Irish Sea Observatory cruise 74

PI: Jo Hopkins (NOC)
Dates: 11th-14th January 2011
Ship: Prince Madog (cruise 01/11)

The science driver for the Irish Sea Observatory is *'to monitor and understand the impacts of natural and anthropogenic forcing of a shelf sea, and to provide a framework for research into the functioning of a shelf-sea in a changing climate*'.

Started in 2002, The Observatory integrates (near) real-time measurements with coupled models into a pre-operational coastal prediction system whose results are displayed online at http://cobs.pol.ac.uk/. Further details about the Observatory may be found on this site.

1. Cruise and Scientific Objectives

1.1 Mooring deployment and recovery

Two permanent monitoring sites are maintained at the locations marked in Figure 1. At each of these sites instrumentation is mounted in a sea bed frame, on a surface buoy and along its mooring chain. Maintaining a long time series of observations will ultimately help to discriminate between natural and anthropogenic variability within Liverpool Bay. The primary aim of the cruise was to recover and redeploy this instrumentation.

Site A 53° 32′ N, 3° 21.8′ W (CTD station 1)

To recover:

a) A sea bed frame containing a 600 kHz RDI ADCP (measuring mean current profile, pressures and directional waves), SeaBird SBE 16*plus* (with pumped conductivity sensor), digiquartz pressure sensor, a SeaPoint turbidity sensor with wiper and SeaBird SBE 16*plus* with an Aanderra oxygen Optode.

b) CEFAS SmartBuoy (including a new weather station system) in a single point mooring. Temperature mini-loggers are attached to the mooring wire at 7.5 m and 15 m below the surface and a SeaBird Microcat temperature and conductivity logger at 10m below the surface. A frame containing a WetLabs ACS unit, Wetlabs fluorometer and SeaBird MicroCat is attached at 5m below the surface.

To deploy:

c) A sea bed frame containing a 600 kHz RDI ADCP (measuring mean current profile, pressures and directional waves), SeaBird SBE 16*plus* (with pumped conductivity sensor), digiquartz pressure sensor, a SeaPoint turbidity sensor with wiper and SeaBird SBE 16*plus* with an Aanderra oxygen Optode.

d) CEFAS SmartBuoy in a single point mooring. Temperature mini-loggers are attached to the mooring wire at 7.5 m and 15 m below the surface and a SeaBird Microcat temperature and conductivity logger at 10m below the surface. A frame containing a WetLabs ACS unit, Wetlabs fluorometer and SeaBird MicoCat is attached at 5m below the surface.

'New' Site B, 53° 32.3' N, 3° 38.4' W (CTD station 20)

To recover:

a) A sea bed frame for a 600 kHz RDI ADCP measuring mean current profile, pressures and directional waves, a SeaBird SBE 16*plus* (with pumped conductivity sensor), digiquartz pressure sensor and a SeaPoint turbidity sensor (fitted with a wiper).

b) A CEFAS SmartBuoy in a single point mooring. Attached to the mooring wire are SeaBird MicroCat temperature, conductivity loggers at 5 m and 10 m below the surface and temperature miniloggers at 7.5 m, 15 m and 20 m below the surface.

To deploy:

c) A sea bed frame for a 600 kHz RDI ADCP measuring mean current profile, pressures and directional waves, a SeaBird SBE 16*plus* (with pumped conductivity sensor), digiquartz pressure sensor and a SeaPoint turbidity sensor (fitted with a wiper).

d) A CEFAS SmartBuoy in a single point mooring. Attached to the mooring wire are SeaBird MicroCat temperature, conductivity loggers at 5 m and 10 m below the surface and temperature miniloggers at 7.5 m, 15 m and 20 m below the surface.

1.2 CTD and LISST survey

The second objective of the cruise was to complete a CTD survey of 34 sites every fives nautical miles covering the eastern Irish Sea (marked in Figure 1). The survey grid covers the area from the coast of North Wales to a line extending westwards from Blackpool, and from the Lancashire coast to a line extending northwards from Great Orme Head. The grid and sampling are designed to determine the effects of the Dee, Mersey and Ribble on the dynamics and biogeochemistry of Liverpool Bay.

At each fixed station samples are taken for the analysis of nutrient concentrations. Nutrients are essential for phytoplankton growth, therefore, understanding the magnitude and changes in sources and inputs of nutrients into Liverpool Bay gives us some understanding of the maximum potential phytoplankton growth in the region and thus potential for carbon sequestration. In addition, monitoring nutrient levels over the long term in Liverpool Bay may provide an early indicator of the risk of eutrophication in this region heavily influenced by river-inputs.

Suspended Particulate Matter Samples (SPM) are taken at each site as part of a long term observatory requirement for total suspended sediment concentrations (now inorganic/organic as well). The samples are also required for marine optics, and for comparisons of absorption and scattering with the ACS instrument. Chlorophyll-a and Coloured Dissolved Organic Matter (CDOM) samples are taken as part of a marine optics study.

Discrete samples for the determination of chlorophyll, SPM, dissolved oxygen, inorganic nutrients and salinity also provide calibration points for the CTD and mooring sensors.

1.3 Grab samples

The third objective was to collected grab samples of the seabed sediment at each station.

1.4 Zooplankton net hauls

The fourth objective was to collect 10 vertical zooplankton net hauls at Site A to determine species diversity and abundance.

2. Cruise Narrative

(All times in GMT throughout report)

The Prince Madog berthed at Vittoria Wharf just before 16:00 on 11/01/2011. Loading was completed by 16:30.

