**Prince Madog cruise 18/04**
**POL Coastal Observatory cruise 17**
**11 - 14 May 2004**

## 1. Objectives

1. At 53º 32´ N 3º 21.8´ W, half a mile west of the Mersey Bar Light Vessel –
To recover
a) A sea bed frame for a 600 kHz ADCP to measure the mean current profile, pressures and directional waves. A pressure recorder, a transmissometer / conductivity / temperature logger and a SeaBird MicroCAT were fitted to the frame.
b) A CEFAS SmartBuoy in a single point mooring with a SeaBird MicroCAT temperature, conductivity logger at 5m below the surface and an Aanderaa temperature and conductivity logger at 10 m below the surface.
c) A sea bed frame for a 1200 kHz ADCP (telemetry ADCP) to measure mean current profile and pressures. An acoustic modem was fitted and linked to the ADCP.
d) A surface toroid (telemetry buoy) with an acoustic modem and an Orbcomm satellite communication system.

To deploy
e) A sea bed frame for a 600 kHz ADCP (waves ADCP) to measure the mean current profile, pressures and directional waves. A pressure recorder, a transmissometer / conductivity / temperature logger and a SeaBird MicroCAT were also fitted to the frame.
f) A CEFAS SmartBuoy in a single point mooring with a SeaBird MicroCAT temperature, conductivity logger at 5m below the surface and an Aanderaa temperature and conductivity logger at 10 m below the surface.
g) A sea bed frame for a 1200 kHz ADCP (telemetry ADCP) to measure mean current profile and pressures. An acoustic modem was fitted and linked to the ADCP. This deployment would only take place if the telemetry system, recoveries (c) and (d), could be repaired.
h) A surface toroid (telemetry buoy) with an acoustic modem and an Orbcomm satellite communication system. This deployment would only take place if the telemetry system, recoveries (c) and (d), could be repaired.

2. To conduct a CTD / LISST survey of 34 stations 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.

3. To collect 10 vertical net hauls at the mooring site.

4. To conduct a 25 hour CTD and water sample station at the mooring site 53º 32´ N 3º 21.8´ W. Chlorophyll, suspended sediments and nutrients were measured from the near surface and near bed water samples.

5. To conduct a side scan sonar and QTC survey in the vicinity of the mooring site along east-west lines 200 m apart between 3º 20´ W– 3º 26´ W. To obtain complementary grab samples.

## 2.1 Scientific personnel

John Howarth
Mike Burke
Mike Smithson
Stewart Cutchey (CEFAS)
Marc Childs (CEFAS)
Jim Bennell (School of Ocean Sciences)
Nicola Coulter (School of Ocean Sciences)
Anne Hammerstein (School of Ocean Sciences)

## 2.2 Ship's officers and crew

A. Price (Master)
S. Regan (Second Officer)
A. Williams (Chief Engineer)
N. Holmes (Second Engineer)
T. Roberts (Bosun)
D.D. Williams (A.B.)
(A.B.)
E. Pritchard (Cook)

## 3. Narrative (times in GMT)

The SmartBuoy toroid, anchor chain, sea-bed frame and instrumentation were loaded onto RV Prince Madog on the afternoon of 10 May 2004. (The toroid was rolled down the walkway.) The ADCP frame was set up on the afterdeck and the tower and instruments fitted to the SmartBuoy toroid.

RV Prince Madog left Menai Bridge at 07:20 on 11 May in misty conditions and weak winds. Recording of surface sampling and of the ship's ADCP started at 08:04, near Puffin Island, see Figure. 1 for the cruise track.

On arrival at the mooring site at 11:45 the transmissometer CTD calibration (number 1) was carried out (10:55 - 11:15). The ADCP was released at 11:30, was on deck at 11:38 and its ballast weight recovered by 11:47. Some weed was growing on the frame and transmissometer. The replacement ADCP was deployed at 12:06, followed by the SmartBuoy between 12:40 and 12:47, slightly closer to the ADCP than intended (about 150 m to SSW). The original SmartBuoy was recovered between 13:06 and 13:16 - its stray line was wrapped round the buoy. The instruments were covered in slime. The telemetry ADCP was released at 13:50, was on the deck at 13:59 and its ballast weight recovered by 14:09. The telemetry toroid was recovered between 14:37 and 14:46. There was no obvious sign why the telemetry system had not been working. Weather conditions had been good for deployment work, but the visibility became poor towards the end. The wave buoy was discernible throughout the mooring work.

