National Oceanography Centre, Southampton

Cruise Report No. 57

Celtic Explorer Cruise CE10005

16-24 SEP 2010

Milford Haven, UK to Galway, Ireland

Porcupine Abyssal Plain Observatory servicing

Principal Scientist

J Campbell

2010

This research survey (ref: CE10005) was carried out with the support of the Marine Institute and part-funded under the Marine Research Sub-programme of the National Development Plan 2007-2013, Ireland.

National Oceanography Centre, Southampton
University of Southampton Waterfront Campus
European Way
Southampton
Hants SO14 3ZH
UK

Tel: +44 (0)23 8059 6077
Email: joc@noc.soton.ac.uk

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CAMPBELL, J et al

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ABSTRACT

The principal objective was to maintain the Porcupine Abyssal Plain (PAP) observatory infrastructure. The main components of this are:-

- A large ODAS buoy mooring (PAP 1) with real time telemetry and multiple underwater and meteorological sensors. The buoy and sensor frame will be recovered and most of the sensors and telemetry systems replaced, before redeployment.
- A sediment trap mooring (PAP 3). This mooring will be recovered and replaced with a new one.
- A Bathysnap camera lander. To be recovered and replaced.

Associated work will include CTD sensor calibration dips and deployment of 2 ARGO floats. The work proposed will be vital to maintaining the long standing time-series measurements at this site, and will also provide critical feedback on sensor and mooring design performance.

This cruise was originally conceived as a key component of the MODOO (MOdular Deep Ocean Observatory) ESONET demonstration project http://www.modoo.info/ . The main part of this project was a BoBo lander belonging to NIOZ that was deployed at the same time as the ODAS buoy in June 2010. This lander should have been recovered during CE10005 to obtain in-situ data from the lander and to assess the performance of the acoustic telemetry system. Unfortunately the lander appears to have suffered an implosion shortly after deployment, and one objective of this cruise will now be to attempt to communicate with the lander's acoustic releases.

An ancillary task led by Marine Institute (MI) involves the collection of samples as part of the Marine Biodiscovery project in NUI, Galway. The aim of this research is to investigate the possibility that phytoplankton species in Irish waters can produce biologically active compounds (bioactives) of significance for use as human medicines.

KEYWORDS

ISSUING ORGANISATION **National Oceanography Centre, Southampton**
University of Southampton, Waterfront Campus
European Way
Southampton SO14 3ZH UK
Tel: +44(0)23 80596116Email: nol@noc.soton.ac.uk

Contents

1 Personnel

Scientific and Technical Personnel

Jon Campbell	NOCS Underwater Systems Laboratory
Thanos Gkritzalis-Papadopoulos	NOCS Ocean Biogeochemistry and Ecosystems Group
Corinne Pebody	NOCS Ocean Biogeochemistry and Ecosystems Group
Diane Purcell	NOCS Ocean Biogeochemistry and Ecosystems Group
Paul Provost	NOCS Sea Systems Sensors and Moorings Group
Rob McLachlan	NOCS Sea Systems Sensors and Moorings Group
Steve Whittle	NOCS Sea Systems Sensors and Moorings Group
James Burris	NOCS Sea Systems Sensors and Moorings Group
Stuart Pinch	UK Met Office Moorings Group
John Barry	Marine Institute
Lucy Hunt	Irish Whale and Dolphin Group

Ships Personnel

Denis Rowan	Master
Robert Inglis	Chief Engineer
Basil Murphy	Chief Officer
Patrick Kilbane	Officer of Watch
Robert Kirby	2nd Engineer
Paul Wray	ETO
Stephen Lantry	Bosun
Jimmy Moran	Cook
Shane Horan	Bosun's Mate
Ken O'Neill	AB Deckhand GP1
Tommy Grealy	AB Deckhand GP1
Louise Richards	Assistant Cook
Lukasz Pawlikowski	Technician
Paddy Kenny	AB Deckhand GP1

2 Itinerary (UTC)

Commenced mobilisation	1500 15th September 2010
Sailed Milford Haven	1130 16th September 2010
Arrived at PAP site	0900 18th September 2010
Departed PAP site	2240 20th September 2010
Docked Galway	1600 22nd September 2010

3 Objectives

The principal objective was to maintain the Porcupine Abyssal Plain (PAP) observatory infrastructure. The main components of this are:-

- A large ODAS buoy mooring (PAP 1) with real time telemetry and multiple underwater and meteorological sensors. The buoy and sensor frame will be recovered and most of the sensors and telemetry systems replaced, before redeployment.
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4 Narrative

Mobilisation was completed on the afternoon of 15th September in Milford Haven Dock and the *Celtic Explorer* sailed slightly ahead of schedule on the midday tide on the 16th. Passage to the PAP site at 48.99° N, 16.37° W was interrupted briefly on 17th for a test of the CTD system (CTD 1). The vessel arrived in the vicinity of the ODAS buoy at 0900 on the 18th and the first ARGO float was deployed. We then continued to the location of the PAP 3 sediment trap mooring which was successfully released just after 1000. The mooring was recovered by 1220 without the acoustic release which appeared to have been lost during the ascent when a rope parted.

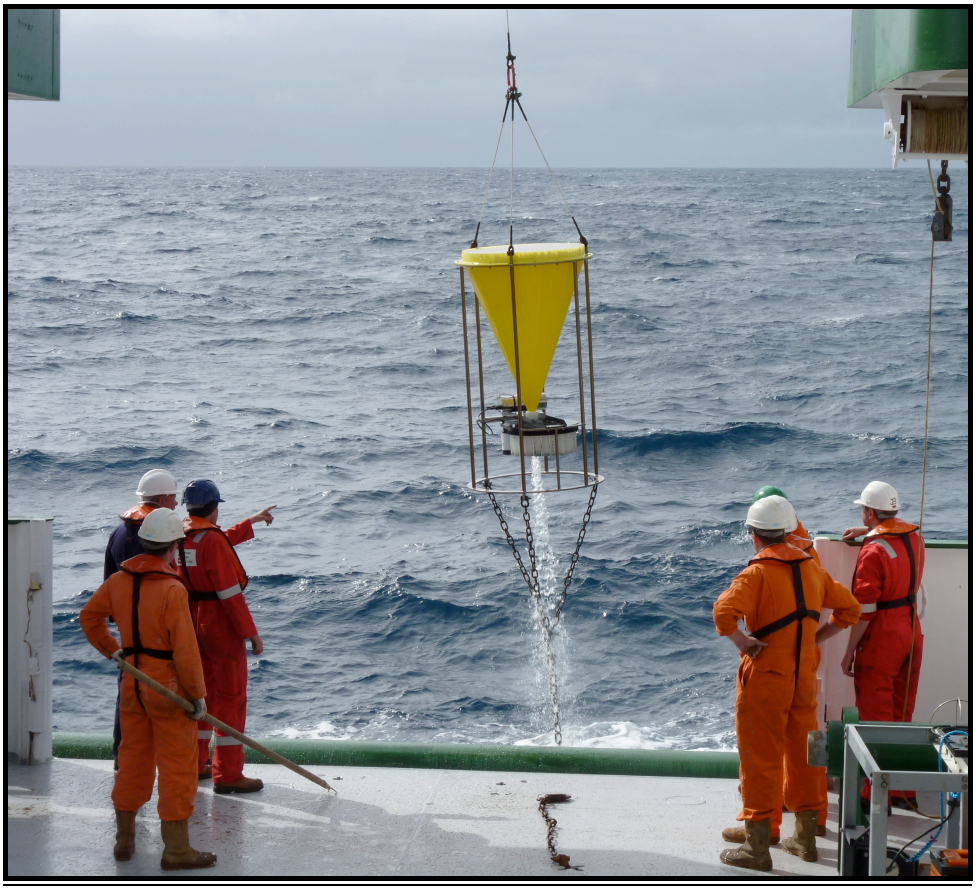
Acoustic interrogation of the Bathysnap began at 1240, but after an hour of trying, no response had been received and so the release code was sent. The Bathysnap was spotted on the surface just before 1600 and it was successfully recovered shortly afterwards.
The first science CTD (CTD 2) commenced at 1635 and went to 4700m to check the acoustic releases to be deployed later in the cruise and to collect water samples for filtering. This was completed by 2100.
The ODAS buoy and sensor frame were recovered just after breakfast on the 19th, and with bad weather forecast for the following day the decision was taken to keep the ship attached to the mooring using the dynamic positioning system, and to redeploy the buoy just before nightfall the same day. All the meteorological sensors on the buoy were replaced and the buoy and top 30m of chain inspected for wear. There was very little deterioration in any of the components and even the armoured cables connecting the buoy and sensor frame appeared unscathed.
There was some evidence of electrochemical activity in the sensor frame, with the large anodes on the frame being reduced to less than half their original size in 3.5 months. The ISUS battery housing was found to have flooded, and the data hub and WETLabs fluorometer both had a badly corroded power connector pin on one of their connectors. It is not clear whether these problems are related.
The buoy telemetry unit and the data hub were both replaced and population of a new sensor frame with sensors continued throughout the day. Another CTD (CTD 3) was performed during the afternoon, this time to 250m to calibrate the 2 MicroCATs, WETLabs and ISUS sensors before securing them in the sensor frame. Only the downwards-looking irradiance sensor was transferred to the new frame as the upward looking sensor failed to function when tested.
The ODAS buoy was redeployed with the new sensor frame just before darkness, and like the recovery the deployment went very smoothly thanks to the experience of the Ships crew and the design of the vessel. The day ended with a plankton net sample to 200m at 2200.
The weather had indeed worsened by the 20th and it would not have been possible to recover or deploy the ODAS buoy. The day began with an attempt to establish communication with the NIOZ BOBO lander which was deployed close to the ODAS buoy in June. The two Benthos releases were repeatedly interrogated but no response was detected. At 1000 another 250m CTD (CTD 4) was performed to collect more water for filtering. At 1500 the PAP 3 sediment trap mooring redeployment commenced and this was completed by 1608. The Bathysnap deployment commenced at 1800 and was completed in 8 minutes.
At 1842 the final CTD (CTD 5) commenced. This went to 1000m to collect water for future sediment trap deployments and to collect water from the chlorophyll maximum (at 53 m) for Fiona Grant at the Marine Institute.
At 2155 the plankton net was deployed to 200m and recovered 30 minutes later. Finally at 2235 the second ARGO float was deployed and at 2240 the passage back to Galway commenced.
On the morning of 22nd September the *Celtic Explorer* arrived in Galway Bay and by 1600 the vessel was inside the lock gates and tied up.