The Madog left her berth at 04:25 on 12/01/2011 and entered the River Mersey via Alfred Lock at 04:57. The ship's surface monitoring and ADCP were switched on at 05:27 on passing the radar tower at Crosby.

Zooplankton net hauls were completed by CEFAS at site A between 06:31 and 07:10.

A pre-recovery CTD was completed at first light (08:07), during which time the wind was 8.3m.s^{-1} (250°). The Site A ADCP frame was recovered successfully by 08:43. The new frame was released at 09:00. The CEFAS SmartBuoy was released at 09:21 and recovery of the old buoy complete by 09:40. All these mooring operations were completed out without any problems and followed by a post-deployment CTD.

The CTD grid and grab sampling was started from station 5 at 12:04 on 12/01/2011, followed by east-west lines (4,6,16,17,28,29,30,27,18,15,7). At 21:46 (station 3), power to the CTD was lost. The CTD main DC power cable connectors inside the carousel had burnt out causing loss of instrumentation power. The connectors were removed and a waterproof cable splice was used as a temporary fix. The offending cable and connectors will be replaced ASAP.

The wind speed at midnight had dropped to 4.7 m.s^{-1} and swung round to 146°.

CTD operations recommenced at 08:30 on 13/01/2011 at station 3, followed by stations 2, 8, 14, 19, 26, 31, 32 and 25. At 04:22 the wind had increased to 12.4 m.s^{-1} (220°) and the sea state picked up to a heavy swell.

Site B (Station 20) was reached at 08:04 and a pre-mooring CTD performed. Given the heavy swell only the ADCP frame was recovered (at 08:46) and re-deployed (at 09:03). A post- mooring CTD was completed. Wind speeds were forecast to decrease into the afternoon so recovery and re-deployment of the SmartBuoy was postponed. So as not to disrupt hours of rest for the engineers later in the day the chains and instrumentation for deployment of SmartBuoy B were prepared and laid out on deck (during watch 2). CEFAS and the Madog crew would therefore be able to deploy and recover without the assistance of NOC engineers.

Following this preparation the CTD grid was continued (13, 1/9, 10, 11, 12, 21). During this time the wind dropped to 6.5m.s^{-1} (236°) and the sea state improved. Note that at station 10 (CTD 28) the LISST 100X was not switched on. Additionally, niskin bottle number 3 (bottom sample) did not close at station 21 (CTD 31). Nutrients followed by SPM and chlorophyll were therefore taken from bottle 4. No salinity sample was taken for this station.

Upon completion of station 21 the Madog returned to Site B. With decreased swell the new SmartBuoy was successfully deployed (at 15:01) and the old buoy recovered at 15:17. A post-deployment CTD was performed.

The remaining CTD stations and grab samples in the south-western corner of the grid were then completed (24, 33, 34, 23, 22) just after 20:00 on 13/01/2011.

The Madog then steamed slowly towards station 35 during which time the wind speed dropped further to 5 $m.s^{-1}$ (162°). Sampling at station 35 took place at 02:23 on 14/01/2011 after which the Madog entered the Mersey heading for a 04:00 lock.

The ships surface monitoring and ADCP were switched off at 03:37 on 14/01/2011.

The Madog entered Alfred Lock at 04:06. The lock gates however could not be closed and an engineer was called. At 05:51 the problem was fixed and the Madog exited the lock at 05:59. Unloading was completed by 06:15 and the Madog left her berth to return to Menai Bridge.