After tidying the deck, CTD 2 was recorded and surface and bed water samples obtained for nutrient determination and filtering for suspended sediments. The first part of the side scan sonar survey started at 15:47 at 53º 33´ N 3º 20.4´ W. The transects were east-west 200 m apart, from 3º 20´ to 3º 26´ W, with the ship steaming at 4 knots. Four transects were made

before the survey was suspended and the ship anchored at 18:55 for the 25 hour station, from 19:00 on 11 May to 20:00 on 12 May. CTDs were recorded on the hour and on the half hour, with water samples being obtained on the hour for nutrients and CEFAS. There followed 10 vertical net hauls for zooplankton, between 20:30 and 21:24, five with a 0.5 m diameter hoop and 200 mpi mesh and five with a 1 m diameter hoop and 60 mpi mesh. The speed of hauling of the net was recorded with a flowmeter. The finer net size was clogged with plankton. There were also plenty of jellyfish in the water. The anchor was hauled in and the side scan sonar survey recommenced at 21:52. The ship's ADCP was switched off to avoid interference with the side scan sonar. The survey was interrupted at the request of the pilotage authority, Mersey Docks, and 14 grab samples obtained from 06:00 – 08:20 13 May on three east-west lines. The side scan sonar survey then recommenced at 08:30 and finished at 10:17. The ship's ADCP was switched back on.

