

Prince Madog cruise 27/07
POL Coastal Observatory cruise 49
21 – 22 November 2007

1. Objectives

1. At 53° 32' N 3° 21.8' W, half a mile west of the Mersey Bar Light Vessel (site A)

To recover

- a) A sea bed frame for a 600 kHz ADCP (waves ADCP) to measure the mean current profile, pressures and directional waves. A Sea-Bird SBE 16*plus* with pumped conductivity sensor, digiquartz pressure sensor and a SeaPoint turbidity sensor was fitted to the frame. The frame was fitted with a SonTek ADV.
- b) A CEFAS SmartBuoy (with cellulose bags) in a single point mooring with SeaBird MicroCat temperature, conductivity loggers at 5 and 10m below the surface and miniloggers at 7.5 and 15 m below the surface.

To deploy

- c) A sea bed frame for a 600 kHz ADCP (waves ADCP) to measure the mean current profile, pressures and directional waves. A Sea-Bird SBE 16*plus* with pumped conductivity sensor, digiquartz pressure sensor and a SeaPoint turbidity sensor were fitted to the frame.
- d) A CEFAS SmartBuoy (with cellulose bags) in a single point mooring with Sea-Bird MicroCat temperature, conductivity loggers at 5 and 10m below the surface and miniloggers at 7.5 and 15 m below the surface.

2. At 53° 27' N 3° 38.6' W (site 21, second site, B)

To recover

- e) A sea bed frame for a 600 kHz ADCP (waves ADCP) to measure the mean current profile, pressures and directional waves. A Sea-Bird SBE 16*plus* with pumped conductivity sensor, digiquartz pressure sensor and a SeaPoint turbidity sensor were fitted to the frame. A 1200 kHz telemetry ADCP was fitted to the frame.
- f) A CEFAS SmartBuoy (with cellulose bags) in a single point mooring with Sea-Bird MicroCat temperature, conductivity loggers at 5m and 10m below the surface and miniloggers at 7.5 and 15 m below the surface.
- g) A telemetry toroid.

To deploy

- h) A sea bed frame for a 600 kHz ADCP (waves ADCP) to measure the mean current profile, pressures and directional waves. A Sea-Bird SBE 16*plus* with pumped conductivity sensor, digiquartz pressure sensor, a SeaPoint turbidity sensor were fitted to the frame. A 1200 kHz telemetry ADCP was fitted to the frame.
- i) A CEFAS SmartBuoy (with cellulose bags) in a single point mooring with Sea-Bird MicroCat temperature, conductivity loggers at 5m and 10m below the surface and miniloggers at 7.5 and 15 m below the surface.
- j) A telemetry toroid.

3. To conduct a CTD / LISST survey of 34 sites every 5 miles covering the eastern Irish Sea between the North Wales coast and Blackpool and the Lancashire coast and the Great Orme, to determine the effects of the rivers Dee, Mersey and Ribble on Liverpool Bay. To obtain

calibration samples for salinity, transmittance, suspended sediment and for chlorophyll at selected stations. To obtain near surface and bed water samples for nutrient and suspended sediment determination.

4. Collect 10 vertical net hauls at mooring site A.
5. Collect sediment samples at each of the CTD sites

2.1 Scientific personnel

Phil Knight (Principal)
Matt Palmer
Mike Smithson
Chris Balfour
Terry Doyle
Ray Edun
Dave Pearce (CEFAS)
Naomi Greenwood (CEFAS)
Anne Hammerstein (School of Ocean Sciences)
Pascal Salaun (Liverpool University)

2.2 Ship's officers and crew

Steve Duckworth (Master)
Lee Waterfield (Chief Officer)
Alan Thompson (Chief Engineer)
Meikle McKay (Second Engineer)
Phil Jones (Bosun)
Dave Leigh (A.B.)
Hefin Griffiths (A.B.)
Robert Weston (Cook)

3. Narrative (times in GMT)

The trolley for the Smartbuoy toroid was left behind at Birkenhead docks. The trailer containing the trolley did not have a registration plate that matched the van and to save time it was left behind. The SmartBuoy toroid, anchor chain clumps, two sea-bed frames (and stacker) and instrumentation were loaded onto RV Prince Madog on the morning of 20 November 2007, just after high water. The ADCP frames were set up on the afterdeck and the tower and instruments fitted to the SmartBuoy toroid.

