Prince Madog cruise 20/06
POL Coastal Observatory cruise 36
21-23 June 2006

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 a Sea-Bird MicroCAT temperature, conductivity logger at 5m and 10m below the surface.

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 and a SeaPoint turbidity sensor were fitted to the frame. The frame is fitted with a SonTek ADV.
e) A CEFAS SmartBuoy in a single point mooring with a Sea-Bird MicroCAT temperature, conductivity logger at 5m and 10m below the surface.

f) Take water sample for Mike Cox (Liverpool University).

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 1.2 MHz telemetry ADCP was fitted to the frame.
b) A CEFAS SmartBuoy (with cellulose bags) in a single point mooring.
c) A telemetry buoy.

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 and a SeaPoint turbidity sensor are fitted to the frame.
e) A CEFAS SmartBuoy (with cellulose bags) in a single point mooring.

e) Take water sample for Mike Cox (Liverpool University).

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
Andy Lane
Dave Pearce (CEFAS)
Naomi Greenwood (CEFAS)
Ray Wilton (School of Ocean Sciences)
Eleanor Howlett (POL PhD student)

2.2 Ship's officers and crew

Steve Duckworth (Master)
Dean Atkinson (Chief Officer)
Alan Thompson (Chief Engineer)
Les Black (Second Engineer)
Phil Jones (Bosun)
Dave Leigh (A.B.)
Robert Cumming (A.B.)
James McKevitt (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 20 June 2006, just after high water. Loading was completed around 09:20. The ADCP and nutrient frames were set up on the afterdeck and the tower and instruments fitted to the SmartBuoy toroid.

The Liverpool Bay weather forecast for Wednesday (21 June 2006) predicted strong to gale force winds (Force 6, building to Force 7 and 8's). At 08:30 wave heights at the Liverpool Bar were around 1.8m and wind speeds on Hilbre Island were around 22-25 knots. It was decided to delay the cruise by 24 hours to see if the conditions improved.

RV Prince Madog left Menai Bridge at 12:00 on 22 June on route to station 21 as the forecast showed an improvement later in the day; see Figure 1 for the cruise track. Underway sampling was started at 12:47 and the ship's ADCP was started at 12:47, near Puffin Island. However, the sea conditions were still not good with quite a large swell and winds of Force 6. It was decided to anchor up in Colwyn Bay to see if conditions improved. Later, the wind dropped and the plan resumed. Once at station 21 the telemetry buoy was recovered. Due to time constraints the RV Prince Madog then returned to Menai Bridge, docking at 20:51. The

telemetry buoy was floated along the loading pier and picked up using the shore crane. It was loaded into the trailer and the operation completed by 21:15 on 22 June.

RV Prince Madog left Menai Bridge at 05:00 on 23 June and arrived at mooring site A at 08:16. A CTD was immediately carried out. One of the bottom bottles did not fire and it was repeated. The Wave ADCP was recovered between 09:10 and 09:23. The ADV head was slightly knocked on recovery. The replacement Wave ADCP was deployed at 09:35. The SmartBuoy was deployed between 09:48 and 09:49. The SmartBuoy was recovered between 09:52 and 09:58. Before leaving site 1 another CTD was carried on site.

CTD's were then carried out at sites 35, 11, 12 and 21. Mooring site B (CTD station 21) was reached at 12:37 and the Wave ADCP recovered between 12:55 and 13:15. The replacement Wave ADCP was deployed at 13:26. The SmartBuoy was deployed between 13:33 and 09:34. The SmartBuoy was recovered between 13:48 and 13:52. Another CTD was carried out at site 21 followed by CTD's at sites 22, 23 and 34. R.V Prince Madog docked at 17:45 and the gear unloaded.

Overall, the most important objectives were met with successful deployments and recoveries at both moorings sites. In addition a limited set of CTD's was achieved within the time constraints of the late departure. No vertical net hauls were carried out.