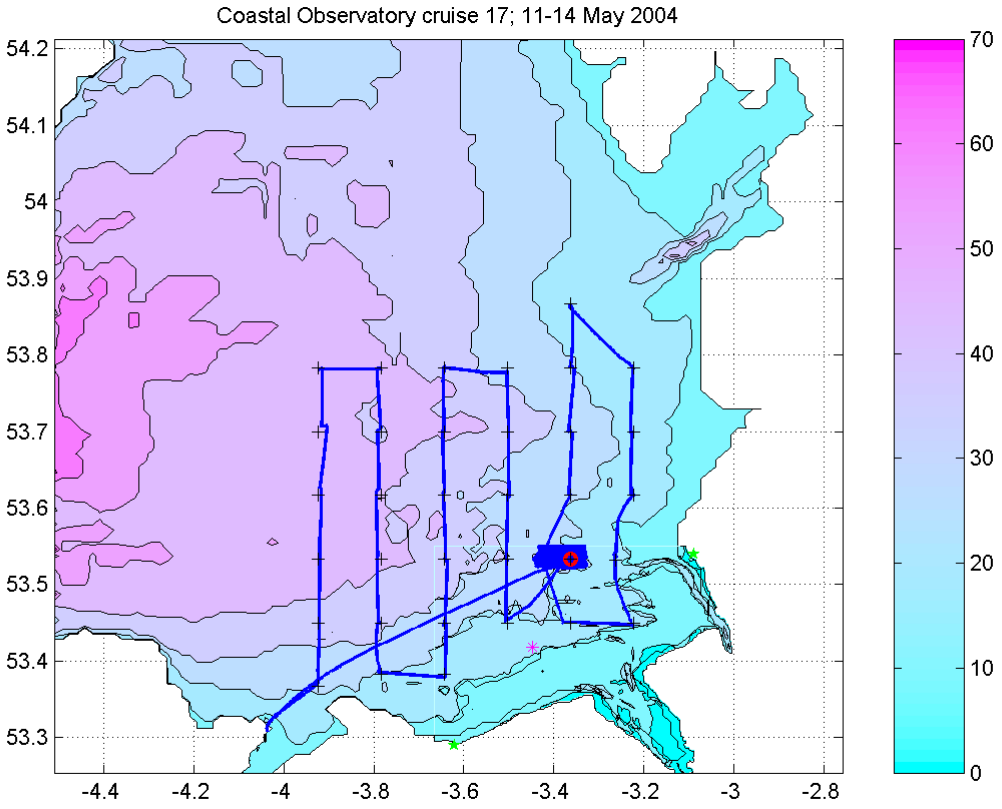


Figure 1. Cruise track

The CTD survey then started at 10:55, going round stations 11, 10, 35, 2 – 9, 12 – 34 (see Figure 1, showing track and CTD locations) and Table 3. Water samples were obtained from near surface and near bed bottles for nutrient analysis by David Hydes at SOC and for suspended sediment determination. The sea had started to warm up in its seasonal cycle, especially near the coast, where in places it was 5ºC warmer than on the previous cruise, 5 weeks earlier. Temperatures were between 9.6 and 13.2ºC and salinities between 30.6 to 33.7. Blooms were in evidence at the mooring site, generally at a low level below the thermocline and especially at the south-western corner of the grid (sites 23, 33 and 34). Most sites were stratified, but by less than 2ºC and 1 psu.

Surface sampling was switched off at 09:55 on 14 May, near Puffin Island and RV Prince Madog was alongside at Menai Bridge at 10:53. Unloading was delayed slightly whilst the ship was fuelled. Because the telemetry system was not redeployed there was too much equipment for the lorry so that a few boxes were left behind in the pavilion to be collected next week.

All the cruise objectives were accomplished since conditions were excellent and the sea was calm throughout (winds were generally less than 6 m $s^{-1}$), although the telemetry system was not redeployed because of a fault in one of the acoustic modems.

**4. Moorings** (times in GMT)

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

a) Mean ADCP 600 kHz RDI 2390; battery case 3036, fitted with new batteries.
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 memory; hourly wave recording enabled.
Clock reset at 09:20:00 on 31 March 2004, delayed start 06:00:00 on 1 April.
The ADCP was stopped at 12:25:00 on 11 May 2004.
The record length is 190,705,015 bytes.

Aanderaa pressure recorder BPR 1357, DSU 8125: 10 minute sampling.
Clock set at 05:19:00 on 31 March, started 05:40:00 on 31 March 2004, first reading at 15:40:49, no time stamp.
Last reading at 09:11:06 on 13 May 2004; clock 45 s slow. 31328 words.

25 cm Sea-Tech Transmissometer, ST637, recording in Aanderaa logger (RCM7 11820 / DSU 13101) fitted with temperature and conductivity sensors. 10 minute sampling, clock set at 05:58:00 on 31 March, started at 06:20:00 on 31 March 2004.
First air reading at 07:20 31 March & last air reading at 05:20 on 1 April 2004.
Blocked path reading between 05:30 and 06:50 on 1 April 2004.
CTD calibration, CTD 1 08:50 and 09:00 (just) 1 April 2004.
Stopped at 10:00 approx on 13 May; clock 35 s slow. 37560 words.

SeaBird MicroCAT temperature, conductivity recorder (37IM29828-2081 – ID=02).
10 minute sampling. Reference pressure 25dB.
Clock set at 07:49:00 on 31/03/2004. Delayed start 08:00:00 on 01/04/2004.
Stopped at 18:21:30 on 12 May 2004; clock 5 s fast. Samplenum = 5967.
Clock reset at 18:23:00 on 12 May; sample interval 10 s; delayed start 19:30
Calibration CTD 52 – in water 19:29:10, on bottom 19:31:50 to 19:34:17.
Stopped 19:50:24 on 12 May. Samplenum = 6088.

The frame, D5, was fitted with two Benthos releases, 8A (s/n 44059) – Pyro OTD101 and 2B (s/n 61170) – Pyro OTD100, and a spooler with 200m of rope for recovery of the ballast weight. Release 2B fired.

b) SmartBuoy Mooring.
SeaBird MicroCAT temperature, conductivity recorder (37IM29828-2010 – ID=01) at 5 m below the surface. 10 minute samples. Reference pressure 25dB.
Clock set at 07:56:30 on 31/03/2004. Delayed start 08:00:00 on 01/04/2004.
Stopped at 18:15:30 on 12 May 2004; clock 16 s fast. Samplenum = 5966.
Clock reset at 18:17:00 on 12 May; sample interval 10 s; delayed start 19:30
Calibration CTD 52 – in water 19:29:10, on bottom 19:31:50 to 19:34:17.
Stopped 19:48:05 on 12 May. Samplenum 6073.