Prince Madog left Menai Bridge at 08:00 on 21 November 2007. The ship's underway pCO₂, surface monitoring and ADCP were switched on by Puffin Island. The relative humidity sensor was still not working.

The Mersey Bar mooring site was reached at 12:03 and a CTD recorded (bottles used: 3 – salinity; 4 -SPM bottom; 9 - SPM top; 10, 11 – surface, Cefas; 8 – Trace metals, LU). The ADCP release was fired at 12:32, the frame quickly surfaced and was grappled. The ADV head may have hit the ship on recovery. The ADCP and its ballast weight were on deck by

12:50. The clamp for the ADV head was swapped onto the new frame which was then deployed at 13:11. The replacement SmartBuoy was deployed at 13:28 and the old buoy recovered between 13:37 and 13:45. A second CTD was recorded at 13:56.

Due to the weather forecast the deployment/recovery of the Smartbuoy at site B was put forward. In order to give Cefas scientists time to refurbish the recovered buoy CTD's were carried out at sites 11, 12 and 21. At site 21 the Seabird (no. 4738, time 16:16 21Nov07) was attached to the CTD (sampling has been set to 1 minute). The refurbished SmartBuoy was deployed between 16:58 and 17:00 and the old one recovered between 17:30 and 17:35 in difficult conditions (moderate swell against tide).

The CTD and grab survey then proceeded with sites 21, 22, 12(only grab), 11 (only grab), 10, 35, 2 – 9. At site 9 the net hauls were carried out starting at 05:30 on the 22 November 2007. This was followed by CTD's at sites 13 and 14. After this CTD's were attempted at sites 20 and 24, before aborting the survey. A final CTD was carried out for trace metal analysis at a site close to Puffin Island where the conditions were more favourable.. The surface monitoring system, ship's ADCP and pCO₂ system were switched off at 12:38, by Puffin Island, and Prince Madog docked at Menai Bridge at 13:42.

Some of the cruise objectives were accomplished; only a limited CTD survey was carried out and the telemetry buoy and bottom mounted ADCP frame from site B were not recovered. Weather conditions progressively became worse and the cruise was abandoned towards midday on the 22 November 2007.

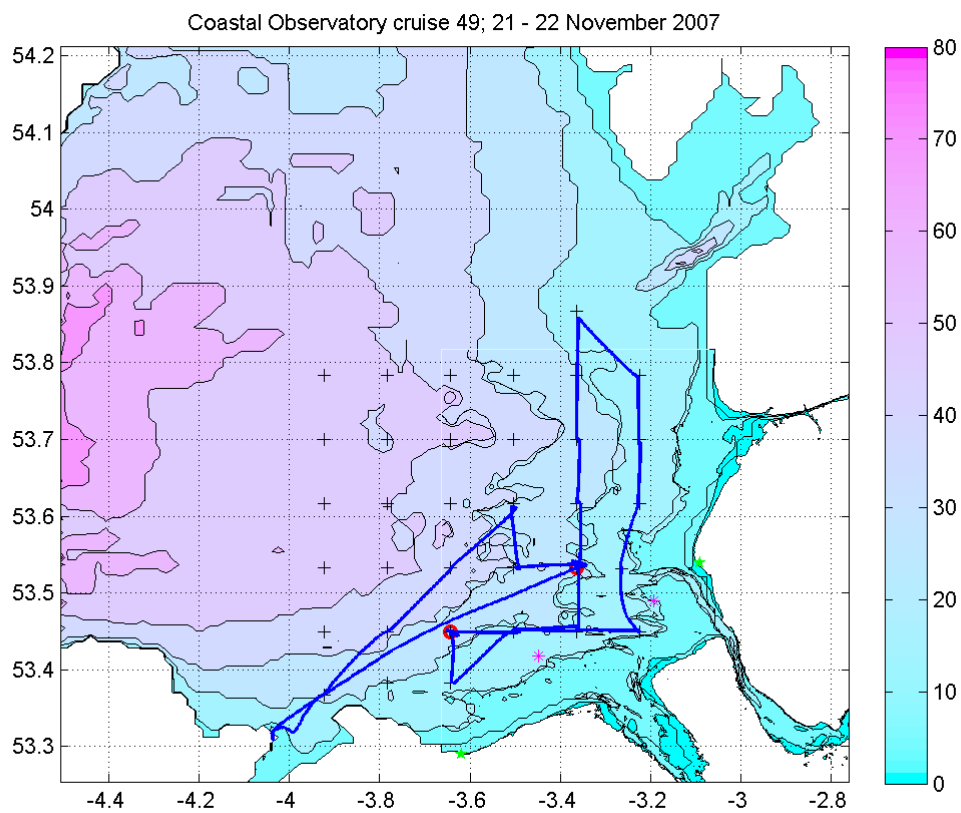


Figure 1. Cruise track.

