RV Prince Madog cruise 16/09
FORMOST Project
POL Dee Experiment cruise (deployment)
5–7 May 2009

1. Objectives

1.1 Coastal Observatory CTD station 12

To deploy at 53°27.0'N 3°30.2'W or as near as possible: a sea bed frame containing a 600 kHz ADCP to measure the mean current profile, and a SeaBird SBE 16*plus* with pumped conductivity sensor, digiquartz pressure sensor and SeaPoint turbidity sensor.

1.2 Hilbre Channel

a) Conduct side scan sonar survey and to take grab samples to determine deployment location for STABLE.
b) To deploy STABLE (v3) in an area with mixed sand/mud sea bed.
c) Conduct 25-hour CTD/LISST station. 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 suspended sediment determination.
d) Hourly sampling of near-surface and bottom water for chlorophyll analysis for calibration of FRRF (fast repetition rate fluorometer) instrument.

1.3 Welsh Channel

a) Conduct side scan sonar survey and to take grab samples to determine deployment location for mini-STABLE.
b) To deploy mini-STABLE.
c) Conduct 25-hour CTD/LISST station. 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 suspended sediment determination.
d) Hourly sampling of near-surface and bottom water for chlorophyll analysis and for calibration of FRRF instrument.

2. Personnel

2.1 Scientific personnel

Andy Lane	(Principal scientist, POL)
Rodolfo Bolaños	(POL)
Mike Burke	(POL)
Ray Edun	(POL)
John Kenny	(POL)
Jaco Baas	(SOS, Bangor University)
Emma Hall	(SOS, Bangor University)
Anne Hammerstein	(SOS, Bangor University)
Peter Hughes	(SOS, Bangor University)
David Rider	(SOS, Bangor University)

2.2 Ship's officers and crew

Steve Duckworth	(Master)
David Shaw	(Chief Officer)
Les Black	(Chief Engineer)
Meikle Mackay	(2nd Engineer)
Phil Jones	(Bosun)
Dominic Kelly	(A.B.)
Dave Leigh	(A.B.)
Colin Hughes	(Cook)

3. Narrative (times in GMT)

3.1 Monday 4th May 2009 (May Day Bank Holiday)

The ADCP frame, STABLE, mini-STABLE, Day grab and table were loaded at 07:00 (Mike Burke and John Kenny were present). Scientists arrived at RV Prince Madog at Vittoria Dock from 16:30 onwards. SOS staff prepared the CTD and set up the sediment filtering apparatus. The chlorophyll filtering equipment (courtesy of the DEOS, University of Liverpool) was already assembled from the previous cruise, however, their vacuum pump had broken down. SOS's FRRF instrument was not available (awaiting repair); chlorophyll sampling will still take place in order for personnel to become familiar with the procedure.

3.2 Tuesday 5th May 2009

RV Prince Madog departed from Vittoria Dock at about 05:00, and exited Alfred Lock at 05:42. The ship's surface monitoring package, ADCP, pCO_2 system was started at 06:14 on passing Seaforth radar tower.

Site 12 was reached at 08:38, and the ADCP frame was deployed at 08:42 followed by a CTD profile at 08:49. Winds were force 4–5 from WSW, with rough sea and medium swell. There was no readout on the CTD winch. The wet lab's GPS display was working intermittently.

On arrival at Hilbre Channel, the ship's ADCP was stopped at 10:34 to avoid interference with the side scan sonar. The side scan sonar survey began at 10:36 recording three lines, finishing at 11:12. Bedforms were located near to the start of the first line, and further south during the second line. Flat beds were found at the end of the first line (south), and near the end of the second line and near the start of the third line (north). The second (south to north) line was hampered by the strong ebbing tidal currents.

Five positions were identified for taking grab samples, including two locations (H4 and H5 from the Dee Experiment deployment cruise in February) where medium silt was previously found. The first grab was attempted at 11:43 at the position near the end of the second side scan survey line (with a flat bed); it retrieved some mud with mostly gravel and failed to close. The second attempt at 11:47 was unsuccessful, surfacing with a screw missing from the lid of one of the jaws. The grab was repaired and a further attempt was made at 12:12, but it returned only gravel. With time running short, grab sampling was abandoned (12:17); it was decided to head for H5 (53°22.495'N 3°17.128'W) of the February deployment cruise.

The anchor was dropped at 12:52 to allow the ship to drift on to position. STABLE was deployed at 12:58 (without the buff and line), with the anchor clump at 13:09 and the spar buoy at 13:12.

The anchor was lowered at 13:25. A grab sample was taken at 13:27, containing gravel and some muddy sand. The 23-hour* station began with a CTD profile at 13:30. Profiles were taken each half-hour; surface and bottom water samples were also obtained with the profiles on the hour for suspended sediment filtration and chlorophyll analysis. Westerly wind speeds increased from about 19:30 onwards to force 6 at first, with accompanying larger waves and medium swell. CTD profiles were not carried out between 23:00 and 00:00 due to strong ebb tidal currents combined with a force 7–8 westerly gale and high swell.

