

Prince Madog cruise 16/07
POL Coastal Observatory cruise 46
26-27 July 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 were fitted to the frame. The frame is 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.
- c) A sea bed frame for two 600 kHz ADCP's (combined setup) to measure turbulence. The frame is fitted with a SonTek ADV.

To deploy

- d) 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, SeaPoint turbidity sensor and Aanderaa C&T sensor were fitted to the frame.
- e) 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

- 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 were fitted to the frame. A 1200 kHz telemetry ADCP was fitted to the frame.
- b) A CEFAS SmartBuoy (with cellulose bags and trace metal sensor) 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.

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 are fitted to the frame. A 1200 kHz telemetry ADCP was fitted to the frame.
- d) A CEFAS SmartBuoy (with cellulose bags and trace metal sensor) 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.

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.

2.1 Scientific personnel

Phil Knight (Principal)
Martin Poulton
John Kenny
Ray Edun
Joe Collins
Chris Balfour
Helen Lees (CEFAS)
Dave Sivyer (CEFAS)
Anne Hammerstein (School of Ocean Sciences)
Conrad Chapman (Liverpool University)

2.2 Ship's officers and crew

Eric Lloyd (Master)
Andy Wallis (Chief Officer)
Arfon Williams (Chief Engineer)
Les Black (Second Engineer)
Tommy Roberts (A.B.)
Gary Barns (A.B.)
David Robinson (A.B.)
Eifion Pritchard (Cook)

3. Narrative (times in GMT)

The SmartBuoy toroid, anchor chain clumps, two sea-bed frames and instrumentation were loaded onto RV Prince Madog on the morning of 25 July 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 06:30 on 26 July 2007. The ship's ADCP and underway recording were switched on at 07:34, by Puffin Island. The pCO₂ system was switched on at 07:10. No meteorological data was recorded since the weather station sensors had been removed prior to replacement. Underway fluorescence measurements were not working.

The Mersey Bar mooring site was reached at 10:24 and a CTD recorded (Bottles used: 3–Salinity, 4-SPM Bottom, 9-SPM Top, 10,11-Cefas). The waves ADCP frame and ballast weight were recovered between 10:41 and 11:03. The replacement ADCP frame was

deployed at 11:53. The new SmartBuoy was deployed 12:20 to 12:21 and the old one recovered between 12:27 and 12:34. The 5-beam ADCP frame (with the ADV) and ballast weight were recovered between 12:51 and 13:05. The zooplankton net hauls were started at 12:30, and finished by 13:45. A final calibration CTD was then carried out at station 1.

The CTD grid commenced visiting sites 10, 35, 2-5, 7-9, 11-20, 25, 24, 21-23, 34, 33. At site B, on 27 July 2007, the new SmartBuoy was deployed 14:01 to 14:02 and the old one recovered between 14:09 and 14:15. The replacement ADCP frame was deployed at 14:29. Between 14:41 and 14:47 the telemetry buoy was recovered. It was refurbished and redeployed between 16:54 and 16:55. . The waves/telemetry ADCP frame was recovered between 17:07 and 17:26.

At 17:35 an additional CTD was carried out on site. The CTD survey was re-commenced starting from station 26, finishing with stations 27-32. Surface monitoring, ship's ADCP and pCO₂ system were switched off at Puffin Island at 07:04, 07:04 & 07:37 respectively, and Prince Madog was alongside at 09:30.

All the major cruise objectives were accomplished, apart from one CTD that was abandoned due to wave conditions. Weather conditions for working were on the limit with moderate/rough swell and winds ranging between Force 4-6 (mainly Force 6) from the SW/WSW.