4. Moorings (times in GMT)

4.1 The set up of the recovered instruments was as follows:

Site A

a) Waves ADCP 600 kHz RDI 2391.

Mode 1: 100 pings every 10 minutes (velocity standard deviation 0.007 m s^{-1}).

35 x 1 m bins (2.65 – 36.65 m above the bed).

Beam co-ordinates - speeds, correlation, echo intensity, % good.

Sound velocity calculated from temperature, depth and salinity of 32.

1Gb PCMCIA memory; hourly wave recording enabled.

Clock reset at 13:59:00 on 2 October; delayed start 08:00:00 on 3 October 2007.

Stopped at 14:47 on 22 November 2007. Clock + 1 minute 53 seconds. Possible problem since up to ten files generated instead of one.

Sea-Bird 16plus S/N 4738 (Not 4596 as listed originally) on base of frame with pumped conductivity sensor underneath. SeaPoint turbidity sensor 10320 taped to roll bar; set up for 0 - 125 FTU range. Sample interval 600 s; digiquartz integration time 40 s, range 400; pump 0.5s, 1 s delay. Clock set at 17:24:00 on 2 October 2007; delayed start at 08:00:00 on 3 October 2007. Batteries ran out. Stopped 23:50:44 on 14 November 2007.

SonTek ADV (Acoustic Doppler Velocimeter); ADV Logger G412; head B331.

ADV transmitter 1.21m above bed (deck). Sample rate 16Hz; burst interval 3600s; samples in each burst 19200; burst length 1200s.

Clock set 14:45:00 on 2 October 2007. Delayed start at 08:00 on 3 October 2007.

Stopped at 14:30 on 22 November 2007.

The frame was fitted with two Benthos releases 70355 – Rx 10.0 kHz, Tx 12.0 kHz, release B and 71919 – Rx 10.5 kHz, Tx 12.0 kHz, release C both with a fizz link, and a spooler with 200m of rope for recovery of the ballast weight.

b) SmartBuoy Mooring.

Sea-Bird MicroCat temperature, conductivity and pressure recorder Serial number 4966 at 5m below the surface. Sample interval 600s.

Clock set at 14:13:00 on 2 October 2007. Delayed start 08:00:00 on 3 October 2007.

Stopped at 01:41 on 22 November 2007. Clock drift +9 seconds.

Sea-Bird MicroCat temperature and conductivity recorder Serial number 2010 at 10m below the surface. Sample interval 600s.

Clock set at 14:25:30 on 2 October 2007. Delayed start 08:00:00 on 3 October 2007.

Stopped at 16:15 on 21 November 2007. Clock drift +18 seconds.

Mini-logger Serial number 2425 at 7.5 m below the surface set to record at 600s intervals.

Clock set at 15:26:00 on 2 October 2007. Delayed start at 08:00:00 on 3 October 2007.

Stopped at 13:40 on 21 November 2007.

Mini-logger Serial number 2112 at 15 m below the surface set to record at 600s intervals.

Clock set at 15:32:00 on 2 October 2007. Delayed start at 08:00:00 on 3 October 2007.

Stopped at 13:50 on 21 November 2007.

The CEFAS SmartBuoy is fitted with one surface CTD, light sensors at 1 and 2 m below the surface, a water sampler which obtains water samples once per day for laboratory nutrient (TOXN and silicate; no filtration therefore no phosphate), fluorometer (SeaPoint), oxygen (Aanderaa Optode) and chlorophyll determination and an in situ NAS2E nutrient analyser. The CTD and light data are transmitted back to CEFAS via Orbcomm. The frame was fitted with bags for the determination of bacterial degradation.

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.

Site B

a) Waves ADCP 600 kHz RDI 5806.

