

NATURAL ENVIRONMENT RESEARCH COUNCIL

APPLICATION FOR CONSENT TO CONDUCT MARINE SCIENTIFIC RESEARCH ICELAND

Date: 29 November 2010

Ship Name	Cruise Number	Dates of Cruise	Country applied for	Port Calls	Dates
RRS James Cook	JC060	09 May - 12 June 2011	Iceland		11 May – 9 June 2011

COASTAL STATE: Iceland

PORT CALL:

DATES: 11th May – 9th June 2011

List Scientific Work by Function e.g.: Magnetometry Gravity, Diving, Seismic, Bathymetry, Seabed Sampling, Trawling, Echo Sounding, Water Sampling U/W T.V.: Moored and Towed instrument	Water Column Incl. Sediment Sampling on the Seabed	Fisheries Research within Fishing Limits	Research Concerning the Natural Resources of the Continental Shelf or its Physical Characteristics	Distance from Coast Between	
				Within 12 NM	12 - 200 NM
Bathymetry, sidescan sonar, chirp profiler	N	N	Y	N	Y
Video surveying	N	N	Y	N	Y
Seabed sampling, coring	Y	N	Y	N	Y
Faunal sampling at seabed	Y	N	Y	N	Y
CTD	Y	N	Y	N	Y
Lander	N	N	Y	N	Y

1. General information

1.1 Cruise name and/or number: RRS JAMES COOK JC060

1.2 Sponsoring institution:

Name: NOCS/NERC

Address: European Way, Southampton, SO14 3ZH

Name of director: Ed Hill

1.3 Scientist in charge of the project:

Name: Dr. Veerle Huvenne

Address: Marine Geosciences, NOCS, European Way, Southampton, SO14 3ZH

Telephone: ++44/2380/596575

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1.4 Scientist(s) from Iceland informed of the planning of the project

Name:

Address:

1.5 **Submitting officer:**

Name: R. Plumley, NERC NMF SS, National
Oceanography Centre, European Way, Empress Dock,
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2. Description of project (Attach additional pages as necessary)

2.1 Nature of objectives of the project:

OCEANS 2025 Theme 5 and MAREMAP, Hatton/Rockall, 2010

This cruise is part of the original field programme for Theme 5 of Oceans 2025, will contribute to the ERC CODEMAP project and most of all, is the first deep-water cruise of the new MAREMAP initiative.

The main objectives are:

- To investigate how benthic ecosystems on continental margins and in the deep ocean respond to spatial and temporal variation in environmental parameters.
- To apply scientific knowledge to the sustainable management of the ocean and its resources.
- To investigate the formation of polygonal fault systems, and the potential association with fluid flow processes.

These objectives will be addressed through the study of four distinct biological/geological topics in the Hatton-Rockall area, between 56 and 61° N and 5 and 18° W, to the northwest of the UK:

- assessment of the recovery (if any) of the Darwin Mounds cold-water coral patches since they were given protection from trawling in 2003
- the environmental conditions that sustain cold-water coral growth on steep topography
- fluid seepage from polygonal faults that reach the seabed in the Hatton-Rockall Basin
- assessing the impact of trawling fisheries on the deep-water banks in the area.

1. Recovery of the Darwin coral mounds since protection from trawling in 2003

The Darwin Mounds are a field of small cold-water coral mounds or patches, each up to 75 m in diameter and 5 m high, which occur at 1000 m water depth in the northern Rockall Trough, NW of the UK. They were discovered in 1998 (Masson et al, 2003) and received protected status in 2003. At the time of their discovery, they had been moderately impacted by bottom trawling, with some mounds undamaged while others were totally trashed (Wheeler et al, 2005). However, it appears as if the area was particularly heavily trawled in the months prior to protection (Davies et al., 2007). Since no subsequent observations have been made, the current state of the mounds is unknown.

Our aim will be to establish how well the coral survived the trawling 'surge' prior to the area being closed to fishing, how effective the trawling ban has been, and to assess the recovery of the coral habitat. New high-resolution sidescan sonar and swath bathymetry datasets will be collected with a well-navigated deep-water platform (Autosub6000). They will be compared to data collected between 1998 and 2002 to look for changes in the coral cover of individual mounds. This remote sensing data will be groundtruthed using the Hybis vehicle. Established growth rates for cold-water corals range from 0.5 to 3 cm yr⁻¹ (Gass and Roberts, 2006). Thus any new colonies growing, for example, on coral debris resulting from trawling damage, should be clearly identifiable using the high-

definition video system. Well-positioned samples, collected either with Hybis or using a small ROV, will allow to establish the genetic source area of any potential coral recolonisation.