Aanderaa current meter RCM7 9631 / DSU 8117 without fin at 10 m below the surface to log temperature and conductivity: 10 minute samples.
Clock set at 05:49:00 on 31 March 2004, started at 05:50:00 on 31 March 2004.
Last reading at 09:50:39 on 13 May 2004; clock 25 s fast. 37566 words.

The CEFAS SmartBuoy is fitted with 2 surface CTDS, light sensors at 1 and 2 m below the surface, a water sampler which obtains water samples once per day for laboratory nutrient (nitrate, nitrite, phosphate) 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.

c) Telemetry ADCP 1200 kHz RDI 0572; battery case 254.
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 20:48:00 on 31 March 2004, delayed start 05:50:00 on 1 April.
The ADCP was stopped at 16:06 on 11 May 2004. Record length is 4,362,379 bytes.

The ADCP recorded 10 minutes averages internally and sent a sub-set of east & north component data (PD12 format) every hour (on the hour) via a LinkQuest modem to the telemetry buoy. LinkQuest recommend that the acoustic modem should not be used in air at full power. Therefore it was plugged into its battery pack just before deployment.

The frame, D6, was fitted with two Benthos releases, 3A (s/n 40226) – Pyro OTD102 and 5A (s/n 44056) – Pyro OTD103, and a spooler with 200m of rope for recovery of the ballast weight. Release 3A fired.

d) Telemetry buoy
A LinkQuest acoustic modem and battery pack, a GPS receiver and an Orbcomm satellite system and battery pack were fixed to a toroid. The Orbcomm system was setup to send e-mails once an hour, containing data from the ADCP (Format PD12) received by the acoustic modem link.

Following deployment the telemetry system appeared not to be working, probably in the acoustic segment since the Orbcomm transmitter responded to e-mailed requests. After recovery, a visual inspection of the frame and buoy indicated no obvious reason for the failure. The battery voltage of the sea bed unit was high, suggesting that the modem had not been transmitting or waking. It was not possible to communicate with the unit (in contrast to

the surface unit). The instrument was opened but nothing faulty was apparent – no leakage, loose boards or leads. It will be returned to LinkQuest / ETL for repair.

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) | Recovery Time | Recovery Date |
|---|---|---|---|---|---|
| Waves ADCP | 53º 31.919′ | 3º 21.796′ | 22 | 11:30 | 11/05/04 |
| SmartBuoy | 53º 31.976′ | 3º 22.048′ | 24 | 13:06 | 11/05/04 |
| Telemetry ADCP | 53º 31.963′ | 3º 22.397′ | 26.5 | 13:50 | 11/05/04 |

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

e) Mean ADCP 600 kHz RDI 3644; battery case 0250.
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 memory; hourly wave recording enabled.
Clock reset at 14:55:00 on 10 May 2004; delayed start 06:00:00 on 11 May - checked.

Aanderaa pressure recorder BPR 444, DSU 3944: 10 minute sampling.
Clock set at 14:21:00 on 10 May; started 14:30:00 on 10 May, first reading at 14:30:47.

25 cm Sea-Tech Transmissometer, ST637, recording in Aanderaa logger (RCM7 11814 / DSU 8122) fitted with temperature and conductivity sensors. 10 minute sampling.
Clock set at 16:27:30 on 10 May 2004; started at 16:30:00 on 10 May.
Air readings between 16:50 and 22:00 on 10 May 2004.
Blocked path readings between 22:10 on 10 May and 05:50 on 1 May 2004.
CTD calibration, CTD 1 at 11:00 and 11:10 on 11 May 2004.

SeaBird MicroCAT temperature, conductivity recorder (37SM32218 –2991, ID=01).
10 minute sampling. Reference pressure 25dB.
Clock set at 14:47:40 on 10 May 2004; delayed start at 12:00 on 11 May 2004.

The frame, D4, was fitted with two Benthos releases 44041 - 14.5 kHz A, pyro OTD105 and 44068 - 11.5 kHz A, pyro OTD104, and a spooler with 200m of rope for recovery of the ballast weight.

f) SmartBuoy Mooring.
SeaBird MicroCAT temperature, conductivity recorder (37IM29828-2506 – ID=03) at 5 m below the surface. 10 minute samples. Fitted with a pressure sensor.
Clock set at 15:36:30 on 10 May 2004. Delayed start 12:00 on 11 May.

