

National Research Vessels

SHIP-TIME PROGRAMME 2012

RESEARCH SURVEY REPORT

Survey Code:	Survey Name:	Chief Scientist/ Institution
CE12006	Biodiscovery and deep-ocean ecosystems	Louise Allcock / NUI Galway

Section A: Award Summary

Title of Research Survey and Survey Code:	Biodiscovery and deep-ocean ecosystems CE12006	
Co-Ordinator/ Chief Scientist:	Mark Johnson / Louise Allcock	
Vessel used for ship-time:	<i>RV Celtic Voyager</i> <input type="checkbox"/> <i>RV Celtic Explorer</i> <input checked="" type="checkbox"/>	
Total number of days at sea:	16	
Total number of grant-aided ship-time days awarded:	18	
Dates of survey:	12/04/2012 to 29/04/2012	
Mobilisation/Demobilisation Ports	Galway / Galway	
Survey Personnel:	<i>No. of Scientists</i> 8	<i>No. of Students</i> 6
Final Report Completed by:	Louise Allcock / Mark Johnson	Date: 27 August 2012.

Section B: Description of the Research Survey

B1 Overview of survey personnel

Names	Institute/ Department/ Course	Position (undergraduate/ post graduate etc)	Number of Days
Scientists			
Louise Allcock	<i>NUI Galway</i>	<i>Lecturer</i>	16
Martin White	<i>NUI Galway</i>	<i>Lecturer</i>	16
Helka Folch	<i>QUB</i>	<i>Post-doc</i>	16
Enrico Schwabe	<i>Munich Museum</i>	<i>Post-doc</i>	16
Laura Würzberg	<i>Uni Hamburg</i>	<i>Post-doc</i>	16
Margaret Rae	<i>NUI Galway</i>	<i>Post-doc</i>	16
Catriona Harrington	<i>UCC</i>	<i>Research Technician</i>	16
Caroline Kivimae	<i>NUI Galway</i>	<i>Post-doc</i>	16
Students			
Angela Stevenson	<i>TCD</i>	<i>Postgraduate</i>	16
Sarah Cosgrove	<i>NUI Galway</i>	<i>Postgraduate</i>	16
Annette Wilson	<i>NUI Galway</i>	<i>Postgraduate</i>	16
Alexandra Oppelt	<i>TCD</i>	<i>Postgraduate</i>	16
Vincent Mouchi	<i>TCD</i>	<i>Postgraduate</i>	16
Kelly Fitzhenry	<i>NUI Galway</i>	<i>Undergraduate</i>	16

B2 Objectives

Briefly outline the overall objectives of the research survey.

Please state if objectives have changed from the original proposal. If survey included a training element please outline clearly.

This is a multidisciplinary deep-sea research cruise, combining two components: biodiscovery, and ecosystem functioning and nutrient recycling. Both components are inter-institutional and interdisciplinary. The biodiscovery component brings together groups from National University of Ireland Galway (NUIG), University College Cork (UCC), Queen's University Belfast (QUB), the Ulster Museum (UM) and the Zoologische Staatssammlung München (ZSM) and expertise in natural products chemistry (NUIG), microbiology (NUIG) and microbial metagenomics (UCC), biodiversity databasing, mapping and analysis (QUB, NUIG) and systematics (NUIG, QUB, ZSM, UM). The ecosystem functioning and nutrient recycling component combines geochemists from Trinity College Dublin (TCD) with microbiologists and oceanographers from NUIG. The scientific objectives of the two components are as follows:

[1] Biodiscovery

Working on the lower slope and at bathyal/abyssal depths in canyon regions we aimed to:

- (i) Identify and map benthic macrofauna using conventional cores and ROV surveys;
- (ii) Improve systematic knowledge of Porifera and Mollusca, groups with known biodiscovery potential, using traditional morphological techniques in combination with molecular biology;
- (iii) Collect marine specimens for freeze-drying and the preparation of extracts in the MI Marine Biodiscovery Laboratory;
- (iv) Collect marine specimens likely to have novel photoactive molecules;
- (v) Characterise bacterial and archaeal diversity in deep sea water and sediment samples over spatial and temporal scales; and
- (vi) Collect marine invertebrate samples (particularly sponges), seawater samples, and marine sediment to study and compare the microbiota associated with each of the samples, culture microorganisms and construct metagenomic libraries.