*This was originally intended to be a 25-hour station. It was curtailed because of the late start, and consideration of safe passage out of Hilbre Channel on the falling tide.

3.3 Wednesday 6th May 2009

The 23-hour station ended with the CTD profile at 12:32. Winds were force 5–6 from SW, with good visibility and moderate sea, low swell.

RV Prince Madog sailed to Welsh Channel via Hilbre Swash and south of North Hoyle wind farm, arriving at 15:12. Three lines of the side scan sonar survey were made between 15:17 and 15:37 (with ship's ADCP stopped at 15:12). An area of flat sea bed was identified at the start of the second (west to east) survey line (15:24). A grab sample, W1 (muddy sand) was taken at this position at 15:49, which would also be the location for mini-STABLE's deployment at 16:19, with the anchor clump deployed at 16:26 and the toroid buoy at 16:29.

The ship anchored at 16:37 and the 25-hour station commenced at 17:02 with half-hourly CTD profiles as in the previous 23-hour station. Strong flood tidal currents (>1.7 knots) and force 7 westerly winds at 17:25 lead to the CTD casts at 17:30 and 18:00 being abandoned. One further CTD profile was made at 18:30, but with waves washing over the starboard-side deck, fast flood tidal currents and force 8 SW gales (gusting force 9, rough sea) likely to continue for some time, the station was discontinued and shelter sought in the Dee estuary 2 km east of Point of Ayr. The WaveNet buoy (at 53°32.06'N 3°21.16'W) near the Bar Light, measured significant wave heights of 1.7 m at 18:30, 1.9 m at 19:00, and 2.0 m at 19:30.

3.4 Thursday 7th May 2009

A decision was made at 04:30 to carry out a 13-hour station, as the weather had improved and a period of markedly lower wave heights (around 1.5 m) was forecast. The previous station position was reached at 05:02. The first CTD profile of the 13-hour station was at 05:04. Winds were force 4–5 from SW, with good visibility, low waves and low to medium swell.

High sediment content in the water lead to long SPM filtration times, causing the vacuum pump to overheat, with a subsequent drop in suction (10:00). Filtering of further samples was delayed to allow the pump to cool down. The vacuum pressure did not return to normal.

At 17:08, the ship's anchor was raised; the final CTD profiles were performed while underway. The 13-hour station finished with the CTD profile of 18:12; RV Prince Madog sailed for Birkenhead via the Mid Hoyle Channel, arriving at Alfred Lock at 20:58, and at Vittoria Dock at 21:22. The ship's surface monitoring package, ADCP, pCO_2 system was stopped at 20:34 on passing Seaforth radar tower.

With the exception of shortened CTD stations (10 hours lost to bad weather) and unsuccessful deployment of the Day grab (repair needed), all other cruise objectives were achieved.