5 Reports

5.1 Sediment traps (Corinne Pebody)

5.1.1 Sediment trap recovery.

All 3 traps were recovered successfully on 18/09/10, although the release was lost from under the 100mab trap. All 3 traps had significant amount of material in them. The pH was checked and had maintained a level of not less than 7.5 so should successfully preserve all material. Each bottle was also measured for estimated volume flux before 1ml buffered formalin was added prior to refrigeration at 5°.



5.1.2 Sediment trap Deployment.

Three sediment traps were prepared, 2 x 21 cup and 1 x 13 cup. 17/09/10 formalin buffered. Water was collected from 1000m on the deep CTD on 18/09/10. 5g NaCl added to 19l of the deep water. On 19/09/10 the salt had nearly totally dissolved, so buffered formalin added.
20/09/10 Salt dissolved so bottles filled and put onto traps and topped up. Traps programmed and deployed:
Trap A 21 cup at 3000m
Trap B 13 cup at 3050m
Trap C 21 cup at 100mab.
The 13 cup was more difficult to program and leaked significantly on deployment. The *Celtic Explorer* deployed the traps inverted which challenges the older traps. It might be better to arrange to deploy these traps the correct way up on subsequent cruises.

5.2 Bathysnap (Corinne Pebody)

5.2.1 Bathysnap recovery

The Bathysnap was successfully recovered on 18/09/10. All looks in good condition. Several hundred pictures were copied off the camera and it had worked well. There is significant overexposure in the foreground of the picture, but the mid and background look good.

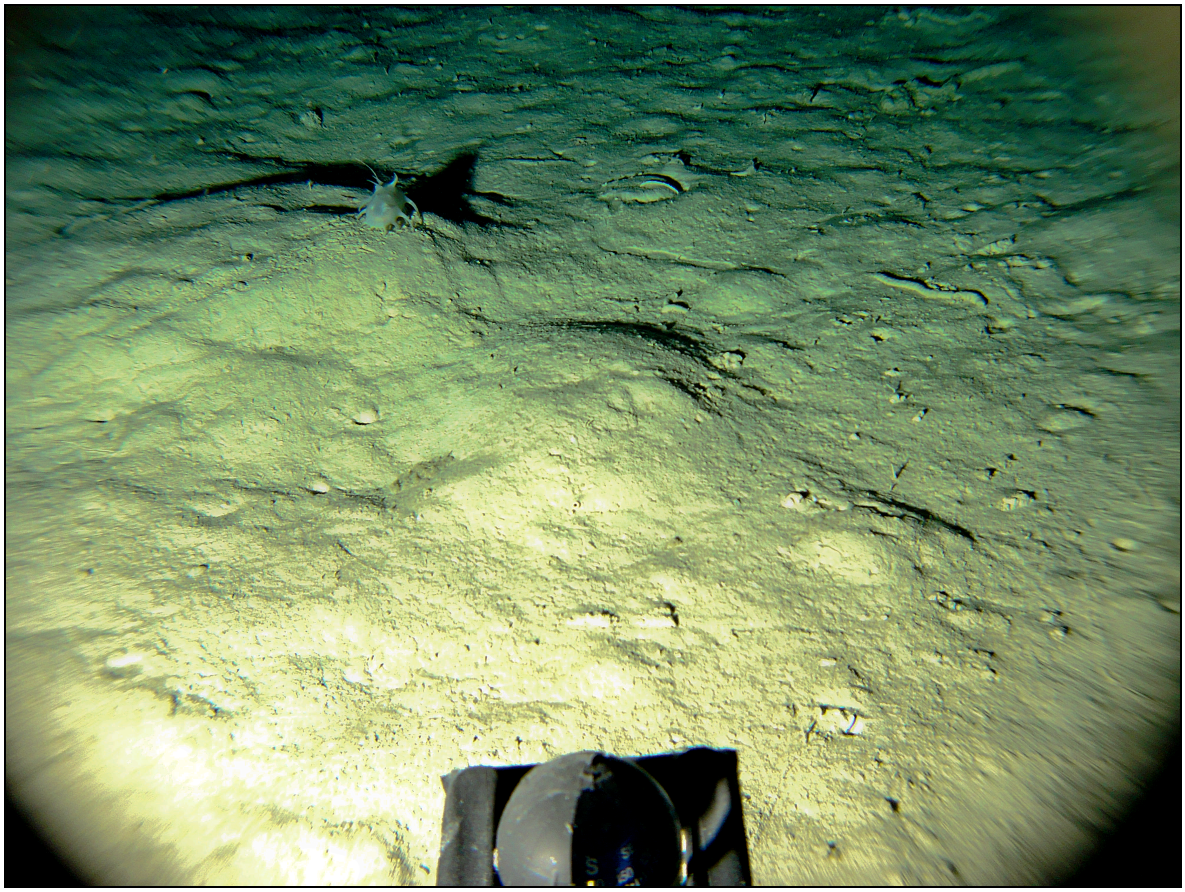


Photo from 07:41 GMT 04 Jul 2010

5.2.2 Bathysnap deployment.

The Bathysnap was sent to the ship ready to deploy. However on the 2 occasions that we tried to observe the flash we failed to see it. So the camera was removed from the frame and the pictures examined. It appears that it had been working all along. So the pictures were copied and the camera reset and returned to the frame. The flash was observed to be working for the afternoon picture 16:46 UTC on 18/09/10.

On recovery of the Bathysnap from the June deployment and review of the pictures, it was apparent that there was significant overexposure in the foreground. To correct for this without losing the mid and back ground there OEV was corrected to -0.6. When the flash was checked, it did not occur, so the camera was removed again and rechecked. The problem was identified as the time delay had been changed from 8 to 6 hours when the counter was reset. This was corrected and the camera reattached to the frame. To be sure the camera wasn't stopping the flash unit in higher light conditions, a dark coat was put over the camera and flash. The flash successfully flashed at 18:10 BST and was subsequently deployed at 17:08 – 17:11 BST on 20.09.10.

