Irish Sea Observatory cruise 77

Dates: 5th–7th June 2011
Ship: R.V. Prince Madog (cruise 43/11)
Principal Scientist: Phil Knight (NOC)

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, results of which are displayed online at http://cobs.pol.ac.uk/ . Further details about the Observatory may be found on this website.

1. Cruise and scientific objectives

1.1 Mooring deployment and recovery

Only one monitoring site is now maintained (Site A, marked Figure 1). At this site instruments are mounted in a sea bed frame, on a surface buoy and along its mooring chain. Site A is also instrumented with a Cefas WaveNet waverider.

Maintaining a long time series of observations will ultimately facilitate the determination of natural and anthropogenic variability within Liverpool Bay. The primary aim of the cruise is 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 (acoustic Doppler current profiler, 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 Aanderaa oxygen Optode.

b) 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 10 m below the surface. A frame containing a WET Labs ac-s unit (measuring spectra of absorption and attenuation), WET Labs fluorometer and SeaBird MicroCAT is attached at 5 m below the surface.

c) Cefas WaveNet waverider.

To deploy:

d) 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 Aanderaa oxygen Optode.

e) Cefas SmartBuoy (including a weather station system) in a single point mooring. SeaBird MicroCAT temperature and conductivity loggers are attached to the mooring wire at 10 m and 15m below the surface together with a mini-logger at 7.5m. In addition, a frame containing a WET Labs ac-s unit, WET Labs fluorometer and SeaBird MicroCAT is attached at 5 m below the surface.

f) Cefas WaveNet waverider.

1.2 CTD and LISST survey

The third cruise objective is to undertake a CTD survey of up to 34 stations every five nautical miles covering the eastern Irish Sea (see Figure 1 and Table 8). The survey grid covers the area from the North Wales coast to a line extending westwards from Blackpool, and from the Lancashire coast to a line extending northwards from Great Ormes Head. The grid and sampling are designed to determine the effects of the rivers Dee, Mersey and Ribble on the dynamics and biogeochemistry of Liverpool Bay. Additional near-shore stations 2a, 3a, 4a, 5a, 11a and 12a (introduced Cruise 75) and 35a (introduced Cruise 77).

At each station, samples are taken for the analysis of nutrients. 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.

Water samples were taken at each site for determining concentrations of SPM as part of a long term Observatory requirement for total suspended sediment concentrations (now inorganic/organic as well). The data are also required for marine optics, and for comparisons of absorption and scattering with the ac-s instrument. Chlorophyll-*a* and CDOM samples are taken as part of the 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 Zooplankton net hauls

Ten vertical zooplankton net hauls are to be collected at Site A to determine species diversity and abundance.

2. Cruise narrative

(All times are in GMT throughout this report)

Sunday, 5th June 2011

Prince Madog was berthed at Menai Bridge between. Loading started at 11:30 and was completed by 13:00. The ship left her berth at 17:30. The ship ADCP and surface/underway underway sampling were switched on passing Puffin Island. The ship anchored to the north of the West Hoyle Bank (53° 26.043N 3° 22.973W). The ship ADCP and surface/underway sampling were switched off.

Monday, 6th June

The ship left her anchorage at 06:00. At 06:05 the ADCP and surface/underway underway sampling were switched on. On route to site A (around 06:50) more than 20+ Bottlenose dolphins were spotted near to the ship and riding the bow wave. Prince Madog arrived at site A at 07:01 and the recovery of the Waverider was started and completed by 07:44 to take advantage of low water slack. The replacement Waverider was deployed between 08:10 and 08:13.