[2] Ecosystem function and nutrient cycling

We aimed to:

- (i) Examine the mechanisms whereby biogenic material, essentially derived for the spring diatom bloom and deposited on the continental shelf, is advected into layers within the open ocean water column from whence it sinks to the sea bed;
- (ii) Delineate the advective extent of these nepheloid layers of biogenic material derived from the continental shelf;
- (iii) Detect and determine the diversity and abundance of deep-sea nitrogen cycling microorganisms;
- (iv) Characterise and determine the origins, lability and recycling rates of dissolved and particulate organic matter supporting the currently accepted net heterotrophic nature of deep-sea CWC reef communities;
- (v) Collect calcifying detritivores (echinoids / asteroids), *Lophelia* branches, coral rubble and sediment to study the transfer of C and N through the detritivore foodweb; and
- (vi) Collect water and sediment samples to determine mixing and resuspension rates at the sediment water interface using natural radiotracers.

The survey included five PhD students and an undergraduate. Although there was no module-style training programme, the work that they undertook and the experience gained by participating in their cruise greatly contributes to their training as marine scientists.

B3 Overview of research survey

*Provide a narrative overview of the research survey including survey timelines
The information provided in this section should not exceed 5 pages (excluding tables and maps)*

Cruise Narrative

Friday 13th April

We departed Galway 11.07 pm and sailed out into Galway Bay.

Saturday 14th April

A spin test was conducted on the Sonardyne system by the ships techs around 6 am. Once this was successfully completed, the ROV was also successfully wet tested and we were steaming towards the Whittard Canyon shortly after lunch. The sea was exceptionally calm and the weather sunny.

Sunday 15th April

The weather remained calm. The ship's tech worked to fix a problem with the main temperature sensor on the CTD. We arrived at our first station around 16:30. This was essentially a shallow site for a test dive on the edge of the shelf to ensure that the ROV was working properly before subsequently diving deeper within the canyon. We ran a CTD on the dive site (Event 1) to obtain speed of sound data for the Sonardyne positioning system. As well as the main temperature sensor, the oxygen sensor was also not working properly as the readings were well outside the expected parameters. When we were ready to launch the ROV (Event 2), it became apparent that the CTD for the ROV was not working because of software/computer issues in the ROV shack. We made a decision to dive without the ROV CTD. There were winch issues after launch with the level winder not working. Nonetheless we reached the bottom successfully. We attempted to take a core, but the core was dropped and the ROV engine was overheating as the pilots tried to maintain a steady position. We returned to the TMS to let the engine cool. We came back out of the TMS and successfully took a core. Problems emerged with the high definition camera. This shallow test dive was useful for highlighting operational issues but didn't yield data pertinent to the canyon system since it was conducted on the edge of the shelf above the canyon. The ROV was recovered to deck and we commenced our night-time CTD programme. This began with a CTD with the SAPS attached (Event 3). Unfortunately the SAPS did not appear to be pumping. We persevered through the night and although the CTDs were successful (oxygen and main temperature sensor excepted), the SAPS remained non-operational.

Monday 16th April

We were on the selected ROV site and ready to dive at 8am, having previously run a CTD at the site. For this dive (Event 12), we attached a stand-alone Microcat CTD as the ROV CTD was still not working. Although the high definition camera was changed overnight, problems with the high definition camera persisted and became worse with increasing depth. We tried to take a core on the canyon floor but the sediment was shallow and kept falling out. We 'hoovered' coral and shell debris extensively using the slurp sampler at the foot of the 'cliff'. We were expecting a near vertical wall based on Infomar bathymetry data and we were not disappointed. The wall climbed from approximately 730 m up to 585 m. The rock was layered and each overhang contained a community consisting of limid bivalves, deep-water oysters, solitary corals and fly-trap anemones. It was difficult to sample and extensive time was lost when the slurp sampler was dropped on more than one occasion and had to be recovered. At the top of the wall, we had approximately 40 minutes dive time remaining and we elected to drop back down and fly straight up the wall taking extensive digital stills. This was essential because the high definition camera was not working and we needed good images to identify the fauna of this unique habitat. This was facilitated by very skillful flying by one of the ROV pilots (Rob Carpenter) extremely close to the wall. The ROV was recovered to deck by 19:35 and we ran a boxcore (Event 13) slightly away from the canyon

wall shortly after. CTDs were conducted through the night. We knew that scientific operations would cease the next morning due to impending bad weather, so we took advantage of the fact that we didn't need to return to a dive site to run out to deeper stations further down the canyon system.