Camera settings are unchanged apart from the OEV and the new time intervals are:

17:10 UTC
23:10 UTC
05:10 UTC

5.3 Zooplankton net sampling (Corinne Pebody and Diane Purcell)

The 200µm zooplankton net was deployed at 23:00 BST on Sunday 19/09/10 and Monday 20/09/10. The net was deployed to 200m and raised at 15 – 20 m/min. Both hauls resulted in a good capture of meso zooplankton with copepods present in a good state with lipid reserves intact etc. Both samples were preserved with buffered formalin to 5%.

5.4 CTD and Water Sampling (Diane Purcell)

CTD 1 Test of system to 100m on the 17th of Sept.

5.4.1 CTD 2: 0-4806m

Taken at : Lat:49^{O}00.9544, Long 16^{0} 27.092
BMT: 17:53:56Sec 18th Sept
Assisted the mooring team with running CTD.
Depths sampled : 4.58, 9.5, 27, 40, 76, 101, 125, 139, 164, 257, 502, 1000, 1999, 2997, 4004, 4806m.
Chlorophyll max noted between: 40-30m (varied between descending and ascending measurements)
Samples taken:
For Inter-calibration of protocol samples, therefore 5 replicate samples were taken for each depth up to 125m.
Below 125m HPLC duplicate filters were taken for each depth to 4806m.
Thermocline measurements was gradual from 40-150m approx. with a oxygen peak at approx 40m, increased chlorophyll on filters noted at bottom of thermocline (will check data log for exact measurements).

5.4.2 CTD 3: 0-278m

Taken at : Lat:49^{O}00.8072, Long 16^{0} 22.76
BMT: 14:17:58Sec 19th Sept
CTD reached sea bed at 14:35, and surfaced at 15:12. BMT
Depths sampled: 5, 10, 20, 40, 45, 50, 75, 100, 125, 150, 200, 250, 278m.
Chlorophyll max noted approx. 50m
Samples taken: HPLC duplicate filters were taken for each depth.
1 lugols sample for phytoplankton identification, and 1 paraformaldehyde sample for flow cytometry was taken at each depth.

5.4.3 CTD 4: 0-250m

Taken at : Lat:49^{O}00.977, Long 16^{0} 25.0782
BMT: 10:36 20th Sept
Depths sampled: 5, 10, 15, 25, 30, 40, 50, 75, 100, 125, 150, 200, 250m.
Chlorophyll max noted approx. 50m
Samples taken: HPLC duplicate filters were taken for each depth.
1 lugols sample for phytoplankton identification, and 1 paraformaldehyde sample for flow cytometry was taken at each depth. (200m sample spilled, heavy seas)

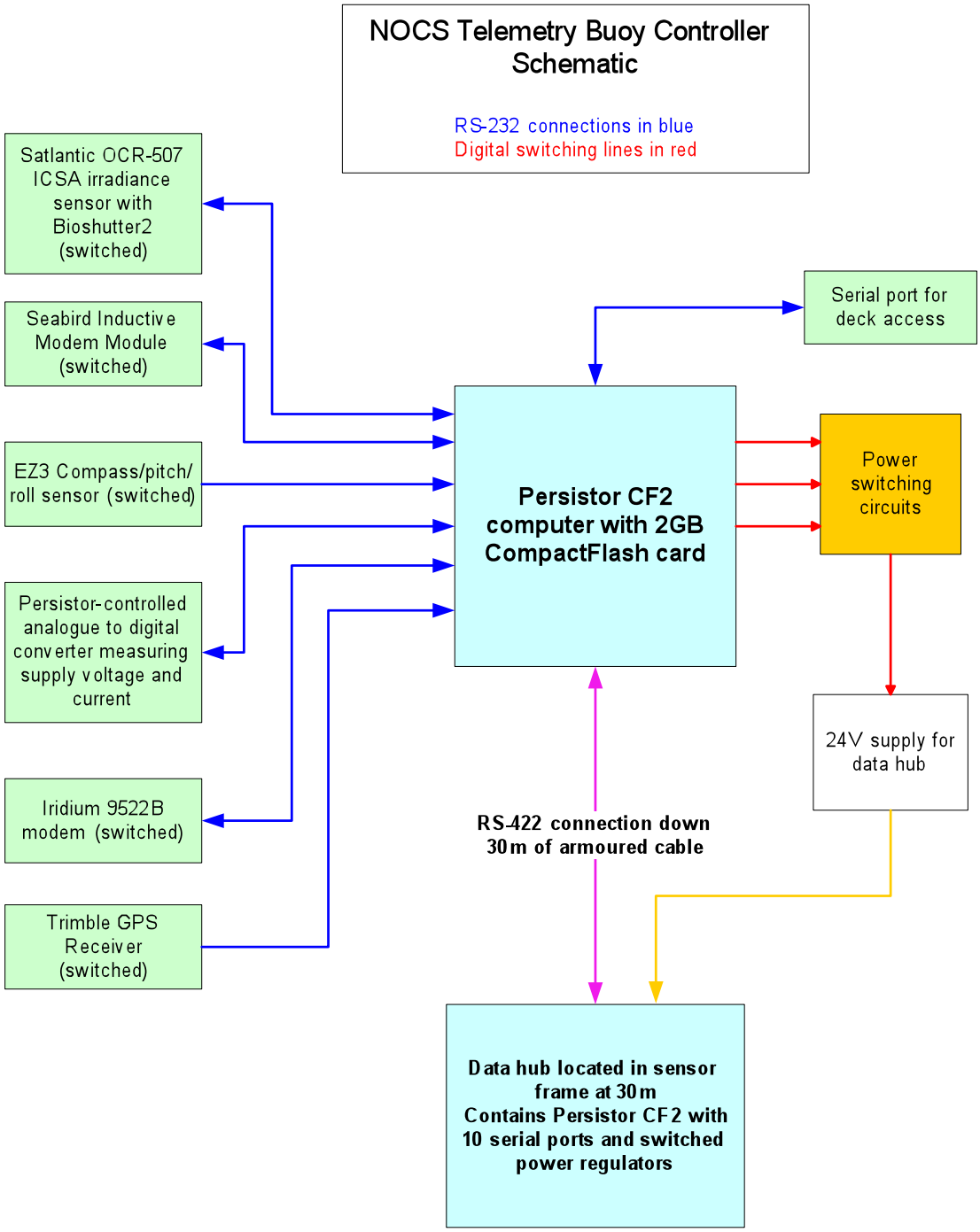
Took Nutrient, chlorophyll for all samples for Thanos, took salinity for 8 depths also.
Assisted Corinne Pebody with Bathysnap operation and monitoring pre-deployment of new camera, also assisted Corinne with setting up sediment trap pre-deployment and plankton net sampling.