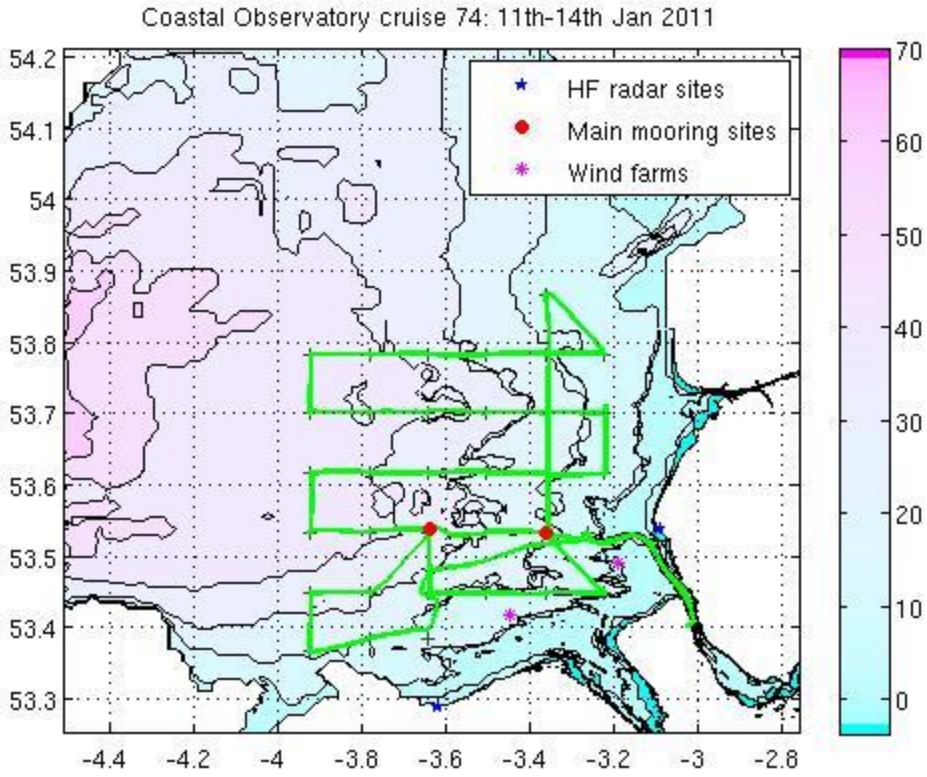

Figure 1. Coastal Observatory Cruise Track #74

3. Moorings

3.1 Recovered Instrumentation

Table 1: Recovered mooring positions and times

	Latitude (N)	Longitude (W)	Depth (m)	Date	Time (GMT)
ADCP frame (Site A)	53°32.1068	3°21.5166	22.2	12/01/2011	08:43
SmartBuoy (Site A)	53°31.8661	3°21.6520	21.6	12/01/2011	09:40
ADCP frame (Site B)	53°32.4677	3°38.6770	36.3	13/01/2011	08:46
SmartBuoy (Site B)	53°32.244	3°38.146	37.2	13/01/2011	15:17

Site A Bedframe: NOCL Rig ID 1113

The table below details the recovered instruments mounted on the seabed frame at Site A

Instrument	S/N	Notes	Clock set	Delayed start	Stopped logging	Clock drift (secs)
RDI 600 kHz ADCP	2390	1 GB memory. Mode 1: 100 pings every 10 minutes 35 × 1 m bins (2.65–36.65 m above the bed, WN035). Beam coordinates – speeds, correlation, echo intensity, % good. Sound velocity calculated from temperature, depth and salinity of 32. 20° beam separation	09:17:00 07/12/2010	10:00:00 07/12/2010	06:58:25 14/01/2011	+50
SeaBird SBE 16plus	4736	Mounted on base of frame with pumped conductivity sensor and SeaPoint turbidity sensor (see below). Sample interval 600 s; digiquartz integration time 40 s, range 400; pump 0.5 s, 1 s delay.	09:37:45 07/12/2010	10:00:00 07/12/2010	13;25:00 17/01/2011	+6
SeaPoint turbidity sensor	10320	Taped to roll bar and setup for 0–125 FTU range and fitted with wiper	-	-	-	-
SeaBird SBE 16 plus	4490	Mounted with Aanderra Optode (see below). Sample interval 600s.	09:55:30 07/12/2010	10:15:00 07/12/2010	13:32:00 17/01/2011	+6
Aanderra Optode	674		-	-	-	-

The frame was fitted with a fizz link, a spooler with 50 m of rope for recovery of the ballast weight and two Benthos releases:
S/N 71919 (Rx=10.5 kHz, Tx=12.0 kHz, RC=C)
S/N 67676 (Rx=11.5 kHz, Tx=12.0 kHz, RC=C)

Site A Mooring: NOCL Rig ID 1112

The following instrumentation was recovered from the SmartBuoy mooring at Site A

Instrument	S/N	Notes	Depth (m)	Clock set	Delayed start	Stopped logging	Clock drift (secs)
SeaBird Microcat	5792	Temperature and conductivity recorder. Mounted on frame with AC-S and fluorometer)	5	09:32:00 07/12/2010	10:00:00 07/12/2010	23:03:00 17/01/2011	+55
AC-S	60	(DH4 data logger S/N 140)	5	15:23:00 03/12/2010	10:00:00 07/12/2010	10:00:00 17/01/2011	+2
Wetlabs fluorometer	1513	Attached to AC-S frame	5	15:32:00 12/11/2010	10:00:00 07/12/2010	18:30:00 17/01/2011	-
SeaBird Microcat	5791	Temperature and conductivity recorder	10	09:32:00 on 07/12/2010	10:00:00 07/12/2010	13:44:00 17/01/2011	+6
StarOddi Mini-logger	2840	Set to record at 600s intervals	7.5	N/A	11:00:00 07/12/2010	13:58:00 17/01/2011	-3.56
Staroddi Mini-logger	2841	Set to record at 600s intervals	15	N/A	11:00:00 07/12/2010	14:05:30 17/01/2011	-3.56

The CEFAS SmartBuoy is fitted with sensors for conductivity, temperature and optical back scatter at 1 m below surface, light sensors at 1 m and 2 m below the surface, a fluorometer (SeaPoint), oxygen sensor (Aanderaa Optode), an in-situ NAS2E nutrient analyzer and a water sampler which obtains samples every fourth day for laboratory analysis (ToxN and silicate) and every eighth day (phytoplankton species, composition and abundance). The conductivity, temperature, optical back scatter and light data are transmitted back to CEFAS via Orbcomm satellite.

A new weather station attached to the SmartBuoy frame was also recovered (Started at 09:34 on 07/12/2010. First sample on 09:40 on 07/12/2010).

The single point mooring was composed of ½″ long link chain, marked by a 1.8 m diameter toroid and anchored by a half tonne clump of scrap chain.

Site B Bedframe: NOCL Rig ID 1115

The table below details the recovered instruments mounted on the seabed frame at Site B

Instrument	S/N	Notes	Clock set	Delayed start	Stopped logging	Clock drift (secs)
RDI 600 kHz ADCP	5806	1 GB memory. Mode 1: 100 pings every 10 minutes 45 × 1 m bins (2.65–46.65 m above the bed, WN045). Beam coordinates –	13:50:10 07/12/2010	15:00:00 07/12/2010	07:04:10 14/01/2011	+49

		speeds, correlation, echo intensity, % good. Sound velocity calculated from temperature, depth and salinity of 32. 20° beam separation				
SeaBird SBE 16plus	4738	Mounted on base of frame with pumped conductivity sensor and SeaPoint turbidity sensor (see below). Sample interval 600 s; digiquartz integration time 40 s, range 400; pump 0.5 s, 1 s delay.	14:04:45 07/12/2010	15:00:00 07/12/2010	13:20:00 17/01/2011	+7
SeaPoint turbidity sensor	10538	Taped to roll bar and setup for 0–125 FTU range and fitted with wiper	-	-	-	-

