27/17 Sta 5, D T=48 +Fe E3
115	27/07/2017	5	D	T=48	+Fe		Low	JC150 7/27/17 Sta 5, D T=48 +Fe E3 xtra

Grid #	Date	Station	Incubation	Timepoint	Treatment	File Name	Grid Quality	Stick Name
116	24/07/2107	5	+Ni	T=24	Ctrl 3		High	JC150 7/24/17 Sta 5, +Ni, Ctrl 3 T=24
117							High	
118	24/07/2107	5	+Ni	T=24	Ctrl 3		High	JC150 7/24/17 Sta 5, +Ni, Ctrl 3 extra T=24
119	24/07/2107	5	+Ni	T=24	+Ni 3		Low to Med	JC150 7/24/17 Sta 5, +Ni, +Ni 3 T=24
120							High	
121	24/07/2107	5	+Ni	T=24	+Ni 3		High	JC150 7/24/17 Sta 5, +Ni, +Ni 3 xtra T=24
122	25/07/2017	5	Trich	T=24	Ctrl 2		High	JC150 7/25/17 Sta 5, Trich T=24 Ctrl 2
123							High	
124	25/07/2017	5	Trich	T=24	Ctrl 2		High	JC150 7/25/17 Sta 5, Trich T=24 Ctrl 2 xtra
125	25/07/2017	5	Trich	T=24	+Ni 1		Low	JC150 7/25/17 Sta 5, Trich T=24 +Ni 1
126						JC150_126	High	
127	25/07/2017	5	Trich	T=24	+Ni 1		High	JC150 7/25/17 Sta 5, Trich T=24 +Ni 1 xtra
128	28/07/2017	6	D-Up	T=0	Ctrl, Initial 1		High	JC150 7/28/17 Sta 6, D T=0 Ctrl 1
129							Med	
130	28/07/2017	6	D-Up	T=0	Ctrl, Initial 2		Med	JC150 7/28/17 Sta 6, D T=0 Ctrl 2
131							Med	
132	02/08/2017	6	DT	T=0	Ctrl, Initial		Med	JC150 8/2/17 Sta 6, DT T=0 Initial 1
133							High	
134	02/08/2017	6	DT	T=0	Ctrl, Initial		High	JC150 8/2/17 Sta 6, DT T=0 Initial 2
135							High	
136	03/08/2017	6	DT	T=12	Ctrl		High	JC150 8/3/17 Sta 6, DT T=12 Ctrl
137							Med	
138	03/08/2017	6	DT	T=12	+Zn		Med	JC150 8/3/17 Sta 6, DT T=12 1A Zn
139							High	

DT = Experiment D, Timecourse

Grid #	Date	Station	Incubation	Timepoint	Treatment	File Name	Grid Quality	Stick Name
140 141	03/08/2017	6	DT	T=12	+Fe		High High	JC150 8/3/17 Sta 6, DT T=12 +Fe 1
142 143	03/08/2017	6	DT	T=24	Ctrl		High High	JC150 8/3/17 Sta 6, DT Ctrl T=24
144 145	03/08/2017	6	DT	T=24	+Zn		Low High	JC150 8/3/17 Sta 6, DT T=24 Zn 1
146 147	03/08/2017	6	DT	T=24	+Fe		High High	JC150 8/3/17 Sta 6, DT T=24 Fe 1
148 149	03/08/2017	6	DT	T=24	Ctrl		High High	JC150 8/3/17 Sta 6, DT T=24 Ctrl 2
150 151	03/08/2017	6	DT	T=24	+Zn		High High	JC150 8/3/17 Sta 6, DT T=24 +Zn 2
152 153	03/08/2017	6	DT	T=24	+Fe		Med High	JC150 8/3/17 Sta 6, DT T=24 +Fe 2
154 155	03/08/2017	6	DT	T=36	Ctrl		High High	JC150 8/3/17 Sta 6, DT T=36 Ctrl
156 157	03/08/2017	6	DT	T=36	+Zn		Med Med	JC150 8/3/17 Sta 6, DT T=36 +Zn
158 159	03/08/2017	6	DT	T=36	+Fe		High High	JC150 8/3/17 Sta 6, DT T=36 +Fe
160 161	04/08/2017	6	DT	T=48	Ctrl	T=48 grid sticks may possibly still say 8/3	High Med	JC150 8/4/17 Sta 6, DT T=48 Ctrl
162 163	04/08/2017	6	DT	T=48	+Zn		High High	JC150 8/4/17 Sta 6, DT T=48 +Zn

