RV Prince Madog 10/10 cruise report
NOC Coastal Observatory cruise 68
28–30 April 2010

1. Cruise objectives

1.1 At site A, 53° 32′ N, 3° 21.8′ W (CTD station 1)

To recover:

a) A sea bed frame containing a 600 kHz RDI ADCP (waves ADCP), SeaBird SBE 16*plus*, digiquartz pressure sensor, SeaPoint turbidity sensor with wiper, and a SeaBird SBE 16*plus* with an Aanderra oxygen Optode.
b) CEFAS SmartBuoy in a single point mooring. Attached to the mooring wire are SeaBird MicroCat temperature, conductivity loggers at 5 m and 10 m below the surface and miniloggers at 7.5 m and 15 m below the surface.

To deploy:

a) A sea bed frame containing a 600 kHz RDI ADCP (measuring mean current profile, pressures and directional waves), SeaBird SBE 16*plus* (with pumped conductivity sensor), digiquartz pressure sensor, a SeaPoint turbidity sensor with wiper and SeaBird SBE 16*plus* (with an Aanderra oxygen Optode).
b) CEFAS SmartBuoy in a single point mooring. Attached to the mooring wire are SeaBird MicroCat (temperature+conductivity) loggers at 5 m and 10 m below the surface and miniloggers at 7.5 m and 15 m below the surface.

To collect ten vertical zooplankton hauls for CEFAS.

Conduct a 25-hour CTD station while at anchor. Obtain half-hourly profiles of salinity, transmittance, suspended sediment and chlorophyll. Obtain hourly calibration samples for salinity, and near-surface and bottom water samples for nutrient (nitrate, phosphate, silicate) and suspended sediment determination; surface samples for a Defra pH/Alkalinity study by David Hydes (NOC, at Southampton).

1.2 At 'new' site B, 53° 32.3′ N, 3° 38.4′ W (CTD station 20)

To recover:

a) A sea bed frame containing a 600 kHz RDI ADCP, a SeaBird SBE 16*plus*, digiquartz pressure sensor and a SeaPoint turbidity sensor fitted with a wiper.
b) A CEFAS SmartBuoy in a single point mooring. Attached to the mooring wire are SeaBird MicroCat temperature, conductivity loggers at 5 m and 10 m below the surface and miniloggers at 7.5 m and 15 m below the surface.

To deploy:

a) A sea bed frame for a 600 kHz RDI ADCP measuring mean current profile, pressures and directional waves. A SeaBird SBE 16*plus* (with pumped conductivity sensor), digiquartz pressure sensor and a SeaPoint turbidity sensor (fitted with a wiper).

b) A CEFAS SmartBuoy in a single point mooring. Attached to the mooring wire are SeaBird MicroCat temperature, conductivity loggers at 5 m and 10 m below the surface and miniloggers at 7.5 m and 15 m below the surface.

1.3 CTD and LISST survey

To conduct a CTD survey including LISST measurements at 34 sites every five nautical miles covering the eastern Irish Sea to determine the effects of the rivers Dee, Mersey and Ribble on Liverpool Bay. The survey covers the area from the coast of North Wales to a line extending westwards from Blackpool, and from the Lancashire coast to a line extending northwards from Great Ormes Head.

To obtain calibration samples for salinity, transmittance and suspended sediment at selected stations. To obtain near surface and bed water samples for nutrient (nitrate, phosphate, silicate) and suspended sediment determination. To obtain surface samples for a Defra pH/Alkalinity study by David Hydes (NOC, at Southampton).

1.4 Other activities

Sea bed sediment samples

Andy Plater (University of Liverpool)

Collect sediment samples at each CTD site with a Day grab.

Changes in dinoflagellates

Lee Bradley (University of Liverpool)

At two outermost stations, collect water samples from the underway flow-through to examine morphological changes in the dinoflagellate species *Lingulodinium Polyedrum*.

Effect of pulsed stratification on primary and secondary production

Anouska Bailey (University of Liverpool)

Collect water samples at inshore and offshore stations for determining: size-fractionated chlorophyll-*a*, DOC/DON, dissolved oxygen, and net community production (24-hour incubations on deck).

Characterising food webs in shelf sea systems

Lucy Abram (University of Liverpool)

Obtain zooplankton and benthic fauna samples, and carry out secondary production grazing incubations on deck for 24 hours to investigate carbon flow between trophic levels.

Testing of equipment and procedures

This is the first time that the NOC has supplied filtering equipment and filters for determining concentrations of suspended sediment and chlorophyll-*a*.

2. Cruise participants

Scientific personnel
Andy Lane (Principal, NOC)
Terry Doyle (NOC)
Ray Edun (NOC)
John Kenny (NOC)
Peter Hughes (Bangor University)
Jennie Keable (CEFAS)
Neil Needham (CEFAS)
Lucy Abram (University of Liverpool)
Anouska Bailey (University of Liverpool)

Ship's officers and crew
Eric Lloyd (Master)
Nick Davis (Chief Officer)
Gary Barnes
Mick Callaghan
Tom Roberts
Arfon Williams (Chief Engineer)
Alan Thompson (2nd Engineer)
Terry Gordon (Cook)

3. Cruise narrative

3.1 Tuesday 27th April 2010

The ship was loaded during the afternoon at Vittoria Wharf, Birkenhead, Wirral.

3.2 Wednesday 28th April 2010

Prince Madog left Vittoria Wharf at 06:30 GMT, sailed into Alfred Lock, and the River Mersey (07:20), passing the Seaforth radar tower at about 07:50. The ship's ADCP and Enviro systems were switched on at 07:25 and 07:30 respectively. Prince Madog arrived at Site A (Station 1) at 09:25 (HW at Liverpool, 10:52).

A LISST-100X particle sizer with internal logging is normally attached to the CTD frame, however the attachment brackets required were not available; the instrument was not deployed. There was no GPS NMEA feed to the CTD computer, and the software would not pass a certain point. The GPS link re-established at 10:40. A CTD cast was attempted but the frame fell a short distance and hit the edge of the deck because the winch was leaking hydraulic fluid from a pipe below the operator's platform. The leak was fixed temporarily.

A CTD cast was made before the mooring work at10:53. Recovery of the old ADCP frame and deployment of the new ADCP frame were straightforward. The normal order of SmartBuoy deployment and then recovery of the old SmartBuoy was swapped to allow reuse of a missing part. This change in procedure requires CTD profiles before recovery and after deployment (instead of only one CTD after finishing all mooring work). The repair to the pipe did not hold, so no further CTD casts were made.

Mooring work at Site A completed at 12:25. Without the ability to carry out CTDs, mooring work at Site B (Station 20, originally scheduled for Friday at high water) was brought forward to coincide with low water (LW at Liverpool, 17:40). Meanwhile, the SmartBuoy recovered earlier was refurbished, and the damaged pipe was removed for a weld repair. The mended pipe tested successfully (13:21).