Tuesday 17th April

CTD work stopped at around 9 am due to worsening weather conditions.

Wednesday 18th April

We spent the whole day hove to with swells of up to 9 m. However the outlook was better and CTD sampling was scheduled to recommence 6 am Thursday with the possibility of an ROV late in the day.

Thursday 19th April

CTD operations started at 6:15 am. These continued smoothly until 1:50 pm when excess wire was accidentally shot on a CTD (Event 23). On recovery it was apparent that cable had become wrapped around the CTD frame. The cable was damaged and had to be reterminated. 200 m of cable had to be cut from the CTD winch. An incident report has been completed by the scientist responsible for CTD operations at that time. Scientific operations resumed at 17:05. We had hoped to drop a boxcore, but the swell remained too high. CTD operations continued through the night.

Friday 20th April

At 6.30 am we dropped a boxcore in 1100 m depth. We then conducted a CTD on the selected ROV dive site. There was slight delay with the boxcore due to difficulty in removing the box from the frame, but a really nice sample was obtained with overlying water intact. The ROV was in the water by 9.30 am (Event 39). The high definition camera was glitching from the start and not working at all by 900 m depth. A problem with the ROV motor occurred at 920 m. The dive was aborted and recovered to deck. The ROV was on deck by 10:55 am. The ROV superintendent reported the problem fixed at 2 pm. The ship's technical officer reported a problem with the Sonardyne ROV positioning software. ROV relaunch commenced at 2:30 pm. By 500 m depth it was clear that there was too much swell to operate safely and the ROV was recovered to deck without leaving the TMS. The swell was considered too great for a boxcore and so we resumed CTD operations after a short period of planning and steaming. From then on and through the night we ran a transect of CTD stations across the canyon repeating them after 6 hours to provide a full tidal cycle of data.

Saturday 21st April

We were on the selected ROV dive site (1350 m depth as yesterday) by 7:30 am and dropped the CTD. Unfortunately the weather was considered too marginal to dive. We therefore moved away from the canyon wall and dropped a boxcore in the middle of the canyon at 1350 m depth (Event 56). The boxcore didn't fire first time so we sent it down again. It worked. The ROV superintendent still considered the swell too marginal to dive at 10:30 am, although the weather was considerably better than Friday afternoon, as evidenced by our ability to boxcore. We then ran a slightly deeper boxcore but this brought up water only. At lunch (12 pm) the conditions were still considered unsuitable for diving. We repeated the earlier boxcore having moved 50 m in the hope of finding better ground. At first, this didn't fire, but we sent it back down and it took a good sample of dark clay. At 3pm the weather was still considered unsuitable for the ROV. We remained on station since the weather did not appear to be much worse than previous diving conditions and we hoped a small improvement might allow us to dive. At 4 pm the weather was still considered unsuitable for diving. There was no point reconsidering at 5 pm since the pilots would want to have the ROV back on deck by 7 pm and it would take about an hour down and an hour to recover given the depth. We therefore recommenced CTD operations heading out first to repeat the deep station at 3,100

m. Having considered the weather forecast, an ROV dive (on the same planned site) was scheduled for 6 am the next morning.

Sunday 22nd April

The oceanography team filtered large volumes of water through the night (>200 litres) using a makeshift rig in place of the non-functional SAPS. We were on the ROV dive site at 6 am and given the go ahead to dive. The ROV was launched at 6:50 am (Event 64). Despite further changing of cables, the high definition camera was practically non-functional by 650 m depth. This was particularly disappointing since we had hoped to show some of our video footage at Titanic Belfast, but it also made collecting very difficult as the other cameras do not have sufficient resolution to allow real-time identification of small organisms. The problem was illustrated when later examination of the digital still photographs revealed organisms that we probably should have collected. We climbed slowly up a slope covered with soft sediment, collecting interesting organisms on the way. The ROV superintendent curtailed the dive because of rising weather conditions and the ROV was smoothly returned to the TMS at approximately 3pm and to deck shortly afterwards. It later transpired that the syringes had not been taken off the ROV CTD prior to diving. However, the separate microcat CTD had also been attached. The deck crew re-rigged the boxcore to allow deeper drops (the hydrographic wire extends only to 1500 m) and we attempted a boxcore at 2,000 m. Unfortunately it didn't fire. The deck crew then attempted to fire the boxcore on deck. This was not successful and a broken pin was found to be the cause. The oceanography team took over after dinner running CTDs amid rising swell and a forecast of fierce weather. All operations stopped at 10 pm because of the weather.