Aanderaa current meter RCM7 9959 / DSU 8123 without fin at 10 m below the surface to log temperature and conductivity: 10 minute samples.

Clock set at 15:15:30 on 10 May 2004; started at 15:20:00 on 10 May.

The CEFAS SmartBuoy is fitted with 2 surface CTDS, light sensors at 1 and 2 m below the surface, a water sampler which obtains water samples once per day for laboratory nutrient (nitrate, nitrite, phosphate) 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.

g) Telemetry ADCP – not deployed since the system was not working.

h) Telemetry buoy – not deployed since the system was not working.

Table 2. Deployed mooring positions and times.

| | Latitude (N) | Longitude (W) | Water Depth (m) | Deployment Time | Date |
|---|---|---|---|---|---|
| (Waverider | 53º 32.171′ | 3º 21.522′ | 26 | 10:42 | 05/03/04) |
| Waves ADCP | 53º 31.979′ | 3º 21.700′ | 22 | 12:06 | 11/05/04 |
| SmartBuoy | 53º 31.902′ | 3º 21.739′ | 23 | 12:47 | 11/05/04 |

## 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. Two water bottles were fired near bed and two 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 SOC (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, 5 – 9 and 11 were filtered for chlorophyll and suspended sediment determination and some filtrate was preserved with mercuric chloride for nutrient determination by CEFAS. A LISST-25 particle sizer was fitted to the CTD and its data logged on the Sea-Bird data logging system. A separate LISST-100 was clamped on the frame and data internally recorded for all CTDs except the first. Copies of the Sea-Bird binary files were taken off for processing and calibration at BODC / POL.

Two CTDs were recorded during mooring operations. No water samples were obtained during the first which was primarily to calibrate the transmissometer about to be deployed on the ADCP frame. CTDs (numbers 3 - 53) were recorded every half hour on the hour / half hour during the 25 hour anchor station at 53º 31.710′ N 3º 22.070′ W. Surface and bed water samples were obtained every hour for nutrient determination by SOC; for filtering for chlorophyll and suspended sediment determination, with some filtrate preserved with mercuric chloride for nutrient determination by CEFAS, and from CTDs 27 to 43 for filtering by SOS. CTDs 54 – 87 were recorded round the grid, see Table 1.

Table 3. Nominal CTD positions.