Dee Experiment cruise (deployment), 5th, 6th and 7th May 2009

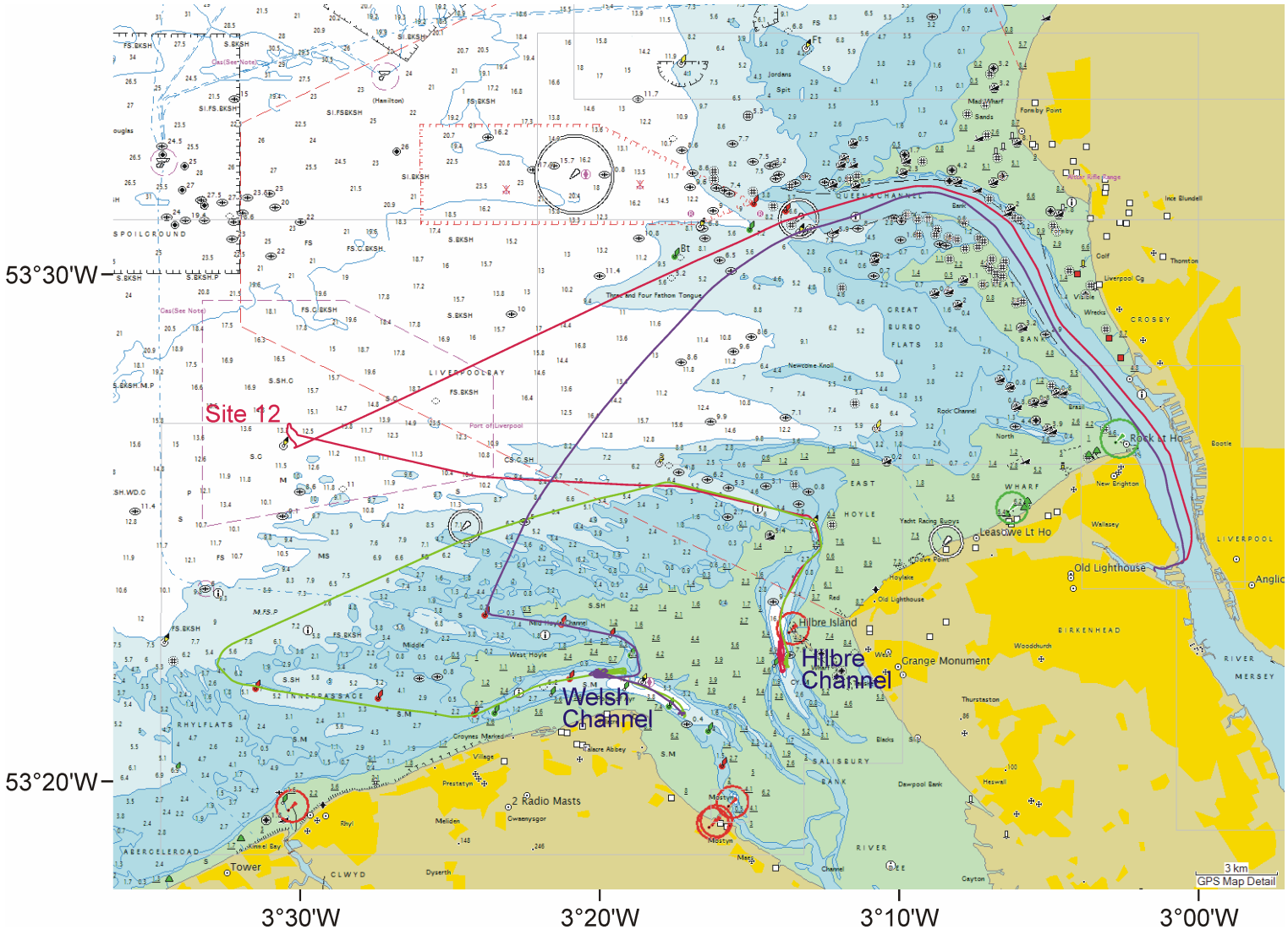

Figure 1. Cruise track

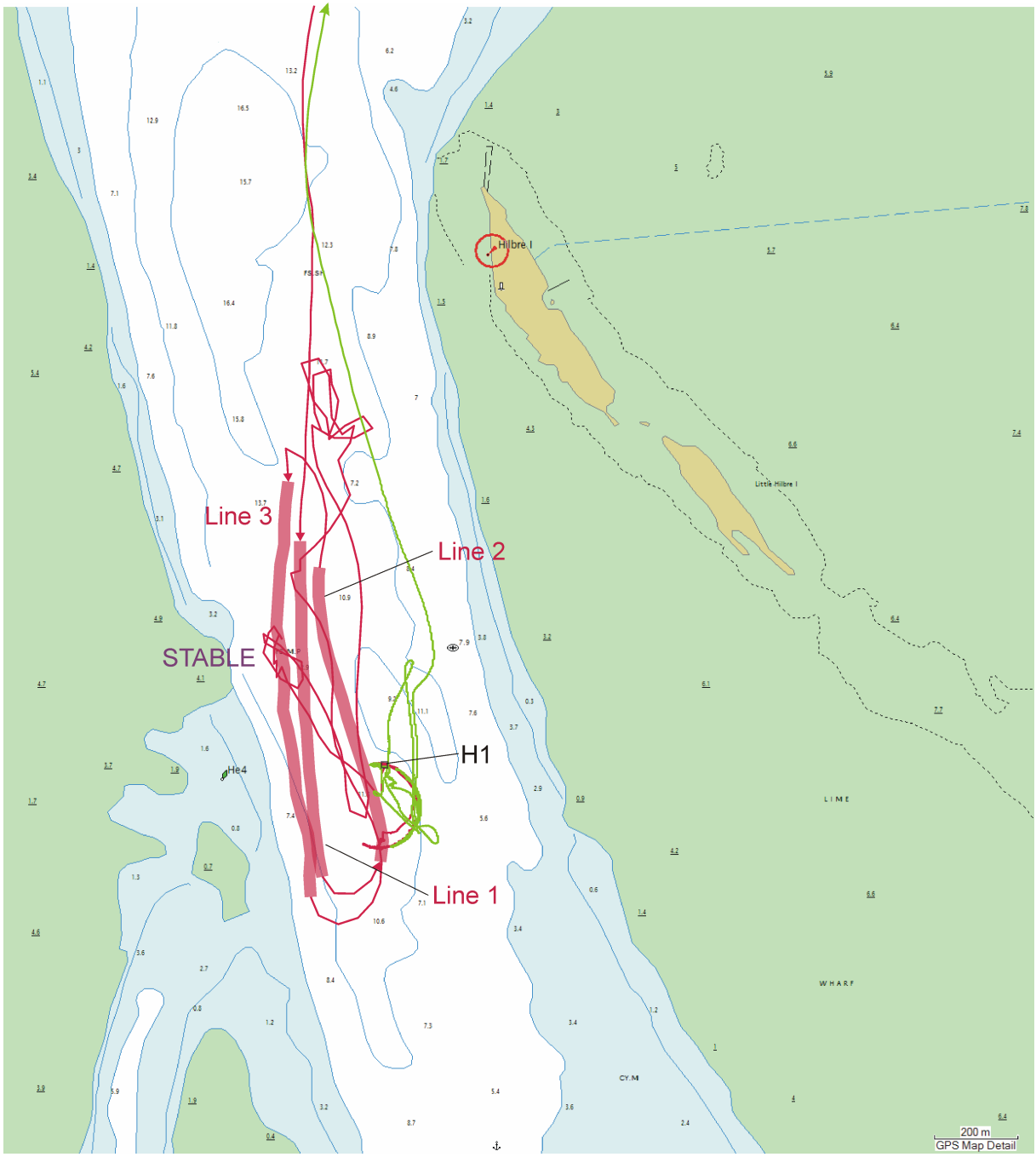

Figure 2. Hilbre Channel 23-hour station and side scan sonar survey lines

4. Moorings (times in GMT)

4.1 The setup of the recovered instruments

No moorings were recovered during this cruise.

4.2 The setup of the deployed instruments

Instrument configurations and setups are the same as those in the Dee Experiment in February/March 2009, and are described in a separate report (Cooke, 2009).

a) **Coastal Observatory CTD station 12**

ADCP frame connected by 200 m spooler line to the ballast weight and Benthos releases s/n 69679 Tx 12.0 kHz, Rx 11.5 kHz, Rc B; s/n 70456 Tx 12.0 kHz, Rx 12.0 kHz, Rc D.

- RDI ADCP 600 kHz s/n 5807
  started logging at 06:00 05/05/09
- SeaBird SBE 16*plus* s/n 4597 with SeaPoint turbidity sensor
  started logging at 06:00 05/05/09

b) **Hilbre Channel**

All instruments were programmed to start recording at 06:00 on 05/05/09 unless stated otherwise.

Spar buoy

- SeaBird SBE 16*plus* s/n 4736

STABLE