Grid #	Date	Station	Incubation	Timepoint	Treatment	File Name	Grid Quality	Stick Name
164	04/08/2017	6	DT	T=48	+Fe		High	JC150 8/4/17 Sta 6, DT T=48 +Fe
165							High	
166	05/08/2017	6	DT	T=60	Ctrl		Med	JC150 8/5/17 Sta 6, DT T=60 Ctrl
167							Med	
168	05/08/2017	6	DT	T=60	+Zn		Med	JC150 8/5/17 Sta6, DT T=60 +Zn
169							Med	
170	05/08/2017	6	DT	T=60	+Fe		High	JC150 8/5/17 Sta 6, DT T=60 +Fe
171							High	
172	05/08/2017	6	DT	T=72	Ctrl		Low	JC150 8/5/17 Sta 6, DT T=72 Ctrl
173							High	
174	05/08/2017	6	DT	T=72	+Zn		High	JC150 8/5/17 Sta 6, D T=0 Initial 1 * MISLABELED
175							High	
176	05/08/2017	6	DT	T=72	+Fe		Low	JC150 8/5/17 Sta 6, D T=0 Initial 2 * MISLABELED
177							High	
178	05/08/2017	7	D	T=0	Ctrl, Initial		High	JC150 8/5/17 Sta 7, D T=0 Initial 1
179							High	
180	05/08/2017	7	D	T=0	Ctrl, Initial		Low	JC150 8/5/17 Sta 7, D T=0 Initial 2
181							Med	
182	07/08/2017	7	D	T=48	Ctrl		Med	JC150 8/7/17 Sta 7, D T=48 Ctrl 1
183							High	
184	07/08/2017	7	D	T=48	+Zn		Low	JC150 8/7/17 Sta 7, D T=48 +Zn 1
185							Med	
186	07/08/2017	7	D	T=48	+Fe		High	JC150 8/7/17 Sta 7, D T=48 +Fe 1
187							High	

Grid #	Date	Station	Incubation	Timepoint	Treatment	File Name	Grid Quality	Stick Name
188	07/08/2017	7	D	T=48	Ctrl		Med	JC150 8/7/17 Sta 7, D T=48 Ctrl 3
189							Med	
190	07/08/2017	7	D	T=48	+Zn		High	JC150 8/7/17 Sta 7, D T=48 +Zn 3
191							Low to Med	
192	07/08/2017	7	D	T=48	+Fe		High	JC150 8/7/17 Sta 7, D T=48 +Fe 3
193							High	

Supplementary Information S12: Plankton Photos

Elizabeth Mann

Representative SXRF Target Cells

Station 1, Exp D T=48, +Zn

JC150_10 #7

Autotrophic flagellate, ~1.5u

JC150_10D #8

Probable dinoflagellate, ~8 x 10u
Small round cell, ~1.4u

JC150_10D #12

Autotrophic flagellate, ~4.0u
Small round cells, ~1.4u
Probable coccolithophore, ~6.5u long with 2u long liths

Representative SXRF Target Cells

Station 2, Exp D T=0 Initial

JC150_29 #13

Probable cyanobacteria, ~1 to 2u

Station 1, Exp D T=48 +N, +Fe

JC150_25

Large pennate diatom, probably only abundant enough for SXRF analysis at Station 7

Representative SXRF Target Cells

Station 5, Exp D T=48, +Fe

Large eukaryotic autotrophs – too rare to be good SXRF targets. Plus coccoliths with their high Ca signature mask the fluorescence from other elements.

Coccolithophore covered in liths

JC150_106

Coccolithophore with some liths removed, so spikes that support liths are visible.

Large autotrophic flagellate

JC150_106

Representative SXRF Grid Large Liths
Station 1, Exp D T=48, +Zn

JC150_10D #11

JC150_10B #14

JC150_10B #25

"Fried egg liths"
Roughly 6 to 9u in diameter

Internal symbiont?

Radiolarian like protist

Radiolarian like protist

10u filter pore

Trich filaments and empty dinoflagellates and pennate

Zooplankton

Station 7, CTD 053 40m

Zooplankton after a meal?

Radiolarian like protist

Autotroph

Autotroph with distinct chloroplasts

Pennate diatoms with dim fluorescence and bright decaying Trichodesmium filament(?)