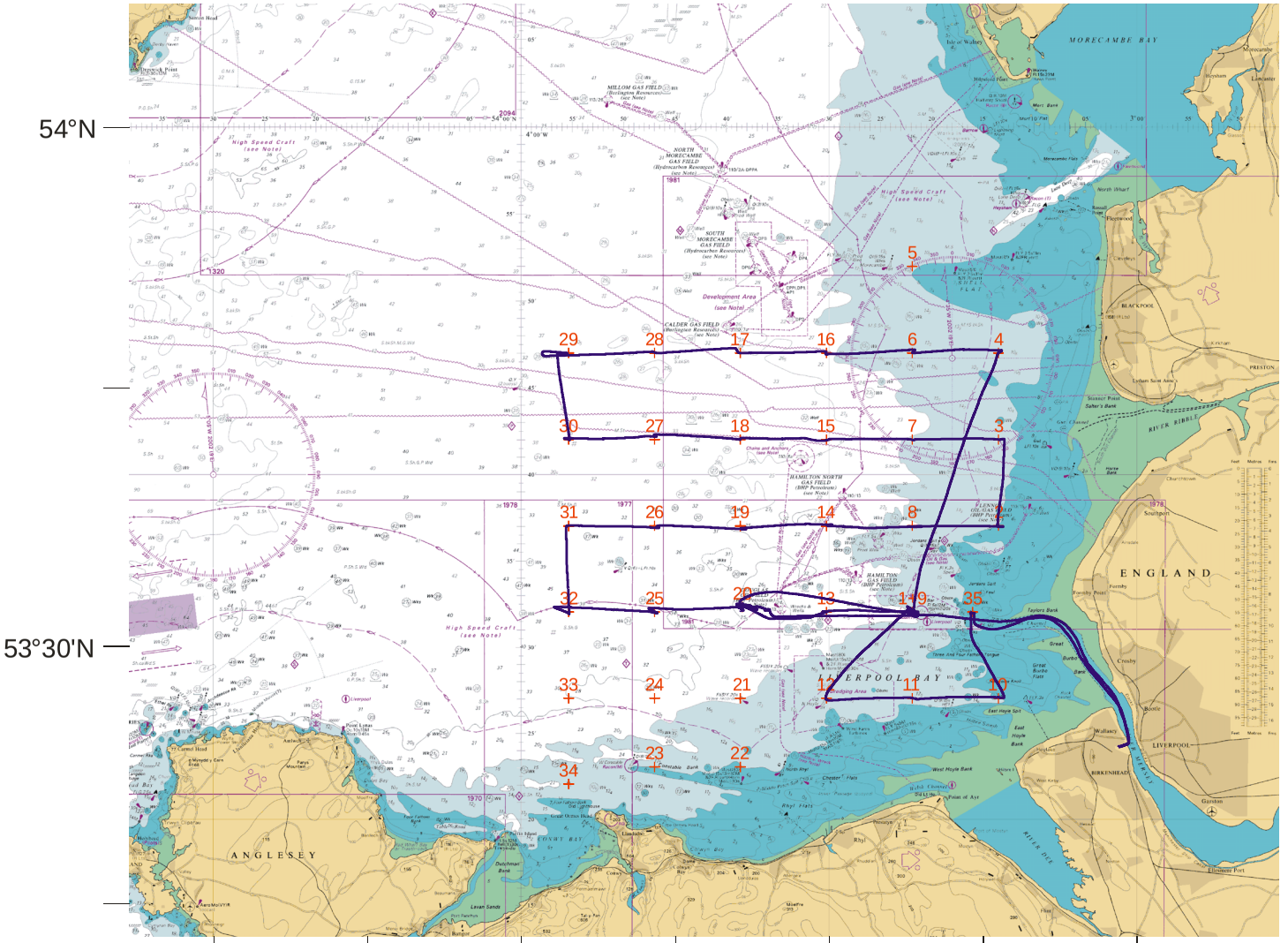

Figure 1. Cruise track

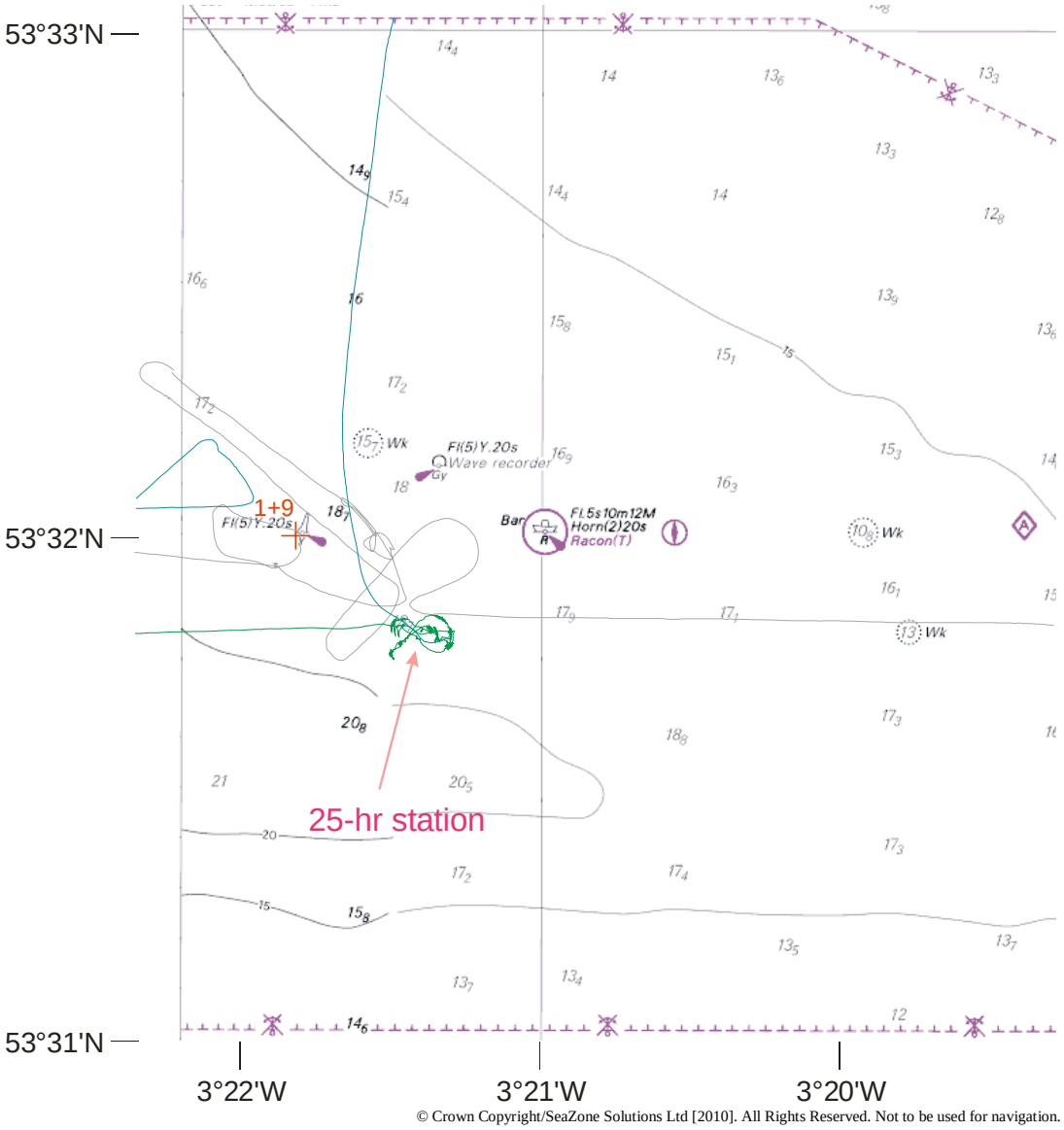

Figure 2. Location of 25-hour CTD station, ~600 m SE of Site A (Stns 1 and 9)

While waiting near to Site B for low water, two SmartBuoys were sighted (~15:00). They had drifted eastwards from their deployment locations. One of these was deployed on the previous cruise (17th March 2010); the other (deployed on 26th January 2010) was not recovered at the same time as it could not be located.

A CTD cast was made at 16:58 before starting mooring work at Site B. The new ADCP frame was deployed and the old one recovered. This was followed by the deployment of the refurbished SmartBuoy with the anchor chain extended by 25 m. The two SmartBuoys were recovered, and then a final CTD cast. Mooring work completed at 18:47. Prince Madog returned to Site A, and dropped anchor at 19:36 (53° 31.807′ N, 3° 21.287′ W), some 600 m SE of the mooring location.

The 25-hour CTD station at Site A began at 20:00 with half-hourly CTD casts. Those on the hour included taking of water samples (in the Niskin bottles); CTD profiles obtained on the half-hour were without water samples. Samples were taken for determining suspended sediment and chlorophyll concentrations, and surface alkalinity. Nutrient samples were taken at the surface only, except for the first and last CTD. Additional samples were obtained for measuring dissolved oxygen, and 'incubating' zooplankton (Anouska Bailey / Lucy Abram).

3.3 Thursday 29th April 2010

Casts scheduled for 01:00 and 01:30 were abandoned because of very fast currents (spring tide, ebb). The pump sampler on the SeaBird CTD failed intermittently, affecting the salinity record on some casts, possibly related to the earlier incident when the frame hit the deck.

Vertical zooplankton hauls were obtained during the 25-hour station.

The 25-hour station ended at 21:00. Prince Madog then sailed to Station 4, and the CTD survey grid started at 22:48.

3.4 Friday 30th April 2010

Prince Madog proceeded westwards (omitting Station 5), following the grid of stations along east-west lines. Water samples from the CTD's Niskin bottles were obtained as for the 25-hour station, and the Day grab was deployed at each station.

At Stations 28 and 29, water samples from the underway flow-through system were taken. Net hauls were carried out at Station 32 (Lucy Abram).

After Station 9, the following stations were visited: 12, 11, 10 and 35 (omitting 21, 22, 23, 24, 33 and 34). The CTD survey finished at 21:20.

The ship's ADCP and Enviro systems were switched off at 22:30 on passing the Seaforth radar tower. Prince Madog arrived at Alfred Lock at 23:00 and Vittoria Wharf at 23:18.