- Microcat SBE37 s/n 5596
- RDI ADCP 600 kHz s/n 3644 in fixed mount
- RDI ADCP 1200 kHz s/n 6489 in gimbals mount
- Sontek ADVs: G355+B285, G358+B292, G496+B281
- D&A Instruments OBS3+ sensors: s/n T8193, s/n T8194, s/n T8195
- Paros Digiquartz pressure sensor s/n P98919
- Transonics ABS transducers: 1 MHz s/n 103; 2 MHz s/n 109; 4 MHz s/n 111
- POL ABS1
- POL SyncGen1
- LISST 100X s/n 1199
- AML MC7 CT logger s/n 1102
- AML microCT sensors: s/n 7216, s/n 7217, s/n 7218
- Marine Electronics 3D ripple profiler
  started logging at 06:00 on 05/05/09 every 2 hours
- Sediment settling tube

c) **Welsh Channel**

All instruments were programmed to start recording at 12:00 on 06/05/09 unless stated otherwise.

Toroid buoy

- Microcat SBE37 s/n 4966

Mini-STABLE frame

- RDI ADCP 1200 kHz s/n 572
- Microcat SBE37 s/n 5595
- Transonics ABS transducers: 1 MHz s/n 102; 2 MHz s/n 108; 4 MHz s/n 109
- POL ABS3
- POL SyncGen3
- Sontek ADVs: G250+B353, G258+B233, G412+B331
- Marine Electronics 2D ripple profiler
  started logging at 06:00 on 06/05/09 every 5 minutes
- LISST 100X s/n 1291
- Sediment settling tube

