Prince Madog cruise 13/07
POL Coastal Observatory cruise 45
20-21 June 2007

1. Objectives

1. At 53º 32´ N 3º 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.

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.
e) A sea bed frame for two 600 kHz ADCP's (combined setup) to measure turbulence. The frame is fitted with a SonTek ADV.

2. At 53º 27´ N 3º 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.

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)
Mike Smithson
John Kenny
Emlyn Jones
Naomi Greenwood (CEFAS)
Jo Foden (CEFAS)
Matt Palmer (School of Ocean Sciences)
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)
Aleksejs Morozovs (Second Engineer)
Tommy Roberts (A.B.)
Sean Doody (A.B.)
Mick Callaghan(A.B.)
Eifion Pritchard (Cook)

3. Narrative (times in GMT)

The SmartBuoy toroid, anchor chain clumps, three sea-bed frames and instrumentation were loaded onto RV Prince Madog on the afternoon of 19 June 2007, just before high water. The ADCP frames were set up on the afterdeck and the tower and instruments fitted to the SmartBuoy toroid. No nutrient bottles were available for the survey sampling. One of the two 600kHz ADCP's on the combined setup was faulty. It was removed from the sea-bed frame and the remaining ADCP left on.

Prince Madog left Menai Bridge at 06:20 on 20 June 2007. The computer server which logs data (Underway, ADCP & pCO_2) and runs the time client was not working. Data was therefore recorded to each host machine with its own clock. The flow through (Underway data) pump was switched on at 07:05. Due to a previous problem with underway salinity measurements a spare CTD was used (SeaBird SBE Model 45, serial number 4542847-0179). The ship's ADCP was switched on at 07:11, by Puffin Island. The pCO_2 system was switched on at 07:17. No meteorological data was recorded since the weather station sensors had been removed prior to replacement.

The Mersey Bar mooring site was reached at 09:52 and a CTD recorded. A sea bed frame for two 600 kHz ADCP's (combined setup, although only one of the pair was left on the frame since the other failed at the setup stage) to measure turbulence was deployed at 10:04. The waves ADCP frame and ballast weight were recovered between 10:08 and 10:23. The replacement ADCP frame was deployed at 10:45. The new SmartBuoy was deployed 11:39 to 11:42 and the old one recovered between 11:56 and 12:05. 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, 2-17, 28-30, 27, 18-20, 25-21. At site B, on 21 June 2007, the new SmartBuoy was deployed 09:53 to 09:56 and the old one recovered between 10:05 and 10:14. Between 10:32 and 10:34 the telemetry buoy was recovered. It was refurbished and redeployed between 12:51 and 12:53. At 11:46 an additional CTD was carried out on site. . The waves/telemetry ADCP frame were recovered between 12:57 and 13:11 (ballast frame lost in recovery). The replacement ADCP frame was deployed at 13:19. The CTD survey was re-commenced starting from station 26, finishing with stations 31-34. Surface monitoring, ship's ADCP and pCO_2 system were switched off at Puffin Island at 17:43, 17:44 & 17:59 respectively, and Prince Madog was alongside at 19:35.

All the major cruise objectives were accomplished. The only problems were the lack of bottles for nutrient samples, the malfunction of one the ADCP's on the combined setup frame (turbulence measurements), and the loss of a ballast frame. Weather conditions were good, mixture of sun and showers, winds occasionally Force 4-5, mainly Force 3 from the NE/E.