3.5 Saturday 1st May 2010

Equipment and moorings were unloaded from 07:00 onwards.

3.6 Summary

Throughout the cruise, winds were force 3 or below, with southerly component (SSE at start, SW by end). The sea state was slight with low swell.

- All moorings were deployed and recovered successfully, including recovery of a second SmartBuoy at Site B
- The 25-hour CTD station at Site A was completed, with two casts missed because of strong currents

- CTD profiles, water samples and sediment grabs were collected at ~80% of stations; starting after LW (instead of after HW) means that the ship was going against the tide for most of the survey route
- Underway, meteorology and ship's ADCP data were collected during the 25-hour station and during the survey grid; the pCO_2 equipment was unavailable

4. Moorings

4.1 Recovered instrumentation

Site A: Bedframe Deployed 13:11 17/03/2010 at 53° 31.959′ N, 3° 21.498′ W
Recovered 11:14 28/04/2010 at 53° 31.973′ N, 3° 21.552′ W

Waves ADCP 600 kHz RDI S/N 5806
Mode 1: 100 pings every 10 minutes
35 × 1 m bins (2.65–36.65 m above the bed)
Beam coordinates – speeds, correlation, echo intensity, % good
Sound velocity calculated from temperature, depth and salinity of 32
Clock set at 12:16:00 on 16/03/2010
Delayed start at 06:00:00 on 17/03/2010
Stopped logging at 14:33:00 on 07/05/2010, drift +65 s, 242 421 256 samples

SeaBird SBE 16*plus* S/N 4738
Mounted on base of frame with pumped conductivity sensor
Includes SeaPoint turbidity sensor (S/N 10538) taped to roll bar setup for 0–125 FTU range and fitted with wiper
Sample interval 600 s; digiquartz integration time 40 s, range 400; pump 0.5 s, 1 s delay
Clock set at 16:06:30 on 15/03/2010
Delayed start at 06:00:00 on 17/03/2010
Stopped logging at 08:47:30 on 10/05/2010, drift +7 s, 7793 samples

Aanderaa Optode (S/N 674) on SeaBird SBE 16*plus* S/N 4490
Mounted upright on top of frame and (not pumped) conductivity sensor underneath
Sample interval 600 s
Clock set at 12:25:00 on 16/03/2010
Delayed start at 06:00:00 on 17/03/2010
Stopped logging at 08:58:30 on 10/05/2010, drift +9 s, 7793 samples

The frame was fitted with a fizz link, a spooler with 50 m of rope for recovery of the ballast weight and two Benthos releases: S/N 71919 (Tx=12.0 kHz, Rx=10.5 kHz, RC=C)
S/N 72863 (Tx=12.0 kHz, Rx=13.5 kHz, RC=A)

Site A: SmartBuoy mooring Deployed 13:29 17/03/2010 at 53° 31.942′ N, 3° 21.832′ W
Recovered 11:57 28/04/2010 at 53° 31.941′ N, 3° 21.871′ W

SeaBird MicroCat temperature and conductivity recorder S/N 4966
Mounted at 5 m below the surface