The Darwin Mounds are developed on the upstream flank of a large sediment drift body, while an extensive field of pockmarks are found on the downstream flank. It is still not clear if both sets of features may be related, e.g. representing different outcomes of fluid expulsion from the seabed (Masson et al., 2003; Huvenne et al., 2009). Detailed chirp profiles, recorded simultaneously with the sidescan sonar and/or multibeam surveys, will give insight in the structure of the sub-seafloor stratigraphy and will illustrate any potential fluid flow pathways. The seismic data will be groundtruthed with well-placed piston cores.

The Wyville-Thomson Ridge and The Faroe-Shetland Channel / Faroe Bank Channel junction region has the highest diversity of deep-water habitat types in UK waters (Masson et al., 2004), due to the extensive occurrence of hard substrata (contourite; sand lenses / channels / barchans / gravel beds / cobble pavements). Hard substratum habitats may require statutory protection under the EC Habitats Directive and part of the Wyville-Thomson Ridge is currently under consideration as a Special Area of Conservation. In addition, this ridge forms the boundary between two water masses of different age and temperature/salinity, and is a potential key area for studies on the deep-sea effects of ocean acidification. The proposed cruise offers opportunities to further understand both aspects in this area.

2. Environmental controls on cold-water coral growth on steep topography

The main aim of an integrated spatial and (short) temporal survey of the near-vertical cold-water coral habitats on the east flank of Rockall Bank is to further constrain and quantify the critical environmental conditions necessary for cold-water coral growth. Until now, cold-water corals have mainly been studied in reef-like settings where the interplay between current regime, sediment dynamics and food availability determine the coral habitat structure, abundance and reef-building potential (e.g. Mienis et al., *subm.*; Huvenne et al., 2005). However, there are other sites of significant coral occurrence in UK deep waters; Rockall Bank is key among these (Davies, et al., 2006). Here, corals have been reported from steep or even near-vertical slopes where the controlling factors may have different limits, setting different constraints on the occurrence of these filter feeders. For example, frequent downslope sediment flows may seriously limit the areas available for colonisation.

The main aim of the proposed work is to map the coral habitat structure on near-vertical settings, and its relation to the overall terrain morphology. In addition, we aim to measure the particle load advected to the cold-water corals, in order to determine the role of the local sediment dynamics and to test the model for the food source of coral communities on the lower flanks of submarine banks proposed by White et al (2005).

3. Fluid seepage from polygonal faults

Sub-seafloor polygonal faulting is a widespread phenomenon affecting sedimentary basins worldwide (Cartwright et al, 2003). It is commonly believed that polygonal faulting is the result of sediment contraction and fluid expulsion. If, as suspected, active fluid expulsion is responsible for these features, then the composition and flux of this fluid will have a substantial impact on our understanding of the global ocean geochemical budget and carbon cycle. Recent investigations of the Hatton Bank have revealed an unprecedented region of polygonal structures that are, uniquely, exposed at the sea floor. Subsequent analysis of pre-existing seismic data reveals that these polygons occur within most of the Hatton Basin. They affect the top 500 to 700 m of sediments and are the first seabed polygons of this size and clarity to be observed (Berndt et al., 2006). The fact that polygonal deformation in the Hatton Basin reaches the seabed suggests that the formation of the polygons is ongoing. Possible carbonate crusts seen in seabed video footage suggest that fluid flow may also be occurring at the present day.

We will map the faults in detail with AUV-based high-resolution sidescan sonar, chirp profiler and multibeam, to understand their morphology, spatial distribution and subsurface connection. The proposed work will provide new constraints on the different proposed hypotheses for the development of polygonal faults (syneresis, residual shear strength faulting, density inversion, or gravitational collapse; see Cartwright et al., 2003 for a recent review). Constraining the processes of fluid flow through these structures will affect our understanding of slope stability, the marine component of the carbon cycle, and hydrocarbon reservoir integrity. Ground-truthing will be carried out with the Hybis vehicle, which will provide high-definition video footage and well-positioned samples. If the expelled fluids transport significant amounts of carbon (as suggested by possible carbonate crusts seen in preliminary seabed video footage), the focusing of these fluids may sustain chemosynthetic benthic ecosystems. Sustainable management of such ecosystems depends on our understanding of their distribution and drivers. In addition, because the amount of expelled fluids may be extensive and even small concentrations of carbon within the expelled fluids would result in large total fluxes, the carbon flux from these systems could have an impact on models of the North Atlantic's carbon cycle, biogeochemistry and predictions for climate change.