A pre-recovery CTD profile was completed at 10:23, during which the wind speeds were around 10 m s^{-1} from the NW and the sea state was moderate and easing. The ADCP frame (new style) at Site A was recovered successfully between 08:41 and 08:46 and the replacement frame (old style) was released at 09:07. The Cefas SmartBuoy was deployed between 09:07 and 09:34. During the initial deployment of the Smartbuoy, the attached weather station was damaged. The broken part was removed from the SmartBuoy prior to deployment. In addition, it was noted later that the Aanderaa Oxygen Optode had not be fitted to the Smartbuoy system. Recovery of the old buoy was started at 09:42 and completed by 09:49. This was followed by, a post-deployment CTD at 10:01 and Cefas net hauls between 10:20 and 11:00.

The CTD survey grid started from station 3a at 12:37, followed by east-west transects (stations 3, 7, 15, 18, 27, 26, 19, 14, 8, 2, 2a, 35a, 35, 1, 13). The wind strength from a NW direction gradually reduced during the day to around 3 m s^{-1}.

Tuesday, 7th June

The CTD survey grid survey continued and the following stations were visited; stations 20, 25, 24, 21, 12, 11, 10, 11a, 12a, 22, 23 and 34, during which wind speeds increased to around 9 m s^{-1} ; also the wind direction moved from SE to SW.

The survey finished at 09:30, and Prince Madog headed for Menai Bridge. The ship's surface monitoring was switched off at 10:10. The ships ADCP had crashed at 08:02 (this had already occurred a few times previously before restarting). Unloading started at 13:00 and was completed by 15:00.