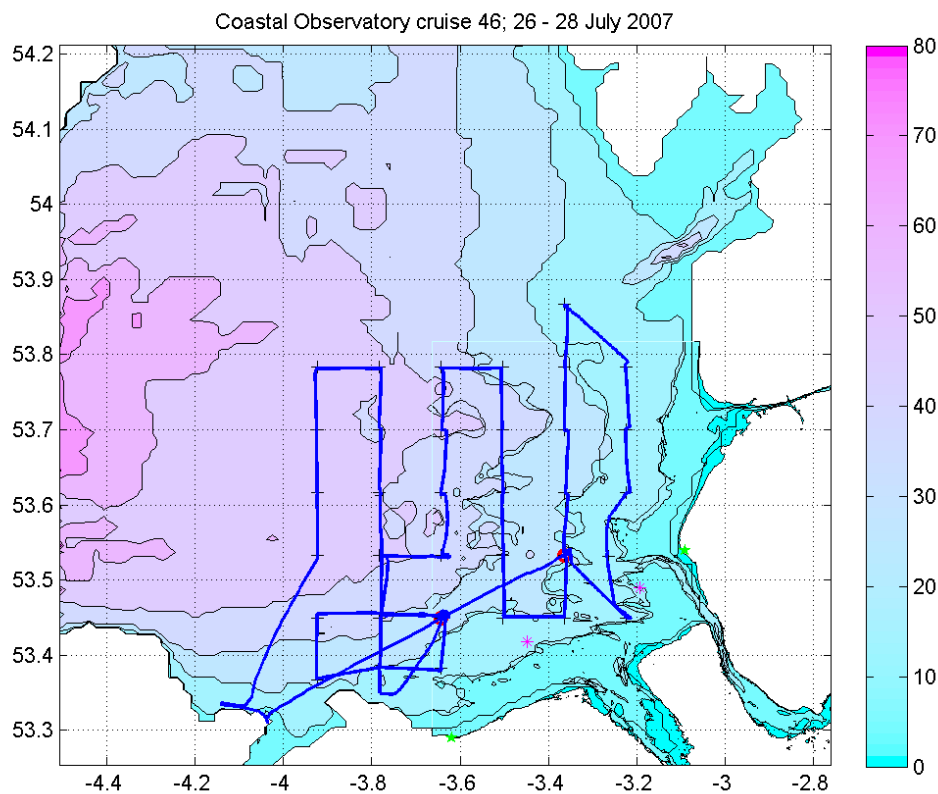


Figure 1. Cruise track.

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 5807.

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 512Mb PCMCIA memory; hourly wave recording enabled.

Clock reset at 12:39:00 on 19 June; delayed start 06:00:00 on 20 June 2006; started ok.

Stopped at 09:34:36 on 27 July 2007.

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

SeaPoint turbidity sensor 10471 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 12:10:45 on 19 June 2007; delayed start at 08:00:00 on 20 June 2007.

Stopped at 19:25 on 26 July 2007.

The frame was fitted with two Benthos releases 72382 – Rx 10.0 kHz, Tx 12.0 kHz, release A and 67679 – 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 and pressure recorder Serial number 2010 at 5m below the surface. Sample interval 600s.

Clock set at 16:18:50 on 19 June 2007. Delayed start 08:00:00 on 20 June 2007.

Stopped at 13:27 on 27 July 2007 (No time to download before re-deploying).

Sea-Bird MicroCat temperature and conductivity recorder Serial number 4966 at 10m below the surface. Sample interval 600s.

Clock set at 12:20:50 on 19 June 2007. Delayed start 08:00:00 on 20 June 2007.

Stopped at 14:15 on 27 July 2007 (No time to download before re-deploying).

Mini-logger Serial number 0149 at 7.5 m below the surface set to record at 600s intervals.

Clock set at 08:14:30 20 June 2007. Delayed start at 10:00:00 on 20 June 2007.

All temperature records not valid. Stopped at 14:43 on 26 July 2007.

Mini-logger Serial number 2184 at 15 m below the surface set to record at 600s intervals.

Clock set at 08:16:00 20 June 2007. Delayed start at 10:00:00 on 20 June 2007.

Stopped at 14:58 on 26 July 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.

c) Turbulence ADCP (combined ADCP setup). 600 kHz ADCP (Bangor, SOS unit). No serial number, no start dates/times. Only one fitted since the other one of the pair failed at the setup stage. No switch off time recorded.

SonTek ADV (Acoustic Doppler Velocimeter); ADV Logger G496; head B353.

ADV transmitter 1.35m above bed (deck). Sample rate 16Hz; burst interval 3600s; samples in each burst 19200; burst length 1200s.

Clock set 16:01:00 on 19 June 2007. Delayed start at 06:00 on 20 June 2007.

No switch off time recorded.

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 12:47:50 on 19 June; delayed start 06:00:00 on 20 June 2007.

Stopped at 01:48 on 28 July 2007. Clock drift +62 seconds.

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 transferred from ADCP 5807.

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

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

Clock reset at 13:52:00 on 19 June; delayed start 06:00:00 on 20 June 2007.

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

Stopped at 01:53 on 28 July 2007. Clock drift plus 20 seconds.