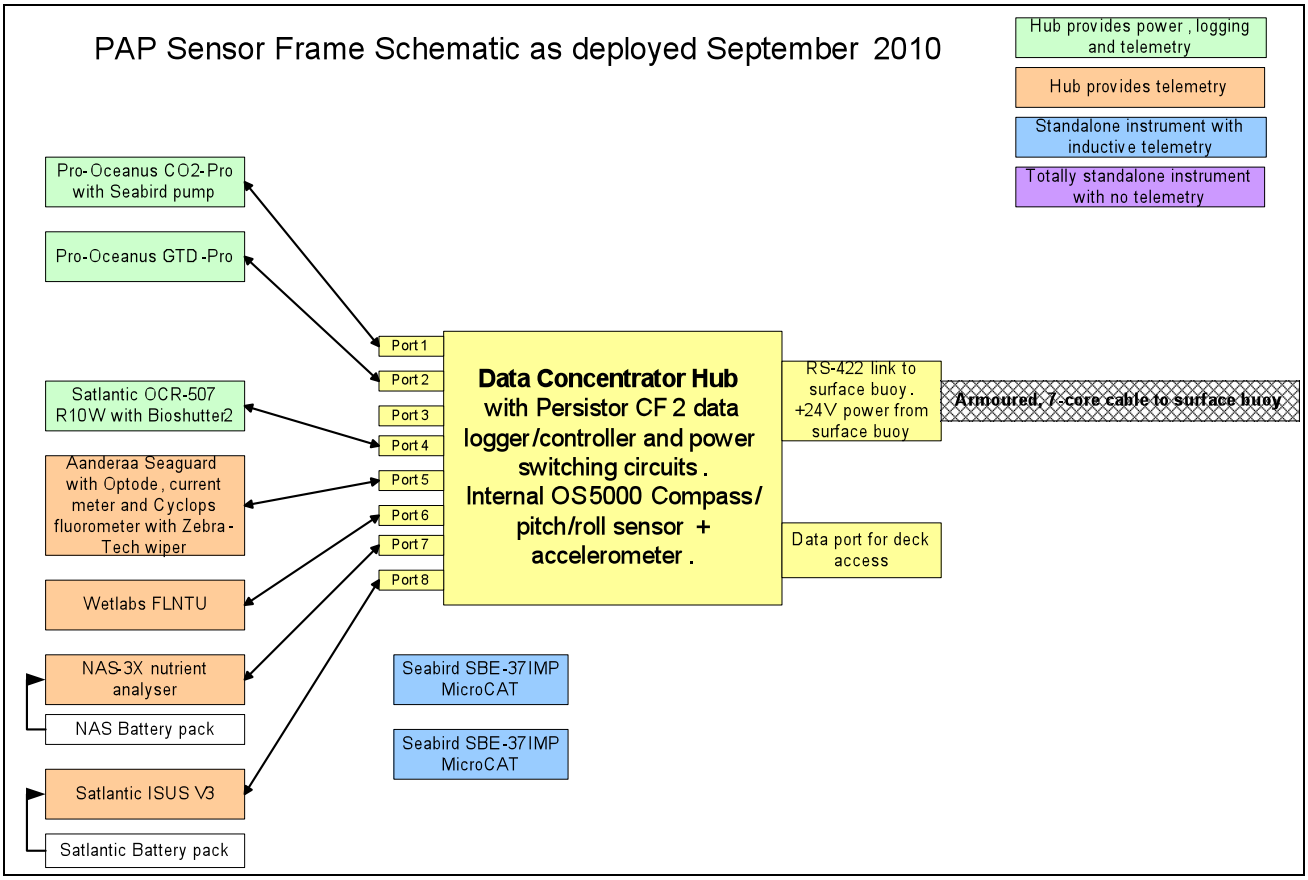
5.4.4 CTD 5: 0-1000m

49.023444°N, 16.395889°W
Completed 19:31 UTC 20th Sept.
Water collected from 1000m for future use in sediment traps and, from chlorophyll max at 53m, samples for Marine Institute Biodiscovery project.

5.5 Telemetry System (Jon Campbell)

The PAP telemetry system has evolved over the past 3 years and currently comprises a buoy telemetry electronics unit and a data concentrator hub in the sensor frame. Schematic drawings of these two units as configured for this deployment are shown below.
Data are transmitted via the Iridium satellite system every 6 hours (typically) and are automatically displayed on the EuroSITES website: http://www.eurosites.info/pap/data.php
Short status messages are also sent via the Iridium SBD (Short Burst Data) email system every 3 hours (typically). The SBD email system is also used to send commands to the buoy to change various settings.


NOCS Telemetry Buoy Controller Schematic
RS-232 connections in blue
Digital switching lines in red
Satlantic OCR-507 ICSA irradiance sensor with Bioshutter2 (switched)
Seabird Inductive Modem Module (switched)
EZ3 Compass/pitch/ roll sensor (switched)
Persistor-controlled analogue to digital converter measuring supply voltage and current
Iridium 9522B modem (switched)
Trimble GPS Receiver (switched)
Serial port for deck access
Persistor CF2 computer with 2GB CompactFlash card
Power switching circuits
24V supply for data hub
RS-422 connection down 30m of armoured cable
Data hub located in sensor frame at 30m
Contains Persistor CF2 with 10 serial ports and switched power regulators



5.5.1 Old Telemetry Buoy unit status

This was still working when recovered apart from the compass/pitch/roll sensor which stopped sending data 6 days after deployment.

5.5.2 Old Data Hub status

This was also working when recovered but had been suffering frequent computer restarts for the preceding 10 days or so. This was caused by corrosion on the connector pin carrying +24V from the armoured cable to the hub. The connector tail on the armoured cable was replaced and the connector on the new Hub was well greased before connection to try and prevent this problem from recurring. The 3-axis accelerometer in the Hub stopped sending data 60 days after deployment.

Both the buoy telemetry unit and data hub were exchanged for the spare units which have the following software/hardware enhancements:

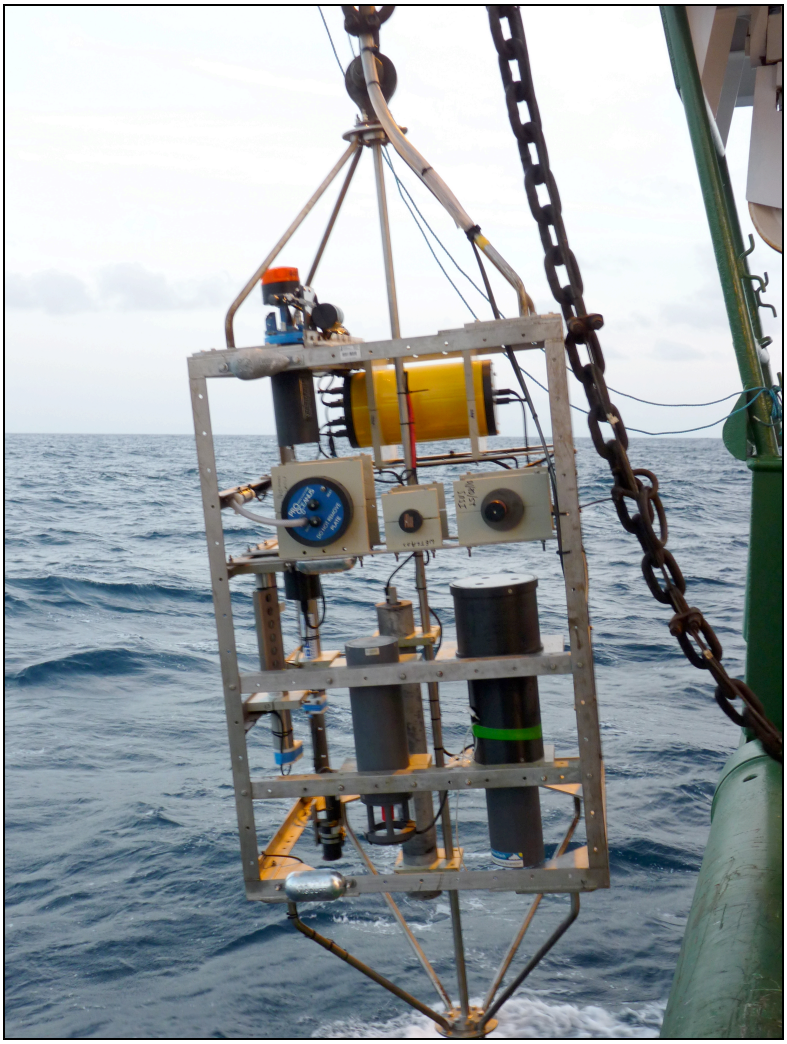
5.5.3 New Telemetry Buoy unit enhancements

- New Iridium 9522B modem fitted.
- Support for Iridium data transfer via RUDICS if selected remotely. The old dial-up system is the default mechanism.
- Support for additional scheduling commands to control the CO2 and ISUS sensors.
- Improved compass power supply switching.
- SeaBird IMM is now powered all the time as it consumes very little power in sleep mode.

5.5.4 New Data Hub enhancements

- The unit now has Delrin (plastic) end caps and the tube has been painted with epoxy to minimize corrosion. The unit has been pressure tested to 50m with the new end caps.
- There is a modified control sequence for the CO2 sensor which allows for a second Auto Zero Point Calibration to be performed once the internal temperature has stabilised.
- Lower resistor value for SeaBird pump switching circuit to reduce power consumption.
- The 5V power supply to the accelerometer is now controlled by a high-side switch.
- Remotely adjustable power switching sequence for Satlantic ISUS sensor if its battery pack fails.
- A new power switching and serial communications board was built to implement some of the above changes, but unfortunately it was not fully tested prior to deployment. It seems likely that there is a wiring error that is preventing RS-422 communications with the Seaguard.