Mode 1: 100 pings every 10 minutes (velocity standard deviation 0.007 m s^{-1}).

35 x 1 m bins (2.65 – 36.65 m above the bed).

Beam co-ordinates - speeds, correlation, echo intensity, % good.

Sound velocity calculated from temperature, depth and salinity of 32.

Fitted with a pressure sensor and 1Gbyte PCMCIA memory; hourly wave recording enabled.

Clock reset at 15:08:00 on 2 October; delayed start 08:00:00 on 3 October 2007.

NOT RECOVERED

Telemetry ADCP 1200 kHz RDI 0572.

Mode 1: 100 pings every 10 minutes (velocity standard deviation 0.003 m s^{-1}).

30 x 1 m bins (2.15 – 31.15 m above the bed). Using 512Mb memory.

Earth co-ordinates - speeds, correlation, echo intensity, % good.

Sound velocity calculated from temperature, depth and salinity of 32.

Clock reset at 15:17:00 on 2 October; delayed start 08:00:00 on 3 October 2007.

LinkQuest acoustic modem set for transmission of ADCP data every hour.

NOT RECOVERED

Sea-Bird 16plus S/N 4597 on base of frame with pumped conductivity sensor underneath.

SeaPoint turbidity sensor 10471; set up for 0 - 125 FTU range.

Aanderaa type 4120 C&T sensor serial number 187.

Sample interval 600 s; digiquartz integration time 40s, range 400; run pump 0.5s, 1 s delay.

Clock set at 17:13:00 on 2 October 2007; delayed start at 08:00:00 on 3 October 2007.

NOT RECOVERED

The frame was fitted with two Benthos releases 71922 – Rx 11.5 kHz, Tx 12.0 kHz, release A and 67879 – Rx 11.5 kHz, Tx 12.0 kHz, release B both with a fizz link, and a spooler with 200m of rope for recovery of the ballast weight.

b) SmartBuoy Mooring.

Sea-Bird MicroCat temperature, conductivity recorder serial number 2506 at 5 m below the surface. Sample interval 600s.

Clock set at 14:30:00 on 2 October 2007. Delayed start 08:00:00 on 3 October 2007.

Stopped 02:40:01 on 22 November 2007.

Sea-Bird MicroCat temperature, conductivity and pressure recorder serial number 2991 at 10m below the surface. Sample interval 600s.

Clock set at 08:30:00 on 3 October 2007. Delayed start 09:00:00 on 3 October 2007.
 Stopped 04:10:00 on 22 November 2007.

Mini-logger Serial number 2427 at 7.5 m below the surface set to record at 600s intervals.
 Clock set at 15:28:00 on 2 October 2007. Delayed start at 08:00:00 on 3 October 2007.
 Stopped 17:30 on 21 November 2007.

Mini-logger Serial number 2108 at 15 m below the surface set to record at 600s intervals.
 Clock set at 15:30:00 on 2 October 2007. Delayed start at 08:00:00 on 3 October 2007.
 Stopped at 17:50 on 21 November 2007.

The CEFAS SmartBuoy is fitted with a surface CTD (including turbidity and fluorescence sensors). The frame was fitted with bags for the determination of bacterial degradation.

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.

Table 1. Recovered mooring positions and times.

	<u>Latitude</u> (N)	<u>Longitude</u> (W)	<u>Water</u> <u>Depth</u> (m)	<u>Recovered</u> <u>Time</u> <u>Date</u>
Waves ADCP (Site A)	53° 32.104'	3° 21.404'	22.4	12:32 21/11/07
SmartBuoy (Site A)	53° 32.053'	3° 21.697'	24.3	13:37 21/11/07
Waves ADCP (Site B)	Not recovered due to poor weather conditions			
Smart Buoy (Site B)	53° 26.932'	3° 38.576'	24.4	17:30 21/11/07
Telemetry toroid (Site B)	Not recovered due to poor weather conditions			

4.2 The set up of the deployed instruments was as follows:

Site A

a) Waves ADCP 600 kHz RDI 3644.

Mode 1: 100 pings every 10 minutes (velocity standard deviation 0.007 m s⁻¹).

35 x 1 m bins (2.65 – 36.65 m above the bed).

Beam co-ordinates - speeds, correlation, echo intensity, % good.

Sound velocity calculated from temperature, depth and salinity of 32.