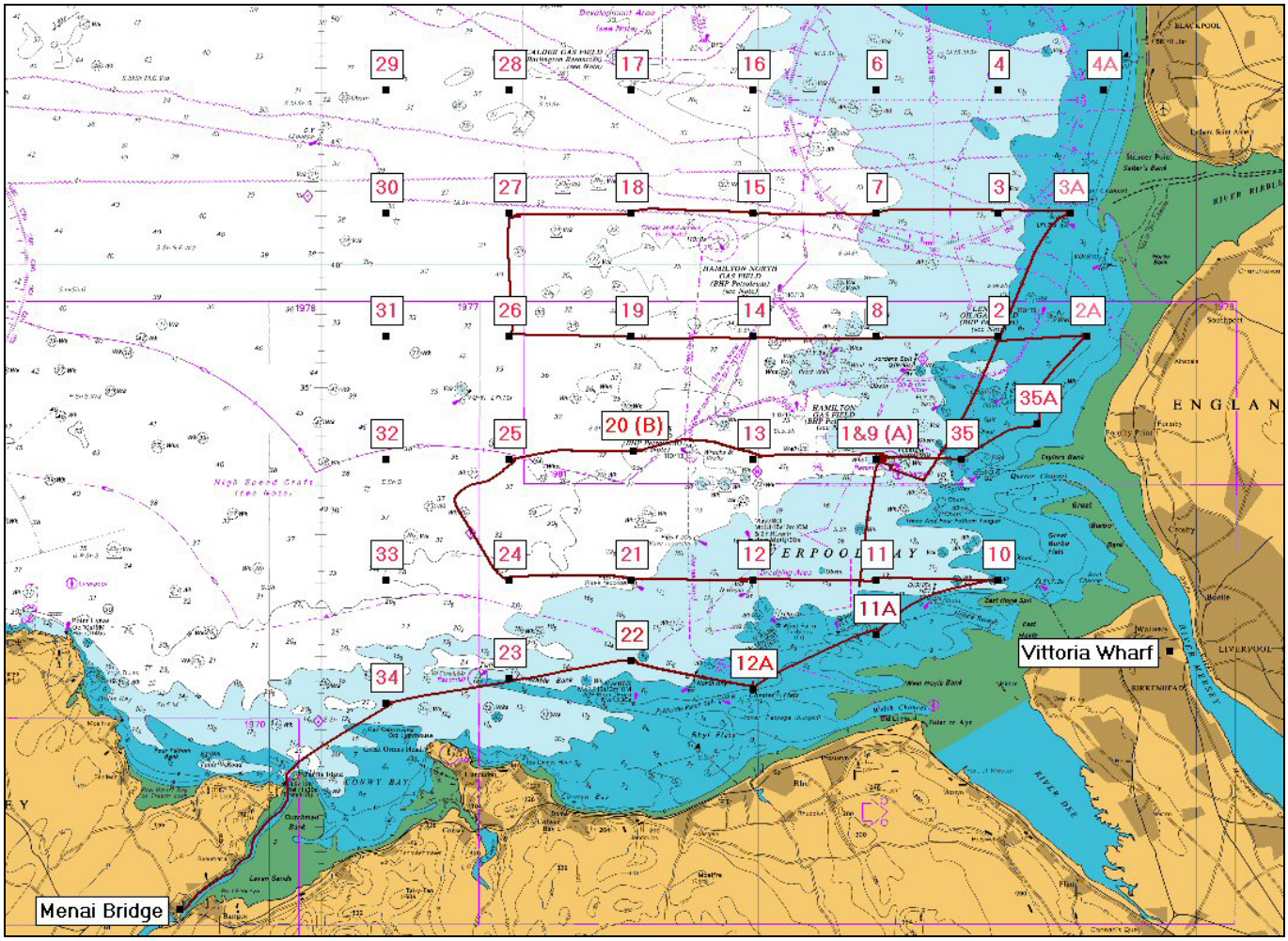

Figure 1. Irish Sea Observatory cruise 77 track

3. Moorings

3.1 Recovered Instrumentation

Table 1. Recovered mooring positions and times

	Latitude (N)	Longitude (W)	Water depth (m)	Date	Time (GMT)
ADCP frame (Site A)	53°32.015	3°21.448	27.7	06/06/2011	08:41
SmartBuoy (Site A)	53°32.001	3°21.766	26.1	06/06/2011	09:42
Cefas Waverider	53°32.045	3°21.247	19.7	06/06/2011	07:20

Site A Bedframe

Table 2 lists the instruments. The frame is fitted with a fizz link, a spooler with 50 m of rope for recovering the ballast weight and two Benthos releases: S/N 70355 (Rx=10.0 kHz, Tx=12.0 kHz, RC=B), S/N 70358 (Rx=11.0 kHz, Tx=12.0 kHz, RC=A).

Table 2. Instruments recovered from Site A bedframe

Instrument	S/N	Notes	Clock set	Delayed start	Stopped logging	Clock Drift (secs)
RDI 600 kHz ADCP	5807	1.0 GB memory. Mode 1: 100 pings every 10 minutes 35 × 1 m bins (2.65–36.65 m above the bed, WNO 35). Beam coordinates – speeds, correlation, echo intensity, % good. Sound velocity calculated from temperature, depth and salinity of 32. Beam separation 20°.	07:58:00 18/04/2011	10:00:00 18/04/2011	14:40:30 08/06/2011	+22
SeaBird SBE 16*plus*	4597	Mounted on frame base 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.	08:39:30 18/04/2011	10:00:00 18/04/2011	12:19:50 09/06/2011	+9
SeaPoint turbidity sensor	10471	Taped to roll bar and setup for 0–125 FTU range and fitted with wiper	-	-		
Teledyne Citadel CTD	2278	Mounted with Aanderaa Optode (see below). Sample rate 4 Hz, interval 600 s, record time 40 s.	08:15:00 18/04/2011	10:00:00 18/04/2011	**No-data due to setup error**	
Aanderaa Optode	669		-	-	-	-

Site A Mooring

Table 3 lists the instruments. 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) and an in-situ NAS2E nutrient analyzer. The NAS2E obtains water samples every fourth day (for laboratory analysis of TOxN and silicate) and every eighth day (phytoplankton species, composition and abundance). 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.