Station 7, CTD 053 90m

Chaetoceros and large autotroph

Dinoflagellate and radiolarian like protist

Centric diatoms and other autotroph

Radiolarian like protist

Rhizoselenia, other pennates

Trichodesmium

Station 7, Twisted filaments with Rhizoselenia

Station 7, Pennate and centric diatom clump with Trichodesmium

Thin filaments associated with Trichodesmium

Station 7, 10x puff

Supplementary Information S13:

Lebus Winch Report

Owain Shepherd

Lebus 18.5mm Umbilical Lift Winch System (Metal Free) - University of Oxford

Owian Shepherd

Sporadic inexplicable stopping of the winch system has been experienced throughout cruise JC150 when control system is in auto. There has been no correlation observed between winch stoppages and haul or veer speeds, cable length paid out, or time system has been in operation. Returning auto potentiometer to the stop position and then back to desired haul or veer speed has been the solution utilised to get winch system operating again and CTD operations resumed. This is clearly a controls issue that will require further investigation if control issues are to be identified and interrogated. In order to achieve this it will be necessary to conduct suitably designed winch trials serials. Previous trials have not recorded suitable or sufficient operational data to even begin to diagnose causes of sporadic winch system controls failure.

Observations:

- Controls system is of a basic design and utilises an unsuitable +18V, +12V, +6V control signal in order to haul, stop and veer.
- Impedance of 50m control cable is likely to be affecting transmission of control voltages to Faber pump regulator.
- Induced voltages within control cable through insufficient shielding may be having an adverse effect on control signal received by the Faber pump regulator.
- Current control system cannot be integrated into ship fitted CLAM system without significant redesign to a digital controller system.
- CCTV cables are unsuitable for harsh weather environment, one had already failed during or prior to trials. No replacement was supplied in order to rectify issue.
- Faber pump regulator experienced temperatures exceeding 70°C during normal winch operations due to insufficient cooling to controls situated in main panel. Excessive temperatures experienced may have been a contributing factor to winch cut out issues
- Sauer Danfoss Series 90 axial piston pump proportional solenoid valve may be receiving occasional spurious signals from the Faber pump regulator, possibly due to control cable impedance or excessive temperatures.
- It would be beneficial to ascertain as to whether the Faber pump regulator is suitable as a control signal generator for the Sauer Danfoss Series 90 axial piston pump proportional solenoid valve.
- Scrolling gear keepers are warped and or twisted therefore cannot be fully assembled. Fortunately no movement was evident during normal winch operations and was continually monitored throughout the cruise.
- TICO 735 C428-40052 line speed indicator was incorrectly wired into control system and therefore did not receive 24V DC line out encoder signal. Accurate line speed indication has now been achieved.
- TICO 735 0735A-20052 line tension indication has been factory calibrated to display the correct tension on the mid layers. Therefore the tension variation across all layers is +/- 20% from the mid layer. Additional error is due to fleeting angle to first sheave on parallelogram frame. This was never taken into consideration in the winch system manufacturing specification; consequently a direct pull approach was adopted by winch system manufacturer.

- If existing winch control system is to remain in operation it would be beneficial to route all wiring internally through the ship. This will significantly lengthen service life of control cables and reduce chance of sustaining damage.
- Existing auto potentiometer is not defective. Simple resistance measurements using a Fluke multi-meter have proven that this is not the cause of sporadic winch stoppages as had been previously suggested during winch trials.

Supplementary Information S13:

Lebus Winch Report

Owain Shepherd

Lebus 18.5mm Umbilical Lift Winch System (Metal Free) - University of Oxford

Owian Shepherd

Sporadic inexplicable stopping of the winch system has been experienced throughout cruise JC150 when control system is in auto. There has been no correlation observed between winch stoppages and haul or veer speeds, cable length paid out, or time system has been in operation. Returning auto potentiometer to the stop position and then back to desired haul or veer speed has been the solution utilised to get winch system operating again and CTD operations resumed. This is clearly a controls issue that will require further investigation if control issues are to be identified and interrogated. In order to achieve this it will be necessary to conduct suitably designed winch trials serials. Previous trials have not recorded suitable or sufficient operational data to even begin to diagnose causes of sporadic winch system controls failure.