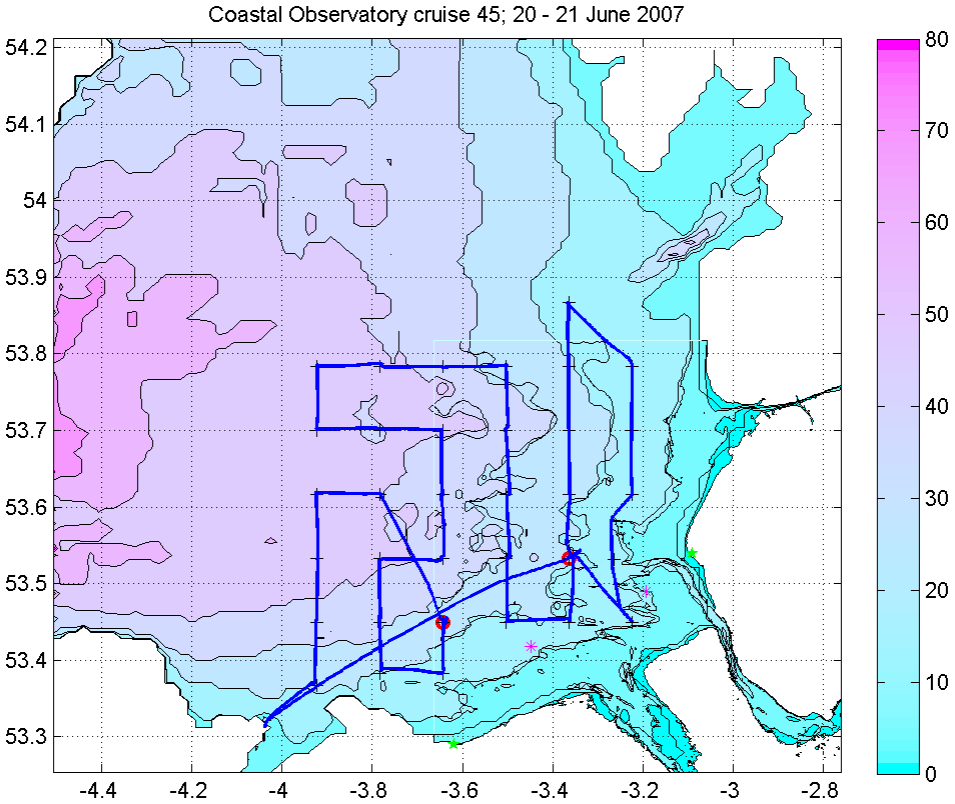

Figure 1. Cruise track.

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 2390**.**
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 1 Gbyte PCMCIA memory; hourly wave recording enabled.
Clock reset at 14:08:00 on 14 May; delayed start 07:00:00 on 15 May 2006; started ok.
Unplugged straight after recovery – no switch off time recorded.

Sea-Bird 16plus S/N 4596 (RS485) on base of frame with pumped conductivity sensor underneath. SeaPoint turbidity sensor 10487 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 13:49 on 14 May 2007; delayed start at 10:00:00 on 15 May 2007.
Stopped at 21:19:05 on 20 June 2007. 5264 samples. Clock +13s.

SonTek ADV (Acoustic Doppler Velocimeter); ADV Logger G412; head B331.
ADV transmitter 1.225m above bed (deck). Sample rate 16Hz; burst interval 3600s; samples in each burst 19200; burst length 1200s. Compass orientation note: Changed to red mark on receiver pointing parallel to frame in direction of ADCP beam 3.
Clock set. Delayed start at 10:00 on 15 May 2007.
Stopped at 21:50:00 on 20 June 2007. Two files recorded C050701 (441Mb), C0507002 (370Mb).

The frame was fitted with two Benthos releases 70338 – Rx 11.0 kHz, Tx 12.0 kHz, release A and 70336 – 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 4998 at 5m below the surface. Sample interval 600s.
Clock set at 13:02:55 on 14 May 2007. Delayed start 10:00:00 on 15 May 2007.
Stopped at 19:15:30 on 20 June 2007. 5240 samples. Clock is +12s.

Sea-Bird MicroCat temperature and conductivity recorder Serial number 2081 at 10m below the surface. Sample interval 600s.
Clock set at 13:11:50 on 14 May 2007. Delayed start 10:00:00 on 15 May 2007.
Stopped at 19:50:01 on 20 June 2007. 5243 samples. Clock is +9s.

Miniloggers set to record at 600s intervals starting at 10:00:00 on 15 May 2007.
Sn 6022E (12 bit), sn 6028E (12 bit) at 7.5 and 15 m below the surface.
Sn 6022E stopped at 19:21:00 on 20 June 2007.
Sn 6028E stopped at 19:05:05 on 20 June 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 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). Clock reset at 16:53:00 on 14 May; delayed start 06:00:00 on 17 May 2007.
No switch off time recorded.

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.

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). 1 Gbyte memory.
Earth co-ordinates - speeds, correlation, echo intensity, % good.
Sound velocity calculated from temperature, depth and salinity of 32.
Clock reset at 16:51:00 on 14 May; delayed start 06:00:00 on 17 May 2007.
LinkQuest acoustic modem set for transmission of ADCP data every hour.
No switch off time recorded.

Sea-Bird 16plus S/N 4738 (RS485) on base of frame with pumped conductivity sensor underneath. SeaPoint turbidity sensor 10320 taped to roll bar; set up for 0 - 500 FTU range, cable later swapped to 0 – 125 FTU range from recovered Mersey Bar ADCP.
Sample interval 600 s; digiquartz integration time 40s, range 400; run pump 0.5s, 1 s delay.
Clock set at 15:32:20 on 14 May 2007; delayed start at 08:00:00 on 17 May 2006.
Switched off at 10:00:03 on 28 June 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 2506 at 5 m below the surface. Sample interval 600s.
Clock set at 21:41 on 15 May 2007. Delayed start 08:00:00 on 17 May 2007.
Switched off at 10:50:01 on 28 June 2007.