Table 3. Instruments recovered from Site A SmartBuoy mooring

Instrument	S/N	Notes	Instrument depth (m)	Clock set	Delayed start	Stopped logging	Clock Drift (secs)
SeaBird MicroCAT	5433	Temperature and conductivity recorder. Mounted on frame with ac-s and fluorometer)	5	09:41:30 18/04/2011	10:00:00 18/04/2011	12:45:50 09/06/2011	+9
WET Labs ac-s	095	(DH4 data logger S/N 161)	5	08:59:00 18/04/2011	09:05:00 18/04/2011	15:18:00 06/06/2011	-2
WET Labs fluorometer	1514	Attached to ac-s frame	5	09:24:00 18/24/2011	09:30:00 18/04/2011	10:40:30 09/06/2011	-46
SeaBird MicroCAT	4998	Temperature and conductivity recorder	10	09:47:30 on 18/04/2011	10:00:00 18/04/2011	12:42:45 09/06/2011	+5
StarOddi Mini-logger	2836	Set to record at 600 s intervals	7.5	N/A	10:00:00 18/04/2011	09:10:00 10/06/2011	-6.5
StarOddi Mini-logger	2837	Set to record at 600 s intervals	15	N/A	10:00:00 18/04/2011	09:13:30 10/06/2011	-6.5

3.2 Deployed Instrumentation

Table 4. Deployed mooring positions and times

	Latitude (N)	Longitude (W)	Water depth (m)	Date	Time (GMT)
ADCP frame (Site A)	53°32.016	3°21.466	20.1	06/06/2011	09:07
SmartBuoy (Site A)	53°31.958	3°21.706	21.7	06/06/2011	09:33

Site A Bedframe

Table 5 lists the instruments on the sea bed frame. The frame is fitted with a fizz link, a spooler with 50 m of rope for recovering the ballast weight and two Benthos releases: S/N 71919 (Rx=10.5 kHz, Tx=12.0 kHz, RC=C), S/N 72858 (Rx=14.5 kHz, Tx=12.0 kHz, RC=A).

Table 5. Instruments deployed on the Site A bedframe

Instrument	S/N	Notes	Clock set	Delayed start
RDI 600 kHz ADCP	2390	1.5 GB memory. Mode 1: 100 pings every 10 minutes 35 × 1 m bins (2.65–36.65 m above the bed, WNO 35). Beam coordinates – speeds, correlation, echo intensity, % good. Sound velocity calculated from temperature, depth and salinity of 32. Beam separation 20°.	14:03:45 05/06/2011	06:00:00 06/06/2011
SeaBird SBE 16*plus*	4736	Mounted on frame base 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.	12:52:30 05/06/2011	06:00:00 06/06/2011
SeaPoint turbidity sensor	10538	Taped to roll bar and setup for 0–125 FTU range and fitted with wiper	-	-
SeaBird SBE 16*plus*	4738	Mounted with Aanderaa Optode (see below). Sample interval 600 s; Digiquartz integration time 40 s, range 400; pump 0.5 s, 1 s delay.	13:03:00 05/06/2011	06:00:00 06/06/2011
Aanderaa Optode	674		-	-

Site A Mooring

Table 6 lists the instruments deployed on the SmartBuoy mooring. 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) and an in-situ NAS2E nutrient analyzer. The NAS2E obtains water samples every fourth day (for laboratory analysis of TOxN and silicate) and every eighth day (phytoplankton species, composition and abundance). Conductivity, temperature, optical back scatter and light data are transmitted back to Cefas via Orbcomm satellite. A weather station was also attached to the SmartBuoy frame.

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.