Monday 23rd April

Swells around 9 m and winds around 50 knots continued throughout the day, with the general consensus being that this storm was worse than the first. Nonetheless the forecast predicted it would subside rapidly and we would shortly be recommencing scientific operations.

Tuesday 24th April

CTD operations recommenced at 6 am and the swell declined rapidly. Consultation took place with the ROV superintendent at 10:30 am. The go ahead to dive was not given so we steamed to a further CTD site and returned to the ROV dive site for further consultation at 12:30 pm. The go ahead to dive was not given. Average swells were 2-2.5 m and the wind was 15 knots but occasional swells (approximately 1 every 10 minutes) of about 4 m were passing through. We held station and agreed to reconsider at 1:30 pm. After consultation with the Master about the weather, the go ahead to dive was finally given at 1:50 pm. The ROV was launched at 2.20 pm (Event 71) but descent was halted 10 minutes later when it became apparent that the Sonardyne transponder on the ROV wasn't working and the ROV returned to deck. At 3:10 pm the ROV superintendent reported that the weather was unsuitable for ROV launch and ROV operations were cancelled for the day. The weather forecast indicated that this was probably the last chance of the cruise for ROV operations. CTD operations began immediately with a CTD at 1,000 m depth in the centre of the canyon. The hydrography team assessed the time remaining for CTD operations and elected to repeat some stations from CE11006 which required considerable steaming time and had not been possible when returning to ROV dive sites by day.

Wednesday 25th - Thursday 26th April

Over the next 48 hours we worked down the canyon arm in which we had been sampling, out to a depth of approximately 3,000 m, and then back up the canyon arm we had sampled in 2011 to increasingly shallow depths, making CTD casts and taking water samples on route. In total, 13 CTDs were undertaken in this time (events 72-84). After this last station it was apparent that there was a possibility of returning to port one tide earlier than expected. Given the ship's tight turn-round schedule, we requested a second engine (which was agreed) and headed for Galway.

Friday 27th April - Saturday 28th April

Three CTDs were run on route home in coastal areas. These were to calibrate the underway data system (events 85-87). They are not shown on the station map (Figure 1). We returned to Galway port on the morning of 28th April.