6 PAP1 Sensors (Thanos Gkritzalis and Jon Campbell)



6.1 Recovery of the sensors that were deployed in June 2010

The sensors that were deployed at the PAP site in June 2010 are presented in the following table:

Sensor/Sampler	Serial No.	Nominal depth (m)	Depth rating	Sampling interval	Comments
Aanderaa Seaguard	217	30	300 m	15 min	Equipped with optode type 4330 s/n:125; Cyclops fluorometer s/n 2100989; Current meter DCS s/n 69
Zebratech wiper	146	30	100 m	4 hrs	Used as a wiper for the Cyclops fluorometer
Satlantic ISUS V3	60	30	300 m	1 hr	Sampling rate during operation is 1 Hz
NAS 3X	2675	30	200 m	4 hrs	Sampling scheme: 00:00-Std analysis; 04:00 – 08:00 – 12:00 – 16:00 – 20:00 Sample analysis
Seabird SBE-37IMP MicroCAT	6905	30	1000 m	30 min	Internal sample interval is 15 minutes
WETLabs FLNTUSB	238	30	300	1 hr	Sampling rate during operation is 1 Hz
Satlantic OCR-507 ICSA Radiometer (Surface buoy)	201	surface	0	3 hrs (only during daylight)	Sampling rate during operation is 1 Hz. The sampling frequency can be changed during deployment
Satlantic OCR-507 R10W Radiometer (Sensor frame downward-looking radiance)	095	30	350m	3 hrs (only during daylight)	Sampling rate during operation is 1 Hz. The sampling frequency can be changed during deployment
Satlantic OCR-507 ICSW Radiometer (Sensor frame upward-looking irradiance)	200	30	350m	3 hrs (only during daylight)	Sampling rate during operation is 1 Hz. The sampling frequency can be changed during deployment
McLane Zooplankton Sampler	12430-01	30	5000 m	3 days	See schedule for sampling frequency
Pro-Oceanus CO2	29-097-45	30	300 m	4 hrs	The sampling frequency can be changed during deployment
Pro-Oceanus GTD	29-099-15	30	300 m	4 hrs	The sampling frequency can be changed during deployment
SCAWS (NOCS Osmo sampler)	-	30	5000 m	1 d	This is a water sampler and samples will be analyzed after the sampler is recovered

The sensor frame had previously been deployed on 1st June 2010 during cruise JR221 and was recovered on 19th September 2010 (i.e. 110 days in the sea).
The following was evident immediately after recovery:

- The anodes on the sensor frame were heavily corroded, which indicates that electrical current was flowing through the sensor frame.
- The ISUS battery pack was flooded and the pressure case's anodized layer was lost. The same applies for: ISUS Nitrate sensor, Pro-Oceanus CO2 sensor, Pro-Oceanus GTD sensor, McLane ZPS battery and electronics case.
- There is evidence of corrosion on the Seaguard 217 unit as the blue coating is covered with small bubbles. Additionally the connection between the Cyclops cable and the bulkhead connector is loose. Surprisingly one of the clamps that hold the Seaguard to pressure the case was missing. This was possibly lost during recovery as the unit is working properly and there were no signs of water in the case.
- The tube that was connecting the outlet of the Osmo sampler with the ZPS and was feeding the ZPS with formalin was lost.
- The filter that was placed on the inlet of the Osmo sampler was lost.

6.1.1 Individual Sensor reports

6.1.1.1 Satlantic ISUS V3 Nitrate Sensor (s/n 60)

Even though the ISUS battery pack flooded, the sensor itself was not damaged. After recovery the sensor was recalibrated and was decided to redeploy it.

6.1.1.2 NAS 3X Nitrate Analyser (s/n 2675)

As was evident from the real time data the NAS battery pack was exhausted.
The sensor itself was recovered in good condition.
The chemicals and standards used during deployment were removed from the sensor and stored at 4°C.
The two standards were sub-sampled and samples are kept in -20°C.
The length of the reduction column has decreased indicating that there might have been "dead space" in the column, which probably reduces the reduction efficiency. Further tests in the lab are needed to answer that.
All data were downloaded and stored on the PAP sensors laptop

6.1.1.3 WETLabs fluorometer (s/n 238)

The fluorometer seems in good condition. However when the power plug was removed one of the pins was heavily corroded and eventually broke. The sensor itself is working properly. Data were downloaded and stored

6.1.1.4 Pro-Oceanus CO2 (29-097-45) and GTD (29-099-15) sensors

The Pro-Oceanus CO2-Pro together with a SeaBird 5T pump were working correctly up to the recovery and suffered no damage other than a loss of anodizing on the case of the CO2-Pro.
The Pro-Oceanus GTD-Pro also worked flawlessly up to recovery, and it also suffered the loss of most of the anodizing from its pressure housing. It had also lost its plastic securing collar but fortunately the end cap had stayed in place.
Further tests in the lab will reveal the exact condition of the sensors.

6.1.1.5 Osmo sampler

The filter that was placed on the sampler's inlet was lost.
As mentioned above the tube that was connecting the sampler with the ZPS was lost. This should not have affected the sampler's performance.
There wasn't much salt left in the salt water compartment, but the fact there were some salt crystals left indicates that the solution in the salt water compartment was still saturated with NaCl and the osmotic gradient between the salt compartment and the MQ water one was still potent. This means that the pumping should not be affected.

6.1.1.6 McLane ZPS

As mentioned above the preservative feeding tube of the ZPS was lost, which indicates that any preservative left in the ZPS was lost as well.
After recovery the deployment data were downloaded and the mesh belt was fully recovered. From the deployment data it's evident that the preservative tube was lost on the 17th of June as at this date there is a record of sudden pressure loss. After that date the pump was not operating but the mesh was.
The sampling reel/mesh was collected by Corinne Pebody and will be analyzed in the lab.
The proximity sensor cable's insulation was slightly damaged at two points.

6.1.1.7 Satlantic Radiometers

Satlantic OCR-507 ICSW s/n 200 (upward-looking) irradiance sensor was found to have its Bioshutter stuck in the open position and the sensor failed to output any data when tested with the new data hub. As a result this sensor was not attached to the new sensor frame and further investigation revealed that there was a breach in the cable harness next to the moulded splice. This appears to be a manufacturing fault.
Satlantic OCR-507 R10W s/n 195 (downward-looking) radiance sensor was transferred to the new sensor frame and worked correctly when tested.
Satlantic OCR-507 ICSA s/n 201 (upward-looking) irradiance sensor mounted on the ODAS buoy. This sensor also had its Bioshutter in the open position when recovered, but this corrected itself when tested and the sensor was redeployed without modification.

6.1.1.8 SeaBird SBE-37 IMP s/n 6905 MicroCAT CTD

This sensor was working when recovered and the internally recorded data were downloaded without problem.

6.2 Pre-deployment calibration CTD

The following sensors were positioned on the CTD rosette frame and will be compared against data from the CTD rosette sensors and data from manually collected samples:

- ISUS 60 Nitrate Sensor and battery pack. The ISUS was recalibrated (1 point calibration with MQ water) before the cast. A new battery pack that will be used also for the 1 year deployment was attached on the CTD frame. The sensor was set to sample continuously during the cast at approx 1Hz.
- WETLabs 238 FLNTUSB fluorometer. The sensor was set to operate continuously at approx 1 Hz.
- Seaguard 219. The sampling interval was set to 10sec. Only the oxygen optode and the Cyclops fluorometer were enabled.
- Seabird SBE-37 IMP MicroCATs serial numbers 6904 and 6907. Sample interval was set to 10 seconds for the CTD dip.

The cast started at 14:25 on the 19/09/2010. The maximum depth was 270m and after recovery the Niskin bottles were sampled for:

- CO2
- Chlorophyll
- Samples for HPLC pigments (Diane Purcell)
- Nutrients

Oxygen samples were not collected as there was not enough time between the end of the CTD and preparation of the sensors for deployment on the PAP1 mooring.
Salinity samples were not collected because there was no water left in the Niskin bottles.
All data from the sensors were downloaded to the PAP sensors laptop.

6.3 Sensors for new one-year deployment

The ODAS buoy was redeployed with the new sensor frame at 19:15 on 19/9/10. The sensors and their sampling intervals are presented in the following table.