Table 6. Instruments deployed on the Site A SmartBuoy mooring

Instrument	S/N	Notes	Instrument depth (m)	Clock set	Delayed start
SeaBird MicroCAT	2506	Temperature and conductivity recorder. Mounted on frame with ac-s and fluorometer)	5	14:40:00 05/06/2011	06:00:00 06/06/2011
WET Labs ac-s	060		5	06:06:30 06/06/2011	06:10:00 06/06/2011
WET Labs fluorometer	1513	Attached to ac-s frame	5	15:07:30 05/06/2011	06:05:00 06/06/2011
SeaBird MicroCAT	5791	Temperature and conductivity recorder	10	14:18:00 05/06/2011	06:00:00 06/06/2011
StarOddi Mini-logger	2840	Set to record at 600 s intervals	7.5	N/A	06:00:00 06/06/2011
SeaBird MicroCAT	5792	Temperature and conductivity recorder	15	14:23:00 05/06/11	06:00:00 06/06/2011

4. CTD and LISST survey

Instrumentation mounted on the rosette frame is listed in Table 7. Near-bed water samples were taken at 3 m above the sea bed to calibrate the CTD salinity. Analysis is by a Guildline Portasal 8410A at Bangor University.

Samples were taken from the following 5-litre Niskin bottles:

near-bed bottle 3 – nutrients and salinity
bottle 4 – SPM, chlorophyll, CDOM
bottle 5 – Cefas

near-surface bottle 8 – nutrients
bottle 9 – SPM, chlorophyll, CDOM
bottle 10 – Cefas
bottle 11 – Cefas

Table 7. Instruments mounted on the CTD 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	26	Downwelling PAR/irradiance sensor
Turner SCUFAII fluorometer	262	
SeaTech T1000 transmissometer	T1021	0.2 m path
SeaBird SBE35 precision thermometer	0041	
Sequoia Scientific LISST-100X particle sizer	1291	Internal logging www.sequoiasci.com/products/part_LISST_100.aspx

5. SPM, chlorophyll and CDOM sampling (Irish Sea Observatory)

Water from near-surface (1 m) and near-bed (3 m above sea bed) were taken to determine SPM, chlorophyll-*a* and CDOM concentrations. Pre-processing, sample collection and post-processing steps are summarised below.

5.1 Suspended particulate matter (*SPM*)

Pre-processing: Whatman 0.7 µm pore size 47 mm diameter glass fibre (GF/F) 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 do not 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, taking entire contents. (e) Stir sample before measuring out, typically 1 litre required, less (500 ml) if transmissometer on CTD indicates turbid conditions. (f) Place pre-weighed filter on to holder and assemble the funnel. Switch on vacuum pump, ensuring suction <0.4 bar (<0.2 bar if done at same time as chlorophyll sample). Add sample in stages – do not allow filter to go dry. (g) Before final 50 ml goes through add 250 ml deionised water; repeat. (h) Put filter back in appropriate dish/bag and store in freezer at −18°C.
Post-processing: (i) Dry filters at 75°C for 3 hours before weighing as in c) above. (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.

5.2 Chlorophyll-a

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

Sample collection: Whatman 0.7 µm pore size 47 mm diameter GF/F filters (straight from box). Use tweezers to handle filters at edges. (n) Use the same water sample as for SPM d) to f), except measure out 500 ml (less if water is turbid) and filter through with vacuum <0.2 bar. Do not rinse. (o) Put filter in the test tube, replace cap, and wrap in aluminium foil with label, then store in freezer at −18°C.

Post-processing: (p) Fluorometric method: make the chlorophyll standard and calibrate the fluorometer (Turner Designs, USA). (q) Take test tubes from freezer, add 5 ml 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 filters 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.

5.3 Coloured dissolved organic matter (*CDOM*)

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

Sample collection: (t) Collect seawater in a clean container, as in d) above. (u) Use tweezers to place a Whatman 0.2 µm pore size 25 mm diameter polycarbonate filter in a clean polypropylene filter holder, replace the sealing ring and screw-on section. Rinse and fill a clean glass beaker with the sample; rinse a 20 ml glass syringe by drawing and discarding some of the sample. Fill the syringe from the beaker and insert the luer tip carefully into the filter holder. Slowly filter enough water to rinse the sample storage bottles. Using the same filter, obtain further filtrate to fill the 50 ml Pyrex bottles. (v) Cap bottles, label and wrap in aluminium foil, then store in freezer at −18°C or refrigerate at 4°C if analysing on ship.