Clock set at 13:21:00 on 16/03/2010
Delayed start at 06:00:00 on 17/03/2010
Stopped logging at 09:12:00 on 10/05/2010, drift +10 s, 7796 samples

SeaBird MicroCat temperature and conductivity recorder S/N 5434
Mounted at 10 m below the surface
Clock set at 13:40:00 on 16/03/2010
Delayed start at 06:00:00 on 17/03/2010
Stopped logging at 09:20:30 on 10/05/2010, drift +5 s, 7797 samples

Mini-logger (StarOddi) S/N 2842
Mounted at 7.5 m below the surface
Set to record at 600s intervals
Delayed start at 06:00:00 on 17/03/2010
Stopped logging at 15:16:15 on 10/05/2010, drift +7 s, 7832 samples

Mini-logger (StarOddi) S/N 2843
Mounted at 15 m below the surface
Set to record at 600s intervals
Delayed start at 06:00:00 on 17/03/2010
Stopped logging at 15:18:30 on 10/05/2010, drift +7 s, 7832 samples

The CEFAS SmartBuoy is fitted with sensors for conductivity, temperature and optical back scatter at 1 m below surface, light sensors at 1 m and 2 m below the surface, a fluorometer (SeaPoint), oxygen sensor (Aanderaa Optode), an in-situ NAS2E nutrient analyzer and a water sampler which obtains samples every fourth day for laboratory analysis (TOxN and silicate) and every eighth day (phytoplankton species, composition and abundance). The conductivity, temperature, optical back scatter and light data are transmitted back to CEFAS via Orbcomm satellite.

The single point mooring was composed 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: Bedframe Deployed 16:30 17/03/2010 at 53° 32.267′ N, 3° 38.533′ W
Recovered 17:15 28/04/2010 at 53° 32.291′ N, 3° 38.579′ W

Waves ADCP 600 kHz RDI S/N 2390
Mode 1: 100 pings every 10 minutes
35 × 1m bins (2.65–36.65 m above the bed)
Beam coordinates – speeds, correlation, echo intensity, % good
Sound velocity calculated from temperature, depth and salinity of 32
Clock reset at 12:09:00 on 16/03/2010
Delayed start at 06:00:00 on 17/03/2010
Stopped logging at 14:28:15 on 07/05/2010, drift +74 s, 242 444 216 samples

SeaBird SBE 16*plus* S/N 4736
Mounted on base of frame with pumped conductivity sensor
Includes SeaPoint turbidity sensor (S/N 10320) taped to roll bar; setup for 0–125 FTU range and fitted with wiper

Sample interval 600 s; digiquartz integration time 40 s, range 400; pump 0.5 s, 1 s delay
Clock reset at 15:35:00 on 15/03/2010
Delayed start at 06:00:00 on 17/03/2010
Stopped logging at 08:51:30 on 10/05/2010, drift +7 s, 7794 samples

The frame was fitted with a fizz link, a spooler with 50 m of rope for recovery of the ballast weight and two Benthos releases: S/N 72378 (Tx=12.0 kHz, Rx=10.5 kHz, RC=A)
S/N 70355 (Tx=12.0 kHz, Rx=10.0 kHz, RC=B)

Site B: SmartBuoy mooring Deployed 13:04 26/01/2010 at 53° 32.308′ N, 3° 38.437′ W
(Deployed on cruise 66) Recovered 18:27 28/04/2010 at 53° 32.142′ N, 3° 36.034′ W
SeaBird MicroCat temperature and conductivity recorder S/N 5791
Mounted at 5 m below the surface
Clock set at 18:58:00 on 25/01/2010
Delayed start at 06:00:00 on 26/01/2010
Stopped logging at 15:07:00 on 10/05/2010, drift +14 s, 15031 samples
SeaBird MicroCat temperature and conductivity recorder S/N 5793
Mounted at 10 m below the surface
Clock set at 12:06:00 on 25/01/2010
Delayed start at 06:00:00 on 26/01/2010
Stopped logging at 15:03:30 on 10/05/2010, drift +39 s, 15031 samples
Mini-logger (StarOddi) S/N 2841
Mounted at 7.5 m below the surface
Set to record at 600 s intervals
Delayed start at 06:00:00 on 26/01/2010
Stopped logging at 15:13:00 on 10/05/2010, drift +8 s, 15032 samples
Mini-logger (StarOddi) S/N 2849
Mounted at 15 m below the surface
Set to record at 600 s intervals
Delayed start at 06:00:00 on 26/01/2010
Stopped logging at 15:23:15 on 10/05/2010, drift +7 s, 15034 samples

Site B: SmartBuoy mooring Deployed 16:48 17/03/2010 at 53° 32.339′ N, 3° 38.409′ W
(Deployed on cruise 67) Recovered 18:10 28/04/2010 at 53° 32.259′ N, 3° 37.285′ W
SeaBird MicroCat temperature and conductivity recorder S/N 5792
Mounted at 5 m below the surface
Clock set at 13:46:00 on 16/03/2010
Delayed start at 06:00:00 on 17/03/2010
Stopped logging at 09:17:40 on 10/05/2010, drift +68 s, 7796 samples
SeaBird MicroCat temperature and conductivity recorder S/N 4998
Mounted at 10 m below the surface
Clock set at 13:35:00 on 16/03/2010
Delayed start at 06:00:00 on 17/03/2010

Stopped logging at 09:15:00 on 10/05/2010, drift +7 s, 7796 samples

Mini-logger (StarOddi) S/N 2844

Mounted at 7.5 m below the surface
Set to record at 600 s intervals
Delayed start at 06:00:00 on 17/03/2010
Stopped logging at 15:21:15 on 10/05/2010, drift +8 s, 7834 samples

Mini-logger (StarOddi) S/N 2852

Mounted at 15 m below the surface
Set to record at 600 s intervals
Delayed start at 06:00:00 on 17/03/2010
Stopped logging at 15:26:15 on 10/05/2010, drift +7 s, 7834 samples

The CEFAS SmartBuoy is fitted with sensors for conductivity, temperature and optical back scatter and a fluorometer at 1 m below surface. 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.