Sensor/Sampler	Serial No.	Sampling interval	Comments
Aanderaa Seaguard	219	1 hr	
Zebratech wiper		6 hrs	Used as a wiper for the Turner Cyclops fluorometer
Satlantic ISUS V3	60	4 hrs	Burst of 10 lines of data every 4 hours
NAS 3X	2673	12 hrs	1 standard sample every week (at 1200) and two samples per day
Seabird SBE-37IMP MicroCATs	6904, 6907	30 min	Internal sample interval is also 30 minutes
WETLabs FLNTUSB	269	6 hrs	Every 6 hours 8 samples. One average value of these 8 is telemetered
Satlantic OCR-507 ICSA Radiometer (Surface buoy)	201	2 hrs (only during daylight)	Sampling rate during operation is 1 Hz. The sampling frequency can be changed during deployment
Satlantic OCR-507 R10W Radiometer (Sensor frame downward-looking radiance)	095	2 hrs (only during daylight)	Sampling rate during operation is 1 Hz. The sampling frequency can be changed during deployment
Pro-Oceanus CO2	29-095-45	12 hrs	The sampling frequency can be changed during deployment
Pro-Oceanus GTD	29-100-15	12 hrs	The sampling frequency can be changed during deployment

It was decided not to deploy the SCAWS (Osmo sampler) for the following reasons:

- For a one year deployment it is necessary to preserve the samples. A mini 1:12 ratio osmotic pump is used for this reason. The preservative is a 1M HCl (ultraclean). The preservative was placed in a 100m FEP tube (1mm ID) which is connected to the main sampling tube. While filling the preservative tube with HCl it was evident that there is a leak on the line. It was not possible to repair this within the time we had before the mooring is redeployed.
- The initial findings of the sensor frame recovery indicated that the sampling tube when it is exposed is very fragile and it is highly possible that any exposed parts will break. The 700m of 1mm FEP sampling tube are winded on two spools and the connecting part is exposed and if it's not protected more than likely it will break and consequently all samples will be lost. As with the preservative addition we didn't have enough time to do the necessary modifications.

6.3.1 Individual Sensor notes

6.3.1.1 NAS 3X (s/n 2673)

The NAS 3X was tested before deployment to verify that all features were working properly. Unfortunately during the tests the cotton plug on the bottom end of the reduction column popped out. A new reduction column was used, but this means that the new column has not been tested for its efficiency.

The standards that were used were a 1μM and a 10 μM NO_3 that were spiked with 200 μl of 7% $HgCl_2$. On Board standards were collected before deployment from both standards.

The first analysis (standard) was set to be at 12:00 pm on Monday the 20/09/2010. From the near real time communication with the PAP mooring it is evident that the NAS operates two times a day (00:00 and 12:00 pm). This means that the NAS will not operate for an entire year as NH_4Cl will run out before then.

6.3.1.2 Satlantic ISUS V3 (s/n 60)

It was decided to redeploy the ISUS 60 with a new battery pack as even though it lost the protective anodizing surface it is still in better condition than ISUS 59. The ISUS is operating smoothly producing real time data.

6.3.1.3 Aanderaa Seaguard (s/n 219)

As mentioned on the sensors deployment table the Seaguard was set to operate every hour. The current meter's pings were set to 600. With this setting the battery lifetime is calculated to be 630 days (twice the deployment period). Serial communication and internal memory were enabled. The Cyclops gain was set to 10x which will allow the fluorometer to capture chlorophyll values above 5 mg/m^3. Unfortunately the RS-422 communication link to the hub was not tested before deployment and appears not to be working as no data has been received from the Seaguard.

6.3.1.4 WETLabs fluorometer (s/n 269)

The WETLabs was set to operate every 05:59:52 hour and so far it operates smoothly.

6.3.1.5 Seabird SBE-37 IMP MicroCATs (s/n 6904, 6907)

The two Seabird MicroCATs were mounted side by side in the sensor frame and were both programmed to sample once every 30 minutes. This is the same interval as the telemetry interrogation, so all the samples should be returned in near real time.

6.4 Post-deployment calibration CTD

The post deployment calibration CTD is necessary in order to identify the drift of the sensors that were deployed in June. As for the pre-deployment calibration CTD the sensors that can be "calibrated" are:

- Seaguard 217: The Seaguard 217 was not post calibrated because the Cyclops connection cable is loose and might fail.
- WETLabs 269: The sensor itself is working properly but the jumper starting plug is damaged and the second one was used for the sensor on the mooring.
- ISUS 60: The sensor was deployed on the mooring.
- MicroCAT: After recovery it was difficult to communicate with the recovered MicroCAT and it was difficult to have it ready for the CTD cast.

The post-deployment calibration CTD (CTD 4) started on 20/09/2010 at 11:00 a.m. As on the pre-calibration CTD, oxygen and salinity samples were not collected, this cast can be used to sample for oxygen and salinity and calibrate the CTD sensors which consequently will calibrate the sensors that were deployed on the pre-deployment calibration CTD.

7 Moorings Operations (Rob McLachlan, Paul Provost, Steve Whittle and James Burris)

7.1 PAP Celtic Explorer Diary of events

Wednesday 15th Sept.
We arrived at the vessel at around 15:00 and commenced mobilisation of vessel using ships crane, all equipment was loaded on board that day.

16th
The morning was spent securing equipment to deck and in the lab ready for sea.
The ship sailed at midday for the PAP site.

17th
A test CTD was carried out to 100m to test the system, all was OK apart from position five on the carousel.

We wound on mooring PAP3 on to one of the net winches. We also built all of the glass buoyancy for PAP3 and the Bathy-snap.
Two releases were secured to the CTD frame ready for a wire test,
We started to load some of the instrumentation in to the instrument frame.

18th
We woke to a splendid visual of the ODAS buoy majestically riding the surf.
One of the ARGO floats was deployed at around 10:00 am.
We followed this with attempts at communication with PAP3 in order to commence a recovery, this was proving somewhat difficult, attempts were made with both the NMFD TT801 and the Ben owned TT301, we tried both deck units numerous times on both sides of the vessel all to no avail.
We decided to manoeuvre the vessel to a different position, this had an immediate effect with good solid ranges received using the NMFD TT801 unit. The mooring was thus released at around 11:00 GMT and the ascent rate was calculated at around 70 m/min.
The mooring was recovered ok with a tangle to contend with but not much of a problem. However, the release was missing; it looks like there must have been a tangle below the bottom current meter that has caused severe friction to the point of failure. The mooring design of PAP3 was changed on board to help prevent this from happening again; two glass spheres were taken from the 10 pack of glass and placed above the release.

We then attempted to establish communication with the Bathy-snap, this proved even more difficult that PAP3, using the two deck units both sides of the ship.
The release was eventually fired "blind" at around 14:47 GMT using the NMFD TT801 unit. And it surfaced around two hours later where recovery commenced, all was recovered OK.

