Prince Madog cruise 07/08
POL Coastal Observatory cruise 51 and Dee recovery cruise
11-15 March 2008

1. Objectives

Coastal Observatory

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 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. Attached to the mooring wire are 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, a SeaPoint turbidity sensor, Aanderaa optode and a SonTek ADV were fitted to the frame.

d) A CEFAS SmartBuoy (with cellulose bags) in a single point mooring. Attached to the mooring wire are 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 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) in a single point mooring. Attached to the mooring wire are Sea-Bird MicroCat temperature, conductivity loggers at 5 and 10m below the surface and miniloggers at 7.5 and 15 m below the surface.

c) A telemetry toroid.

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, a SeaPoint turbidity sensor were fitted to the frame. A 1200 kHz telemetry ADCP was fitted to the frame.

e) A CEFAS SmartBuoy (with cellulose bags) in a single point mooring. Attached to the mooring wire are Sea-Bird MicroCat temperature, conductivity loggers at 5 and 10m below the surface and miniloggers at 7.5 and 15 m below the surface.

f) 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.

Dee Experiment (recovery)
6. At 53º 27′ N 3º 30.2′ W (site 12)
To recover
An ADCP frame.

7. At 53º 22.4′ N 3º 14.1′ W (Hilbre Channel, Dee Estuary)
a) To conduct a 25 hour CTD / LISST survey every 30 minutes

To recover
b) STABLE lander

8. At 53º 22.2′ N 3º 19.6′ W (Welsh Channel, Dee Estuary)
a) To conduct a 25 hour CTD / LISST survey every 30 minutes

To recover
b) Mini-STABLE lander

2.1 Scientific personnel

Phil Knight (Principal Scientist)
Chris Balfour (2nd leg only, Birkenhead to Barrow)
John Kenny
Andy Lane
Ben Moate
Richard Cooke
Emlyn Jones (1st leg only, Barrow to Birkenhead)
Dave Sivyer (CEFAS)
Laura Bristow (CEFAS)
Anne Hammerstein (School of Ocean Sciences)

2.2 Ship's officers and crew

Steve Duckworth (Master)
David Shaw (Chief Officer)
Alan Thompson (Chief Engineer)
Les Black (Second Engineer)
Mick Mackay (Second Engineer)
Phil Jones (Bosun)

Dave Leigh (A.B.)
Tom Ainsworth (Cook)

3. Narrative (times in GMT)

The anchor chain clumps, two sea-bed frames and instrumentation were loaded onto RV Prince Madog, located in Barrow, on the afternoon of 10 March 2008. The ADCP frames were set up on the afterdeck by POL engineers and the tower and instruments fitted to the SmartBuoy toroid by CEFAS personnel.

Prince Madog left Barrow at 23:45 on 10 March 2008. For the first 6 hours sea conditions were rough with winds of Force 7-8 from W/NW. Later in the morning winds eased allowing for safe passage into the Hilbre Channel. The ship's underway pCO_2, surface monitoring and ADCP were switched on at 23:45.

We arrived in the Hilbre Channel at 12:20 on the 11 March and deployed the anchor in preparation for recovery of STABLE. STABLE was recovered between 12:20 and 12:58. Towards the end of recovery the winds began to increase to a Force 6-7. The forecast was Force 10-11 later, so we headed back into Birkenhead (Vittoria Dock) to unload STABLE and wait for the weather conditions to ease. The ship's underway pCO_2, surface monitoring and ADCP were switched off at 14:55. Bikenhead, Vittoria dock, was reached at 15:25. We were delayed going back out to sea for 24 hours due to high winds and large waves. Waves at the main mooring had reached over 5m during the night (The maximum wave height that we can safely recover a Cefas buoy is 1.2m).