4.2 Deployed instrumentation configuration

Site A: Bedframe Deployed 11:31 28/04/2010 at 53° 31.974′ N, 3° 21.487′ W

Waves ADCP 600 kHz RDI S/N 5807 firmware v50.36

Mode 1: 100 pings every 10 minutes
35 × 1 m bins (2.65–36.65 m above the bed)
Beam coordinates – speeds, correlation, echo intensity, % good
Sound velocity calculated from temperature, depth and salinity of 32
Clock set at 16:00:00 on 27/04/2010
Delayed start at 06:00:00 on 28/04/2010

SeaBird SBE 16*plus* S/N 5309 (RS232)

Mounted on base of frame with pumped conductivity sensor
Incl. SeaPoint turbidity sensor (S/N 10471) taped to roll bar setup for 0–125 FTU range and fitted with wiper. Sample interval 600 s; digiquartz integration time 40 s, range 400; pump 0.5 s, 1 s delay
Clock set at 15:59:00 on 27/04/2010
Delayed start at 06:00:00 on 28/04/2010

Aanderaa Optode (S/N 675) on SeaBird SBE 16*plus* S/N 4741 (RS232)

Mounted upright on top of frame and (not pumped) conductivity sensor underneath
Sample interval 600 s
Clock set at 16:07:00 on 27/04/2010
Delayed start at 06:00:00 on 28/04/2010

FSI CTD S/N 2195

Sample at rate 4 Hz for 40 s every 600 s, average sample 40 s
Clock set at 12:58:00 on 27/04/2010
Delayed start at 06:00:00 on 28/04/2010

The frame was fitted with a fizz link, a spooler with 50 m of rope for recovery of the ballast weight and two Benthos releases: S/N 72381 (Rx=11.0 kHz, Tx=12.0 kHz, RC=B)
S/N 69676 (Rx=11.5 kHz, Tx=12.0 kHz, RC=C)

Site A: SmartBuoy mooring Deployed 12:25 28/04/2010 at 53° 31.984′ N, 3° 21.788′ W

SeaBird MicroCat temperature and conductivity recorder S/N 2081
- Mounted at 5 m below the surface
- Clock set at 13:24:00 on 27/04/2010
- Delayed start at 06:00:00 on 28/04/2010

SeaBird MicroCat temperature and conductivity recorder S/N 5790
- Mounted at 10 m below the surface
- Clock set at 13:36:00 on 27/04/2010
- Delayed start at 06:00:00 on 28/04/2010

Mini-logger (StarOddi) S/N 2836
- Mounted at 7.5 m below the surface
- Set to record at 600s intervals
- Delayed start at 06:00:00 on 28/04/2010

Mini-logger (StarOddi) S/N 2838
- Mounted at 15 m below the surface
- Set to record at 600s intervals
- Delayed start at 06:00:00 on 28/04/2010

The CEFAS SmartBuoy is fitted with sensors for conductivity, temperature and optical back scatter at 1 m below surface, light sensors at 1 m and 2 m below the surface, a fluorometer (SeaPoint), oxygen sensor (Aanderaa Optode), an in-situ NAS2E nutrient analyzer and a water sampler which obtains samples every fourth day for laboratory analysis (TOxN and silicate) and every eighth day (phytoplankton species, composition and abundance). The conductivity, temperature, optical back scatter and light data are transmitted back to CEFAS via Orbcomm satellite.

The single point mooring was composed 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: Bedframe Deployed 17:36 28/04/2010 at 53° 32.368′ N, 3° 38.407′ W

Waves ADCP 600 kHz RDI S/N 12239 firmware v50.36
- Mode 1: 100 pings every 10 minutes
- 45 × 1 m bins (2.65–46.65 m above the bed, WN45)
- Beam coordinates – speeds, correlation, echo intensity, % good
- Sound velocity calculated from temperature, depth and salinity of 32
- Clock reset at 16:04:30 on 27/04/2010
- Delayed start at 06:00:00 on 28/04/2010

SeaBird SBE 16*plus* S/N 4737 (RS485)
- Mounted on base of frame with pumped conductivity sensor

Incl. SeaPoint turbidity sensor (S/N 10537) taped to roll bar; setup for 0–125 FTU range and fitted with wiper
Sample interval 600 s; digiquartz integration time 40 s, range 400; pump 0.5 s, 1 s delay

Clock reset at 15:43:00 on 27/04/2010
Delayed start at 06:00:00 on 28/04/2010

The frame was fitted with a fizz link, a spooler with 50 m of rope for recovery of the ballast weight and two Benthos releases: S/N 70358 (Rx=11.0 kHz, Tx=12.0 kHz, RC=A)
S/N 72382 (Rx=10.0 kHz, Tx=12.0 kHz, RC=A)

Site B: SmartBuoy mooring Deployed 17:54 28/04/2010 at 53° 32.450′ N, 3° 38.352′ W
SeaBird MicroCat temperature and conductivity recorder S/N 2010
Mounted at 5 m below the surface
Clock set at 13:27:00 on 27/04/2010
Delayed start at 06:00:00 on 28/04/2010
SeaBird MicroCat temperature and conductivity recorder S/N 2506
Mounted at 10 m below the surface
Clock set at 13:29:00 on 27/04/2010
Delayed start at 06:00:00 on 28/04/2010
Mini-logger (StarOddi) S/N 2840
Mounted at 7.5 m below the surface
Set to record at 600 s intervals
Delayed start at 06:00:00 on 28/04/2010
Mini-logger (StarOddi) S/N 2848
Mounted at 15 m below the surface
Set to record at 600 s intervals
Delayed start at 06:00:00 on 28/04/2010

The CEFAS SmartBuoy is fitted with sensors for conductivity, temperature and optical back scatter and a fluorometer at 1 m below surface. 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.

5. CTD

The SeaBird 911 CTD recorded downwelling PAR light levels, temperature, conductivity, oxygen concentration, transmittance and fluorescence at 24 Hz. The frame was fitted with an altimeter. The CTD temperature data was checked against a SeaBird SBE35 precision thermometer. Water samples were taken from a near-bed (3 m above bed) bottle for calibration of the CTD salinity data by Anne Forbes-Brook (Bangor University). Water samples were taken from the near surface (1 m) and near bed (3 m above bed) bottles and