Observations:

- Controls system is of a basic design and utilises an unsuitable +18V, +12V, +6V control signal in order to haul, stop and veer.
- Impedance of 50m control cable is likely to be affecting transmission of control voltages to Faber pump regulator.
- Induced voltages within control cable through insufficient shielding may be having an adverse effect on control signal received by the Faber pump regulator.
- Current control system cannot be integrated into ship fitted CLAM system without significant redesign to a digital controller system.
- CCTV cables are unsuitable for harsh weather environment, one had already failed during or prior to trials. No replacement was supplied in order to rectify issue.
- Faber pump regulator experienced temperatures exceeding 70°C during normal winch operations due to insufficient cooling to controls situated in main panel. Excessive temperatures experienced may have been a contributing factor to winch cut out issues
- Sauer Danfoss Series 90 axial piston pump proportional solenoid valve may be receiving occasional spurious signals from the Faber pump regulator, possibly due to control cable impedance or excessive temperatures.
- It would be beneficial to ascertain as to whether the Faber pump regulator is suitable as a control signal generator for the Sauer Danfoss Series 90 axial piston pump proportional solenoid valve.
- Scrolling gear keepers are warped and or twisted therefore cannot be fully assembled. Fortunately no movement was evident during normal winch operations and was continually monitored throughout the cruise.
- TICO 735 C428-40052 line speed indicator was incorrectly wired into control system and therefore did not receive 24V DC line out encoder signal. Accurate line speed indication has now been achieved.
- TICO 735 0735A-20052 line tension indication has been factory calibrated to display the correct tension on the mid layers. Therefore the tension variation across all layers is +/- 20% from the mid layer. Additional error is due to fleeting angle to first sheave on parallelogram frame. This was never taken into consideration in the winch system manufacturing specification; consequently a direct pull approach was adopted by winch system manufacturer.

- If existing winch control system is to remain in operation it would be beneficial to route all wiring internally through the ship. This will significantly lengthen service life of control cables and reduce chance of sustaining damage.
- Existing auto potentiometer is not defective. Simple resistance measurements using a Fluke multi-meter have proven that this is not the cause of sporadic winch stoppages as had been previously suggested during winch trials.

Supplementary Information S14:

Sensors and Moorings BODC document checklist

Jeff Benson

Sensors and Moorings BODC Document checklist

Cruise: JC150	Date: 12 August 2017	Compiled by: J. Benson

Document	Notes	Included
CTD Profiling Calibrations	Calibration sheets of all the instruments used on the CTD package or other profiling equipment. Named by serial number, document type and date.	Y
CTD Profiling Histories	Work and deployment history sheets of all the instruments used on the CTD package or other profiling equipment. Named by serial number. xxxx HISTORY is the latest electronic file.	Y
Towed Vehicle Calibrations	Calibration sheets of all the instruments used on the towed vehicle. Named by serial number, document type and date.	N/A
Towed Vehicle Histories	Work and deployment history sheets of all the instruments used on the towed vehicle. Named by serial number. xxxx HISTORY is the latest electronic file.	N/A
Salinity Data	Log sheets and any electronic files, graphs etc. that have been created during or after the cruise.	Y
Cruise reports	Technical report, sensor changes, instrumentation report, post cruise assessment et al.	Y
Daily Diary		N/A
Log Sheets	Electronic copies of all paper log sheets used.	Y

Notes:

Supplementary Information S15:

CTD sensor and geometry information sheets

Jeff Benson

CTD sensor and rig geometry information sheet

Cruise	JC150
Technicians	J. Benson, D. Childs
Date	12 August 2017
CTD type	24-way s/s frame, 20L water samplers, SBE 9/11+
	24-way titanium frame, 10L water samplers, SBE 9/11+

Forwarding instructions/additional information:

See cruise report for other details.

Following items in italics are s/s system.

Following items in bold are titanium system.

Secondary sensor pair mounted on vane for both systems.