Sea-Bird 16plus S/N 4736 on base of frame with pumped conductivity sensor underneath.

SeaPoint turbidity sensor 10490; set up for 0 - 125 FTU range.

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

Clock set at 12:04:50 on 19 June 2007; delayed start at 08:00:00 on 20 June 2007.

Stopped at 01:37 on 28 July 2007. Clock drift minus 4 seconds.

The frame was fitted with two Benthos releases 71922 – Rx 11.5 kHz, Tx 12.0 kHz, release A and 72858 – Rx 14.5 kHz, Tx 12.0 kHz, release A 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 5 m below the surface. Sample interval 600s.

Clock set at 20:39:00 on 20 June 2007. Delayed start 06:00:00 on 21 June 2007.
 Stopped at 12:34 on 28 July 2007. Clock drift minus 5 seconds.

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

Clock set at 19:43:45 on 20 June 2007. Delayed start 06:00:00 on 21 June 2007.
 Stopped at 12:06 on 28 July 2007. Clock drift minus 4 seconds.

Mini-logger Serial number 6028E at 7.5 m below the surface set to record at 600s intervals.
 Clock set at 19:34:20 20 June 2007. Delayed start at 06:00:00 on 21 June 2007.
 Stopped at 23:40 on 27 July 2007.

Mini-logger Serial number 6022E at 15 m below the surface set to record at 600s intervals.
 Clock set at 19:31:40 20 June 2007. Delayed start at 06:00:00 on 21 June 2007.
 Stopped at 23:24 on 27 July 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 and a trace metal sensor.

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° 32.062'	3° 21.281'	21.7	10:41	26/07/07
SmartBuoy (Site A)	53° 32.178'	3° 21.425'	23.1	12:27	26/07/07
Turbulence ADCP (Site A)	53° 32.198'	3° 21.575'	20.6	12:51	26/07/07
Waves ADCP (Site B)	53° 27.069'	3° 38.413'	26.2	17:07	27/07/07
Smart Buoy (Site B)	53° 27.177'	3° 38.542'	23.5	14:09	27/07/07
Telemetry toroid (Site B)	53° 27.051'	3° 38.512'	25.6	14:41	27/07/07

4.2 The set up of the deployed 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 10:50:00 on 25 July; delayed start 08:00:00 on 26 July 2007; started ok.

Sea-Bird 16plus S/N 4738 on base of frame with pumped conductivity sensor underneath.

SeaPoint turbidity sensor 10320 taped to roll bar; set up for 0 - 125 FTU range.

Aanderaa type 4120 C&T sensor serial number 187.

Sample interval 600 s; digiquartz integration time 40 s, range 400; pump 0.5s, 1 s delay.
Clock set at 08:28:10 on 25 July 2007; delayed start at 08:00:00 on 26 July 2007.

SonTek ADV (Acoustic Doppler Velocimeter); ADV Logger G412; head B331.
ADV transmitter 1.25m above bed (deck). Sample rate 16Hz; burst interval 3600s; samples in each burst 19200; burst length 1200s.
Clock set 10:17:05 on 25 July 2007. Delayed start at 08:00 on 26 July 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 2991 at 5m below the surface. Sample interval 600s.
Clock set at 09:04:00 on 25 July 2007. Delayed start 08:00:00 on 26 July 2007.

Sea-Bird MicroCat temperature and conductivity recorder Serial number 2506 at 10m below the surface. Sample interval 600s.
Clock set at 09:13:00 on 25 July 2007. Delayed start 08:00:00 on 26 July 2007.

Mini-logger Serial number 2192E at 7.5 m below the surface set to record at 600s intervals.
Clock set at 10:47:56 25 July 2007. Delayed start at 10:00:00 on 26 July 2007.

Mini-logger Serial number 2407 at 11.5 m below the surface set to record at 600s intervals.
Clock set at 10:52:10 25 July 2007. Delayed start at 10:00:00 on 26 July 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 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.

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

Clock reset at 10:46:00 on 25 July; delayed start 08:00:00 on 26 July 2007.

Telemetry ADCP 1200 kHz RDI 6489.

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 09:40:00 on 25 July; delayed start 15:00:00 on 25 July 2007 (early for testing purposes).
 LinkQuest acoustic modem set for transmission of ADCP data every hour.