Table 1. Nominal CTD positions, stations visited and samples taken

Station	Latitude (N)	Longitude (W)	Visited	Sediments & Chl-*a*	Nutrients top+bot	Grab no.	CEFAS calibration	pH
1(A)&9	53° 32.0′	3° 21.8′	yes	yes	yes	23	yes	yes
2	53° 37.0′	3° 13.4′	yes	yes	yes	13	yes	yes
3	53° 42.0′	3° 13.4′	yes		yes	12		yes
4	53° 47.0′	3° 13.4′	yes	yes	yes	1		yes
5	53° 52.0′	3° 21.8′						
6	53° 47.0′	3° 21.8′	yes		yes	2		yes
7	53° 42.0′	3° 21.8′	yes	yes	yes	11	yes	yes
8	53° 37.0′	3° 21.8′	yes		yes	14		yes
10	53° 27.0′	3° 13.4′	yes	yes	yes	26	yes	yes
11	53° 27.0′	3° 21.8′	yes	yes	yes	25		yes
12	53° 27.0′	3° 30.2′	yes	yes	yes	24		yes
13	53° 32.0′	3° 30.2′	yes		yes	22		yes
14	53° 37.0′	3° 30.2′	yes	yes	yes	15		yes
15	53° 42.0′	3° 30.2′	yes		yes	10		yes
16	53° 47.0′	3° 30.2′	yes	yes	yes	3		yes
17	53° 47.0′	3° 38.6′	yes	yes	yes	4	yes	yes
18	53° 42.0′	3° 38.6′	yes	yes	yes	9		yes
19	53° 37.0′	3° 38.6′	yes	yes	yes	16	yes	yes
20(B)*	53° 32.3′	3° 38.4′	yes	yes	yes	21	yes	yes
21*	53° 27.0′	3° 38.6′						
22	53° 23.0′	3° 38.6′						
23	53° 23.0′	3° 47.0′						
24	53° 27.0′	3° 47.0′						
25	53° 32.0′	3° 47.0′	yes		yes	20		yes
26	53° 37.0′	3° 47.0′	yes	yes	yes	17		yes
27	53° 42.0′	3° 47.0′	yes	yes	yes	8		yes
28	53° 47.0′	3° 47.0′	yes	yes	yes	5		yes
29	53° 47.0′	3° 55.4′	yes	yes	yes	6		yes
30	53° 42.0′	3° 55.4′	yes	yes	yes	7	yes	yes
31	53° 37.0′	3° 55.4′	yes		yes	18		yes
32	53° 32.0′	3° 55.4′	yes	yes	yes	19	yes	yes
33	53° 27.0′	3° 55.4′						
34	53° 22.0′	3° 55.4′						
35	53° 32.0′	3° 15.9′	yes	yes	yes	27		yes

*Before cruise 66 (26/01/2010), Stn 21 was referred to as Site B and Stn 20 was at 53° 32.0′ N 3° 38.6′ W

filtered to determine suspended sediment load concentration, nutrient concentration, ammonia oxidation/nitrification rate assessment, surface alkalinity (Defra) and for CEFAS calibration. A LISST-100X particle sizer with internal logging is normally attached to the CTD frame, however the attachment brackets required were not available, so the instrument was not deployed. Copies of the SeaBird binary files were taken off for processing and calibration at BODC / NOC. A LISST-25 particle sizer was fitted to the CTD and its data logged on the SeaBird data logging system.

6. Surface sampling

The intake of the surface sampling system is located about 3 m below the water line of RV Prince Madog. The parameters recorded every minute by the WS Oceans system are: date, transmittance, hull temperature (°C), barometric pressure (mbar), fluorescence, oxygen concentration, turbidity, salinity and conductivity sensor water temperature (°C).
A met package measures and records barometric pressure (mbar), solar radiation (W m^{-2}), PAR (photosynthetically active radiation, µmol m^{-2} s^{-1}), air temperature (°C), relative humidity, relative wind speed (m s^{-1}), relative wind direction (°) with zero indicating wind on the bow, minimum air temperature (°C), maximum air temperature (°C) and wind gust (m s^{-1}).

The ship was fitted with a 300 kHz ADCP set to record current velocity 25 × 2 m bins (bin nearest the surface at 5.1 m depth), every 30 s with 29 pings per ensemble.

Underway data and ship's ADCP data were recorded every minute.

All systems were recording from 07:30 28/04/2010 and were stopped by 22:30 30/04/2010 at the Seaforth radar tower.

Acknowledgements

The assistance of the master, officers and crew of the RV Prince Madog and all scientists is appreciated in ensuring the success of this cruise.

We are grateful to the Mersey Docks and Harbour Company for permission to anchor in the no-anchor zone.

Glossary

ADCP	acoustic Doppler current profiler
BODC	British Oceanographic Data Centre
CEFAS	Centre for Environment, Fisheries and Aquaculture Science
CTD	conductivity, temperature, depth
DOC	dissolved organic carbon
DON	dissolved organic nitrogen
LISST	laser in situ scattering transmissometry – particle size analyzer
NOC	National Oceanography Centre (based at Liverpool and Southampton)
NOCS	National Oceanography Centre Southampton (NOC from 1st April)
PAR	photosynthetically active radiation
pCO2	partial pressure of carbon dioxide
POL	Proudman Oceanographic Laboratory, Liverpool (NOC from 1st April)
TOxN	Total oxidisable nitrogen