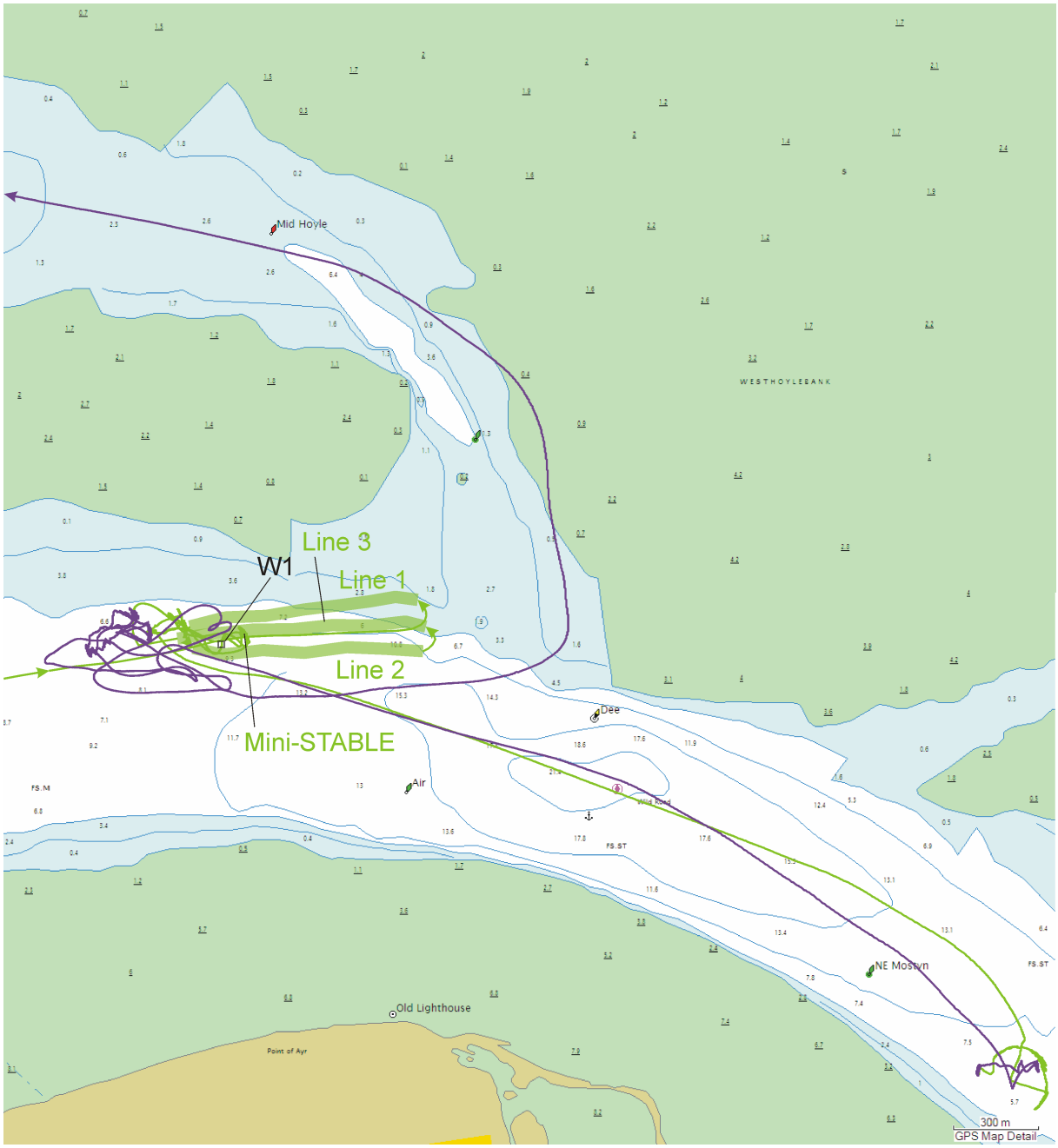

Figure 3. Welsh Channel 13-hour station and side scan sonar survey lines

Table 1. Deployed mooring positions and times

	Latitude (N)	Longitude (W)	Water depth (m)	Deployed Time	Deployed Date
ADCP frame (Coast Obs. Stn12)	53°26.998'	3°30.256'	21.8	08:40	05/05/09
STABLE (Hilbre Channel)	53°22.514'	3°14.156'	15.8	12:58	05/05/09
Mini-STABLE (Welsh Channel)	53°22.138'	3°19.782'	10.64	16:20	06/05/09

5. CTD

The Sea-Bird 911 CTD recorded downwelling PAR light levels, temperature, conductivity, transmittance and fluorescence at 24 Hz. The frame was fitted with an altimeter. 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. Water samples were taken from the near surface (1 m) and near bed bottles and filtered to determine suspended sediment load concentration. 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. Bottles used: No.3 salinity (bottom) and from cast 011 chlorophyll (bottom), No.4 suspended sediment (bottom), No.5 chlorophyll (bottom) up to cast 009, No.9 suspended sediment (surface), No.10 chlorophyll (surface).

6. Surface sampling

The intake for the surface sampling system is located underneath RV Prince Madog, at about 3 m below the sea surface. The WS Oceans Systems logger recorded the following parameters every minute: date, transmissance, hull temperature (°C), barometric pressure (mbar), fluorescence, turbidity, salinity, conductivity, sensor water temperature (°C). Sea surface temperature, salinity and transmittance were calibrated against the CTD by BODC. In addition a pCO_2 sensor is incorporated into the surface sampling system.

The meteorology package measured and recorded barometric pressure (mbar), solar radiation (W m^{-2}), PAR (µmol m^{-2}), air temperature (°C), relative humidity, relative wind speed (m s^{-1}), relative wind direction (°) – zero indicates wind on the bow, minimum air temperature (°C), maximum air temperature (°C), wind gust (m s^{-1}).

Underway data, pCO_2 and ship's ADCP data were recorded every minute. The ship is fitted with a 300 kHz ADCP set to record 25 × 2-m bins (with the bin nearest the surface at 5.1 m depth), every 30 seconds with 29 pings per ensemble. The systems were switched on at 06:14 on Tuesday 5th May 2009 on passing Seaforth radar tower. The ADCP and underway systems were switched off at 20:34 on Thursday 7th May 2009 on passing Seaforth radar tower.

7. Sea bed sediment samples: Day grab

Although five locations (Table 2) were identified for grab samples near the STABLE site, only two grabs were taken: one at each of the STABLE (H1) and mini-STABLE (W1) sites.