Clock reset at 11:45 on 20 November; delayed start 18:00:00 on 20 November 2007.

Sea-Bird 16plus S/N 4737 on base of frame with pumped conductivity sensor underneath.

SeaPoint turbidity sensor 10489 taped to roll bar; set up for **0 - 500 FTU range**.

Sample interval 600 s; digiquartz integration time 40 s, range 400; pump 0.5s, 1 s delay.

Clock set at 10:57:00 on 20 November 2007; delayed start at 08:00:00 on 21 November 2007.

SonTek ADV (Acoustic Doppler Velocimeter); ADV Logger G250; head B252.

Distance from center of three prong head on ADV transmitter to deck was 1.305m (i.e. above sea bed). Sample rate 16Hz; burst interval 3600s; samples in each burst 19200; burst length 1200s. Time reset to 14:15 on 20 November 2007, logging set to start at 10:00:00 on 21 November 2007.

The frame D6 was fitted with two Benthos releases 72382 – Rx 10.0 kHz, Tx 12.0 kHz, release A and 71904 – Rx 10.0 kHz, Tx 12.0 kHz, release C both with a fizz link, and a spooler with 200m of rope for recovery of the ballast weight.

b) SmartBuoy Mooring.

Sea-Bird MicroCat temperature, conductivity and pressure recorder Serial number 2081 at 5m below the surface. Sample interval 600s.

Clock set at 12:05:00 on 20 November 2007. Delayed start 08:00:00 on 21 November 2007.

Sea-Bird MicroCat temperature and conductivity recorder Serial number 4998 at 10m below the surface. Sample interval 600s.

Clock set at 12:31 on 20 November 2007. Delayed start 08:00:00 on 21 November 2007.

Mini-logger Serial number 6024 at 7.5 m below the surface set to record at 600s intervals. Delayed start at 08:00:00 on 21 November 2007.

Mini-logger Serial number 6026 at 15 m below the surface set to record at 600s intervals. Delayed start at 08:00:00 on 21 November 2007.

The CEFAS SmartBuoy is fitted with one surface CTD, light sensors at 1 and 2 m below the surface, a water sampler which obtains water samples once per day for laboratory nutrient (TOXN and silicate; no filtration therefore no phosphate), fluorometer (SeaPoint), oxygen (Aanderaa Optode) and chlorophyll determination and an in situ NAS2E nutrient analyser. The CTD and light data are transmitted back to CEFAS via Orbcomm. The frame was fitted with bags for the determination of bacterial degradation.

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.

Site B

a) Waves ADCP – Not deployed

b) SmartBuoy Mooring.

Sea-Bird MicroCat temperature, conductivity recorder serial number 5434 at 5 m below the surface. Sample interval 600s.

Clock set at 12:43:00 on 20 November 2007. Delayed start 08:00 on 22 November 2007.

Sea-Bird MicroCat temperature, conductivity and pressure recorder serial number 5433 at 10m below the surface. Sample interval 600s.

Clock set at 12:39:00 on 20 November 2007. Delayed start 08:00:00 on 22 November 2007.

Mini-logger Serial number 6025 at 7.5 m below the surface set to record at 600s intervals. Delayed start at 15:30:00 on 21 November 2007.

Mini-logger Serial number 6027 at 15 m below the surface set to record at 600s intervals. Delayed start at 15:30:00 on 21 November 2007.

The CEFAS SmartBuoy is fitted with a surface CTD (including turbidity and fluorescence sensors). The frame was fitted with bags for the determination of bacterial degradation.

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.

Table 2. Deployed mooring positions and times.

	<u>Latitude</u> (N)	<u>Longitude</u> (W)	<u>Water</u> <u>Depth</u> (m)	<u>Deployed</u> <u>Time</u>	<u>Date</u>
Waves ADCP (Site A)	53° 32.102'	3° 21.404'	21.1	13:11	21/11/07
SmartBuoy (Site A)	53° 32.049'	3° 21.527'	21.4	13:29	21/11/07
Waves ADCP (Site B)	Not deployed				
Smart Buoy (Site B)	53° 26.851'	3° 38.573'	25.6	17:00	21/11/07
Telemetry toroid (Site B)	Left in situ and not refurbished due to poor weather conditions				