4. Fisheries impacts on Hatton and Rockall Bank

The deep-water banks north-west of the UK are well-known fishing grounds for an international fishing fleet (e.g. Durán-Muñoz et al., 2009). A large proportion of this fishing activity is based on deep-sea trawling, which is one of the most destructive fishing methods world-wide. As the importance of ecosystem-based management is increasing, and the idea of deep-water Marine Protected Areas is becoming more common, there is an urgent need for a status assessment of the various benthic habitats in those areas. Based on an evaluation of VMS data from the past years, a comparison will be made between areas with minimal impact and areas with a very high trawling frequency. The pattern of trawl marks will be mapped, sediment cores will provide evidence for the depth of sediment disturbance and video surveys will allow to identify differences in benthic communities. The resulting conclusions will support future conservation measures, and will form the basis of a monitoring strategy for deep-water trawled areas.

2.2 Relevant previous or future research cruises:

Previous cruises in the area (amongst others): RV Colonel Templar cruises 01 and 02/98; Charles Darwin 112, 119 and 123; Discovery 248

2.3 Previously published research data relating to the project:

References

- Berndt, C., Jacobs, C., Gay, A., Hitchen, K., and Long, D., 2006. Km-scale polygonal seafloor depressions in the Hatton Basin: New clues on the origin of polygonal fault systems, EGU General Assembly: Vienna, Austria.
- Cartwright, J.A., James, D., and Bolton, A., 2003, The genesis of polygonal fault systems: a review, *in* van Rensbergen, P., Hillis, R.R., Maltman, A., and Morley, C.K., eds., *Subsurface Sediment Mobilization*, Volume 216, Geological Society London, 223-243.
- Davies, A.J., Narayanaswamy, B.E., Hughes, D.J. & Roberts, J.M., 2006. An Introduction to the Benthic Ecology of the Rockall - Hatton Area (SEA 7). Department of Business Enterprise and Regulatory Reform, London. (www.offshore-sea.org.uk/consultations/SEA_7/).
- Davies, A.J., Roberts, J.M. and Hall-Spencer, J., 2007. Preserving deep-sea natural heritage: emerging issues in offshore conservation and management. *Biological conservation*, 138: 299-312.
- Gass, S.E. and Roberts, J.M. 2006. The occurrence of the cold-water coral *Lophelia pertusa* on oil and gas platforms in the North Sea: Colony growth, recruitment and environmental controls on distribution. *Marine Pollution Bulletin* 52, 549-559.
- Huvenne, V.A.I., Beyer, A., de Haas, H., Dekindt, K., Henriot, J.P., Kozachenko, M., Olu-Le Roy, K., Wheeler, A.J. and the TOBI/Pelagia 197 and CARACOLE cruise participants, 2005. The seabed appearance of different coral bank provinces in the Porcupine Seabight, NE Atlantic : results from sidescan sonar and ROV seabed mapping. In: A. Freiwald and J.M. Roberts (Editors), *Cold-water corals and ecosystems*. Springer-Verlag, Heidelberg, pp. 535-569.

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- Huvenne, V.A.I., Masson, D.G. and Wheeler, A.J., 2009. Sediment dynamics of a sandy contourite: the sedimentary context of the Darwin cold-water coral mounds, Northern Rockall Trough. *International Journal of Earth Sciences*, 98(4): 865-884. doi: 10.1007/s00531-008-0312-5
- Masson, D.G., Bett, B.J., Billett, D.S.M., Jacobs, C.L., Wheeler, A.J. and Wynn, R.B. 2003. A fluid escape origin for deep-water coral-topped mounds in the northern Rockall Trough. *Marine Geology* 194, 159-180.
- Masson, D.G., Wynn, R.B. & Bett, B.J., 2004. Sedimentary environment of the Faroe-Shetland and Faroe Bank Channels, north-east Atlantic, and the use of bedforms as indicators of bottom current velocity in the deep ocean. *Sedimentology*, 51, 1207-1241.
- Mienis, F., de Stigter, H.C., de Haas, H. and van Weering, T.C.E., 2009. Near-bed particle deposition and resuspension in a cold-water coral mound area at the Southwest Rockall Trough margin, NE Atlantic. *Deep-Sea Research I*, 56(6): 1026-1038. doi:10.1016/j.dsr.2009.01.006
- Wheeler, A.J., Bett, B.J., Billett, D.S.M., Masson, D.G. and Mayor, D., 2005. The impact of demersal trawling on NE Atlantic deep-water coral habitats: the case of the Darwin Mounds, UK. In: P.W. Barnes and J.P. Thomas (Editors), *Benthic habitats and the effects of fishing*. America Fisheries Society, Bethesda, Maryland, pp. 807-817
- White, M., Mohn, C., de Stigter, H. & Mottram, G. (2005). Deep-water coral development as a function of hydrodynamics and surface productivity around the submarine banks of the Rockall Trough, NE Atlantic. In: Freiwald, A. & Roberts, J.M. (Eds.). *Cold-water corals and ecosystems*. Springer-Verlag, Heidelberg, 503-514.