Table 2. Grab sampling, nominal positions

	Latitude (N)	Longitude (W)	Water depth (m)
Hilbre Channel			
1. Flat bed (2nd turn)	53°22.762'	3°14.046'	
2. Site H5 (deployment 02/09)	53°22.495'	3°14.128'	12.8
3. Site H4 (deployment 02/09)	53°22.453'	3°14.094'	12.4
4. Patchy bed forms (2nd line)	53°22.762'	3°14.046'	
5. Flat bed (start 2nd line)	53°22.169'	3°13.989'	

8. Side scan sonar

Side scan sonar surveys were undertaken with a C-MAX Ltd CM800-FSH (s/n10496) dual-frequency digital towfish system with 500-m range, towed behind the ship at a speed of approximately 4 knots. All data records were stored on optical disk. Three lines were completed in Hilbre Channel (record 1). A further three lines were covered in Welsh Channel (record 2). [Processing software: C-MAX 800 v6.92 (© 2000).]

Acknowledgements
The assistance of the Master, officers, and crew is appreciated in ensuring the success of this cruise.

Reference
Cooke, R.D. (2009) River Dee Estuary Experiment 2009 deployment report, v1.0., 27pp.

Glossary

ABS	acoustic backscatter
ADV	acoustic Doppler velocimeter
ADCP	acoustic Doppler current profiler
BODC	British Oceanographic Data Centre
CTD	conductivity, temperature, depth
DEOS	Department of Earth and Ocean Sciences, University of Liverpool
LISST	laser in situ scattering transmissometry – particle size analyzer
OBS	optical backscatter
PAR	photosynthetically active radiation
pCO_2	partial pressure of carbon dioxide
POL	Proudman Oceanographic Laboratory
SOS	School of Ocean Sciences, Bangor University
STABLE	Sediment transport and boundary layer equipment