Table 2. Station log

Date	Time GMT	Station	Latitude (N)	Longitude (W)	Water depth (m)	Activity	Data type
28/04/10	07:30	Seacombe Ferry				Start: ship ADCP, Enviro	*see* (a) *below*
	10:53	Site A (Stn 1)	53° 32.003′	3° 21.535′	28.0	CTD cast 001; bottles 3, 7–12	B02/H10/H16/H17
	11:14	A	53° 31.973′	3° 21.552′	27.7	ADCP frame recovered	*see* (b) *below*
	11:31	A	53° 31.974′	3° 21.487′	27.3	ADCP frame deployed	*see* (b) *below*
	11:57	A	53° 31.941′	3° 21.871′	28.0	SmartBuoy recovered	*see* (c) *below*
	12:25	A	53° 31.984′	3° 21.788′	26.6	SmartBuoy deployed	*see* (c) *below*
	16:58	Site B (Stn 20)	53° 32.377′	3° 38.641′	31.5	CTD cast 002; bottles 3, 4, 9, 10	B02/H10/H16/H17
	17:15	B	53° 32.291′	3° 38.579′	32.0	ADCP frame recovered	*see* (b) *below*
	17:36	B	53° 32.368′	3° 38.407′	33.4	ADCP frame deployed	*see* (b) *below*
	17:54	B	53° 32.450′	3° 38.352′	33.7	SmartBuoy deployed	*see* (c) *below*
	18:04	B	53° 32.259′	3° 37.285′	32.0	SmartBuoy recovered (cruise 67)	*see* (c) *below*
	18:21	B	53° 32.142′	3° 36.034′	31.8	SmartBuoy recovered (cruise 66)	*see* (c) *below*
	18:38	B	53° 32.129′	3° 36.156′	31.8	CTD cast 003 (**y**); bottle 9	B02/H10/H16/H17
	19:36	Site A (Stn 1)	53° 31.807′	3° 21.287′	23.8	Anchor dropped for 25-hr station	
	20:02	A4	53° 31.781′	3° 21.287′	24.7	CTD cast 004 (**y**); bottles 2–6, 8–11	B02/H10/H16/H17
	20:13	A5	53° 31.778′	3° 21.286′	25.3	CTD cast 005 (surface); bottles 3, 4	B02/H10/H16/H17
	20:33	A6	53° 31.783′	3° 21.287′	26.2	CTD cast 006 (**X**)	B02/H10/H16/H17
	21:02	A7	53° 31.773′	3° 21.295′	27.4	CTD cast 007 (**z**); bottles 3, 4, 9–12	B02/H10/H16/H17
	21:33	A8	53° 31.780′	3° 21.289′	28.2	CTD cast 008 (**z**); bottles 3–5, 9, 10	B02/H10/H16/H17
	22:03	A9	53° 31.807′	3° 21.284′	28.2	CTD cast 009 (**z**); bottles 3, 4, 9–12	B02/H10/H16/H17
	22:32	A10	53° 31.823′	3° 21.292′	28.6	CTD cast 010 (**X**)	B02/H10/H16/H17
	23:00	A11	53° 31.836′	3° 21.313′	28.1	CTD cast 011 (**z**); bottles 3, 4, 9–12	B02/H10/H16/H17
	23:30	A12	53° 31.838′	3° 21.329′	28.3	CTD cast 012	B02/H10/H16/H17
29/04/10	00:01	A13	53° 31.841′	3° 21.338′	27.6	CTD cast 013 (**z**); bottles 3, 4, 9–12	B02/H10/H16/H17
	00:32	A14	53° 31.795′	3° 21.429′	27.4	CTD cast 014 (**z**)	B02/H10/H16/H17
	02:02	A15	53° 31.781′	3° 21.453′	25.8	CTD cast 015 (**y**); bottles 3, 4, 9–12	B02/H10/H16/H17
	02:29	A16	53° 31.756′	3° 21.480′	24.4	CTD cast 016 (**y**)	B02/H10/H16/H17
	03:00	A17	53° 31.762′	3° 21.490′	23.6	CTD cast 017 (**y**); bottles 3, 4, 9–12	B02/H10/H16/H17
	03:32	A18	53° 31.760′	3° 21.482′	22.8	CTD cast 018 (**y**)	B02/H10/H16/H17
	04:01	A19	53° 31.766′	3° 21.487	22.2	CTD cast 019 (**y**); bottles 3, 4, 9–12	B02/H10/H16/H17
	04:30	A20	53° 31.767′	3° 21.485′	21.7	CTD cast 020	B02/H10/H16/H17
	04:59	A21	53° 31.792′	3° 21.440′	>19.1	CTD cast 021 (**y**); bottles 3, 4, 9–12	B02/H10/H16/H17
	05:30	A22	53° 31.807′	3° 21.353′	20.6	CTD cast 022	B02/H10/H16/H17
	06:00	A23	53° 31.806′	3° 21.339′	20.4	CTD cast 023; bottles 3–6, 8–12	B02/H10/H16/H17
	06:30	A24	53° 31.803′	3° 21.336′	21.2	CTD cast 024 (**z**)	B02/H10/H16/H17
	07:01	A25	53° 31.793′	3° 21.333′	21.8	CTD cast 025 (**y**); bottles 3–5, 8–12	B02/H10/H16/H17
	07:32	A26	53° 31.792′	3° 21.317′	23.1	CTD cast 026	B02/H10/H16/H17
	08:00	A27	53° 31.788′	3° 21.292′	24.0	CTD cast 027 (**z**); bottles 3, 4, 9–12	B02/H10/H16/H17
	08:30	A28	53° 31.778′	3° 21.288′	24.9	CTD cast 028 (**z**)	B02/H10/H16/H17
	09:00	A29	53° 31.775′	3° 21.291′	26.1	CTD cast 029; bottles 3–5, 8–12	B02/H10/H16/H17
	09:33	A30	53° 31.775′	3° 21.294′	27.4	CTD cast 030	B02/H10/H16/H17
	10:01	A31	53° 31.777′	3° 21.292′	28.0	CTD cast 031; bottles 3–5, 8–12	B02/H10/H16/H17
	10:30	A32	53° 31.779′	3° 21.293′	28.5	CTD cast 032	B02/H10/H16/H17
	10:59	A33	53° 31.782′	3° 21.297′	28.6	CTD cast 033 (**y**); bottles 3–5, 8–12	B02/H10/H16/H17
	11:30	A34	53° 31.774′	3° 21.304′	28.5	CTD cast 034 (**y**)	B02/H10/H16/H17
	12:02	A35	53° 31.782′	3° 21.384′	28.2	CTD cast 035 (**y**); bottles 3–5, 8–12	B02/H10/H16/H17
	12:32	A36	53° 31.793′	3° 21.395′	27.7	CTD cast 036 (**y**)	B02/H10/H16/H17
	13:01	A37	53° 31.795′	3° 21.398′	26.8	CTD cast 037 (**y**); bottles 3–5, 8–12	B02/H10/H16/H17
	13:31	A38	53° 31.815′	3° 21.447′	26.0	CTD cast 038 (**y**)	B02/H10/H16/H17
	14:02	A39	53° 31.820′	3° 21.442′	25.1	CTD cast 039 (**y**); bottles 3–5, 8–12	B02/H10/H16/H17
	14:32	A40	53° 31.819′	3° 21.444′	24.1	CTD cast 040 (**y**)	B02/H10/H16/H17
	14:59	A41	53° 31.820′	3° 21.446′	23.6	CTD cast 041 (**y**); bottles 3–5, 8–12	B02/H10/H16/H17
	15:31	A42	53° 31.826′	3° 21.475′	22.5	CTD cast 042 (**y**)	B02/H10/H16/H17
	16:00	A43	53° 31.830′	3° 21.474′	21.9	CTD cast 043 (**z**); bottles 3–5, 8–12	B02/H10/H16/H17
	16:32	A44	53° 31.815′	3° 21.486′	21.3	CTD cast 044 (**y**)	B02/H10/H16/H17
	17:03	A45	53° 31.822′	3° 21.479′	20.9	CTD cast 045; bottles 3–5, 8–12	B02/H10/H16/H17
	17:32	A46	53° 31.827′	3° 21.472′	20.7	CTD cast 046	B02/H10/H16/H17
	18:00	A47	53° 31.830′	3° 21.460′	20.6	CTD cast 047; bottles 3–5, 8–12	B02/H10/H16/H17
	18:30	A48	53° 31.831′	3° 21.442′	20.7	CTD cast 048	B02/H10/H16/H17
	19:00	A49	53° 31.813′	3° 21.386′	21.3	CTD cast 049 (**z**); bottles 3–5, 8–12	B02/H10/H16/H17
	19:30	A50	53° 31.803′	3° 21.353′	21.8	CTD cast 050	B02/H10/H16/H17
	20:00	A51	53° 31.792′	3° 21.320′	23.2	CTD cast 051 (**z**); bottles 3, 4, 9–12	B02/H10/H16/H17
	20:30	A52	53° 31.807′	3° 21.279′	24.0	CTD cast 052 (**X**)	B02/H10/H16/H17
	20:58	A53	53° 31.807′	3° 21.281′	25.3	CTD cast 053; bottles 3, 4, 9–12	B02/H10/H16/H17
	21:07					Anchor raised	

(continued…)

Table 2. Station log (continued…)