5. CTD

The Sea-Bird 911 CTD recorded downwelling PAR light levels (CEFAS light sensor), temperature, conductivity, transmittance, oxygen (no calibration samples) and fluorescence at 24 Hz. The frame was fitted with an altimeter, which was not totally reliable, so that measurements were taken to within an estimated 3 m above the bed. The rosette will take twelve 10 l water bottles although the capacity is reduced by one (for the LISST-25). One/two water bottles were fired near bed and one/two/three near the surface, when needed. The CTD temperature data was checked against a Sea-Bird SBE35 precision thermometer. Water samples were taken from a near bed bottle for calibration of the CTD salinity data. Water samples were taken from the near surface and near bed bottles and frozen for nutrient analysis by NOC (nitrate, phosphate, silicate), and also were filtered to determine suspended sediment load and calibrate the CTD transmissometer, by the School of Ocean Sciences. Water samples from the second near surface bottle from stations 1 and 21 were filtered for chlorophyll and suspended sediment determination and some filtrate was preserved with mercuric chloride for nutrient determination by CEFAS, (in addition samples at station 1 were taken for oxygen analysis). A LISST-100C particle sizer with internal logging was also attached to the CTD frame and its data periodically downloaded for analysis by SOS. Copies of the Sea-Bird binary files were taken off for processing and calibration at BODC / POL. A LISST-25 particle sizer was fitted to the CTD and its data logged on the Sea-Bird data logging system.

Table 3. Nominal CTD positions. (Ss – Suspended sediments, Nu – Nutrients)

<u>Site</u>	<u>Latitude</u> (N)	<u>Longitude</u> (W)	<u>Visited</u> <u>on this</u> <u>cruise</u>	<u>Cefas</u> Chloropyll & Nu & Ss	<u>POL</u> Nu	<u>POL</u> Ss	<u>Grab</u>
1	53° 32'	3° 21.8'	yes	yes	yes	yes	no
2	53° 37'	3° 13.4'	yes		yes	yes	yes
3	53° 42'	3° 13.4'	yes		yes	yes	yes
4	53° 47'	3° 13.4'	yes		yes	yes	yes
5	53° 52'	3° 21.8'	yes	yes	yes	yes	yes
6	53° 47'	3° 21.8'	yes	yes	yes	yes	yes
7	53° 42'	3° 21.8'	yes	yes	yes	yes	yes
8	53° 37'	3° 21.8'	yes	yes	yes	yes	yes

9	53° 32'	3° 21.8'	yes	yes	yes	yes	yes
10	53° 27'	3° 13.4'	yes		yes	yes	yes
11	53° 27'	3° 21.8'	yes	yes	yes	yes	yes
12	53° 27'	3° 30.2'	yes		yes	yes	yes
13	53° 32'	3° 30.2'	yes		yes	yes	yes
14	53° 37'	3° 30.2'	yes		yes	yes	yes
15	53° 42'	3° 30.2'	no				
16	53° 47'	3° 30.2'	no				
17	53° 47'	3° 47.0'	no				
18	53° 42'	3° 38.6'	no				
19	53° 37'	3° 38.6'	no				
20	53° 32'	3° 38.6'	no				
21	53° 27'	3° 38.6'	yes	yes	yes	yes	yes
22	53° 23'	3° 38.6'	yes		yes	yes	yes
23	53° 23'	3° 47.0'	no				
24	53° 27'	3° 47.0'	no				
25	53° 32'	3° 47.0'	no				
26	53° 37'	3° 47.0'	no				
27	53° 42'	3° 47.0'	no				
28	53° 47'	3° 47.0'	no				
29	53° 47'	3° 55.4'	no				
30	53° 42'	3° 55.4'	no				
31	53° 37'	3° 55.4'	no				
32	53° 32'	3° 55.4'	no				
33	53° 27'	3° 55.4'	no				
34	53° 22'	3° 55.4'	no				
35	53° 32'	3° 15.9'	yes		yes	yes	yes

LU 53° 19.154' 3° 59.647' Trace metal station (used due to poor weather conditions)

Table 4. Surface and bottom parameters from CTD, noted in log book.