Eventually Prince Madog left Birkenhead at 04:30 on 13 March 2008. The ship's underway pCO_2, surface monitoring and ADCP were switched on at 04:50. An attempt was made to carry out moorings work at the main mooring site, however the winds were still Force 6 and the wave heights were around 1.7m. Therefore we changed plan and headed for the Welsh Channel. Once in the Welsh Channel the anchor was deployed. Five CTD's (every 30 minutes) were carried out of a planned 24 hour station (WC1-5). This was cut short due to time constraints, day light and tidal conditions in order to recover Mini-STABLE. The Mini-STABLE was recovered between 13:26 and 13:44. Once on deck it was obvious that the lander had been damaged. On inspection the damage looked like it had occurred prior to recovery. The ADCP had been destroyed, with only the case left, and the LIST100 was partially damaged on the case and head. The ship was then manoeuvred further into the Dee Estuary to spend some time striping down Mini-STABLE to leave enough room on deck for further moorings work.

The following CTD bottle numbers were used for water samples: (3 for salinity, 4 for bottom, 9 for top and 10 for Cefas use). The CTD survey was started, visiting stations 10, 11, 12, 22, 23, 34, 33, 32, 25, 24, 20, 13. SPM, nutrient and grab samples were taken at each station visited (no grab sample at site 25 due to sea conditions). The Mersey Bar mooring site was reached at 07:57 on 14 March 2008 and a CTD recorded (site 1). The ADCP release was fired at 08:18, the frame quickly surfaced and was grappled. The ADCP and its ballast weight were on deck by 08:30. The replacement ADCP was then deployed at site A at 10:25. The replacement SmartBuoy was deployed at 10:51 and the old buoy recovered between 10:59 and 11:13. A second CTD was recorded at 11:26. This was followed by Zooplankton 0.5m and 1m net hauls between 12:20 and 13:20. A CTD was carried out at site 35.

Once at site B (site 21) a CTD was carried out. The ADCP at site 21 was then recovered between 16:00 and 16:10. The telemetry toroid was then recovered between 16:36 and 16:40. The telemetry toroid was deployed at 18:20. The replacement ADCP was deployed at 18:30. The replacement Smartbuoy was redeployed at 18:58 and the old Smartbuoy recovered between 19:18 and 19:25. This was followed by another CTD (site21). Due to working at both mooring sites during the day the number of hours worked by the crew was over their limit for a 24 hour period. Therefore the ship moved to an anchorage to allow the crew a rest period. The ship's underway pCO_2, surface monitoring and ADCP were switched off at 20:27.

The anchor was lifted at 05:42 on 15 March 2008. The ship's underway pCO_2, surface monitoring and ADCP were switched on at 05:42. The ADCP at site 12 was recovered between 06:20 and 06:35. The following CTD stations were then visited, 14, 8, 2, 3, 7, 6, 4, and 5. The ship's underway pCO_2, surface monitoring and ADCP were switched off at 14:28. The RV Prince Madog arrived at Barrow at 14:30. The ship was then unloaded. One 0.5 tonne anchor had to be left on the ship since the lorry was probably overloaded (limited to 3.5 tonnes) with other equipment.

All the major moorings objectives were accomplished. However, CTD sites were missed out and both 24 hour stations aborted, due to very poor weather conditions throughout the cruise. Work was essentially carried out during lulls between 2-3 storms during the week.