Sea-Bird MicroCat temperature and conductivity recorder serial number 2991 at 10m below the surface. Sample interval 600s.
Clock set at 14:30:00 on 15 May 2007. Delayed start 08:00:00 on 17 May 2007.

Switched off at 10:30:01 on 28 June 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.

No other instrumentation was fitted to the mooring.

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.

	Latitude (N)	Longitude (W)	Water Depth (m)	Recovered Time	Date
Waves ADCP (Site A)	53º 32.049´	3º 21.539´	25.2	10:08	20/06/07
SmartBuoy (Site A)	53º 32.098´	3º 22.046´	25.0	11:56	20/06/07
Waves ADCP (Site B)	53º 27.063´	3º 38.550´	25.3	12:57	21/06/07
Smart Buoy (Site B)	53º 27.059´	3º 38.363´	27.1	10:05	21/06/07
Telemetry toroid (Site B)	53º 27.003´	3º 38.571´	27.1	10:32	21/06/07

4.2 The set up of the deployed 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 2007; started ok.

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.

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.

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.

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.

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.

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.

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.

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.

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.

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.

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.

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.

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.

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.

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 2. Deployed mooring positions and times.

	Latitude (N)	Longitude (W)	Water Depth (m)	Deployed Time	Deployed Date
Waves ADCP (Site A)	53º 32.062´	3º 21.281´	21.7	10:45	20/06/07
SmartBuoy (Site A)	53º 32.178´	3º 21.425´	23.1	11:39	20/06/07
Turbulence ADCP (Site A)	53º 32.198´	3º 21.575´	20.6	10:04	20/06/07
Waves ADCP (Site B)	53º 27.069´	3º 38.413´	26.2	13:19	21/06/07
Smart Buoy (Site B)	53º 27.177´	3º 38.542´	23.5	09:53	21/06/07
Telemetry toroid (Site B)	53º 27.051´	3º 38.512´	25.6	12:51	21/06/07

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.

No nutrient samples were taken (no bottles were available).

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

Site	Latitude (N)	Longitude (W)	Visited on this cruise	Cefas Chloropyll & Nu & Ss	POL Nu	POL Ss	Trace metal
1	53º 32´	3º 21.8´	yes	yes	no	yes	
2	53º 37´	3º 13.4´	yes		no	yes	
3	53º 42´	3º 13.4´	yes		no	yes	
4	53º 47´	3º 13.4´	yes		no	yes	
5	53º 52´	3º 21.8´	yes	yes	no	yes	
6	53º 47´	3º 21.8´	yes	yes	no	yes	
7	53º 42´	3º 21.8´	yes	yes	no	yes	
8	53º 37´	3º 21.8´	yes	yes	no	yes	
9	53º 32´	3º 21.8´	yes	yes	no	yes	
10	53º 27´	3º 13.4´	yes		no	yes	
11	53º 27´	3º 21.8´	yes	yes	no	yes	
12	53º 27´	3º 30.2´	yes		no	yes	yes
13	53º 32´	3º 30.2´	yes		no	yes	yes
14	53º 37´	3º 30.2´	yes		no	yes	
15	53º 42´	3º 30.2´	yes		no	yes	
16	53º 47´	3º 30.2´	yes		no	yes	
17	53º 47´	3º 47.0´	yes		no	yes	
18	53º 42´	3º 38.6´	yes		no	yes	
19	53º 37´	3º 38.6´	yes		no	yes	
20	53º 32´	3º 38.6´	yes		no	yes	yes
21	53º 27´	3º 38.6´	yes	yes	no	yes	yes
22	53º 23´	3º 38.6´	yes		no	yes	yes
23	53º 23´	3º 47.0´	yes		no	yes	yes
24	53º 27´	3º 47.0´	yes		no	yes	yes
25	53º 32´	3º 47.0´	yes		no	yes	yes
26	53º 37´	3º 47.0´	yes		no	yes	

27	53º 42´	3º 47.0´	yes	no	yes
28	53º 47´	3º 47.0´	yes	no	yes

29	53º 47´	3º 55.4´	yes	no	yes
30	53º 42	3º 55.4´	yes	no	yes
31	53º 37´	3º 55.4´	yes	no	yes
32	53º 32´	3º 55.4´	yes	no	yes
33	53º 27´	3º 55.4´	yes	no	yes
34	53º 22´	3º 55.4´	yes	no	yes
35	53º 32´	3º 15.9´	yes	no	yes

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

Nominal positions.