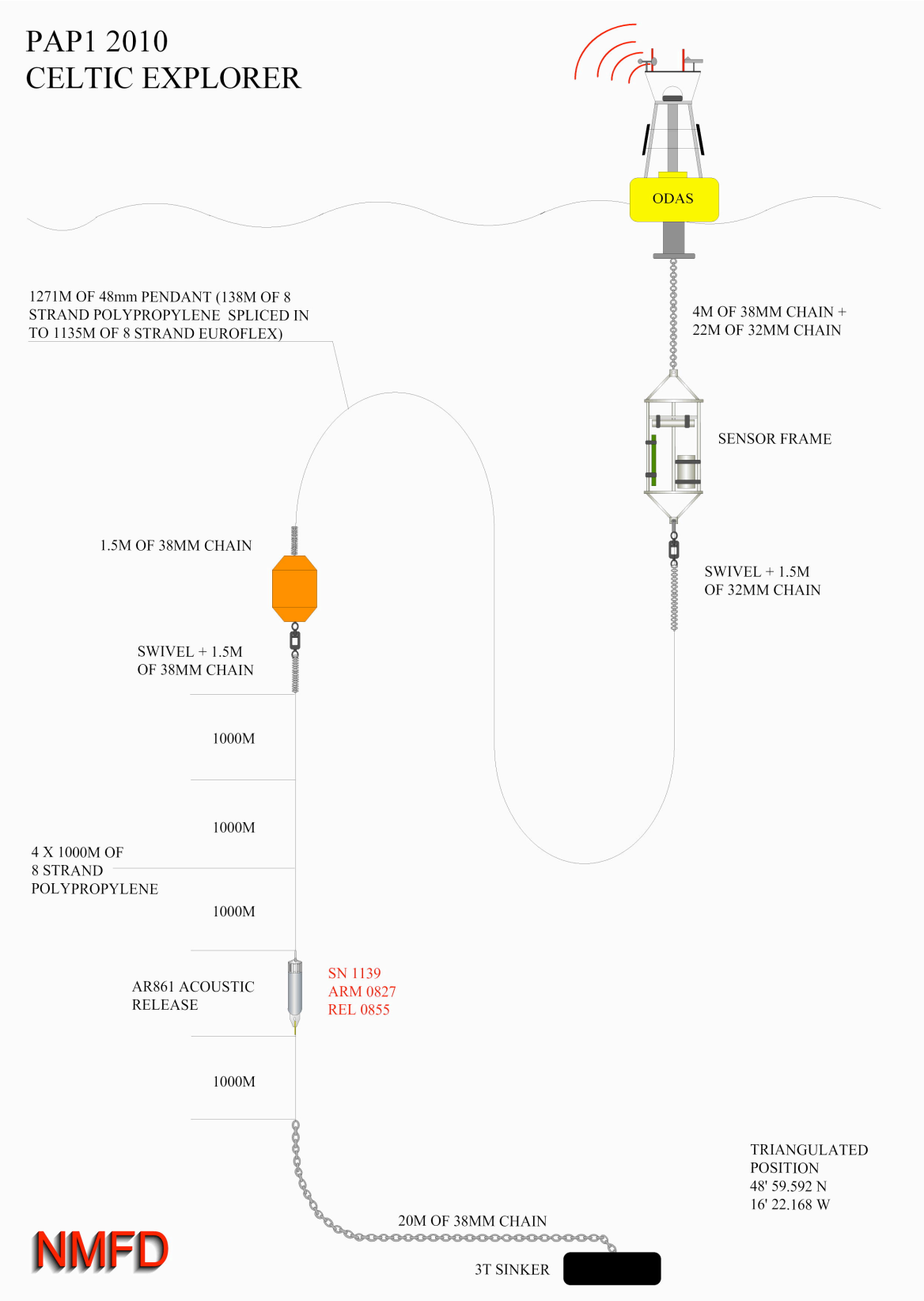
We then started a deep CTD at around 17:45 GMT. We are using this cast to test two releases, serial numbers 1186 (Ben's) and 255. Once again communication was difficult, with the Ben owned TT301 giving the best indication of the releases working.
Both releases had fired.

19th
Recovery of the ODAS buoy was started this morning by approaching the buoy with the stern of the vessel and hooking in to the top of the mast. The buoy was lifted on to the deck and secured whilst the chain beneath the buoy was stopped off. Once the buoy was secure, recovery of the chain commenced, stopping off at various points until the instrument frame was on deck; the mooring was then stopped off more permanently using the ring attached through the thimble.
Inspection and servicing of the buoy and sensor frame was the carried out for the remainder of the day.
See Condition of Mooring for details.

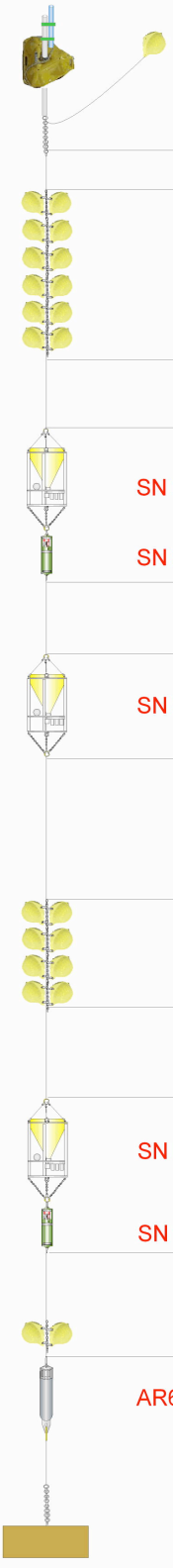
The ODAS buoy and instrument frame were then deployed over the stern.

20th
We started by preparing for the PAP3 deployment, some difficulties were noticed with the 13 way sediment trap communications; this was pinpointed to the comms lead and was subsequently repaired.
PAP3 was then deployed over the stern with no real issues, all went well.
We then had to wait for the Bathy Snap to flash to prove that it was working; once this was confirmed the unit was deployed.
This was the end of mooring operations.

7.2 Mooring diagrams



PAP3 2010
AS DEPLOYED
CELTIC EXPLORER



RECOVERY LINE

BILLINGS FLOAT WITH
LIGHT SN B1001

15M POLYPROP

12 X 17" GLASS
SPHERES

50M POLYESTER

SEDIMENT TRAP
3000M FROM BOTTOM
RCM 8

SN ML12432-01

SN 9686

50M POLYESTER

SEDIMENT TRAP
3000M FROM BOTTOM

SN 520 (13 WAY)