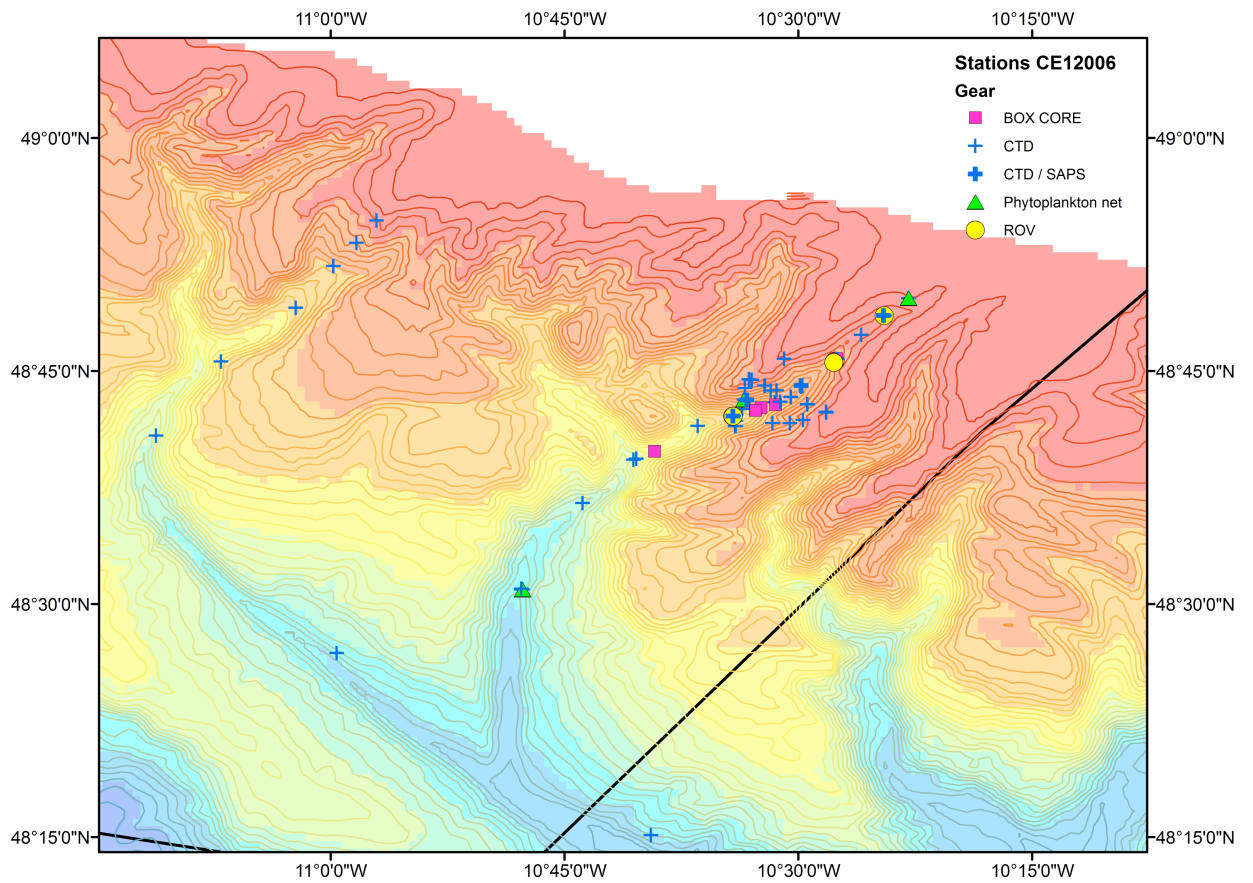


Figure 1. Sampling stations. See also Table 1.

Table 1. List of Stations

Event number	Decimal Latitude	Decimal Longitude	Depth	Date / time (UTC)	Gear
1	48.8093	-10.4081	375	15/04/2012 15:35	CTD
2	48.8094	-10.4081	375	15/04/2012 16:25	ROV
3	48.8095	-10.4088	375	15/04/2012 19:16	CTD/ SAPS
4	48.8281	-10.3821	197	15/04/2012 21:38	CTD
5	48.8281	-10.382	197	15/04/2012 22:00	Phytoplankton net
6	48.7344	-10.4969	1000	15/04/2012 23:12	CTD/ SAPS
7	48.7344	-10.497	1000	15/04/2012 23:53	CTD/ SAPS
8	48.7335	-10.4969	1000	16/04/2012 01:16	CTD
9	48.6907	-10.5676	1320	16/04/2012 02:57	CTD
10	48.761	-10.459	740	16/04/2012 00:00	CTD
11	48.761	-10.459	740	16/04/2012 07:15	CTD/ SAPS
12	48.7607	-10.4608	750	16/04/2012 07:22	ROV
13	48.7631	-10.4588	741	16/04/2012 18:35	BOX CORE
14	48.7606	-10.4606	750	16/04/2012 19:21	CTD
15	48.691	-10.6075	1820	16/04/2012 21:23	CTD
16	48.6558	-10.6732	2200	16/04/2012 23:49	CTD
17	48.6083	-10.7305	2758	17/04/2012 02:36	CTD
18	48.5156	-10.7961	3100	17/04/2012 05:47	CTD
19	48.7009	-10.5689	1350	19/04/2012 05:13	CTD
20	48.7164	-10.5248	1096	19/04/2012 06:57	CTD
21	48.6906	-10.5667	1290	19/04/2012 08:26	CTD
22	48.6964	-10.5669	1575	19/04/2012 09:45	CTD
23	48.7091	-10.56	1410	19/04/2012 11:31	CTD
24	48.7192	-10.558	860	19/04/2012 16:11	CTD
25	48.7192	-10.558	860	19/04/2012 17:00	Phytoplankton net
26	48.7316	-10.5571	641	19/04/2012 17:40	CTD
27	48.7403	-10.5496	381	19/04/2012 18:30	CTD
28	48.763	-10.5151	275	19/04/2012 00:00	CTD
29	48.8091	-10.4077	380	19/04/2012 20:34	CTD
30	48.7886	-10.4326	493	19/04/2012 00:00	CTD
31	48.7627	-10.458	730	19/04/2012 22:40	CTD
32	48.733	-10.4968	1000	19/04/2012 23:52	CTD
33	48.7164	-10.525	1104	20/04/2012 01:10	CTD
34	48.694	-10.5276	957	20/04/2012 02:36	CTD
35	48.6938	-10.509	645	20/04/2012 03:37	CTD
36	48.6973	-10.4948	440	20/04/2012 04:30	CTD
37	48.7139	-10.5243	1100	20/04/2012 05:45	BOX CORE
38	48.7016	-10.5698	1270	19/04/2012 16:11	CTD
39	48.7015	-10.5696	1310	20/04/2012 08:40	ROV
40	48.7015	-10.5699	1300	20/04/2012 13:30	ROV
41	48.741	-10.5526	345	20/04/2012 16:05	CTD
42	48.7342	-10.5361	554	20/04/2012 16:45	CTD
43	48.7288	-10.5295	720	20/04/2012 17:35	CTD
44	48.7219	-10.5077	990	20/04/2012 18:28	CTD