CTD no	Site	Nuts	Latitude (N)	Longitude (W)	Water depth (m)	Temp (deg)	Salinity
		T/ B				T / B	T / B
2	1	--/--	53º 32´	3º 21.8´	25	15.0 / 14.8	32.3 / 32.4
3	10	--/--	53º 27´	3º 13.4´	19	16.0 / 15.8	31.7 / 31.8

4	35	--/--	53º 31.9´	3º 15.9´	17	15.6 / 15.5	32.1 / 32.1
5	2	--/--	53º 37´	3º 13.4´	16	16.1 / 15.9	31.9 / 32.1
6	3	--/--	53º 42´	3º 13.4´	19	16.0 / 15.9	32.2 / 32.3
7	4	--/--	53º 47´	3º 13.4´	18	16.0 / 15.9	32.3 / 32.4
8	5	--/--	53º 52´	3º 21.8´	17	15.7 / 15.7	32.4 / 32.5
9	6	--/--	53º 47´	3º 21.8´	20	15.5 / 15.5	32.4 / 32.4
10	7	--/--	53º 42´	3º 21.8´	23	15.2 / ----	32.4 / ----
11	8	--/--	53º 37´	3º 21.8´	24	15.4 / 15.0	32.2 / 32.4
12	9	--/--	53º 32´	3º 21.8´	21	15.7 / 15.4	32.0 / 32.2
13	11	--/--	53º 27´	3º 21.8´	17	15.8 / 15.3	31.7 / 32.1
14	12	--/--	53º 27´	3º 30.2´	17	14.9 / 14.6	32.4 / 32.6
15	13	--/--	53º 32´	3º 30.2´	30	14.4 / 14.1	32.7 / 32.8
16	14	--/--	53º 37´	3º 30.2´	28	14.3 / 13.8	32.8 / 32.9
17	15	--/--	53º 42´	3º 30.2´	38	14.1 / 13.5	33.0 / 33.1
18	16	--/--	53º 47´	3º 30.2´	27	13.8 / 13.8	32.9 / 32.9
19	17	--/--	53º 47´	3º 38.6´	38	13.5 / 13.3	33.3 / 33.4
20	28	--/--	53º 47´	3º 47.0´	43	13.2 / 13.1	33.4 / 33.5
21	29	--/--	53º 47´	3º 55.4´	45	12.7 / 12.7	33.8 / 33.9
22	30	--/--	53º 42	3º 55.4´	45	12.9 / 12.8	33.7 / 33.8
23	27	--/--	53º 42´	3º 47.0´	43	13.2 / 12.9	33.4 / 33.6
24	18	--/--	53º 42´	3º 38.6´	43	13.6 / 13.3	33.2 / 33.2
25	19	--/--	53º 37´	3º 38.6´	34	13.6 / 13.3	33.3 / 33.5
26	20	--/--	53º 32´	3º 38.6´	35	13.8 / 13.6	33.3 / 33.4
27	25	--/--	53º 32´	3º 47.0´	44	13.5 / 13.3	33.5 / 33.6
28	24	--/--	53º 27´	3º 47.0´	32	14.0 / 13.7	33.1 / 33.3
29	23	--/--	53º 23´	3º 47.0´	17	15.4 / 14.7	32.4 / 32.8
30	22	--/--	53º 23´	3º 38.6´	12	15.3 / 15.2	32.3 / 32.3
31	21- 1	--/--	53º 27´	3º 38.6´	23	15.0 / 14.3	32.5 / 33.0
32	21- 2	--/--	53º 27´	3º 38.6´	24	14.8 / ----	32.8 / ----
33	26	--/--	53º 37´	3º 47.0´	43	13.6 / 13.2	33.3 / 33.5
34	31	--/--	53º 37´	3º 55.4´	48	13.3 / 13.1	33.6 / 33.7
35	32	--/--	53º 32´	3º 55.4´	49	13.1 / 12.9	33.9 / 33.9
36	33	--/--	53º 27´	3º 55.4´	40	14.0 / 13.4	33.5 / 33.6
37	34	--/--	53º 22´	3º 55.4´	26	14.8 / 14.5	33.0 / 33.1

Note: No nutrient samples were taken

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 (µmols / m^2s), Air Temperature (ºC), Relative Humidity, Relative Wind Speed (m s^{-1}), Relative Wind Direction (º) – zero indicates wind on the bow, Transmissance, Hull Temperature (ºC), Barometric Pressure (mbar), Fluorescence, Turbidity, Salinity, Minimum Air Temp (ºC), Maximum Air Temp (ºC), Wind Gust (m s^{-1}), GPS Time, Latitude, Longitude, Barometric Pressure Minimum (mbar), Barometric Pressure Maximum (mbar), Conductivity sensor water temperature (ºC). 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.

Underway data were recorded every minute from 07:05 on 20 June until 17:43 on 21 June 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.

pCO_2 data were recorded from 07:17 on 20 June until 17:59 on 21 June 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 07:11 on 20 June to 17:44 on 21 June 2007, starting and ending at Puffin Island.

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