500+500+500+100M
10mm POLYESTER

8 X 17" GLASS
SPHERES

50M POLYESTER

SEDIMENT TRAP
100M FROM BOTTOM
RCM 8

SN ML12432-03

SN 12688

50M POLYESTER

2 X 17" GLASS

AR661 SN 255 ARM EC62 REL EC85

45M POLYESTER

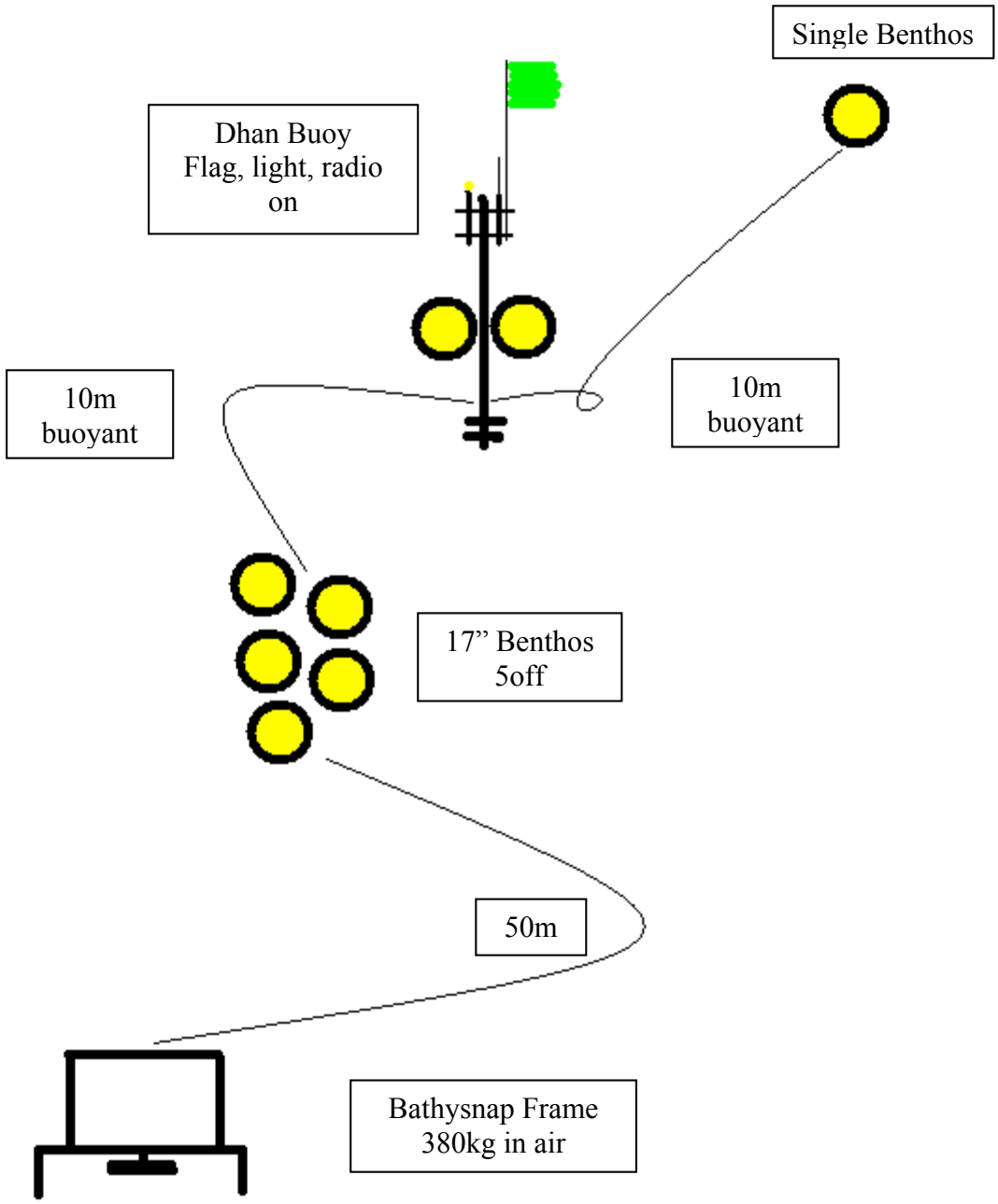
10M 1/2" CHAIN

850KG ANCHOR

WATER DEPTH 4844M

NMFD

7.2.1 Bathysnap as deployed from Celtic Explorer 20 Sep 2010 (Ben Boorman)



Release	S/N 1186	AR8x1
Window	0875	
Release	0855	
Wait time	4s	
Active time	20s	
Pinger	0847	

7.3 PAP1 Mooring condition

The mechanical parts of the mooring that were recovered were found to be in good condition with no cause for concern. The only noticeable wear points being at the shackle points at either end of the sensor frame, the top end (shallow end) of the frame had some minor wear on the steel eye that the shackle attaches to, the eye was replaced as part of the replacement instrument frame. The lower end (deeper end) of the sensor frame showed some minor wear on the shackle that attaches to the frame. Again, this shackle was replaced for the deployment.
None of the above gave any cause for concern.

The 32mm chain with the power and communication wires attached to it was all in excellent condition. The chain itself showed no signs of wear or corrosion. The wires that are bulldog-gripped to the chain was one area that we thought might need attention, however this turned out to be in excellent condition with the exception of some minor damage on one of the cables that was deemed to have happened during recovery and was subsequently repaired.

The sensor frame was mechanically sound; however the anodes had corroded at a rate that we had not predicted. For the deployment more anodes were added to the frame.

8 Marine Mammal Observer Summary (Lucy Hunt)

8.1 Background and methodology

In 2008, the Irish Whale and Dolphin Group (IWDG) in collaboration with the Galway-Mayo Institute of Technology commenced PReCAST, a three-year project (2008-2011) which aims to provide robust scientific data to support conservation policy and provide guidance to state agencies in implementing national and international obligations. PReCAST is committed to gaining a more complete understanding of the seasonal distribution, relative abundance and habitat use of cetaceans within the Irish EEZ.

As part of this project a cetacean distribution and relative abundance survey was conducted on board the R.V. *Celtic Explorer* during the National Oceanography Centre's cruise in September 2010. The survey area covered waters in the Celtic Sea, Abyssal Plain and Porcupine Sea Bight. The survey areas were opportunistic and based on predetermined locations chosen by the National Oceanography Centre.

A single marine mammal observer was present on board during the survey and conducted watches from the 'crow's nest' located above the bridge, 18m above sea level. Observer effort focused on a 90-degree arc ahead of the ship; however sightings located up to 90 degrees to port and starboard were also included. The observer scanned the area by eye and using 10 X 50 binoculars. Bearings to sightings were measured using an angle board and distances were estimated with the aid of distance measuring stick. Environmental data were recorded every 15 minutes using Logger 2000 software (IFAW 2000). Sightings were also recorded using Logger 2000. Automated position data were obtained through a laptop computer linked to GPS receiver.

8.2 Cetacean Survey Results

Forty-four hours of survey time were logged with 69% (30.5 hrs) of this at Beaufort sea state three or less; and 31% (13.5 hrs) at Beaufort sea state ≥ four. There were 28 sightings of at least four cetacean species, with a total of 115 individuals recorded. Common dolphin sightings were the most commonly encountered (57% of all sightings) and abundant.

Identified cetacean species were common dolphin (*Delphinus delphis*), pilot whale (*Globicephala melas*), humpback whale (*Megaptera novaeangliae*), sei whale (*Balaenoptera borealis*) and fin whale (*Balaenoptera physalus*). Three sightings were downgraded to unidentified dolphin and unidentified whale, according to the IWDG's cetacean sightings database classification scheme (IWDG 2009), as a positive id of these animals could not be made. Sperm whales were the most commonly encountered and during the survey, while the common dolphin was the most abundant. A leather back turtle was also sighted during the survey in the Porcupine Sea Bight.

Table 1: Sightings, counts and group size ranges for cetaceans sighted during the survey.

Species	**No. Sightings**	**No. Individuals**	**Range of Group Size**
Common dolphin	16	100	1-50
Humpback whale	2	2	1
Sei whale	1	1	1
Pilot whale	1	6	6
Fin whale	4	5	1-2
Unidentified whale	3	3	1

8.3 Bird Activity

Daily species lists were made of all seabird species seen around the survey vessel. Eight seabird species were recorded during the survey: Gannet (*Morus bassanus*), Fulmar (*Fulmarus glacialis*), Kittiwake (*Rissa tridactyla*), Herring gull (*Larus argentatus*), Lesser black-backed gull (*Larus fuscus*), Guillemot (*Uria aalge*), Great Shearwater (*Puffinus gravis*) and Auk species.

9 Acknowledgements

The success and smooth running of this cruise was largely due to the experience and professionalism of Captain Rowan and his crew, underpinned by Aodhán FitzGerald and the Operations Group at the Marine Institute. Special mention is due to John Barry and bosun Stephen Lantry for the smooth and efficient way they ran the deck operations that were a key part of this cruise.
Thank you all, it was a pleasure to work together.

10 Station List for Celtic Explorer CE10005

Day	Station#	Date	UTC	Event	Latitude N	Longitude W
259		16-Sep-10	11:30	Departed Milford Haven		
260		17-Sep-10		Test CTD 1 to 100m - CTD1		
261	1	18-Sep-10	09:09	ARGO float 3905 deployed	49.023389	16.388106
	2		09:44	At PAP3 - dunker overside	48.993258	16.487856
			10:03	Try new location	48.992903	16.489142
			10:07	Released		
			10:53	Spotted on surface	49.003203	16.487111
			11:25	1st Sediment trap on deck		
			12:20	Final Sediment trap on deck.		
	3		12:40	Over bathysnap - dunker deployed	49.003511	16.449419
			13:47	Release code sent - no response to ranging	49.005317	16.449500
			14:30	Still pinging - no response		
			15:50	Bathysnap spotted on surface	49.011944	16.454028
			16:20	Bathysnap on deck		
	4		16:35	Start CTD 2 - chlorophyll max at 45m	49.015944	16.450225
			18:20	At 4700m		
			19:00	CTD coming up		
			20:55	CTD back on deck		
262	5	19-Sep-10	08:05	ODAS buoy on deck	49.013528	16.369833
			08:33	Sensor frame on deck		
			14:21	CTD 3 ready to go		
			14:25	Start CTD with PAP1 sensors		
			15:15	CTD back on deck		
			19:15	ODAS buoy redeployed		
			22:00	Start Plankton net 1		

263	7	20-Sep-10	07:50	Trying to interrogate BoBo lander	48.990778	16.388944
			09:40	Gave up on BoBo		
	8		10:05	Start CTD 4	49.001536	16.417972
			10:37	CTD back on deck	49.001472	16.418028
	9		15:00	Commenced PAP3 mooring deployment	49.007139	16.482361
			16:08	PAP3 anchor away	48.989028	16.492167
	10		18:00	Commenced Bathysnap deployment		
			18:08	Bathysnap dropped	49.005694	16.448472
	11		18:42	Commence 1000m CTD 5	49.023444	16.395889
			19:25	Chlorophyll max 53 m		
			19:31	CTD back on deck	49.023444	16.395889
			21:55	Start plankton net 2	49.023365	16.395978
			22:25	Plankton net on deck		
			22:35	ARGO float 3906 deployed	49.023365	16.395978
			22:40	Steaming for Galway		
264		21-Sep-10		Steaming for Galway		
265		22-Sep-10	15:30	Tied up in Galway harbour		