Sea-Bird 16plus S/N 4596 on base of frame with pumped conductivity sensor underneath.
 SeaPoint turbidity sensor 10487; set up for 0 - 125 FTU range.
 Sample interval 600 s; digiquartz integration time 40s, range 400; run pump 0.5s, 1 s delay.
 Clock set at 07:58:00 on 25 July 2007; delayed start at 08:00:00 on 26 July 2007.

The frame was fitted with two Benthos releases 70358 – Rx 11.0 kHz, Tx 12.0 kHz, release A and 70356 – Rx 10.5 kHz, Tx 12.0 kHz, release D 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 5 m below the surface. Sample interval 600s.
 Stopped at 13:15:00 on 27 July 2007. Restarted start 13:30:00 on 27 July 2007 (Still contained data from previous cruise).

Sea-Bird MicroCat temperature and conductivity recorder serial number 2010 at 10m below the surface. Sample interval 600s.
 Stopped at 13:27 on 27 July 2007. Restarted at 13:40:00 on 27 July 2007 (Still contained data from previous cruise).

Mini-logger Serial number 6023E at 7.5 m below the surface set to record at 600s intervals.
 Clock set at 13:13:00 27 July 2007. Delayed start at 13:30:00 on 27 July 2007.

Mini-logger Serial number 2421 at 11.5 m below the surface set to record at 600s intervals.
 Clock set at 13:11:00 27 July 2007. Delayed start at 13:30:00 on 27 July 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° 32.110'	3° 21.413'	22.4	11:53	26/07/07
SmartBuoy (Site A)	53° 32.101'	3° 21.544'	22.4	12:20	26/07/07
Waves ADCP (Site B)	53° 27.321'	3° 38.347'	23.9	14:29	27/07/07
Smart Buoy (Site B)	53° 27.018'	3° 38.320'	23.4	14:01	27/07/07
Telemetry toroid (Site B)	53° 27.382'	3° 38.382'	25.2	16:54	27/07/07

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.

Note: Data from the LISST-100C could not be downloaded during the first periodic download (18:50 on 26 July 2007).

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	POL Nu	POL Ss	Trace metal
1	53° 32'	3° 21.8'	yes	yes	yes	yes	
2	53° 37'	3° 13.4'	yes		yes	yes	
3	53° 42'	3° 13.4'	yes		yes	yes	
4	53° 47'	3° 13.4'	yes		yes	yes	
5	53° 52'	3° 21.8'	yes	yes	yes	yes	
6	53° 47'	3° 21.8'	yes	no	no	no	
7	53° 42'	3° 21.8'	yes	yes	yes	yes	
8	53° 37'	3° 21.8'	yes	yes	yes	yes	
9	53° 32'	3° 21.8'	yes	yes	yes	yes	
10	53° 27'	3° 13.4'	yes		yes	yes	
11	53° 27'	3° 21.8'	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	
15	53° 42'	3° 30.2'	yes		yes	yes	
16	53° 47'	3° 30.2'	yes		yes	yes	
17	53° 47'	3° 47.0'	yes		yes	yes	
18	53° 42'	3° 38.6'	yes		yes	yes	
19	53° 37'	3° 38.6'	yes		yes	yes	
20	53° 32'	3° 38.6'	yes		yes	yes	yes

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'	yes		yes	yes	yes
24	53° 27'	3° 47.0'	yes		yes	yes	yes
25	53° 32'	3° 47.0'	yes		yes	yes	yes
26	53° 37'	3° 47.0'	yes		yes	yes	
27	53° 42'	3° 47.0'	yes		yes	yes	
28	53° 47'	3° 47.0'	yes		yes	yes	

29	53° 47'	3° 55.4'	yes	yes	yes
30	53° 42'	3° 55.4'	yes	yes	yes
31	53° 37'	3° 55.4'	yes	yes	yes
32	53° 32'	3° 55.4'	yes	yes	yes
33	53° 27'	3° 55.4'	yes	yes	yes
34	53° 22'	3° 55.4'	yes	yes	yes
35	53° 32'	3° 15.9'	yes	yes	yes

Note: During CTD 29 the top bottle was not fired. It was re-done but identified as CTD 30.