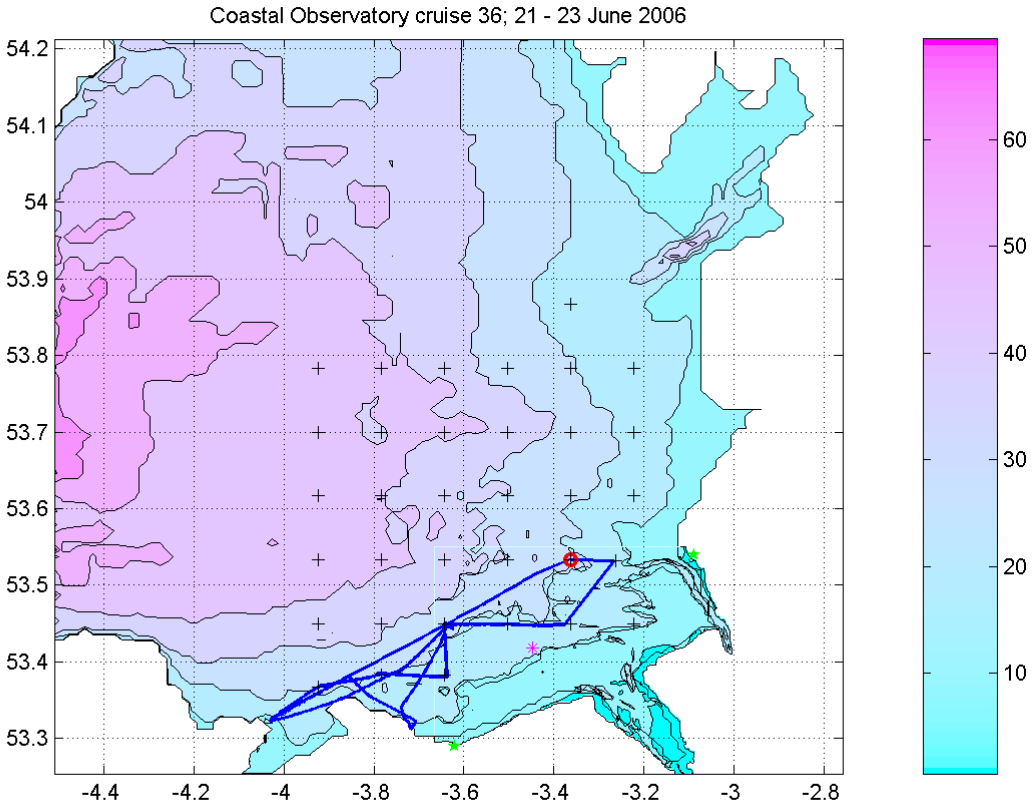

Figure 1. Cruise track.

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**;** battery pack 3036
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 14:46:00 on 8 May; delayed start 08:00:00 on 9 May 2006; started ok.
Unplugged from battery on recovery.

Sea-Bird 16*plus* S/N 4737 on base of frame with pumped conductivity sensor underneath. SeaPoint turbidity sensor: S/N 10489 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 13:43:30 on 8 May 2006; delayed start at 12:00:00 on 9 May 2006.
Stopped at 13:24:00 on 28 June 2006. Number of samples = 7203.

SonTek ADV (Acoustic Doppler Velocimeter); ADV Logger (Base G321, sensor A640)
Sensor height to middle of fork 1.59m. Sample rate 16Hz; burst interval 3600s; samples in each burst 19200; burst length 1200s. The ADV reported that it was unable to initialise the compass. Compass orientation changed (Red mark on prong pointing towards the end and away from the frame; same direction as beam 3 of] the ADCP). Clock reset to 13:32:30 on 9 May 2006. Delayed start at 14:00:00 on 9 May 2006.
Unplugged from battery on recovery.

The frame D4 was fitted with two Benthos releases 72858 – Rx 14.5 kHz, Tx 12.0 kHz, release A and 72863 – Rx 13.5 kHz, Tx 12.0 kHz, release X 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 and conductivity recorder Serial number 2991 at 5m below the surface. Sample interval 600s.
Clock set at 14:18:30 on 8 May 2006. Delayed start 12:00:00 on 9 May 2006.
Stopped at 12:10:20 on 28 June 2006. Number of samples = 7196.

Sea-Bird MicroCAT temperature and conductivity recorder Serial number 2506 at 10m below the surface. Sample interval 600s.
Clock set at 14:06:30 on 8 May 2006. Delayed start 12:00:00 on 9 May 2006.
Stopped at 10:28:30 on 28 June 2006. Number of samples = 7185.