Rig geometry:

ID	Vertical distance from pressure sensor (m)
A	1.50
B	0.30 titanium system, 0.10 s/s system (with 20L samplers), 0.30 s/s system (with 10L samplers),
C**	0.07
D	0.00

**NOTE: C & D may be minimal.

Fitted Sensors**:

Manufacturer	Sensor/Instrument	Serial No.	Comments (Casts installed)	Calibration applied?**	Last calibration date
SBE 11plus V2	CTD deck unit	11P-22559-0532	All casts	Y	25 July 2011
SBE 9plus	CTD Underwater Unit	09P-77801-1182	All casts	Y	12 March 2014
NOCS	Stainless steel 24-way frame	SBE CTD9	All casts	N/A	N/A
Paroscientific	Digiquartz Pressure sensor	129735	All casts	Y	12 March 2014
SBE 3P	Primary Temperature Sensor	3P-5785 (Ti)	All casts	Y	17 September 2015
SBE 4C	Primary Conductivity Sensor	4C-2450	All casts	Y	17 September 2015
SBE 5T	Primary Pump	5T-4539	All casts	N/A	25 July 2014
SBE 3P	Secondary Temperature Sensor	3P-4380 (Ti)	All casts	Y	18 February 2016
SBE 4C	Secondary Conductivity Sensor	4C-4143 (Ti)	All casts	Y	17 September 2015
SBE 5T	Secondary Pump	5T-6916	All casts	N/A	21 December 2012
SBE 32	24-way Carousel	32-19817-0243	All casts	N/A	22 July 2016
SBE 43	Primary Dissolved Oxygen Sensor	43-0619	All casts	Y	9 September 2015
Benthos PSA-916T	Altimeter	41302	All casts	Y	20 April 2007
WETLabs C-Star	Transmissometer	CST-1654DR	All casts	Y	6 April 2017
CTG Aquatracka MKIII	Fluorometer	88-2050-095	All casts	Y	13 October 2016
WETLabs BBRTD	Optical Backscattering Sensor	BBRTD-182	All casts	Y	6 March 2017
CTG/PML	2pi-PAR Sensor UWIRR	PAR 01	All casts less than 500m and during daylight	Y	16 September 2014
CTG/PML	2pi-PAR Sensor-DWIRR	PAR 09	All casts less than 500m and during daylight	Y	16 September 2014
OTE	20L Water Samplers	1 through 24	All casts	N/A	N/A
SBE 9plus	**CTD Underwater Unit**	**09P-71442-1142 (Ti)**	**All titanium casts**	**Y**	**26 February 2016**
NOCS	**Titanium 24-way frame**	**SBE CTD TITA1**	**All titanium casts**	**N/A**	**N/A**
Paroscientific	**Digiquartz Pressure sensor**	**124216**	**All titanium casts**	**Y**	**26 February 2016**

Manufacturer	Sensor/Instrument	Serial No.	Comments (Casts installed)	Calibration applied?**	Last calibration date
SBE 3P	Primary Temperature Sensor	3P-4814 (Ti)	All titanium casts	Y	2 June 2016
SBE 4C	Primary Conductivity Sensor	4C-3874 (Ti)	All titanium casts	Y	22 March 2016
SBE 5T	Primary Pump	5T-5301	All titanium casts	N/A	25 July 2014
SBE 3P	Secondary Temperature Sensor	3P-5494 (Ti)	All titanium casts	Y	22 July 2016
SBE 4C	Secondary Conductivity Sensor	4C-4139 (Ti)	All titanium casts	Y	14 July 2015
SBE 5T	Secondary Pump	5T-4510	All titanium casts	N/A	25 July 2014
SBE 32	24-way Carousel	32-71442-0940 (Ti)	All titanium casts	N/A	5 April 2016
SBE 43	Primary Dissolved Oxygen Sensor	43-0709	All titanium casts	Y	21 August 2015
Tritech PA-200	Altimeter	6196.11B171	All titanium casts	Y	15 November 2006
WETLabs C-Star	Transmissometer	CST-1720TR	All titanium casts	Y	16 April 2015
CTG Aquatracka MKIII	Fluorometer	088244	All titanium casts	Y	29 September 2016
WETlabs	BBRTD Light Scatter Sensor	BBRTD-759R	All titanium casts	Y	12 September 2016
CTG/PML	2pi-PAR Sensor UWIRR	PAR 03	All casts less than 500m & during daylight	Y	16 September 2014
CTG/PML	2pi-PAR Sensor DWIRR	PAR 02	All casts less than 500m & during daylight	Y	25 May 2016
OTE	10L TMF Water Samplers	1 through 24	All titanium casts	N/A	N/A