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

<u>CTD</u> <u>no</u>	<u>Site</u>	<u>Nuts</u>	Nominal positions.		<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
2	1	1/2	53° 32'	3° 21.8'	21	16.6 / 16.0	31.5 / 32.1
3	10	3/4	53° 27'	3° 13.4'	15	16.7 / 16.7	30.1 / 30.2

4	35	5/6	53° 31.9'	3° 15.9'	13	16.6 / 16.6	31.0 / 31.0
5	2	7/8	53° 37'	3° 13.4'	13	16.9 / 16.9	31.0 / 31.0
6	3	9/10	53° 42'	3° 13.4'	18	16.8 / 16.8	31.0 / 31.0
7	4	11/12	53° 47'	3° 13.4'	19	17.0 / 17.0	31.3 / 31.3
8	5	13/14	53° 52'	3° 21.8'	18	16.8 / 16.8	32.0 / 32.0
---	6	--/--	53° 47'	3° 21.8'	---	----- / -----	----- / -----
9	7	15/16	53° 42'	3° 21.8'	25	16.3 / 16.2	32.0 / 32.0
10	8	17/18	53° 37'	3° 21.8'	25	15.7 / 15.7	32.5 / 32.6
11	9	19/20	53° 32'	3° 21.8'	25	16.1 / 15.8	32.4 / 32.7
12	11	21/22	53° 27'	3° 21.8'	19	16.2 / 16.1	32.4 / 32.5
13	12	23/24	53° 27'	3° 30.2'	18	16.3 / 16.8	32.5 / 32.6
14	13	25/26	53° 32'	3° 30.2'	30	15.6 / 15.6	33.0 / 33.2
15	14	27/28	53° 37'	3° 30.2'	27	16.0 / 15.2	32.3 / 33.3
16	15	29/30	53° 42'	3° 30.2'	35	16.1 / 15.2	32.0 / 33.2
17	16	31/32	53° 47'	3° 30.2'	24	16.5 / 15.9	31.5 / 32.5
18	17	33/34	53° 47'	3° 38.6'	34	15.9 / 15.1	32.6 / 33.4
19	18	35/36	53° 42'	3° 38.6'	38	15.4 / 15.1	33.2 / 33.4
20	19	37/38	53° 37'	3° 38.6'	31	15.6 / 15.1	32.7 / 33.4
21	20	39/40	53° 32'	3° 38.6'	35	15.5 / 15.5	33.3 / 33.3
22	25	41/42	53° 32'	3° 47.0'	46	15.2 / 14.7	33.7 / 33.9
23	24	43/44	53° 27'	3° 47.0'	34	15.0 / 15.0	33.7 / 33.7
24	21-1	45/46	53° 27'	3° 38.6'	28	15.8 / 15.8	33.1 / 33.1
25	22	47/48	53° 23'	3° 38.6'	16	16.0 / 16.0	32.9 / 32.9
26	23	49/50	53° 23'	3° 47.0'	15	16.0 / 15.9	32.9 / 33.0
27	34	51/52	53° 22'	3° 55.4'	24	15.4 / 15.2	33.6 / 33.7
28	33	53/54	53° 27'	3° 55.4'	37	14.9 / 14.8	33.9 / 33.9
29	21-2	55/56	53° 27'	3° 38.6'	24	15.9 / 15.9	33.1 / 33.1
31	26	57/58	53° 37'	3° 47.0'	42	14.8 / 14.8	33.9 / 33.9
32	27	59/60	53° 42'	3° 47.0'	42	15.2 / 15.1	33.5 / 33.5
33	28	61/62	53° 47'	3° 47.0'	41	15.0 / 14.7	33.6 / 33.8
34	29	63/64	53° 47'	3° 55.4'	42	14.9 / 14.4	33.7 / 34.1
35	30	65/66	53° 42'	3° 55.4'	41	14.6 / 14.6	34.0 / 34.0
36	31	67/68	53° 37'	3° 55.4'	44	14.8 / 14.8	33.9 / 33.9
37	32	69/70	53° 32'	3° 55.4'	43	15.0 / 14.7	33.8 / 34.0

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 high quality temperature sensor has been fitted. The meteorological sensors had been removed prior to replacement, so no wind speed, direction, air temperature, relative humidity or solar radiation data were recorded.

Flow through fluorescence was not working.

Underway data were recorded every minute from 07:34 on 26 July until 07:04 on 28 July 2007, starting and ending at Puffin Island. Copies of the data were taken off the ship as an Excel file, along with a copy of the ship's navigation data.

pCO₂ data were recorded from 07:10 on 26 July until 07:37 on 28 July 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 07:34 on 26 July to 07:04 on 28 July 2007, starting and ending at Puffin Island.

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