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 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

f) Site B. 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 1Gbyte PCMCIA memory; hourly wave recording enabled.
Clock reset at 15:38:30 on 8 May; delayed start 08:00:00 on 9 May 2006.
Unplugged from battery on recovery.

Sea-Bird 16*plus* S/N 4597 on base of frame with pumped conductivity sensor underneath.
SeaPoint turbidity sensor: SN 10471 taped to roll bar; 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 14:38:30 on 8 May 2006; delayed start at 12:00:00 on 11 May 2006.
Stopped at 12:53:00 on 28 June 2006. Number of samples = 6912.

Telemetry ADCP 1.2 MHz RDI 0572.
Mode 1: 100 pings every 10 minutes (velocity standard deviation 0.003 m s^{-1}).
Earth 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.
Clock reset at 15:23:00 on 8 May 2006; delayed start 15:50:00 on 11 May 2006.
Unplugged from battery on recovery.

The frame D3 was fitted with two Benthos releases 70358 – Rx 11.0 kHz, Tx 12.0 kHz, release A and 71922 – Rx 11.5 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.

g) SmartBuoy Mooring.
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 31.971´	3º 21.612´	21.2	09:10	23/06/06
SmartBuoy (Site A)	53º 32.068´	3º 21.631´	23.5	09:52	23/06/06
Waves ADCP (Site B)	53º 26.911´	3º 38.428´	26.8	12:55	23/06/06
Smart Buoy (Site B)	53º 26.626´	3º 37.419´	25.7	13.48	23/06/06
Telemetry toroid	53º 26.987´	3º 38.462´	25.5	17:52	22/06/06

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

Site A

a) Waves ADCP 600 kHz RDI 5806**;** battery pack #2
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 09:31:30 on 20 June; delayed start 06:00:00 on 21 June 2006; started ok.

Sea-Bird 16*plus* S/N 4736 on base of frame with pumped conductivity sensor underneath.
SeaPoint turbidity sensor: S/N 10490 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 08:25:40 on 20 June 2006; delayed start at 06:00:00 on 21 June 2006.

SonTek ADV (Acoustic Doppler Velocimeter); ADV Logger 258
Sensor height to middle of fork 1.59m. Sample rate 16Hz; burst interval 3600s; samples in each burst 19200; burst length 1200s. Compass orientation note: Red mark on prong pointing along scaffold pole towards the ADCP frame. Delayed start at 06:00 on 21 June 2006.

The frame D4 was fitted with two Benthos releases 72850 – Rx 11.5 kHz, Tx 12.0 kHz, release C and 72381 – Rx 11.0 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 and conductivity recorder Serial number 2081 at 5m below the surface. Sample interval 600s. ID #02
Clock set at 07:57:10 on 20 June 2006. Delayed start 06:00:00 on 21 June 2006.

Sea-Bird MicroCAT temperature and conductivity recorder Serial number 2010 at 10m below the surface. Sample interval 600s. ID #01
Clock set at 08:02:00 on June 2006. Delayed start 06:00:00 on 21 June 2006.

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 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
f) Site B. Waves ADCP 600 kHz RDI 3644; battery pack #1
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 09:44:13 on 20 June; delayed start 06:00:00 on 21 June 2006.

Sea-Bird 16*plus* S/N 4596 on base of frame with pumped conductivity sensor underneath. SeaPoint turbidity sensor: SN 10487 taped to roll bar; 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 08:18:00 20 June 2006; delayed start at 06:00:00 on 21 June 2006.

The frame D3 was fitted with two Benthos releases 70356 – Rx 10.5 kHz, Tx 12.0 kHz, release D and 72382 – Rx 10.0 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.

g) SmartBuoy Mooring.
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 2. Deployed mooring positions and times.

	Latitude (N)	Longitude (W)	Water Depth (m)	Deployed Time	Deployed Date
Waves ADCP (Site A)	53º 31.970´	3º 21.659´	26.6	09:35	23/06/06
SmartBuoy (Site A)	53º 32.030´	3º 21.521´	26.3	09:48	23/06/06
Waves ADCP (Site B)	53º 26.923´	3º 38.400´	26.4	13:26	23/06/06
Smart Buoy (Site B)	53º 26.968´	3º 38.489´	25.0	13:34	23/06/06

4.3 Water for Mike Cox (Liverpool University)
Water collected from surface intake at sites A and B between each SmartBuoy deployment and recovery.