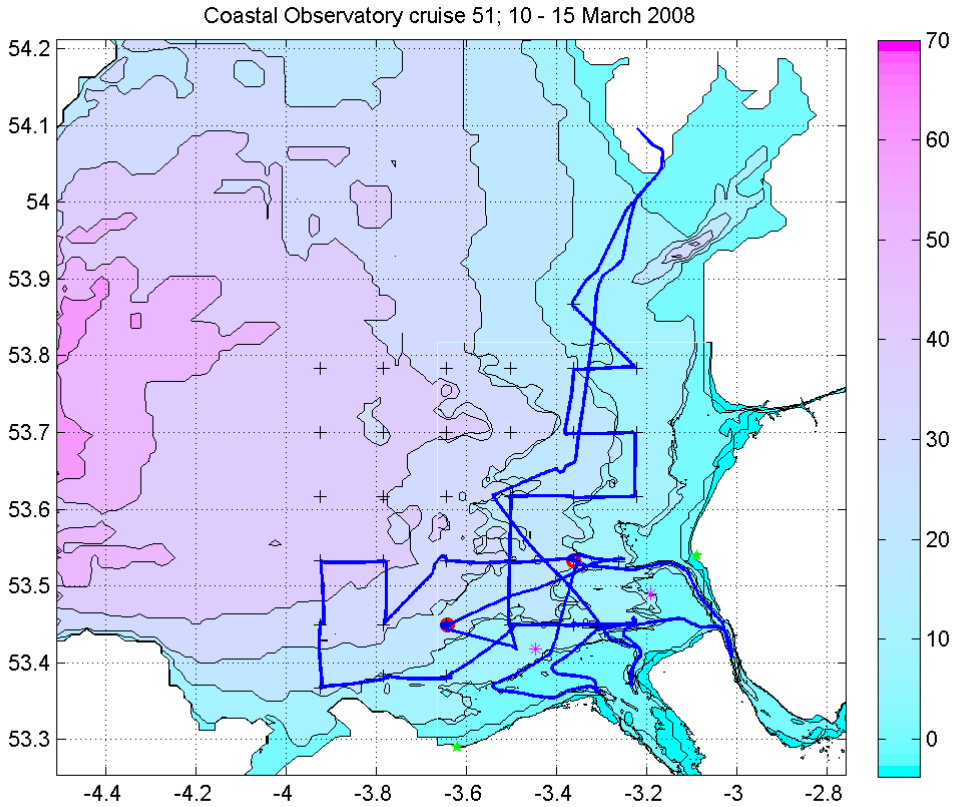

Figure 1. Cruise track.

4. Moorings (times in GMT)

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

Site A
a) ADCP 600 kHz RDI 5803**.**
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 set at 14:20 on 8 January 2008; delayed start 12:00:00 on 9 January 2008.
No stop time recorded.

Sea-Bird 16plus S/N 4848 on base of frame with pumped conductivity sensor underneath. Sample interval 600s. SeaPoint turbidity sensor 10538 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 13:57:00 on 8 January 2008; delayed start at 12:00:00 on 9 January 2008. Batteries ran out. Replaced batteries for calibration dip at station 7, CTD number 27.

SonTek ADV (Acoustic Doppler Velocimeter); ADV Logger G250; head B252.
Distance from center of three prong head on ADV transmitter to deck was 1.220m (i.e. above sea bed). Sample rate 16Hz; burst interval 3600s; samples in each burst 19200; burst length 1200s. Time reset to 10:01:00 on 11 January 2008, logging set to start at 11:00:00 on 11 January 2008. Stopped 14 March 2008 at 08:57:30. Clock drift GMT-7 seconds. Some corrosion in head connection in case.

The frame was fitted with two Benthos releases s/n 70358 – Rx 11.0 kHz, Tx 12.0 kHz, release A and s/n 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 s/n 4966 at 5m below the surface. Sample interval 600s.
Clock set at 14:48:00 on 8 January 2008. Delayed start 10:00:00 on 9 January 2008.
Stopped at 08:11:02 on 15 March 2008.

Sea-Bird MicroCat temperature and conductivity recorder s/n 2991 at 10m below the surface. Sample interval 600s.
Clock set at 15:41 on 8 January 2008. Delayed start 10:00 on 9 January 2008.
Stopped at 09:30:00 on 15 March 2008. Clock GMT+17 seconds.

Mini-logger s/n 6028 at 7.5 m below the surface set to record at 600s intervals. Clock set at 15:30:21 on 8 January 2008. Delayed start at 10:00:00 on 9 January 2008. Stopped at 14:13:43 on 14 March 2008.

Mini-logger s/n 0142 at 15 m below the surface set to record at 600s intervals. Clock set at 07:07:00 on 8 January 2008. Delayed start at 08:00:00 on 11 January 2008. Recorded data until 10:20:00 on 10 February 2008.