Event number	Decimal Latitude	Decimal Longitude	Depth	Date / time (UTC)	Gear
45	48.7141	-10.4905	600	20/04/2012 19:39	CTD
46	48.7053	-10.47	285	20/04/2012 21:05	CTD
47	48.7219	-10.5079	1025	20/04/2012 21:51	CTD
48	48.7406	-10.5523	361	20/04/2012 23:24	CTD
49	48.7342	-10.5355	580	21/04/2012 00:16	CTD
50	48.729	-10.5231	740	21/04/2012 01:17	CTD
51	48.7219	-10.508	1034	21/04/2012 02:27	CTD
52	48.7142	-10.49	615	21/04/2012 03:36	CTD
53	48.7061	-10.4703	298	21/04/2012 04:26	CTD
54	48.722	-10.508	1030	21/04/2012 04:55	CTD
55	48.7013	-10.5695	1350	21/04/2012 06:29	CTD
56	48.7106	-10.5399	1333	21/04/2012 08:18	BOX CORE
57	48.7077	-10.5459	1380	21/04/2012 10:30	BOX CORE
58	48.7078	-10.5457	1410	21/04/2012 12:17	BOX CORE
59	48.5154	-10.7947	3028	21/04/2012 17:35	CTD
60	48.6547	-10.6761	2220	21/04/2012 22:22	CTD
61	48.7012	-10.5692	1333	22/04/2012 02:08	CTD
62	48.5154	-10.7947	50	21/04/2012 20:15	Phytoplankton net
63	48.7627	-10.4584	745	22/04/2012 03:30	CTD
64	48.7014	-10.5697	1335	22/04/2012 05:50	ROV
65	48.6639	-10.6537	2047	22/04/2012 15:47	BOX CORE
66	48.7015	-10.5692	1346	22/04/2012 19:19	CTD
67	48.7015	-10.569	1284	22/04/2012 05:17	CTD
68	48.719	-10.555	999	24/04/2012 07:00	CTD/ SAPS
69	48.759	-10.4619	745	24/04/2012 08:52	CTD
70	48.8094	-10.4075	376	24/04/2012 10:22	CTD
71	48.7591	-10.4619	750	24/04/2012 13:20	ROV
72	48.7169	-10.5193	1070	24/04/2012 15:09	CTD
73	48.7016	-10.5698	1330	24/04/2012 17:33	CTD
74	48.7016	-10.5698	1330	24/04/2012 19:00	CTD/ SAPS
75	48.5163	-10.796	3090	24/04/2012 23:55	CTD
76	48.2518	-10.6575	3150	25/04/2012 04:37	CTD
77	48.4472	-10.9935	2911	25/04/2012 22:48	CTD
78	48.6806	-11.1866	2536	26/04/2012 05:18	CTD
79	48.7601	-11.1172	1570	26/04/2012 10:19	CTD
80	48.8177	-11.0373	1449	26/04/2012 12:52	CTD
81	48.8624	-10.9969	1020	26/04/2012 00:00	CTD
82	48.8624	-10.9971	1009	26/04/2012 14:33	CTD
83	48.8873	-10.9725	680	26/04/2012 16:09	CTD
84	48.9114	-10.9509	334	26/04/2012 17:05	CTD
85	51.5918	-10.8355	157	27/04/2012 18:08	CTD
86	52.5082	-10.2492	96	28/04/2012 01:20	CTD
87	53.2153	-9.14682	16	28/04/2012 07:16	CTD