Date	Time GMT	Station	Latitude (N)	Longitude (W)	Water depth (m)	Activity	Data type
29/04/10						Start CTD survey grid	
	22:48	4	53° 47.025′	3° 13.312′	21.3	CTD cast 054, bottles 3, 4, 9, 10	B02/G02/H10/H16/H17
	23:36	6	53° 47.054′	3° 21.738′	24.6	CTD cast 055 (**y**); bottles 3, 4, 11, 12	B02/G02/H10/H16/H17
30/04/10	00:25	16	53° 46.953′	3° 30.302′	29.8	CTD cast 056 (**y**); bottles 3, 4, 9, 10	B02/G02/H10/H16/H17
	01:11	17	53° 47.044′	3° 38.830′	38.7	CTD cast 057 (**y**); bottles 3, 4, 9–11	B02/G02/H10/H16/H17
	01:58	28	53° 47.005′	3° 46.818′	43.3	CTD cast 058 (**y**); bottles 3, 4, 9, 10	B02/G02/H10/H16/H17
	03:01	29	53° 46.913′	3° 55.709′	43.0	CTD cast 059 (**z**); bottles 3, 4, 9, 10	B02/G02/H10/H16/H17
	03:55	30	53° 42.000′	3° 55.368′	40.0	CTD cast 060 (**y**); bottles 2–6, 9–11	B02/G02/H10/H16/H17
	04:49	27	53° 42.190′	3° 46.808′	38.6	CTD cast 061 (**y**); bottles 3, 4, 9, 10	B02/G02/H10/H16/H17
	05:39	18	53° 42.021′	3° 38.622′	35.8	CTD cast 062; bottles 3, 4, 9, 10	B02/G02/H10/H16/H17
	06:26	15	53° 41.990′	3° 30.101′	33.8	CTD cast 063; bottles 3, 10	B02/G02/H10/H16/H17
	07:10	7	53° 41.978′	3° 21.736′	21.5	CTD cast 064 (**z**); bottles 3, 4, 9–11	B02/G02/H10/H16/H17
	07:51	3	53° 41.998′	3° 13.243′	15.3	CTD cast 065; bottles 3, 10	B02/G02/H10/H16/H17
	08:36	2	53° 36.955′	3° 13.343′	12.3	CTD cast 066; bottles 3, 4, 9–11	B02/G02/H10/H16/H17
	09:28	8	53° 36.977′	3° 21.604′	26.0	CTD cast 067; bottles 3, 10	B02/G02/H10/H16/H17
	10:23	14	53° 37.031′	3° 30.089′	33.7	CTD cast 068; bottles 3, 4, 9, 10	B02/G02/H10/H16/H17
	11:15	19	53° 36.841′	3° 38.540′	36.2	CTD cast 069 (**y**); bottles 3, 4, 9–11	B02/G02/H10/H16/H17
	12:03	26	53° 36.968′	3° 46.742′	44.7	CTD cast 070 (**z**); bottles 3, 4, 9, 10	B02/G02/H10/H16/H17
	12:55	31	53° 37.034′	3° 55.463′	49.4	CTD cast 071 (**y**); bottles 3, 9	B02/G02/H10/H16/H17
	13:41	32	53° 31.929′	3° 55.257′	49.1	CTD cast 072 (**y**); bottles 3, 4, 8–12	B02/G02/H10/H16/H17
	15:06	25	53° 31.978′	3° 46.800′	44.9	CTD cast 073 (**z**); bottles 3, 9	B02/G02/H10/H16/H17
	15:17	25	53° 32.072′	3° 47.141′	43.1	CTD cast 074 (**y**); bottles 3, 9	B02/G02/H10/H16/H17
	16:12	20	53° 32.344′	3° 38.477′	33.6	CTD cast 075; bottles 3, 4, 8–11	B02/G02/H10/H16/H17
	17:01	13	53° 31.980′	3° 30.241′	29.0	CTD cast 076; bottles 3, 4, 8, 9	B02/G02/H10/H16/H17
	17:48	9	53° 32.083′	3° 21.954′	20.4	CTD cast 077; bottles 3–5, 8–12	B02/G02/H10/H16/H17
	18:50	12	53° 26.939′	3° 30.230′	15.0	CTD cast 078; bottles 3, 4, 9, 10	B02/G02/H10/H16/H17
	19:32	11	53° 27.003′	3° 21.790′	15.0	CTD cast 079; bottles 3, 4, 9–11	B02/G02/H10/H16/H17
	20:19	10	53° 27.041′	3° 13.329′	14.0	CTD cast 080; bottles 3, 4, 9–11	B02/G02/H10/H16/H17
	21:10	35	53° 31.995′	3° 16.116′	14.0	CTD cast 081; bottles 3, 4, 9, 10	B02/G02/H10/H16/H17
	22:30	Seaforth, radar tower				Stop: ship ADCP, Enviro	*see* (a) *below*

NOTES

a) Ship ADCP, Enviro – B02/D71/H16/H71/M02/M06
b) ADCP frame – D09/H21/ D90 (sound velocity, turbidity)
c) SmartBuoy –B02/B08/H17/H21/H24/H25/H26/D90 (T, conductivity, optical backscatter; some miniloggers T, pressure)
d) CTD profiles with water bottle samples also include H09/H27/P01
e) Anouska and Lucy were measuring B01/B02/B06/H21
f) Net hauls B08/B09

CTDs: **X**) pump blocked **y**) pump blocked at surface; up/downcast OK **z**) pump blocked on downcast; upcast OK

Data type

B01 Primary productivity
B02 Phytoplankton pigment (e.g., chlorophyll, fluorescence)
B06 Dissolved organic matter (including DOC)
B08 Phytoplankton
B09 Zooplankton
B73 Sediment traps
D09 Sea level (incl. bottom pressure, inverted echo sounder)
D71 Current profile (e.g., ADCP)
D90 Other physical oceanographic measurements
G02 Grab
G04 Core – soft bottom
G24 Long/short range sidescan sonar
G90 Other geological/geophysical measurements
H09 Water bottle stations
H10 CTD stations
H16 Transparency (e.g., transmissometer)
H17 Optics (e.g., underwater light levels)
H21 Oxygen
H24 Nitrate
H25 Nitrite
H26 Silicate
H27 Alkalinity
H71 Surface measurements underway (T, S)
M02 Incident radiation
M06 Routine standard (meteorology) measurements
M71 Atmospheric chemistry
P01 Suspended matter

Addendum, 8th June 2010

The intermittent 'failure' of the CTD pump sampler referred to in section 3.3 was more likely to have been caused by obstructions, e.g., air bubbles or jellyfish. Previous operator experience suggests that when this happens during the initial deployment period, with the CTD just below the sea surface, it can be cleared on deck before redeployment.