** Were the manufacturer's calibrations applied during NMF-run Sea-Bird processing?

***Please include details of LADCP, CTD carousel and deck unit in addition to CTD and auxiliary sensors.

Spare Sensors*:**

Manufacturer	Sensor/Instrument	Serial No.	Comments (Casts installed)	Calibration applied?**	Last calibration date
SBE 11plus	CTD deck unit	11P-319817-0495	N/A	Y	15 July 2011
SBE 9plus	CTD Underwater Unit	09P-39607-0803 (Ti)	N/A	Y	9 July 2014
Paroscientific	Digiquartz Pressure sensor	93896	N/A	Y	9 July 2014
SBE 9plus	CTD Underwater Unit	09P-77801-1257	N/A	Y	7 November 2015

Instrument	Description	Serial Number	Calibration Type	Fitted	Last Calibration
Paroscientific	*Digiquartz Pressure sensor*	*134949*	*N/A*	*Y*	*16 November 2015*
SBE 3P	**Temperature Sensor**	**3P-5660 (Ti)**	N/A	Y	**21 July 2015**
SBE 3P	**Temperature Sensor**	**3P-5700 (Ti)**	N/A	Y	**17 September 2015**
SBE 4C	*Conductivity Sensor*	*4C-3698*	*N/A*	*Y*	*1 June 2016*
SBE 4C	**Conductivity Sensor**	**4C-3567 (Ti)**	N/A	Y	**14 July 2015**
SBE 4C	**Conductivity Sensor**	**4C-4138 (Ti)**	N/A	Y	**17 September 2015**
SBE 5T	**Pump**	**5T-3086**	N/A	N/A	**24 April 2015**
SBE 5T	**Pump**	**5T-3088**	N/A	N/A	**24 April 2015**
SBE 5T	**Pump**	**5T-3607**	N/A	N/A	**15 May 2013**
SBE 5T	**Pump**	**5T-3609**	N/A	N/A	**19 April 2013**
SBE 5T	**Pump**	**5T-6320**	N/A	N/A	**14 March 2012**
SBE 32	**24-way Carousel**	**32-34173-0493 (Ti)**	N/A	N/A	**25 July 2014**
SBE 43	**Dissolved Oxygen Sensor**	**43-0363**	N/A	Y	**2 March 2016**
SBE 43	**Dissolved Oxygen Sensor**	**43-0862**	N/A	Y	**2 March 2016**
CTG Aquatracka MKIII	**Fluorometer**	**88-2615-124**	N/A	Y	**2 February 2017**
WET Labs C-Star	**Transmissometer**	**CST-1797TR**	N/A	Y	**26 August 2016**
WETLabs BBRTD	**Optical Backscattering Sensor**	**BBRTD-1163**	N/A	Y	**7 March 2017**
Benthos PSA-916T	**Altimeter**	**47597**	N/A	Y	**22 February 2010**
Benthos PSA-916T	**Altimeter**	**59493**	N/A	Y	**28 November 2012**
CTG/PML	**2pi-PAR Sensor**	**PAR 04**	N/A	Y	**8 February 2017**
CTG/PML	*2pi-PAR Sensor*	*PAR 10*	*N/A*	Y	*16 September 2014*
CTG/PML	*2pi-PAR Sensor*	*PAR 11*	*N/A*	Y	*16 September 2014*
OTE	**10L Water Samplers**	**1C through 24C**	N/A	N/A	N/A
Guildline Autosal 8400B	Salinometer	65764	Main instrument	N/A	Service 2 August 2016 & Alignment 14 August 2015
Guildline Autosal 8400B	Salinometer	68958	N/A	N/A	Service 18 May 2016 & Alignment 21 May 2015

*** Please include details of LADCP, CTD carousel and deck unit in addition to CTD and auxillary sensors.

** Are the manufacturer's calibrations applied during NMF-run Sea-Bird processing?

Sea-Bird processing:

The table below lists the Sea-Bird processing routines run by NMF staff (if any). Note this is only the modules that were run by NMF, not by scientific staff.