Post-processing: Samples should be analysed on ship, or transferred frozen to the laboratory and processed as soon as possible. Significant deterioration in quality can occur in hours or days. (w) Allow the sample and a bottle of Milli-Q water to reach room temperature (important). Switch on the spectrophotometer (Shimadzu, Japan) and allow it to warm up (takes about 1 hour). (x) Use clean glass syringes, filter the sample as in u) above; rinse twice and fill two 10 cm path length cuvettes ensuring no air bubbles on the inside, no scratches. Wipe smears/prints off the 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 or 2 nm); repeat five times every 300 seconds for each of (three) samples per site.

6. Cefas sampling

Zooplankton hauls were made at Site A. At selected CTD stations (shown in Table 12) near-surface (~1 m) samples were taken for: chlorophyll, suspended particulate matter, dissolved inorganic nutrients, salinity and dissolved oxygen. Dissolved oxygen samples were also taken from near-bed at Site A.

6.1 Zooplankton vertical haul samples

Ten zooplankton samples were collected at Site A between 10:29 and 11:10 on 06/06/2011 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.

6.2 Chlorophyll

Known volumes were filtered through GF/F filters (Whatman, UK). Filters are frozen at −18° 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).

6.3 Suspended particulate matter

For measurements of suspended particulate matter, known volumes of water collected by Niskin bottle are passed through pre-weighed 0.4 µm pore size 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.

6.4 Salinity

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

6.5 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).

6.6 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, NO_2, Si, PO_4 and NH_4 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, UK).

7. Nutrient sampling (Claire Mahaffey, University of Liverpool)

Water samples were taken from the near-surface (1 m) and near-bed (3 m above the sea bed) for the analyses of nitrate, nitrite, phosphate and silicate. Sampling locations are indicated in Table 9.

Samples are collected directly from the 5-litre Niskin bottles into acid-washed, deionised water rinsed 125 ml HDPE screw cap bottles. Bottles are rinsed three times and filled with ~100 ml of sample. Samples are capped, labelled and placed in a −18°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 one week of collection using a Bran and Luebbe QuAAtro Pro 5-channel nutrient analyser (purchased by NOC).

8. Surface/underway sampling

Underway sea surface measurements, meteorological variables and ship's navigation were recorded between 18:17 on 05/06/2011 and 10:10 on 07/06/2011 (note: switched off while at overnight anchorage). The intake of the surface sampling system is located about 3 m below the water line of R.V. Prince Madog. The parameters recorded every minute by the WS Oceans system and found in the underway file are:

- time (GMT), latitude and longitude
- heading (°), track, ground speed (m s^{-1}), water speed (m s^{-1}) and depth (m)
- air temperature (°C), humidity and pressure (mbar)
- solar radiation (W m^{-2}) and PAR (photosynthetically active radiation, µmol m^{-2} s^{-1})
- current velocities components U, V
- relative wind speed (m s^{-1}), relative wind direction (° where zero indicates wind on the bow), true wind speed (m s^{-1}), true wind direction (°) and gusts (m s^{-1})
- sea temperature (°C) and salinity
- thermosalinograph (TSG) temperature (°C) and TSG 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 18:17 on 05/06/2011 and 08:02 on 07/06/2011 (Note: there were gaps due to ADCP crashes throughout the cruise).

9. Data quality control (from John Howarth, NOC)

Preliminary assessment of moored data deployed in April and recovered in June 2011

Coastal Observatory cruises 76, 77: Prince Madog cruises 11/11, 43/11: duration 49 days.

Site A – Frame: NOCL rig id 1125: (first deployment in new style frame)

600 kHz ADCP sn 5807: The data look ok. The ADCP head is 0.15 m higher in the new frame.