<u>CTD</u> <u>no</u>	<u>Site</u>	<u>Nuts</u>	<u>Nominal positions.</u>		<u>Water</u> <u>depth</u> <u>(m)</u>	<u>Temp</u> <u>(deg)</u>	<u>Salinity</u>
			<u>Latitude</u> <u>(N)</u>	<u>Longitude</u> <u>(W)</u>			
		T/ B				T / B	T / B
1	1-1		53° 32'	3° 21.8'	23	10.8 / 10.8	32.4 / 32.4
2	1-2	1/2	53° 32'	3° 21.8'	21	10.0 / 10.6	31.8 / 32.3
3	11	3/4	53° 27'	3° 21.8'	18	10.4 / 10.4	32.0 / 32.0
4	12	5/6	53° 27'	3° 30.2'	17	10.7 / 10.7	32.2 / 32.2
5	21-1	7/8	53° 27'	3° 38.6'	25	10.9 / 10.9	32.4 / 32.4
6	21-2	9/10	53° 27'	3° 38.6'	30	11.1 / 11.1	32.5 / 32.5
7	22	11/12	53° 23'	3° 38.6'	18	10.5 / 10.5	32.0 / 32.0
8	10	13/14	53° 27'	3° 13.4'	19	10.2 / 10.2	31.9 / 31.9
9	35	15/16	53° 31.9'	3° 15.9'	15	9.7 / 9.8	31.7 / 31.7
10	2	17/18	53° 37'	3° 13.4'	14	10.4 / 10.4	32.1 / 32.1
11	3	19/20	53° 42'	3° 13.4'	16	10.3 / 10.4	32.3 / 32.3
12	4	21/22	53° 47'	3° 13.4'	15	10.0 / 10.0	32.2 / 32.2

13	5	23/24	53° 52'	3° 21.8'	12	9.4 / 9.4	32.1 / 32.1
14	6	25/26	53° 47'	3° 21.8'	17	10.4 / 10.7	32.5 / 32.7
15	7	27/28	53° 42'	3° 21.8'	23	10.9 / 11.1	32.7 / 32.9
16	8	29/30	53° 37'	3° 21.8'	25	10.3 / 10.8	32.2 / 32.6
17	9	31/32	53° 32'	3° 21.8'	22	----- / 10.8	----- / 32.4
18	13	33/34	53° 32'	3° 30.2'	34	11.3 / 11.3	32.7 / 32.7
19	14	35/36	53° 37'	3° 30.2'	32	11.3 / 11.3	32.8 / 32.8

6. Surface sampling

The intake for the surface sampling system is located underneath RV Prince Madog, at about 3 m below sea level. The parameters recorded every minute by the WS Oceans system are: Date, Solar Radiation (W m^{-2}), PAR ($\mu\text{mols} / \text{m}^2\text{s}$), Air Temperature ($^{\circ}\text{C}$), Relative Humidity, Relative Wind Speed (m s^{-1}), Relative Wind Direction ($^{\circ}$) – zero indicates wind on the bow, Transmittance, Hull Temperature ($^{\circ}\text{C}$), Barometric Pressure (mbar), Fluorescence, Turbidity, Salinity, Minimum Air Temp ($^{\circ}\text{C}$), Maximum Air Temp ($^{\circ}\text{C}$), Wind Gust (m s^{-1}), GPS Time, Latitude, Longitude, Barometric Pressure Minimum (mbar), Barometric Pressure Maximum (mbar), Conductivity sensor water temperature ($^{\circ}\text{C}$). Sea surface temperature, salinity and transmittance were calibrated against the CTD by BODC. In addition a pCO_2 sensor was incorporated into the surface sampling system.

A new sonic anemometer was fitted prior to the cruise. No PAR data were recorded and the relative humidity sensor recorded bad data. The transmittance, fluorescence and turbidity were all recorded as voltages.

Underway, including navigation, data were recorded every minute from 09:12 on 21 November until 12:38 on November 2007, starting and ending at Puffin Island.

pCO_2 data were recorded from about 08:28 on 21 November until 12:38 on 22 November 2007, starting and ending at Puffin Island.

The ship was fitted with a 300 kHz ADCP set to record 25 x 2m bins, the bin nearest the surface was at 5.1 m depth, every 30 seconds with 29 pings / ensemble. Data were recorded from 09:12 on 21 November to 12:38 on 22 November 2007, starting and ending at Puffin Island.

Acknowledgements

The assistance of the master, officers, and crew contributed greatly to the success and safety of the cruise.