The frame was fitted with a fizz link, a spooler with 50 m of rope for recovery of the ballast weight and two Benthos releases:
S/N 72863 (Rx=13.5 kHz, Tx=12.0 kHz, RC=A)
S/N 72381 (Rx=11.0 kHz, Tx=12.0 kHz, RC=B)

Site B Mooring: NOCL Rig ID 1114

The following instrumentation was recovered from the SmartBuoy mooring at Site B

Instrument	S/N	Notes	Depth (m)	Clock set	Delayed start	Stopped logging	Clock drift (secs)
SeaBird Microcat	2506	Temperature and conductivity recorder.	5	09:45:30 07/12/2010	10:00:00 07/12/2010	13:49:50 17/01/2011	+11
SeaBird Microcat	5434	Temperature and conductivity recorder	10	09:35:00 on 07/12/2010	10:00:00 07/12/2010	13:40:50 17/01/2011	+5
StarOddi Mini-logger	2842	Set to record at 600s intervals	7.5	N/A	11:00:00 07/12/2010	14:10:30 17/01/2011	-3.56
Staroddi Mini-logger	2848	Set to record at 600s intervals	15	N/A	11:00:00 07/12/2010	14:15:30 17/01/2011	-3.56
Staroddi Mini-logger	2851	Set to record at 600s intervals	20	N/A	11:00:00 07/12/2010	14:20:00 17/01/2011	-3.56

The CEFAS SmartBuoy is fitted with sensors for conductivity, temperature and optical back scatter and a fluorometer at 1 m below surface. The single point mooring was composed mainly of ½″ long link chain, marked by a 1.8 m diameter toroid and anchored by a half tonne clump of scrap chain.

3.2 Deployed Instrumentation

Table 2: Deployed mooring positions and times

	Latitude (N)	Longitude (W)	Depth (m)	Date	Time (GMT)
ADCP frame (Site A)	53°32.0602	3°21.4408	22.0	12/01/2011	09:00
SmartBuoy (Site A)	53°32.0830	3°21.6580	22.1	12/01/2011	09:21
ADCP frame (Site B)	53°32.4198	3°38.6310	35.9	13/01/2011	09:03
SmartBuoy (Site B)	53°32.414	3°38.387	38.2	13/01/2011	15:02

Site A Bedframe

The following instrumentation was mounted on the seabed frame deployed at Site A.

Instrument	S/N	Notes	Clock set	Delayed start
RDI 600 kHz ADCP	3644	1.5 GB memory. Mode 1: 100 pings every 10 minutes 35 × 1 m bins (2.65–36.65 m above the bed, WN035). Beam coordinates – speeds, correlation, echo intensity, % good. Sound velocity calculated from temperature, depth and salinity of 32. 20° beam separation.	11:18:00 11/01/2011	06:00:00 12/01/2011
SeaBird SBE 16plus	4597	Mounted on base of frame with pumped conductivity sensor and SeaPoint turbidity sensor (see below). Sample interval 600 s; digiquartz integration time 40 s, range 400; pump 0.5 s, 1 s delay.	12:07:00 11/01/2011	06:00:00 12/01/2011
SeaPoint turbidity sensor	10471	Taped to roll bar and setup for 0–125 FTU range and fitted with wiper	-	-
SeaBird SBE 16 plus	4741	Mounted with Aanderra Optode (see below). Sample interval 600s.	12:31:00 11/01/2011	06:00:00 12/01/2011
Aanderra Optode	675		-	-

The frame was fitted with a fizz link, a spooler with 50 m of rope for recovery of the ballast weight and two Benthos releases:

S/N 72382 (Rx=10.0 kHz, Tx=12.0 kHz, RC=A)

S/N 70358 (Rx= 11.0 kHz, Tx=12.0 kHz, RC=A)

Site A Mooring

The following instrumentation was deployed from the SmartBuoy mooring at Site A

Instrument	S/N	Notes	Depth (m)	Clock set	Delayed start
SeaBird Microcat	4966	Temperature and conductivity recorder. Mounted on frame with AC-S and fluorometer)	5	13:12:30 11/01/2011	06:00:00 12/01/2011
AC-S	59	(DH4 data logger S/N 119)	5	18:31:00 11/01/2011	08:50:00 12/01/2011
Wetlabs fluorometer	1514	Attached to AC-S frame	5	19:08:00 11/01/2011	07:40:00 12/01/2011
SeaBird Microcat	5790	Temperature and conductivity recorder	10	12:56:00 on 11/01/2011	06:00:00 12/01/2011
StarOddi Mini-logger	2836	Set to record at 600s intervals	7.5	N/A	06:00:00 12/01/2011
Staroddi Mini-logger	2837	Set to record at 600s intervals	15	N/A	06:00:00 12/01/2011

The CEFAS SmartBuoy is fitted with sensors for conductivity, temperature and optical back scatter at 1 m below surface, light sensors at 1 m and 2 m below the surface, a fluorometer (SeaPoint), oxygen sensor (Aanderaa Optode), an in-situ NAS2E nutrient analyzer and a water sampler which obtains samples every fourth day for laboratory analysis (ToxN and silicate) and every eighth day (phytoplankton species, composition and abundance). The conductivity, temperature, optical back scatter and light data are transmitted back to CEFAS via Orbcomm satellite.