SeaBird 16+ sn 4597 with SeaPoint turbidity sn 10471.
The temperature and pressure data look ok. The conductivity / salinity data are wrong throughout; by comparison with the Microcats the salinity is between 1 and 4 psu too low.

Teledyne Citadel CTD SN278 with Optode sn 669. No data were recorded because the default set-up within the instrument was incorrect for independent battery operation. This problem will also affect the next deployment.

Site A – Mooring: NOCL rig id 1124

Microcats sns 5433 and 4998. Temperature and salinity data look ok; when the water column is well mixed agreeing to better than 0.005°C for temperature and 0.01 for salinity.

Star Oddis sns 2836 and 2837. Data look ok. By comparison with the Microcats, sn 2836 agreed to within 0.01°C and sn 2837 recorded 0.01°C too low.

Met package

Not deployed

10. Cruise participants and acknowledgements

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

Scientific personnel	*Ship's officers and crew*
Phil Knight (NOC), Principal Scientist	Steve Duckworth (Master)
Terry Doyle (NOC)	Peter Trett (Chief Officer)
Emlyn Jones (NOC)	Tommy Roberts (A/Bosun)
John Kenny (NOC)	Phil Jones (Bosun)
Dave Sivyer (Cefas)	Dave Leigh (AB)
David Pearce (Cefas)	Les Black (Chief Engineer)
Andy Lane (NOC)	Meikle Mackay (2nd Engineer)
Anne Forbes-Brook(Bangor Uni.)	Colin Hughes (Cook)

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Glossary

ac-s	an instrument recording spectra of: *a*, absorption; *c*, attenuation
ADCP	acoustic Doppler current profiler
BODC	British Oceanographic Data Centre
CDOM	chromomorphic or coloured dissolved organic matter
Cefas	Centre for Environment, Fisheries and Aquaculture Science
CTD	conductivity, temperature, depth
IAPSO	International Association for the Physical Sciences of the Oceans
LISST	laser in situ scattering transmissometry – particle size analyser
NOC	National Oceanography Centre
PAR	photosynthetically active radiation
SPM	suspended particulate matter
TSG	thermosalinograph
TOxN	total oxidisable nitrogen

Table 8. Nominal positions of CTD stations

Station	Latitude (N)	Longitude (W)
1 & 9 (A)	53° 32.0′	3° 21.8′
2	53° 37.0′	3° 13.4′
3	53° 42.0′	3° 13.4′
4	53° 47.0′	3° 13.4′
5	53° 52.0′	3° 21.8′
6	53° 47.0′	3° 21.8′
7	53° 42.0′	3° 21.8′
8	53° 37.0′	3° 21.8′
10	53° 27.0′	3° 13.4′
11	53° 27.0′	3° 21.8′
12	53° 27.0′	3° 30.2′
13	53° 32.0′	3° 30.2′
14	53° 37.0′	3° 30.2′
15	53° 42.0′	3° 30.2′
16	53° 47.0′	3° 30.2′
17	53° 47.0′	3° 38.6′
18	53° 42.0′	3° 38.6′
19	53° 37.0′	3° 38.6′
20 (B)*	53° 32.3′	3° 38.4′
21*	53° 27.0′	3° 38.6′
22**	53° 23.7′	3° 38.6′

Station	Latitude (N)	Longitude (W)
23	53° 23.0′	3° 47.0′
24	53° 27.0′	3° 47.0′
25	53° 32.0′	3° 47.0′
26	53° 37.0′	3° 47.0′
27	53° 42.0′	3° 47.0′
28	53° 47.0′	3° 47.0′
29	53° 47.0′	3° 55.4′
30	53° 42.0′	3° 55.4′
31	53° 37.0′	3° 55.4′
32	53° 32.0′	3° 55.4′
33	53° 27.0′	3° 55.4′
34	53° 22.0′	3° 55.4′
35	53° 32.0′	3° 15.9′
35a	53° 33.4′	3° 10.7′
2a	*53° 37.0′*	*3° 07.5′*
3a	*53° 42.0′*	*3° 08.5′*
4a	*53° 47.0′*	*3° 06.0′*
5a	*53° 50.9′*	*3° 13.4′*
11a	*53° 24.9′*	*3° 21.8′*
12a	*53° 22.7′*	*3° 30.2′*