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 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.
Clock set at 14:14 on 8 January 2008; delayed start 10:00:00 on 09 January 2008.
No stop time recorded

Telemetry ADCP 1200 kHz RDI 3052**.**
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).
Earth co-ordinates - speeds, correlation, echo intensity, % good.
Sound velocity calculated from temperature, depth and salinity of 32.
Clock reset at 14:16:20 on 8 January; delayed start 16:00:00 on 9 January 2008.
LinkQuest acoustic modem set for transmission of ADCP data every hour.
No stop time recorded

Sea-Bird 16plus S/N 4596 on base of frame with pumped conductivity sensor underneath. Sample interval 600s. SeaPoint turbidity sensor 10487 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 13:37:00 on 8 January 2008; delayed start at 10:00:00 on 9 January 2008. No stop time recorded.

The frame was fitted with two Benthos releases s/n 70356 – Rx 10.5 kHz, Tx 12.0 kHz, release D and s/n 72863 – Rx 13.5 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 recorder s/n 2010 at 5 m below the surface. Sample interval 600s.
Clock set at 10:00:00 on 11 January 2008. Delayed start 10:20:00 on 11 January 2008.
Stopped at 09:20:44 on 15 March 2008.

Sea-Bird MicroCat temperature, conductivity recorder s/n 2506 at 10 m below the surface. Sample interval 600s.
Clock set at 10:11:00 on 11 January 2008. Delayed start 11:00:00 11 January 2008.
Stopped at 10:44:58 on 15 March 2008.

Mini-logger s/n 6024 at 7.5 m below the surface set to record at 600s intervals.
Clock set at 10:47:14 on 11 January 2008. Delayed start at 11:00:00 on 11 January 2008.
Stopped at 07:51:59 on 15 March 2008.

Mini-logger s/n 6026 at 15 m below the surface set to record at 600s intervals.
Clock set at 11:00:08 on 11 January 2008. Delayed start at 11:10:00 on 11 January 2008.
Stopped at 07:59:39 on 15 March 2008.

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. A 'trace metal monitoring probe' was attached to the buoy by Conrad Chapman (University of Liverpool). Trace metal sensor head was missing on recovery.

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.

Dee Experiment

a) Hilbre Channel (STABLE)

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.
Clock set at 18:02:10 on 13 February 2008; delayed start 06:00:00 on 14 February 2008.
No stop time recorded.

ADCP 1200 kHz RDI 6489**.** (on gimbaled mounting bracket)
Mode 1: 100 pings every 10 minutes (velocity standard deviation 0.003 m s^{-1}).
30 x 1 m bins (2.15 – 31.15 above the bed).
Earth co-ordinates - speeds, correlation, echo intensity, % good.
Sound velocity calculated from temperature, depth and salinity of 32.
Clock set at 17:51:30 on 13 February 2008; delayed start 06:00:00 on 14 February 2008.
No stop time recorded.

Additional list of equipment on Stable 3 – No starts/stops available at time of writing report.

- Sontek ADV G496 with probe B281
- Sontek ADV G355 with probe B285
- Sontek ADV G358 with probe B292
- D&A Instruments model OBS3+ optical backscatter sensors, T8193, T8194, T8195.
- Paro Scientific Digiquartz pressure sensor
- POL ABS1 acoustic backscatter instrument
- POL SyncGen1 timing clock generator.
- Sequoia Scientific LISST100X
- AML model MC7 CT logger with probes 7216, 7217, 7218
- Marine Electronics 3-D ripple profiler
- POL settling tube type sediments trap

b) Welsh Channel (Mini-STABLE)

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.
Clock set at 14:24:10 on 11 February 2008; delayed start 08:00:00 on 12 February 2008.
Unit destroyed by suspected trawl wire. No transducers or electronics left on recovery of Mini-STABLE. All that was left was an empty case.