Module	Run?	Comments
Configure	N	
Data Conversion	Y	**As per BODC guidelines Version1.0 October 2010 (Oxygen Concentration umol/kg as per scientific party; also ran SVP conversion with appended file name)**
Bottle Summary	Y	As per BODC guidelines Version1.0 October 2010
Mark Scan	N	
Align CTD	Y	As per BODC guidelines Version1.0 October 2010 **(dissolved oxygen advanced 5 seconds)** (appended file name)
Buoyancy	N	
Cell Thermal Mass	Y	As per BODC guidelines Version1.0 October 2010 (appended file name)
Derive	Y	As per BODC guidelines Version1.0 October 2010 (appended file name)
Bin Average	Y	As per BODC guidelines Version1.0 October 2010 (appended file name); **SVP (Del Grosso, appended file name)**
Filter	Y	As per BODC guidelines Version1.0 October 2010 (appended file name)
Loop Edit	Y	As per BODC guidelines Version1.0 October 2010 (appended file name)
Wild Edit	N	**Not applicable.**
Window Filter	N	
ASCII In	N	
ASCII Out	N	**SVP (Del Grosso, appended file name)**
Section	N	
Split	N	
Strip	Y	As per BODC guidelines Version1.0 October 2010 (appended file name)
Translate	N	
Sea Plot	N	
SeaCalc II	N	

Field calibrations

The table below details any calibrations against independent (bottle) samples that were applied by NMF staff

Sensor serial no.	Coefficients

SENSOR INFORMATION

SHIP: RRS JAMES COOK	CRUISE: JC150

FORWARDING INSTRUCTIONS / ADDITIONAL INFORMATION:

Other non-CTD sensors/instruments

Checked By: J. Benson	DATE: 25th June 2017

Instrument / Sensor	Manufacturer/ Model	Serial Number	Channel	Comments
Autosal salinometer	Guildline 8400B	68958	n/a	spare
Autosal salinometer	Guildline 8400B	65764	n/a	main
FastOcean PTX fluorometer	CTG FRRF MKIII	14-9727-004	n/a	spare
Fast Repetition Rate Flurometer	CTG FRRF MKI	182042	n/a	bench mount
Fast Repetition Rate Flurometer	CTG FRRF MKI	182043	n/a	bench mount
SAPS Weight	NOCS	SAPSW03	n/a	
Titanium CTD Swivel	MDS SU3000-2-Ti	1246-1	n/a	

SENSOR INFORMATION

SHIP: RRS JAMES COOK	CRUISE: JC150

FORWARDING INSTRUCTIONS / ADDITIONAL INFORMATION:
Spare Stainless/Titanium Steel 24-way CTD frame
(titanium sensors in **bold**)

Checked By: J. Benson	DATE: 25th June 2017

Instrument / Sensor	Manufacturer/ Model	Serial Number	Channel	Casts Used
Primary CTD deck unit	SBE 11plus	11p-19817-0495	n/a	
CTD Underwater Unit	SBE 9plus	09p-87077-1257	n/a	
CTD Underwater Unit	**SBE 9plus**	**09p-39607-0803 (T)**	**n/a**	
Primary Temperature Sensor	**SBE 3P**	**3p-5660 (T)**	**F0**	
Primary Conductivity Sensor	SBE 4C	4c-3698	F1	
Digiquartz Pressure sensor	Paroscientific	134949	F2	
Digiquartz Pressure sensor	**Paroscientific**	**93896**	**F2**	
Secondary Temperature Sensor	**SBE 3P**	**3p-5700 (T)**	**F3**	
Secondary Conductivity Sensor	**SBE 4C**	**4c-4138 (T)**	**F4**	
Primary Pump	**SBE 5T**	**5t-3086**	**n/a**	
Secondary Pump	**SBE 5T**	**5t-3088**	**n/a**	
Primary Pump	**SBE 5T**	**5t-3607**	**n/a**	
Secondary Pump	**SBE 5T**	**5t-3609**	**n/a**	
Primary Pump	**SBE 5T**	**5t-6320**	**n/a**	
24-way Carousel	**SBE 32**	**32-34173-0493 (T)**	**n/a**	
Dissolved Oxygen Sensor	**SBE 43**	**43-0363**	**V0**	
Dissolved Oxygen Sensor	**SBE 43**	**43-0862**	**V0**	
Altimeter	**Benthos 916T**	**47597**	**V2**	
Altimeter	**Benthos 916T**	**59493**	**V2**	
Light Scattering Sensor	**WETLabs BBRTD**	**BBRTD-1163**	**V3**	
Fluorometer	**CTG Aquatracka MKIII**	**88-2615-124**	**V6**	
Transmissometer	**WETLabs C-Star**	**1797TR**	**V7**	
2pi-PAR Sensor	**CTG/PML**	**04 (T)**	**V4**	
2pi-PAR Sensor	CTG/PML	10	V3	
2pi-PAR Sensor	CTG/PML	11	V7	
10L Water Samplers	OTE	1C-24C	n/a	