Table 4. Station log

Date	Time	Station	Latitude (N)	Longitude (W)	Water depth (m)	Activity	Data type
05/05/09	06:14	**Seaforth radar tower**				Start: ship ADCP, pCO_2, Enviro	*see* (a) *below*
	08:42	**CoastObs** Station 12	53°26.990'	3°30.236'	21.8	ADCP frame deployed	D09/D71/H16
	08:49	Stn 12	53°26.956'	3°30.176'	20.7	CTD cast 001	B02/H10/H16/H17
		Hilbre Channel					
	10:36	Side scan sonar survey	53°22.617'	3°14.117'	19.6	Line 1 start (record 1, three lines)	G24
	10:46	Side scan sonar survey	53°22.177'	3°14.060'	15.3	Line 1 end	G24
	10:54	Side scan sonar survey	53°22.571'	3°14.078'	17.4	Line 2 end	G24
	11:19	Side scan sonar survey	53°22.514'	3°14.070'	17.2	Line 3 end	
	12:58	STABLE site	53°22.514'	3°14.156'	15.8	STABLE deployed	*see* (b) *below*
	13:27	H1	53°22.337'	3°13.937'	13.4	Grab sample	G02
	13:32	HC1	53°22.337'	3°13.940'	13.2	CTD cast 002	B02/H10/H16/H17
	14:03	HC2	53°22.330'	3°13.912'	13.2	CTD cast 003; bottles 3–5, 9, 10	B02/H10/H16/H17
	14:33	HC3	53°22.318'	3°13.891'	13.1	CTD cast 004	B02/H10/H16/H17
	15:01	HC4	53°22.309'	3°13.876'	13.1	CTD cast 005; bottles 3–5, 9, 10	B02/H10/H16/H17
	15:32	HC5	53°22.316'	3°13.886'	13.2	CTD cast 006	B02/H10/H16/H17
	16:01	HC6	53°22.318'	3°13.886'	13.4	CTD cast 007; bottles 3–5, 9, 10	B02/H10/H16/H17
	16:31	HC7	53°22.321'	3°13.893'	14.1	CTD cast 008	B02/H10/H16/H17
	17:02	HC8	53°22.286'	3°13.872'	15.6	CTD cast 009; bottles 3–5, 9, 10	B02/H10/H16/H17
	17:33	HC9	53°22.239'	3°13.942'	16.5	CTD cast 010	B02/H10/H16/H17
	18:01	HC10	53°22.229'	3°13.963'	17.5	CTD cast 011; bottles 3, 4, 9, 10	B02/H10/H16/H17
	18:32	HC11	53°22.227'	3°13.952'	18.8	CTD cast 012	B02/H10/H16/H17
	19:02	HC12	53°22.228'	3°13.935'	19.2	CTD cast 013; bottles 3, 4, 9, 10	B02/H10/H16/H17
	19:31	HC13	53°22.229'	3°13.953'	19.4	CTD cast 014	B02/H10/H16/H17
	20:00	HC14	53°22.238'	3°13.901'	20.3	CTD cast 015; bottles 3, 4, 9, 10	B02/H10/H16/H17
	20:31	HC15	53°22.293'	3°13.865'	20.1	CTD cast 016	B02/H10/H16/H17
	21:01	HC16	53°22.307'	3°13.872'	20.2	CTD cast 017; bottles 3, 4, 9, 10	B02/H10/H16/H17
	21:30	HC17	53°22.302'	3°13.868'	19.4	CTD cast 018	B02/H10/H16/H17
	22:01	HC18	53°22.305'	3°13.872'	19.2	CTD cast 019; bottles 3, 4, 9, 10	B02/H10/H16/H17
	22:32	HC19	53°22.330'	3°13.910'	18.2	CTD cast 020	B02/H10/H16/H17
06/05/09	00:31	HC20	53°22.336'	3°13.927'	15.3	CTD cast 021	B02/H10/H16/H17
	01:01	HC21	53°22.330'	3°13.909'	14.8	CTD cast 022; bottles 3, 4, 9, 10	B02/H10/H16/H17
	01:33	HC22	53°22.317'	3°13.884'	14.2	CTD cast 023	B02/H10/H16/H17
	02:01	HC23	53°22.308'	3°13.871'	14.1	CTD cast 024; bottles 3, 4, 9, 10	B02/H10/H16/H17
	02:33	HC24	53°22.284'	3°13.861'	14.1	CTD cast 025	B02/H10/H16/H17
	03:02	HC25	53°22.285'	3°13.861'	14.1	CTD cast 026; bottles 3, 4, 9, 10	B02/H10/H16/H17
	03:32	HC26	53°22.285'	3°13.851'	13.7	CTD cast 027	B02/H10/H16/H17
	04:02	HC27	53°22.298'	3°13.863'	14.4	CTD cast 028; bottles 3, 4, 9, 10	B02/H10/H16/H17
	04:32	HC28	53°22.290'	3°13.861'	14.8	CTD cast 029	B02/H10/H16/H17
	05:02	HC29	53°22.285'	3°13.860'	15.5	CTD cast 030; bottles 3, 4, 9, 10	B02/H10/H16/H17
	05:32	HC30	53°22.263'	3°13.864'	16.8	CTD cast 031	B02/H10/H16/H17
	06:01	HC31	53°22.236'	3°13.904'	17.1	CTD cast 032; bottles 3, 4, 9, 10	B02/H10/H16/H17
	06:30	HC32	53°22.233'	3°13.908'	18.2	CTD cast 033	B02/H10/H16/H17
	07:00	HC33	53°22.245'	3°13.882'	19.2	CTD cast 034; bottles 3, 4, 9, 10	B02/H10/H16/H17
	07:30	HC34	53°22.241'	3°13.888'	19.6	CTD cast 035	B02/H10/H16/H17
	08:01	HC35	53°22.252'	3°13.874'	19.6	CTD cast 036; bottles 3, 4, 9, 10	B02/H10/H16/H17
	08:30	HC36	53°22.261'	3°13.867'	20.0	CTD cast 037	B02/H10/H16/H17
	09:00	HC37	53°22.277'	3°13.863'	20.6	CTD cast 038; bottles 3, 4, 9, 10	B02/H10/H16/H17
	09:30	HC38	53°22.304'	3°13.898'	19.7	CTD cast 039	B02/H10/H16/H17
	10:00	HC39	53°22.312'	3°13.919'	19.6	CTD cast 040; bottles 3, 4, 9, 10	B02/H10/H16/H17
	10:30	HC40	53°22.322'	3°13.931'	18.3	CTD cast 041	B02/H10/H16/H17
	11:01	HC41	53°22.334'	3°13.457'	18.2	CTD cast 042; bottles 3, 4, 9, 10	B02/H10/H16/H17
	11:31	HC42	53°22.339'	3°13.952'	18.4	CTD cast 043	B02/H10/H16/H17
	12:02	HC43	53°22.254'	3°13.867'	16.3	CTD cast 044; bottles 3, 4, 9, 10	B02/H10/H16/H17
	12:32	HC44	53°22.297'	3°13.874'	15.7	CTD cast 045	B02/H10/H16/H17
		Welsh Channel					
	15:17	Side scan sonar survey	53°22.196'	3°19.455'	6.08	Line 1 start (record 2, three lines)	G24
	15:22	Side scan sonar survey	53°22.161'	3°19.232'	9.67	Line 1 end	
	15:24	Side scan sonar survey	53°22.099'	3°19.848'	10.97	Line 2 start	G24
	15:29	Side scan sonar survey	53°22.098'	3°19.248'	9.69	Line 2 end	G24
	15:37	Side scan sonar survey	53°22.129'	3°20.024'	10.0	Line 3 end	
	15:49	W1	53°22.125'	3°19.887'	10.78	Grab sample (near start of line 2)	G02
	16:20	Mini-STABLE site	53°22.138'	3°19.782'	10.64	Mini-STABLE deployed	*see* (c) *below*
	17:02	WC1	53°22.182'	3°19.997'	10.17	CTD cast 046; bottles 3, 4, 9, 10	B02/H10/H16/H17
	18:30	WC2	53°22.157'	3°19.978'	13.2	CTD cast 047	B02/H10/H16/H17
	19:00					*CTD station discontinued*	

(continued…2)

Table 4. Station log (continued…2)