Marine Electronics ripple profiler (No information)

ADV (1) case G258 (Possibly G250) probe B233, clock reset to 14:43:00 GMT on 11 February 2008. Logging set to start at 06:00:00 GMT on 12 February 2008, syncmode=START. No stop time recorded.

ADV (2) case G412 probe B331, clock reset to 15:33:00 GMT on 11 February 2008. Deployment set to start at 06:00:00 GMT on 12 February 2008. No stop time recorded.

POL ABS 3 (Acoustic Backscatter Instrument) at 1MHz, 2MHz and 4 MHz. 4MHz averaged PRF. Clock set to GMT 15:20 on 11 February 2008. Start time set to 06:00 12 February 2008. No Stop time recorded.

SyncGen3. Clock set to 15:25 on 11 February 2008. Start time set to 06:00 on 12 February 2008.

UEA timed sediment tube trap. Failed to operate timed spacers between sediment. The tube however did fill with sediment and was brought back intact.

LIST 100 S/N 1109
Clock set to 15:35 on 11 February 2008. Start time set to 06:00 on 12 February 2008. Burst mode, 10 measurements in 3 seconds, sample interval 40 seconds, 30 samples per burst. Start at 06:00 on 12 February 2008. No stop time recorded.

c) Site 12 (53º 27′ N 3º 30.2′ W)

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.
Clock set at 14:15:10 on 11 February 2008; delayed start 08:00:00 on 12 February 2008.
No stop time recorded.

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

Sample interval 600s. SeaPoint turbidity sensor 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 18:04:05 on 11 February 2008; delayed start at 08:00:00 on 12 February 2008. No stop time recorded.

The frame was fitted with two Benthos releases 67679 – Rx 11.5 kHz, Tx 12.0 kHz, release B 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.

Table 1. Recovered mooring positions and times.

	Latitude (N)	Longitude (W)	Water Depth (m)	Recovered Time	Date
ADCP (Site A)	53º 32.024´	3º 21.435´	25.4	08:18	14/3/2008
SmartBuoy (Site A)	53º 32.024´	3º 21.484´	20.4	10:59	14/3/2008
ADCP (Site B)	53º 26.977´	3º 38.487´	29.3	16:00	14/3/2008
Smart Buoy (Site B)	53º 26.896´	3º 38.689´	29.1	19:18	14/3/2008
Telemetry toroid (Site B)	53º 27.077´	3º 38.439´	27.6	16:36	14/3/2008
STABLE (Hilbre Channel)	53º 22.375´	3º 14.130´	12.6	12:33	11/3/2008
Mini-STABLE (Welsh Channel)	53º 22.162´	3º 19.582´	15.6	13:26	13/3/2008
ADCP (Site 12)	53º 26.873´	3º 30.231´	17.7	06:20	15/3/2008

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

Site A
a) 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). 1Gb memory.
Beam co-ordinates - speeds, correlation, echo intensity, % good.
Sound velocity calculated from temperature, depth and salinity of 32.
Clock set at 16:21:20 on 10 March 2008; delayed start 06:00:00 on 11 March 2008.

Sea-Bird 16plus S/N 5309 (RS232) on base of frame with pumped conductivity sensor underneath. Sample interval 600s. Attached Aanderaa Optode Serial No. 675
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 15:44:00 on 10 March 2008; delayed start at 06:00:00 on 11 March 2008.

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

Distance from center of three prong head on ADV transmitter to deck was 1.195m (i.e. above sea bed). Sample rate 16Hz; burst interval 3600s; samples in each burst 19200; burst length 1200s. Time reset to 10:00:00 on 14 March 2008, logging set to start at 11:00:00 on 14 March 2008.

The frame was fitted with two Benthos releases s/n 70355 – Rx 10.0 kHz, Tx 12.0 kHz, release B and s/n 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 s/n 5792 at 5m below the surface. Sample interval 600s.
No note in log book for date/times for clock reset and delayed start.

Sea-Bird MicroCat temperature and conductivity recorder s/n 5790 at 10m below the surface. Sample interval 600s.
Clock set at 16:10 on 10 March 2008. Delayed start 06:00 11 March 2008.