The single point mooring was composed of ½″ long link chain, marked by a 1.8 m diameter toroid and anchored by a half tonne clump of scrap chain.

Site B Bedframe

The following instrumentation was mounted on the seabed frame deployed at Site B.

Instrument	S/N	Notes	Clock set	Delayed start
RDI 600 kHz ADCP	5807	1 GB memory. Mode 1: 100 pings every 10 minutes 45 × 1 m bins (2.65–46.65 m above the bed, WN045). Beam coordinates – speeds, correlation, echo intensity, % good. Sound velocity calculated from temperature, depth and salinity of 32. 20° beam separation.	11:49:10 11/01/2011	06:00:00 12/01/2011
SeaBird SBE 16plus	4737	Mounted on base of frame with pumped conductivity sensor and SeaPoint turbidity sensor (see below). Sample interval 600 s; digiquartz integration time 40 s, range 400; pump 0.5 s, 1 s delay.	12:17:30 11/01/2011	06:00:00 12/01/2011
SeaPoint turbidity sensor	10537	Taped to roll bar and setup for 0–125 FTU range and fitted with wiper	-	-

The frame was fitted with a fizz link, a spooler with 50 m of rope for recovery of the ballast weight and two Benthos releases:
S/N 71922 (Rx=11.5 kHz, Tx=12.0 kHz, RC=A)
S/N 70356 (Rx=10.5 kHz, Tx= 12.0 kHz, RC=D)

Site B SmartBuoy

The following instrumentation was deployed from the SmartBuoy mooring at Site B

Instrument	S/N	Notes	Depth (m)	Clock set	Delayed start
SeaBird Microcat	4998	Temperature and conductivity recorder.	5	13:07:00 11/01/2011	06:00:00 12/01/2011
SeaBird Microcat	5433	Temperature and conductivity recorder	10	13:02:00 11/01/2011	06:00:00 12/01/2011
StarOddi Mini-logger	2838	Set to record at 600s intervals	7.5	N/A	06:00:00 12/01/2011
Staroddi Mini-logger	2849	Set to record at 600s intervals	15	N/A	06:00:00 12/01/2011
Staroddi Mini-logger	2852	Set to record at 600s intervals	20	N/A	06:00:00 12/01/2011

The CEFAS SmartBuoy is fitted with sensors for conductivity, temperature and optical back scatter and a fluorometer at 1 m below surface. The single point mooring was composed mainly of ½″ long link chain, marked by a 1.8 m diameter toroid and anchored by a half tonne clump of scrap chain.

4. CTD and LISST survey

The following instrumentation was mounted on the rosette frame:

Instrument	S/N	Notes
SeaBird temperature sensor (SBE 3)	P4100	
SeaBird conductivity sensor (SBE 4)	2543	
SeaBird 43 oxygen sensor	1491	
LI-COR LI 192SB (downwelling PAR/Irradiance sensor)	26	
Turner SCUFAII Fluorometer	262	
SeaTech T1000 Transmissometer	T1021	0.2m path
SeaBird SBE35 precision thermometer	0041	
Sequoia Scientific LISST-100X particle sizer	1291	Internal logging http://www.sequoiasci.com/products/part_LISST_100.aspx

The Satlantic SUNA nitrate analyzer was not fitted to the CTD during this cruise. This was to test the possibility that it could be causing the pump on the conductivity cell to intermittently fail (possibility by drawing too much power?). No problems with the pump were noted during the cruise.

Water samples were taken by Anne Forbes-Brook (Bangor University) near the sea bed (3m above bottom) for calibration of the CTD salinity. Samples were analysed on a Guildline Portasal 8410A at the University of Bangor.

Samples were taken from the following 5L Niskin bottles:

Near bed:

Bottle 3 – SPM/chlorophyll/CDOM
Bottle 4 – Nutrients and salinity
Bottle 5 – CEFAS

Near surface:

Bottle 8 – Nutrients
Bottle 9 – SPM/chlorophyll/CDOM;
Bottle 10, 11 – CEFAS

5. Nutrient sampling (for Claire Mahaffey, UoL)

Nutrient samples were taken from the near surface (1m) and near bed (3 mab) for the analysis of nitrate plus nitrite, phosphate and silicate.

Samples are collected directly from 5L Niskin bottles into acid-washed, deionised water rinsed 125ml HDPE screw cap bottles. Bottles are rinsed 3 times and filled with ~ 100ml of sample. Samples are capped, labeled and placed in a -20°C freezer and frozen upright. Samples are transported frozen to the University of Liverpool for analysis. Samples are defrosted overnight in the dark prior to analysis and analyzed within 1 week of collection using a NOC-funded Bran and Luebbe QuAAtro Pro 5-channel nutrient analyser.

The location of samples collected are detailed in Table 3.

6. SPM, Chlorophyll and CDOM sampling (for Andy Lane, NOC-L)

Water from the near surface (1m) and near bed (3 mab) was taken for the determination of SPM, chlorophyll-a and CDOM. The following sections detail the pre-processing, sample collection and post-processing steps.

6.1 Suspended Particulate Matter (SPM)

Pre-processing: Whatman GF/F 0.7µm poresize 47mm diameter filters. Use tweezers to handle filters at edges. (a) Examine filters for damage, etc. Rinse to remove loose fibres and plasticiser; place in aluminium dishes and dry in the oven at 75°C for 2 hours. (b) Check filters don't stick to the dishes; transfer to muffle furnace and combust at 400°C for 4 hours. (Above 450°C may alter the filter matrix.) (c) Place in desiccator for half hour before weighing (5-figure balance in grams).