3. Methods and means to be used

3.1 Particulars of vessel

Name: RRS James Cook
Nationality: British
Owner: NERC
Operator: NMF SS
Overall Length: 86.20 metres
Maximum draught: 6.7 metres
Net tonnage: 1620 **Gross tonnage:** 5401
Propulsion: Motor
Cruising Speed: 11 knots **Maximum speed:** 15 knots
Call sign: MLRM6
Method of capability of communication (including telex, frequencies):
Inmarsat Voice: 764538468 **Fax:** 764538470 **Telex:** 423501712=jame x
SAT C Number: 423501712
Name of Master: TBA
Number of Crew: 23
Number of Scientists on board: 31
MMSI: 235010700

3.2 Aircraft or other craft to be used in the project: Autosub6000 AUV

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3.3 Particulars of methods and scientific instruments

Types of samples and data	Methods to be used	Instruments to be used
Bathymetric data, seabed reflectivity	Multibeam echosounder, sidescan sonar, chirp profiler	Shipborne EM120 and SBP120, Autosub6000 AUV equipped with SM2000 multibeam and EdgeTech sidescan sonar & chirp
Video Surveying	Towed or ROV-based video & photo cameras	Hybis, SHRIMP, potentially a Mohican-style ROV
Seabed sediment samples	Variety of coring devices	ROV push cores, Megacorer, Boxcorer, Piston Corer
Samples of benthic fauna	Coring and ROV-based manipulator work	Megacorer, Boxcorer, Hybis or ROV
Conductivity, Temperature, Fluorescence, Oxygen content of water mass	CTD profiling	CTD frame + sensors, CTD on Autosub6000
Continuous record of currents, temperature & photographs	lander	SAMS microlander (short deployments), potentially Bathysnap

3.4 Indicate whether harmful substances will be used:

No harmful substances will be put into the water or on the seabed. Potentially hazardous substances will be taken on board for on-board experiments. A list is currently being compiled.

3.5 Indicate whether drilling will be carried out: None

3.6 Indicate whether explosives will be used: None

4. Installations and equipment

Details of installations and equipment (dates of laying, servicing, recovery; exact locations and depth):

Short-term deployments of the SAMS Microlander ("Suil na Mara") in study areas 1, 2 and 4 (~1 week each, depending on weather conditions) (see map below)

Potential deployment of a Bathysnap-style lander in study area 1, to be recovered after ca. 1 year (currently under discussion with JNCC).

Potential deployment of marker (type: glass sphere float on 10 m rope & weight) at the seabed in the Darwin Mound area (study area 1) to help future monitoring activities. Also under discussion with JNCC.

5. Geographical areas

5.1 Indicate geographical areas in which the project is to be conducted (with reference in latitude and longitude)

Study areas (see boxes on map):