| Site | CTD | Latitude (N) | Longitude (W) | Visited on this cruise | Chlorophyll & nutrients | Suspended Sediments nutrients |
|---|---|---|---|---|---|---|
| 1 | 2 | 53º 32′ | 3º 21.8′ | yes | yes | yes |
| 2 | 57 | 53º 37′ | 3º 13.4′ | yes | | yes |
| 3 | 58 | 53º 42′ | 3º 13.4′ | yes | | yes |
| 4 | 59 | 53º 47′ | 3º 13.4′ | yes | | yes |
| 5 | 60 | 53º 52′ | 3º 21.8′ | yes | yes | yes |
| 6 | 61 | 53º 47′ | 3º 21.8′ | yes | yes | yes |
| 7 | 62 | 53º 42′ | 3º 21.8′ | yes | yes | yes |
| 8 | 63 | 53º 37′ | 3º 21.8′ | yes | yes | yes |
| 9 | 64 | 53º 32′ | 3º 21.8′ | yes | yes | yes |
| 10 | 55 | 53º 27′ | 3º 13.4′ | yes | | yes (no nutrients) |
| 11 | 54 | 53º 27′ | 3º 21.8′ | yes | yes | yes |
| 12 | 65 | 53º 27′ | 3º 30.2′ | yes | | yes |
| 13 | 66 | 53º 32′ | 3º 30.2′ | yes | | yes |
| 14 | 67 | 53º 37′ | 3º 30.2′ | yes | | yes |
| 15 | 68 | 53º 42′ | 3º 30.2′ | yes | | yes |
| 16 | 69 | 53º 47′ | 3º 30.2′ | yes | | yes |
| 17 | 70 | 53º 47′ | 3º 38.6′ | yes | | yes |
| 18 | 71 | 53º 42′ | 3º 38.6′ | yes | | yes |
| 19 | 72 | 53º 37′ | 3º 38.6′ | yes | | yes |
| 20 | 73 | 53º 32′ | 3º 38.6′ | yes | | yes |
| 21 | 74 | 53º 27′ | 3º 38.6′ | yes | | yes |
| 22 | 75 | 53º 23′ | 3º 38.6′ | yes | | yes |
| 23 | 76 | 53º 23′ | 3º 47.0′ | yes | | yes |
| 24 | 77 | 53º 27′ | 3º 47.0′ | yes | | yes |
| 25 | 78 | 53º 32′ | 3º 47.0′ | yes | | yes |
| 26 | 79 | 53º 37′ | 3º 47.0′ | yes | | yes |
| 27 | 80 | 53º 42′ | 3º 47.0′ | yes | | yes |
| 28 | 81 | 53º 47′ | 3º 47.0′ | yes | | yes |
| 29 | 82 | 53º 47′ | 3º 55.4′ | yes | | yes |
| 30 | 83 | 53º 42 | 3º 55.4′ | yes | | yes |
| 31 | 84 | 53º 37′ | 3º 55.4′ | yes | | yes |
| 32 | 85 | 53º 32′ | 3º 55.4′ | yes | | yes |
| 33 | 86 | 53º 27′ | 3º 55.4′ | yes | | yes |
| 34 | 87 | 53º 22′ | 3º 55.4′ | yes | | yes |
| 35 | 56 | 53º 32′ | 3º 15.9′ | yes | | yes |

## 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 / $m^2$s), 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.

Data were recorded every minute from 08:04 on 11 May, near Puffin Island on the way out, until 09:55 on 14 May, near Puffin Island on the way back. The system failed to record data from 14:18 to 19:15 on 12 May, from 06:37 to 07.26 on 13 May and at 04:50 on 13 May. 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 between 08:04 on 11 May and 09:55 on 14 May, with gaps when it was switched off during side scan surveys to avoid interference with side scan sonar.

## 7. Side scan sonar survey and grab sampling

The side scan sonar survey occupied 16 east-west lines 6.6 km long and 200 m apart, between 3º 20´ W and 3º 26´ W (Figure 2). The ship steamed at about 4 knots and the fish was about 10 m off the bed. 14 grab samples were obtained with a shipek grab along three of the lines.

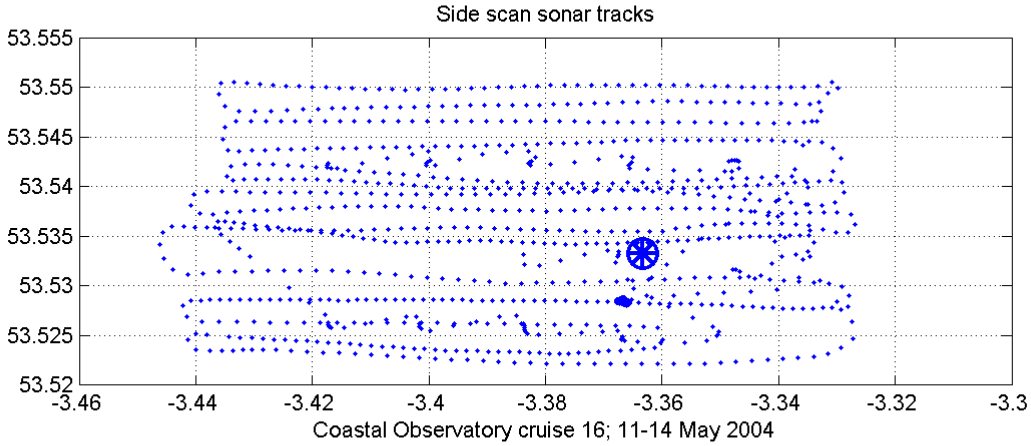


Figure 2. Map of the side scan sonar survey.

**Acknowledgements**
The assistance of the Captain, officers, bosun, and crew contributed greatly to the success of the cruise.