Sample collection: (d) Use clean buckets placed beneath Niskin bottles (on the CTD frame) and take entire contents. (e) Stir sample before measuring out, typically 1L required, less (500ml) if transmissometer on CTD indicates turbid conditions. (f) Place filter on to holder and assemble the funnel. Switch on vacuum pump, ensuring suction <0.4bar (<0.2 bar if done at same time as chlorophyll sample). Add sample in stages - don't

allow paper to go dry. (g) Before final 50ml goes through add 100ml of deionised water; repeat once. (h) Put filter back in to appropriate dish/bag. Store in freezer at -18°C.

Post-processing: (i) Dry filters at 75°C for 3 hours before weighing as in (c). (j) Dry again at 75°C for a further 1 hour before weighing again. (k) Repeat step j) if weights are not the same. Difference in weight from original filter weight divided by the sample volume gives concentration of total SPM. (l) Combust at 500°C for 3 hours to remove organic fraction, then weigh. Differences in weights from original divided by volume gives inorganic SPM concentration.

6.2 Chorophyll-a

Pre-processing: (m) Clean test tubes with screwcaps, numbered and placed in rack.

Sample collection: (n) Use the same water sample as for SPM d) to f), except measure out 500ml and filter through Whatman GF/F 0.7µm poresize 47mm diameter filters (straight from box) with vacuum <0.2bar. Do not rinse. (o) Put filter in the test tube, replace cap, and wrap in aluminium foil with label. Store in freezer.

Post-processing: (p) Fluorometric method: make the chlorophyll standard and calibrate the fluorometer. (q) Take test tubes from freezer, add 5ml of cold 90% acetone, place foil-wrapped tubes in a polypropylene beaker with water and sonicate in the water bath for 15 minutes. Do not allow the samples to warm up, and avoid exposing them to high light levels. (r) Remove filter papers leaving the pigmented acetone, analyse in the fluorometer as soon as possible. Add one drop of 10% hydrochloric acid to convert chlorophyll to phaeophytin and analyse again.

6.3 Coloured dissolved organic matter (CDOM)

Pre-processing: (s) Start with a new stock of clean glass bottles and caps. Rinse with 1-N hydrochloric acid and then Milli-Q water and air-dry before use.

Sample collection: (t) Collect seawater in a clean container. (u) Place Whatman polycarbonate 0.2µm poresize 47mm diameter filter in the holder on glass funnel support and secure funnel with spring clamp; insert this into the flask and attach side arm to vacuum pump tubing (<0.2bar). Filter 150 ml of sampled water into flask, and use this to rinse glassware and sample storage bottles. Using same filter, obtain further filtrate to fill the 50 ml Pyrex bottles. (v) Cap bottles, label and refrigerate at 4°C in dark.

Post-processing: Samples should be analysed on ship, or transferred under refrigeration to the lab and processed as soon as possible.
Significant deterioration in quality can occur in hours or days. (w)
Spectrophotometry: switch on instrument and allow it to warm up (takes about 1 hour); allow sample and a bottle of Milli-Q water to reach room temperature (important). (x) Use clean glass syringes, rinse twice and fill two 10 cm path length cuvettes; make sure there are no air bubbles inside, no scratches, wipe smears / prints off outside. (y) Obtain a baseline first: fill both cuvettes with Milli-Q water and place them in the appropriate light path in the spectrophotometer sample chamber. (z) Fill the cuvette with the sample and leave the other with Milli-Q water as a reference blank. Carry out optical density or ‘absorbance’ scans from 380 nm to 750 nm at 0.5 nm spacing (slit width 1 nm); repeat five times every 300 seconds for each of three samples per site.

7. Grab sampling (for Andy Plater, UoL)

Grab samples were taken from the sea bed at each station. A small handful (>=100 g) of sediment was removed from the grab, sealed in a plastic bag and frozen in a -18°C freezer.

8. Zooplankton vertical haul samples (CEFAS)

Ten zooplankton samples were collected at site A between 06:31 and 07:10 on 12/01/2011 using ring-nets hauled vertically through the water column from near bed to the surface.

Two different ring-nets were used; a 0.5 m diameter ring net with 80 µm mesh and a 1 m diameter ring net with a 270 µm mesh. The volume of water passing through the net is calculated from the readings of a mechanical flow meter (GO, USA) mounted at the mouth of each net. Five repeat hauls are completed with each net and the replicate samples bulked for analysis. Samples are preserved with buffered formalin (4% final concentration). On return to the laboratory, samples are analysed by microscope to determine species diversity and abundances. For microscope analysis, each sample is washed into observation fluid (Steedman 1976). Sub-samples (0.5 ml to 10 ml) are taken using a Stempel pipette and individual animals were counted.

9. CEFAS sampling

The following near surface (1m) samples were taken for CEFAS: chlorophyll, suspended particulate matter, dissolved inorganic nutrients, salinity and dissolved oxygen. Sites sampled are detailed in Table ?. Dissolved oxygen samples were taken from the near bed at Site A.

9.1 Chlorophyll

Known volumes were filtered through glass fibre (GF/F, What man, UK) filters. Filters are frozen at -20^{o}C immediately after filtration then extracted in acetone and analysed on return to the laboratory. A fluorometer (Turner Designs, USA) is used to measure extracted pigment fluorescence, and phaeopigments after acidification with HCl, following the method described by Tett (1987). The fluorometer is calibrated using a solution of pure chlorophyll a with concentration being determined spectrophotometrically. This method includes some chlorophyllides in the analysis therefore results are referred to as ‘chlorophyll’ rather than ‘chlorophyll a’ (Tett 1987).