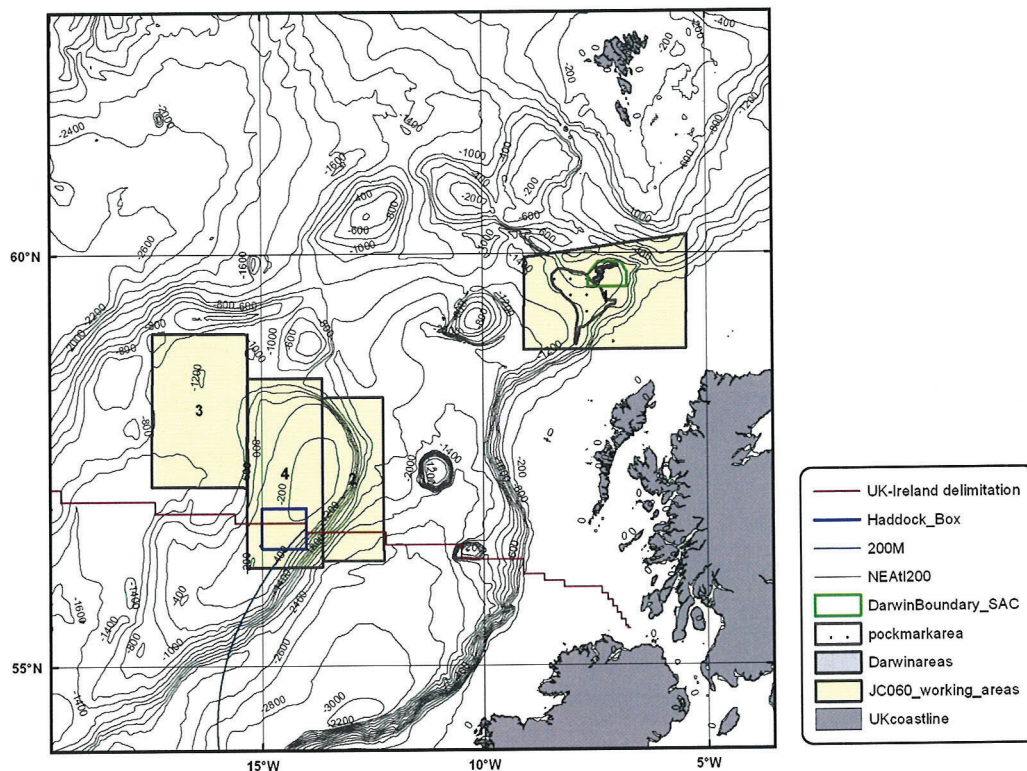
1. Darwin Mound area, N Rockall Trough
2. East Rockall Bank
3. Hatton Basin
4. Rockal Bank

Overall study area: UK and Irish waters between 56° – 61° N and 5° – 18° W.

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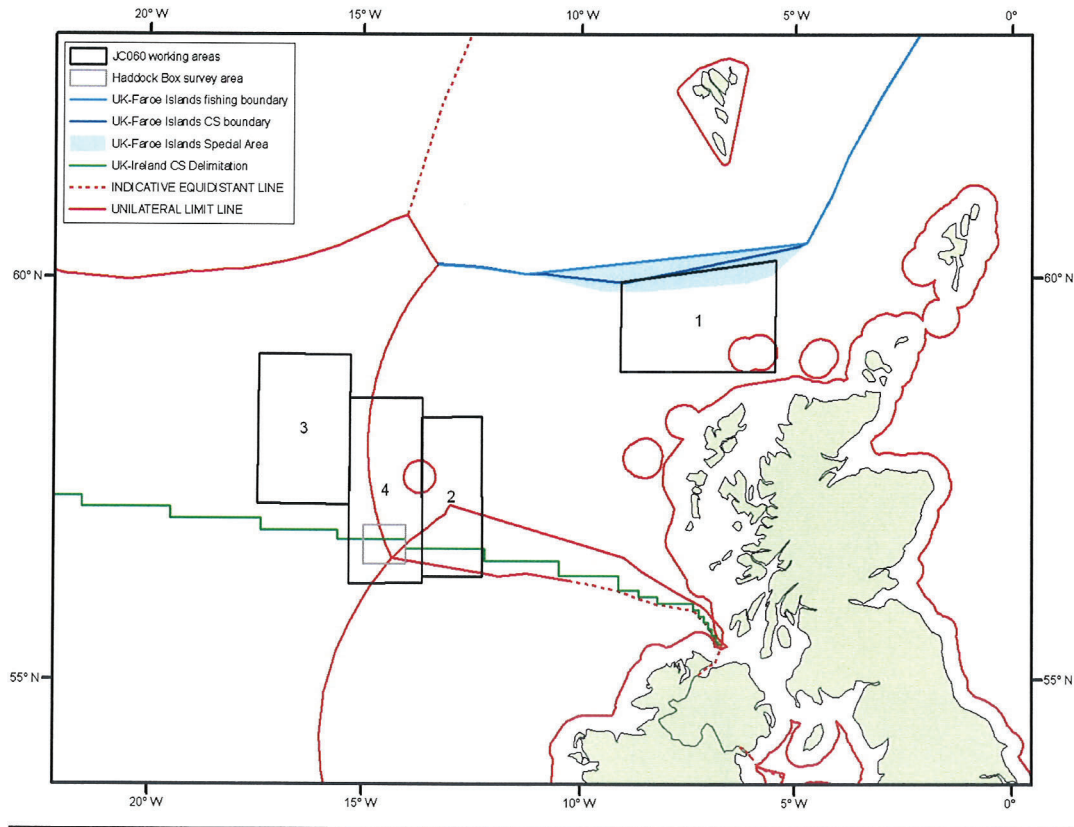
Box no	Lat (dec degr N)	Long (dec. degr. W)
1	58.89457894710	-9.08883050993
1	59.95444066630	-9.06775535704
1	60.20593571840	-5.44347912236
1	58.89457894710	-5.46839965820
1	58.89457894710	-9.08883050993
2	58.33942148310	-12.25908583260
2	56.34314456460	-12.24726918150
2	56.34508850100	-13.62508911130
2	58.33535620170	-13.63129456650
2	58.33942148310	-12.25908583260
4	58.57065545840	-13.62009285750
4	56.26233216020	-13.62009285750
4	56.25264860560	-15.33371445520
4	58.57065545840	-15.30761869480
4	58.57065545840	-13.62009285750
3	59.09813812260	-17.43813842770
3	59.08813779080	-15.30129100280
3	57.26000000000	-15.33277038570
3	57.27053010020	-17.46961781070
3	59.09813812260	-17.43813842770