Date	Time	Station	Latitude (N)	Longitude (W)	Water depth (m)	Activity	Data type
		Welsh Channel (contd)				*CTD station resumed*	
07/05/09	05:04	WC3	53°22.068'	3°20.023'	15.1	CTD cast 048; bottles 3, 4, 9, 10	B02/H10/H16/H17
	05:30	WC4	53°22.152'	3°20.090'	10.87	CTD cast 049	B02/H10/H16/H17
	06:01	WC5	53°22.142'	3°20.087'	11.56	CTD cast 050; bottles 3, 4, 9, 10	B02/H10/H16/H17
	06:31	WC6	53°22.137'	3°20.088'	13.3	CTD cast 051	B02/H10/H16/H17
	07:01	WC7	53°22.130'	3°20.089'	14.3	CTD cast 052; bottles 3, 4, 9, 10	B02/H10/H16/H17
	07:32	WC8	53°22.130'	3°20.087'	15.1	CTD cast 053	B02/H10/H16/H17
	08:00	WC9	53°22.135'	3°20.084'	15.2	CTD cast 054; bottles 3, 4, 9, 10	B02/H10/H16/H17
	08:31	WC10	53°22.144'	3°20.086'	16.5	CTD cast 055	B02/H10/H16/H17
	09:00	WC11	53°22.139'	3°20.083'	16.7	CTD cast 056; bottles 3, 4, 9, 10	B02/H10/H16/H17
	09:31	WC12	53°22.153'	3°20.091'	15.9	CTD cast 057	B02/H10/H16/H17
	10:03	WC13	53°22.163'	3°20.130'	15.8	CTD cast 058; bottles 3, 4, 9, 10	B02/H10/H16/H17
	10:31	WC14	53°22.125'	3°20.224'	15.8	CTD cast 059	B02/H10/H16/H17
	11:01	WC15	53°22.115'	3°20.235'	16.0	CTD cast 060; bottles 3, 4, 9, 10	B02/H10/H16/H17
	11:35	WC16	53°22.113'	3°20.254'	15.4	CTD cast 061	B02/H10/H16/H17
	12:03	WC17	53°22.110'	3°20.268'	14.2	CTD cast 062; bottles 3, 4, 9, 10	B02/H10/H16/H17
	12:33	WC18	53°22.110'	3°20.276'	13.3	CTD cast 063	B02/H10/H16/H17
	13:03	WC19	53°22.108'	3°20.283'	12.6	CTD cast 064; bottles 3, 4, 9, 10	B02/H10/H16/H17
	13:33	WC20	53°22.103'	3°20.282'	11.9	CTD cast 065	B02/H10/H16/H17
	14:03	WC21	53°22.112'	3°20.288'	11.3	CTD cast 066; bottles 3, 4, 9, 10	B02/H10/H16/H17
	14:34	WC22	53°22.119'	3°20.290'	10.5	CTD cast 067	B02/H10/H16/H17
	15:02	WC23	53°22.107'	3°20.285'	10.4	CTD cast 068; bottles 3, 4, 9, 10	B02/H10/H16/H17
	15:31	WC24	53°22.128'	3°20.279'	9.9	CTD cast 069	B02/H10/H16/H17
	16:01	WC25	53°22.180'	3°20.177'	8.7	CTD cast 070; bottles 3, 4, 9, 10	B02/H10/H16/H17
	16:31	WC26	53°22.179'	3°20.145'	8.9	CTD cast 071	B02/H10/H16/H17
	17:04	WC27	53°22.179'	3°20.132'	8.73	CTD cast 072; bottles 3, 4, 9, 10	B02/H10/H16/H17
	17:31	WC28	53°22.062'	3°20.095'	12.2	CTD cast 073	B02/H10/H16/H17
	18:01	WC29	53°22.106'	3°20.015'	11.94	CTD cast 074; bottles 3, 4, 9, 10	B02/H10/H16/H17
	18:12	WC30	53°22.028'	3°20.162'	12.25	CTD cast 075	B02/H10/H16/H17
	20:34	**Seaforth, radar tower**				Stop: ship ADCP, pCO_2, Enviro	*see* (a) *below*

NOTES:

a) Ship ADCP, pCO_2, Enviro – B02/D71/H16/H71/M02/M06/M71
b) Hilbre Channel STABLE – B73/D09/D71/H10/H16/G90/P01
c) Welsh Channel mini-STABLE – B73/D71/H10/H16/G90/P01
d) CTD profiles on the hour also include H09/P01
e) Ripple profiler, scanning of bedforms – G90

Data type:

B02	Phytoplankton pigment (e.g., chlorophyll, fluorescence)	H09	Water bottle stations
B73	Sediment traps	H10	CTD stations
D09	Sea level (incl. bottom pressure, inverted echo sounder)	H16	Transparency (e.g., transmissometer)
D71	Current profile (e.g., ADCP)	H17	Optics (e.g., underwater light levels)
D90	Other physical oceanographic measurements	H71	Surface measurements underway (T, S)
G02	Grab	M02	Incident radiation
G04	Core – soft bottom	M06	Routine standard (meteorology) measurements
G24	Long/short range side scan sonar	M71	Atmospheric chemistry
G90	Other geological/geophysical measurements	P01	Suspended matter