Mini-logger s/n 6023 at 7.5 m below the surface set to record at 600s intervals. Delayed start at 08:00:00 on 13 March 2008.

Mini-logger s/n 6027 at 15 m below the surface set to record at 600s intervals. Delayed start at 08:00:00 13 March 2008.

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 5803
(Note: This was on previous cruise and was re-deployed due to a shortage of other ADCPs)
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). 1 Gb memory.
Beam co-ordinates - speeds, correlation, echo intensity, % good.
Sound velocity calculated from temperature, depth and salinity of 32.
Clock set at 13:28:50 on 14 March 2008; delayed start 14:00:00 on 14 March 2008.

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). 1 Gb memory.
Earth co-ordinates - speeds, correlation, echo intensity, % good.
Sound velocity calculated from temperature, depth and salinity of 32.
Clock reset at 16:41:00 on 10 March; delayed start 06:00:00 on 13 March 2008.
LinkQuest acoustic modem set for transmission of ADCP data every hour.

Sea-Bird 16plus S/N 5310 (RS232) on base of frame with pumped conductivity sensor underneath.Sample interval 600s. 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 15:35:00 on 10 March 2008; delayed start at 06:00:00 on 11 March 2008.

The frame was fitted with two Benthos releases s/n 72382 – Rx 10.0 kHz, Tx 12.0 kHz, release A and s/n 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.

b) SmartBuoy mooring.
Sea-Bird MicroCat temperature, conductivity recorder s/n 5791 at 5 m below the surface. Sample interval 600s.
Clock set at 16:07:20 on 10 March 2008. Delayed start 06:00:00 on 11 March 2008.

Sea-Bird MicroCat temperature, conductivity recorder s/n 5793 at 10 m below the surface. Sample interval 600s.
Clock set at 16:03:30 on 10 March 2008. Delayed start 06:00:00 on 11 March 2008.

Mini-logger **NOT DEPLOYED** (7.5 m below the surface set to record at 600s intervals).
Mini-logger **NOT DEPLOYED (**15 m below the surface set to record at 600s intervals).

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.

	Latitude (N)	Longitude (W)	Water Depth (m)	Deployed Time	Date
ADCP (Site A)	53º 32.024´	3º 21.414´	20.1	10:25	14/3/2008
SmartBuoy (Site A)	53º 32.017´	3º 21.491´	20.3	10:51	14/3/2008
ADCP (Site B)	53º 26.970´	3º 38.526´	25.3	18:30	14/3/2008
Smart Buoy (Site B)	53º 26.896´	3º 38.313´	22.0	18:58	14/3/2008
Telemetry toroid (Site B)	53º 27.085´	3º 38.399´	25.2	18:20	14/3/2008

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 is accurate enough to sample down to

0.5m 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 bottom 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)