5.2 Attach chart (s) at an appropriate scale showing the geographical areas of the intended work and, as far as practicable, the positions of intended stations, the tracks of survey lines, and the locations of installations and equipment



Exact positions and survey lines will be decided upon depending on weather conditions and sampling results.

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DIP CLEAR INFORMATION

UNCLOS Group, NOC, Southampton – 26th November 2010

CRUISE: RRS James Cook, Leg JC060

PSO: Veerle Huvenne

Introduction and General Comments

The attached map shows the proposed survey areas for cruise JC060, with indicative maritime limits of all the countries whose waters the ship passes through.

Specific Comments

Survey box areas are located within the 12M and 200M limits of the United Kingdom and within 200M of Republic of Ireland and would necessitate clearance requests.

Areas beyond the 200M limits are in an area that is subject to: (a) a Continental Shelf submission made by the United Kingdom according to Article 76 of UNCLOS, (b) a Continental Shelf submission made by the Republic of Ireland according to Article 76 of UNCLOS, and (c) Continental Shelf submissions in preparation by the Faroe Islands and Iceland. Following the intent of paragraph 1 and paragraph 3 of Article 77 of UNCLOS, and in accordance with Article 246, diplomatic clearance applications for this area should be addressed to Iceland and the Faroe Islands as well as to the UK and the Republic of Ireland.

In accordance with Article 257, however, and in respect of waters beyond 200 M, scientific research conducted only in the water column does not require a request for clearance.

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Please note:

The maritime limits shown on this figure are for illustrative purposes only, but are representative of States' juridical areas. Should detail of specific lines be required, please advise the UNCLOS Group.

6. Dates

6.1 Expected dates of first entry into Iceland and final departure from research area of the research vessel:

Expected first entry 11 May 2011
Expected final departure 09 June 2011

6.2 Indicate if multiple entry is expected:

Potentially, depending on the results obtained in each of the study areas

7. Port calls

7.1 Dates and names of intended ports of call in Iceland:

None

7.2 Any special logistical requirements at ports of call: None

7.3 Name/Address/Telephone of shipping agent (if available):

N/A

8. Participation

8.1 Extent to which Iceland will be enabled to participate or to be represented in the research project:

The project is designed, managed and executed by UK researchers, funded by NERC, and carried out by partners from NERC/NOCS, SAMS, University of Aberdeen, University of Plymouth, Heriot-Watt University, JNCC, CEFAS.

8.2 Proposed dates and ports for embarkation/disembarkation:

Embark: Birkenhead, UK: 5th – 9th May 2011
Disembark: Birkenhead, UK: 12th – 13th June 2011

9. Access to data, samples and research results

9.1 Expected dates of submission to Iceland of preliminary reports which should include the expected dates of submission of the final results:

Reports will be submitted to BODC and NOCS library
Six months after completion of Cruise

9.2 Proposed means for access by Iceland to data and samples:

Through contact with either BODC or chief scientist

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- 9.3 Proposed means to provide Iceland with assessment of data, samples and research results or provide assistance in their assessment or interpretation:**

Through contact with either BODC or chief scientist

- 9.4 Proposed means of making research results internationally available:**

Publication of research papers

Potentially publication of status report for the Darwin cold-water coral area – currently under discussion with JNCC.

.....(On behalf of the Principal Scientist

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