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) and by two to accommodate a bottle with reversing thermometers. One/two water bottles were fired near bed and one/two/three near the surface, when needed. One of the near bed bottles was fitted with two electronic thermometers to check the CTD temperature data. Water samples were taken from this bottle for calibration of the CTD salinity data. (At the CEFAS stations, see below, this bottle was fired near the surface). 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-25 particle sizer was fitted to the CTD and its data logged on the Sea-Bird data logging system. A LISST-100 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.

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

Site	Latitude (N)	Longitude (W)	Visited on this cruise	Cefas Chloropyll & Nu	Cefas Ss	POL Nu	POL Ss
1	53º 32′	3º 21.8′	yes	yes	yes	yes	no
2	53º 37′	3º 13.4′	no				
3	53º 42′	3º 13.4′	no				
4	53º 47′	3º 13.4′	no				
5	53º 52′	3º 21.8′	no				
6	53º 47′	3º 21.8′	no				
7	53º 42′	3º 21.8′	no				
8	53º 37′	3º 21.8′	no				
9	53º 32′	3º 21.8′	no				
10	53º 27′	3º 13.4′	no				
11	53º 27′	3º 21.8′	yes	no	no	yes	yes
12	53º 27′	3º 30.2′	yes			yes	yes
13	53º 32′	3º 30.2′	no				
14	53º 37′	3º 30.2′	no				
15	53º 42′	3º 30.2′	no				
16	53º 47′	3º 30.2′	no				
17	53º 47′	3º 47.0′	no				
18	53º 42′	3º 38.6′	no				
19	53º 37′	3º 38.6′	no				
20	53º 32′	3º 38.6′	no				
21	53º 27′	3º 38.6′	yes	yes	yes	yes	yes
22	53º 23′	3º 38.6′	yes			yes	yes
23	53º 23′	3º 47.0′	yes			yes	yes
24	53º 27′	3º 47.0′	no				
25	53º 32′	3º 47.0′	no				
26	53º 37′	3º 47.0′	no				
27	53º 42′	3º 47.0′	no				
28	53º 47′	3º 47.0′	no				
29	53º 47′	3º 55.4′	no				
30	53º 42	3º 55.4′	no				
31	53º 37′	3º 55.4′	no				
32	53º 32′	3º 55.4′	no				
33	53º 27′	3º 55.4′	no				
34	53º 22′	3º 55.4′	yes			yes	yes
35	53º 32′	3º 15.9′	yes			yes	no

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	1/ 2	53º 32′	3º 21.8′	27	13.5 /13.5	32.7 / 32.7
3	1	3/ 4	53º 32′	3º 21.8′	26	13.6 /13.5	32.6 / 32.6
4	35	5/ 6	53º 31.9′	3º 15.9′	16	14.0 /13.8	32.3 / 32.4
5	11	7 / 8	53º 27′	3º 21.8′	18	14.4/ 13.9	32.4 / 32.7
6	12	9/10	53º 27′	3º 30.2′	18	13.8/ 13.6	32.9 / 33.0
7	21	11/12	53º 27′	3º 38.6′	24	13.4/13.1	33.2 / 33.2
8	21	13/14	53º 27′	3º 38.6′	23	13.6/13.3	33.1 / 33.2
9	22	15/16	53º 23′	3º 38.6′	11	14.6/14.3	32.8 / 32.9
10	23	17/18	53º 23′	3º 47.0′	14	14.3 /14.1	33.1 / 33.1
11	34	19/20	53º 22′	3º 55.4′	21	14.0 / 13.8	33.2 / 33.2

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.

Underway data were recorded every minute from 12:47 on 22 June until 19:58 on 22 June 2006, and 05:00 on 23 June until 16:55 on 23 June 2006, 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.

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 12:47 on 22 June until 19:58 on 22 June 2006, and from 05:00 on 23 June until 16:55 on 23 June 2006 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. Also thanks to Dave Pearce (CEFAS) and Naomi Greenwood (CEFAS) for allowing access to filtering equipment since the normal equipment was not available for POL sediment filtration.