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

** Before cruise 60 (01/04/2009), Station 22 was at 52°23.0′ N 3° 38.6′ W.

Table 9. Station log

Station	CTD #	Date & Time	Latitude (N)	Longitude (W)	Water depth (m)	SPM & Chl	CDOM	Nutrients srf & bot	Cefas (srf chl, SPM, salinity & nutrients)
1	1	06/06/11 08:30	53° 31.942′	3° 21.507′	20.3	✓	✓	✓	✓ + srf/bot O_2
1	2	06/06/11 10:01	53° 31.919′	3° 21.525′	21.9				✓ + srf/bot O_2
3a	3	06/06/11 12:37	53° 42.095′	3° 08.686′	13.6	✓	✓	✓	
3	4	06/06/11 13:10	53° 42.142′	3° 13.334′	20.8	✓	✓	✓	
7	5	06/06/11 14:06	53° 42.092′	3° 21.813′	27.7	✓	✓	✓	✓
15	6	06/06/11 15:00	53° 42.024′	3° 30.081′	39.8	✓	✓	✓	
18	7	06/06/11 15:48	53° 42.096′	3° 38.674′	40.5	✓	✓	✓	
27	8	06/06/11 16:26	53° 41.881′	3° 46.777′	42.8	✓	✓	✓	✓
26	9	06/06/11 17:06	53° 37.190′	3° 46.955′	40.4	✓		✓	
19	10	06/06/11 17:55	53° 36.998′	3° 38.753′	30.1	✓		✓	
14	11	06/06/11 18:44	53° 36.986′	3° 30.164′	29.9	✓		✓	✓
8	12	06/06/11 19:31	53° 36.967′	3° 21.603′	21.3	✓		✓	
2	13	06/06/11 20:15	53° 36.940′	3° 13.550′	10.6	✓		✓	
2a	14	06/06/11 20:53	53° 36.974′	3° 07.616′	7.0	✓		✓	
35a	15	06/06/11 21:40	53° 33.399′	3° 10.792′	7.1	✓		✓	
35	16	06/06/11 22:21	53° 32.034′	3° 16.012′	12.7	✓		✓	
1	17	06/06/11 22:58	53° 32.196′	3° 21.600′	23.2	✓	✓	✓	✓
13	18	06/06/11 23:46	53° 32.102′	3° 29.968′	32.3	✓	✓	✓	
20	19	07/06/11 00:35	53° 32.337′	3° 38.150′	39.0	✓	✓	✓	
25	20	07/06/11 01:23	53° 31.985′	3° 46.740′	47.4	✓	✓	✓	
24	21	07/06/11 02:23	53° 27.163′	3° 47.020′	36.2	✓		✓	
21	22	07/06/11 03:07	53° 27.119′	3° 38.566′	28.3	✓		✓	✓
12	23	07/06/11 03:52	53° 27.110′	3° 30.837′	21.1	✓		✓	
11	24	07/06/11 04:42	53° 27.059′	3° 21.920′	19.3	✓		✓	
10	25	07/06/11 05:28	53° 27.046′	3° 13.336′	15.6	✓		✓	
11a	26	07/06/11 06:13	53° 24.917′	3° 21.940′	9.9	✓		✓	
12a	27	07/06/11 06:58	53° 22.687′	3° 30.301′	10.4	✓		✓	
22	28	07/06/11 07:42	53° 23.728′	3° 38.291′	13.9	✓		✓	
23	29	07/06/11 08:25	53° 22.965′	3° 46.907′	10.4	✓		✓	✓
34	30	07/06/11 09:15	53° 22.008′	3° 55.366′	20.4	✓		✓	