SENSOR INFORMATION

SHIP: RRS JAMES COOK	CRUISE: JC150

FORWARDING INSTRUCTIONS / ADDITIONAL INFORMATION:

Stainless Steel 24-way CTD frame

Checked By: J. Benson	DATE: 25th June 2017

Instrument / Sensor	Manufacturer/ Model	Serial Number	Channel	Casts Used
Primary CTD deck unit	SBE 11plus	11p-22559-0532	n/a	All casts
CTD Underwater Unit	SBE 9plus	09p-77801-1182	n/a	All stainless casts
Stainless steel 24-way frame	NOCS	SBE CTD9	n/a	All stainless casts
Primary Temperature Sensor	SBE 3P	3p-5785 (T)	F0	All stainless casts
Primary Conductivity Sensor	SBE 4C	4c-2450	F1	All stainless casts
Digiquartz Pressure sensor	Paroscientific	129735	F2	All stainless casts
Secondary Temperature Sensor	SBE 3P	3p-4380 (T)	F3	All stainless casts
Secondary Conductivity Sensor	SBE 4C	4c-4143 (T)	F4	All stainless casts
Primary Pump	SBE 5T	5t-4539	n/a	All stainless casts
Secondary Pump	SBE 5T	5t-6916	n/a	All stainless casts
24-way Carousel	SBE 32	32-19817-0243	n/a	All stainless casts
Dissolved Oxygen Sensor	SBE 43	43-0619	V0	All stainless casts
Altimeter	Benthos 916T	41302	V2	All stainless casts
2pi-PAR Sensor DWIRR	CTG/PML	09	V3	All stainless casts less than 500m with daylight
Transmissometer	WETLabs C-Star	CST-1654DR	V4	All stainless casts
Fluorometer	CTG Aquatracka MKIII	88-2050-095	V5	All stainless casts
2pi-PAR Sensor UWIRR	CTG/PML	01	V6	All stainless casts less than 500m with daylight
Light Scattering Sensor	WETLabs BBRTD	BBRTD-182	V7	All stainless casts
20L Water Samplers	OTE	1-24	n/a	All stainless casts

SENSOR INFORMATION

SHIP: RRS JAMES COOK	CRUISE: JC150

FORWARDING INSTRUCTIONS / ADDITIONAL INFORMATION: **Titanium 24-way CTD frame**

Checked By: J. Benson	DATE: 25th June 2017

Instrument / Sensor	Manufacturer/ Model	Serial Number	Channel	Casts Used
Primary CTD deck unit	SBE 11plus	11P-22559-0532	n/a	All casts
CTD Underwater Unit	SBE 9plus	09P-71442-1142 (T)	n/a	All titanium casts
Titanium 24-way CTD frame	NOCS	SBE CTD TITA1	n/a	All titanium casts
Primary Temperature Sensor	SBE 3P	03P-4814 (T)	F0	All titanium casts
Primary Conductivity Sensor	SBE 4C	04C-3874 (T)	F1	All titanium casts
Digiquartz Pressure sensor	Paroscientific	124216	F2	All titanium casts
Secondary Temperature Sensor	SBE 3P	03P-5494 (T)	F3	All titanium casts
Secondary Conductivity Sensor	SBE 4C	04C-4139 (T)	F4	All titanium casts
Primary Pump	SBE 5T	05T-5301	n/a	All titanium casts
Secondary Pump	SBE 5T	05T-4510	n/a	All titanium casts
24-way Carousel	SBE 32	32-71442-0940 (T)	n/a	All titanium casts
Primary Dissolved Oxygen Sensor	SBE 43	43-0709	V0	All titanium casts
Altimeter	Tritech PA200	6196.118171	V2	All titanium casts
Fluorometer	CTG Aquatracka MkIII	088244	V3	All titanium casts
2pi-PAR Sensor UWIRR	CTG/PML	03 (T)	V4	All titanium casts less than 500m with daylight
2pi-PAR Sensor DWIRR	CTG/PML	02 (T)	V5	All titanium casts less than 500m with daylight
Light Scattering Sensor	WETLabs BBRTD	BBRTD-759R	V6	All titanium casts
Transmissometer	WETLabs C-Star	CST-1720TR	V7	All titanium casts
10L TMF Water Samplers	OTE	1-24	n/a	All titanium casts