9.2 Suspended particulate matter

For measurements of suspended particulate matter (SPM), known volumes of water collected by Niskin bottle are passed through pre-weighed 0.4 µm polycarbonate filters and rinsed with 2×50 ml ultrapure water. Filters are then dried in a desiccator at room temperature and weighed until filter weight remains constant.

9.3 Salinity

A subsample is collected from the Niskin bottle into a 250ml glass bottle and sealed. Salinity is using a Guildline portable autosalinometer (Guildline, Canada), which had been standardised with IAPSO standard seawater.

9.4 Dissolved oxygen

Water samples for oxygen determination are collected from the Niskin bottle and preserved in triplicate using the Winkler method (Winkler, 1888). Samples are analysed in the laboratory using an automatic titration system (Sensoren Instrumente Systeme, Germany) with a photometric endpoint according to Williams and Jenkinson (1982).

9.5 Dissolved inorganic nutrients

A subsample from the Niskin bottle is filtered under low vacuum through a GF/F filter (Whatman, UK), placed in a HDPE sample bottle and preserved with mercuric chloride (final concentration 0.02 g l^{-1}). Samples are refrigerated until analysis for concentration of TOxN, NO2, Si, PO4 and NH4 using a Skalar continuous flow analyser (Skalar, Netherlands) according to Kirkwood (1996). Sample concentrations are compared to in-house standards prepared in natural seawater and commercial seawater standards (Ocean Scientific International Ltd (OSIL), UK).

10. Surface/Underway sampling

Underway sea surface measurements, meteorological variables and ship's navigation were recorded between 05:27 on 12/01/2011 and 03:37 on 14/01/2011. The intake of the surface sampling system is located about 3m below the water line of RV Prince Madog. The parameters recorded every minute by the WS Oceans system and found in the underway file are:

- Time (GMT), Latitude, Longitude
- Heading (°), Track, Ground Speed (m/s), Water Speed (m/s), Depth (m)
- Air Temperature (°C), Humidity, Pressure (mbar)
- Solar Radiation (W m^{-2}), PAR (photosynthetically active radiation, µmol m^{-2} s^{-1})
- U, V
- Relative wind speed (m/s), Relative wind direction (° where zero indicates wind on the bow), True wind speed (m/s), True wind direction (°), Gusts (m/s)
- Sea Temperature (°C), Salinity
- TGS Temperature (°C), TGS Conductivity
- Transmissance
- Oxygen
- Turbidity
- Fluorescence
- Flow

The ship was fitted with a 300 kHz ADCP set to record current velocity 25 × 2 m bins (bin nearest the surface at 5.1 m depth), every 30 s with 29 pings per ensemble. Data were recorded between 05:27 on 12/01/2011 and 03:37 on 14/01/2011.

11. Quality control comments (from John Howarth, NOC)

Preliminary assessment of moored data deployed in December 2010 and recovered in January 2011

Coastal Observatory cruises 73, 74: Prince Madog cruises 49/10, 01/11: duration 36 days.

Site A - Frame

600 kHz ADCP sn 2390: The data look ok.

SeaBird 16+ sn 4736 with SeaPoint turbidity sn 10320.
There is no turbidity data.
The temperature and pressure data look ok. Compared with both Microcats the salinity data are too low throughout by ~0.06 – this discrepancy has been observed on a previous deployment.

SeaBird 16+ sn 4490 with Optode sn 674. The temperature data look ok; salinity as expected are not. The salinities from sn 4736 and its temperatures were used to calculate oxygen values. The oxygen data look ok.
The instrument was set up to record at 5, 15, ... minutes past the hour. It would be better to have it on 00, 10, .. minutes past the hour to correspond to the rest of the instruments, especially as the temperature and salinity data from the pumped SeaBird are used in the oxygen calculations.

Site A - Mooring

Microcats sns 5792 and 5791. Temperature and salinity data look ok.

Star Oddis sns 2840 and 2841. Data look ok.

Met. station – data not received yet.

Site B new site - Frame

600 kHz ADCP sn 5806. The data look ok except that there was no pressure record. This had a knock on effect on the wave measurements since the adcp selected the wrong bins for the orbital current measurements (too deep), possibly because ED (the depth of transducer in decimetres) was set to 300. Suggested value for ED for site B is 365 and for site A is 255 (mean water depth values). Wave information was obtained from the sea surface detected from the back-scatter signal but this slightly reduces the data quality.

The frame tilt increased during the deployment to 6 degrees.

SeaBird 16+ sn4738 with SeaPoint turbidity sn 10538. Temperature, pressure data look ok, although temperature may be reading too high by 0.03°C. Throughout the record there are constant mean salinity differences with the Microcats. On previous deployments sn 4738 recorded about 0.11 too low which is consistent with the differences observed here (but see Microcat comment).

Site B new site – Mooring

Microcats sns 2506 and 5434. Temperature data look ok. sn 2506 salinity appears to be 0.05 too low.

Star Oddis sns 2842, 2848 and 2851. Data look ok – 2848 may be reading 0.01°C too high.

12. Cruise participants and acknowledgements

The assistance of the master, officers and crew of the RV Prince Madog and all scientists is appreciated in ensuring the success of this cruise.