B4 Benefits, impact and contribution of the outputs to marine research and the marine sector in general.

*Outline clearly the specific outcomes and benefits of the research survey.
The information provided in this section should not exceed 1/2 page (excluding tables and maps)*

The cruise supports the work of the Beaufort Biodiscovery award. The provision of deep-water specimens provides considerable novelty for biodiscovery and directly supports research groups in NUIG, UCC and QUB. This is in the generation of extracts (NUIG), clone libraries and cultures (UCC) or taxonomic specimens (QUB). The biotope discovered on the ROV dive of 16th April may be novel and should add to the accurate description of deep-sea habitats. Accurate description is the first step in both understanding and protecting marine habitats. Although the amount of ROV work was limited by weather and technical difficulties, extensive hydrographic work yielded important data which will contribute to our knowledge of ecosystem functioning.

The cruise represents formative experience for the postgraduates involved, increasing the national capacity for individuals with ship time experience. This also supports their PhD research projects in coral ecosystem function and pelagic benthic coupling. These projects should lead to a fuller understanding of how ecosystems on the continental margin function and how variation in physical forcings (including climate change) may lead to changes in these ecosystems. Specific outcomes are the provision of material (corals, sediments and filtered water samples) to support the PhDs in TCD and NUIG.

B5 Data

Provide a description of the data collected from the research survey, the usage of the data and how it will be stored.

The information provided in this section should not exceed 1/2 page (excluding tables and maps)

The data from the cruise fall into two main categories: video and image data, and numerical data.

Video and image data are stored on a proprietary RAID system (Drobo) which offers protection against individual hard drive failure. The RAID system is owned by Dr Louise Allcock and NUIG and copies of the images can be obtained on request. Additional back-ups of the data have been made to portable systems. Video analysis will be undertaken by postgraduate students, however the absence of high def video means that this may be limited. Subsea digital stills, and microscope stills are stored on the RAID system and have been distributed to cruise participants for research purposes.

Numerical data are stored in a MySQL database purpose built by Dr Helka Folch, the Beaufort Marine Biodiscovery data post-doc. This database is owned by Dr Folch at the Marine Institute but copies have been distributed to interested parties. A back-up is kept on the RAID system at NUI Galway. The database houses all the station data, Sonardyne data, CTD data and specimen data and the specimen tracking system contained therein is compatible with the Beaufort Biodiscovery database, allowing specimen tracking through this larger programme. Subsets of data (e.g., station lists etc) can be obtained in user-friendly formats by request to h.folch@qub.ac.uk. The data are currently being analysed by cruise participants.

B6 Contribution to marine research programmes

Outline specific National/EU/International research programmes this survey supported. Please include the funding sources for these programmes as well as the total amount of funding leveraged (Repeat the table below, if necessary).

National/EU/International Research programme(s):	Beaufort Biodiscovery Award
Total Programme cost:	<i>7.23 million</i>
Value to Irish partners:	<i>7.23 million</i>
Project duration:	<i>2008-2015</i>
Contract no.:	
Project partners:	<i>NUIG, UCC, QUB</i>
Project web address:	<i>http://www.qub.ac.uk/research-centres/MarineBiodiscovery/</i>

The cruise forms part of the ongoing support for the marine biodiscovery programme. This includes improving the knowledge of the marine biodiversity in Irish waters and supplying material to project partners and to the Marine Biodiscovery Laboratory run as part of the Beaufort award.

Appendices

Please number and attach any relevant Appendices here.