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

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

CTD no	Site	Nuts	Nominal positions. Latitude (N)	Longitude (W)	Water depth (m)	Temp (deg)	Salinity
		T/ B				T / B	T / B
6	10	51_10_T/51_10_B	53º 27′	3º 13.4′	---	7.4 / 7.4	33.6 / 33.6
7	11	51_11_T/51_11_B	53º 27′	3º 21.8′	---	7.4 / 7.4	33.7 / 33.7
8	12	51_12_T/51_12_B	53º 27′	3º 30.2′	15	7.3 / 7.4	33.4 / 33.6
9	22	51_22_T/51_22_B	53º 23′	3º 38.6′	12	7.6 / 7.6	33.9 / 33.9
10	23	51_23_T/51_23_B	53º 23′	3º 47.0′	14	7.6 / 7.6	33.9 / 33.9
11	34	51_34_T/51_34_B	53º 22′	3º 55.4′	25	7.7 / 7.7	34.0 / 34.0
12	33	51_33_T/51_33_B	53º 27′	3º 55.4′	41	7.9 / 7.9	34.0 / 34.0
13	32	51_32_T/51_32_B	53º 32′	3º 55.4′	48	7.9 / 7.9	34.0 / 34.0
14	25	51_25_T/51_25_B	53º 32′	3º 47.0′	---	7.4 / 7.6	33.5 / 33.7
15	24	51_24_T/51_24_B	53º 27′	3º 47.0′	---	---- / ----	---- / ----
16	20	51_20_T/51_20_B	53º 32′	3º 38.6′	---	---- / ----	---- / ----
17	13	51_13_T/51_13_B	53º 32′	3º 30.2′	---	---- / ----	---- / ----
18	1-1	51_01_T/51_01_B	53º 32′	3º 21.8′	---	7.1 / 7.2	32.3 / 33.4
19	1-2		53º 32′	3º 21.8′	22	7.2 / 7.2	33.3 / 33.5
20	35	51_35_T/51_35_B	53º 31.9′	3º 15.9′	14	7.3 / 7.2	33.5 / 33.5
21	21-1	51_21_T/51_21_B	53º 27′	3º 38.6′	27	7.3 / 7.3	33.1 / 33.2
22	21-2		53º 27′	3º 38.6′	25	7.1 / 7.3	32.9 / 33.2
23	14	51_14_T/51_14_B	53º 37′	3º 30.2′	32	6.9 / 7.0	32.2 / 32.6
24	8	51_8_T/51_8_B	53º 37′	3º 21.8′	24	6.9 / 7.1	31.4 / 32.9
25	2	51_2_T/51_2_B	53º 37′	3º 13.4′	11	7.2 / 7.2	33.3 / 33.3
26	3	51_3_T/51_3_B	53º 42′	3º 13.4′	16	7.0 / 7.1	31.9 / 33.3
27	7	51_7_T/51_7_B	53º 42′	3º 21.8′	22	6.8 / 7.1	31.2 / 33.1
28	6	51_6_T/51_6_B	53º 47′	3º 21.8′	18	6.8 / 6.9	31.1 / 32.4
29	4	51_4_T/51_4_B	53º 47′	3º 13.4′	15	6.8 / 6.9	31.0 / 32.7
30	5	51_5_T/51_5_B	53º 52′	3º 21.8′	15	6.8 / 6.7	31.1 / 31.4

Table 5. Surface and bottom parameters from CTD, noted in log book for the Dee.
Welsh Channel (WC). **NO CTD's from Hilbre Channel (HC)**. At Anchor. Lat and Lon as read off ships GPS.

CTD no	Site	Date/time	Nominal positions. Latitude (N)	Longitude (W)	Water depth (m)	Temp (deg)	Salinity
		13 March 08				T / B	T / B
1	WC1	11:00	53º 22.16′	3º 19.89′	10.7	7.2/7.2	33.37/33.37
2	WC2	11:30	53º 22.14′	3º 19.89′	12.6	7.2/7.2	33.39/33.39

3	WC3	12:00	53º 22.15´	3º 19.89´	13.5	7.3/7.3	33.42/33.42
4	WC4	12:30	53º 22.15´	3º 19.89´	15.4	7.4/7.4	33.55/33.54
5	WC5	13:00	53º 22.15´	3º 19.89´	15.0	7.4/7.4	33.62/33.62

* Suspended sediments (Ss) taken for CTD nos. 1, 3 and 5

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 (not currently operational), 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 sonic anemometer was fitted. The transmittance, fluorescence and turbidity were all recorded as voltages.

Underway (including navigation) data, pCO2 and ships ADCP data were recorded every minute between:

- (Barrow) 23:45 on 10 March 2008 until (Entrance to Liverpool) 14:55 on 11 March 2008
- (Liverpool) 04:50 on 13 March 2008 until (Entrance to Liverpool) 20:27 on 14 March 2008 (* stopped ADCP logging 10:44 and restarted at 10:45 on 13 March 2008))
- (Southern part of grid) 05:42 on 15 March 2008 until (Barrow) 14:28 on 15 March 2008

Sampling started and ended at Barrow. 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.

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