Scientific personnel

Jo Hopkins (NOC), PSO
Danny McLaughlin (NOC)
Terry Doyle (NOC)
Chris Balfour (NOC)
Emlyn Jones (NOC)
Jack Phelps (UoL/NOC)
Andy Lane (NOC)
Dave Pearce (CEFAS)
Neil Needham (CEFAS)
Anne Forbes-Brook (Bangor University)

Ship's officers and crew

Eric Lloyd (Master)
Nick Davis (Chief Officer)
Phil Cosgrove (AB)
Mick Callaghan (AB)
Tom Roberts (AB)
Arfon Williams (Chief Engineer)
Alan Thompson (2nd Engineer)
Terry Gordon (Cook)

13. References

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Table 3. Nominal CTD positions, stations visited and samples taken. Times in GMT.

Station	CTD #	Lat (N)	Lon (W)	Date - Time	Depth (m)	SPM & chl-a	CDOM	Nutrients top+bot	Grab #	CEFAS (surface chloro, SPM, salinity + nutrients)
1(A)	1	53° 32.0′	3° 21.8′	12/01/11 08:07	21.5	No	No	No	No	Yes + surface O2
1(A)	2	53° 32.0′	3° 21.8′	12/01/11 09:49	22.7	Yes	Yes	Yes	1	Yes + bottom O2
2	16	53° 37.0′	3° 13.4′	13/01/11 01:26	13.8	Yes	No	Yes	15	Yes
3	15	53° 42.0′	3° 13.4′	13/01/11 00:43	17.5	Yes	No	Yes	14	No
4	4	53° 47.0′	3° 13.4′	12/01/11 13:00	18.0	Yes	No	Yes	3	No
5	3	53° 52.0′	3° 21.8′	12/01/11 12:04	15.5	Yes	No	Yes	2	Yes
6	5	53° 47.0′	3° 21.8′	12/01/11 13:47	22.4	Yes	No	Yes	4	No
7	14	53° 42.0′	3° 21.8′	12/01/11 20:57	23.5	Yes	No	Yes	13	Yes
8	17	53° 37.0′	3° 21.8′	13/01/11 02:11	27.9	Yes	No	Yes	16	No
9	27	53° 32.0′	3° 21.8′	13/01/11 10:46	23.9	Yes	Yes	Yes	25	Yes + surface O2
10	28	53° 27.0′	3° 13.4′	13/01/11 11:48	-	Yes	No	Yes	26	Yes
11	29	53° 27.0′	3° 21.8′	13/01/11 12:33	17.8	Yes	No	Yes	27	No
12	30	53° 27.0′	3° 30.2′	13/01/11 13:20	18.9	Yes	No	Yes	28	No
13	26	53° 32.0′	3° 30.2′	13/01/11 09:59	30.0	Yes	Yes	Yes	24	No
14	18	53° 37.0′	3° 30.2′	13/01/11 02:59	34.1	Yes	No	Yes	17	No
15	13	53° 42.0′	3° 30.2′	12/01/11 20:06	37.7	Yes	No	Yes	12	No
16	6	53° 47.0′	3° 30.2′	12/01/11 14:34	28.3	Yes	No	Yes	5	No
17	7	53° 47.0′	3° 38.6′	12/01/11 15:21	38.3	Yes	No	Yes	6	Yes
18	12	53° 42.0′	3° 38.6′	12/01/11 19:16	39.3	Yes	No	Yes	11	No
19	19	53° 37.0′	3° 38.6′	13/01/11 03:47	34.0	Yes	No	Yes	18	Yes
20(B)*	24	53° 32.3′	3° 38.4′	13/01/11 08:04	37.7	No	No	No	23	Yes + surface O2
20(B)*	25	53° 32.3′	3° 38.4′	13/01/11 09:10	36.3	Yes	Yes	Yes	No	No
20(B)*	31 ?	53° 32.3′	3° 38.4′	13/01/11 15:32	37.7	No	No	No	No	Yes
21*	31	53° 27.0′	3° 38.6′	13/01/11 14:11	26.6	Yes	No	Yes	29	Yes
22	37	53° 23.7′	3° 38.6′	13/01/11 20:03	19.6	Yes	No	Yes	34	No
23	36	53° 23.0′	3° 47.0′	13/01/11 19:12	15.6	Yes	No	Yes	33	No
24	32	53° 27.0′	3° 47.0′	13/01/11 16:32	34.2	Yes	No	Yes	30	No
25	23	53° 32.0′	3° 47.0′	13/01/11 07:10	43.6	Yes	Yes	Yes	22	No
26	20	53° 37.0′	3° 47.0′	13/01/11 04:35	42.9	Yes	No	Yes	19	No
27	11	53° 42.0′	3° 47.0′	12/01/11 18:25	42.3	Yes	No	Yes	10	No
28	8	53° 47.0′	3° 47.0′	12/01/11 16:07	44.6	Yes	No	Yes	7	No
29	9	53° 47.0′	3° 55.4′	12/01/11 16:52	44.4	Yes	No	Yes	8	No
30	10	53° 42.0′	3° 55.4′	12/01/11 17:36	45.6	Yes	No	Yes	9	Yes
31	21	53° 37.0′	3° 55.4′	13/01/11 05:21	47.7	Yes	No	Yes	20	No
32	22	53° 32.0′	3° 55.4′	13/01/11 06:13	48.2	Yes	Yes	Yes	21	Yes
33	33	53° 27.0′	3° 55.4′	13/01/11 17:18	39.3	Yes	No	Yes	31	No
34	35	53° 22.0′	3° 55.4′	13/01/11 18:06	24.7	Yes	No	Yes	32	Yes
35	38	53° 32.0′	3° 15.9′	14/01/11 02:23	14.3	Yes	Yes	Yes	35	No

*Before cruise 66 (26/01/2010), Stn 21 was referred to as Site B and Stn 20 was at 53° 32.0′ N 3° 38.6′ W.