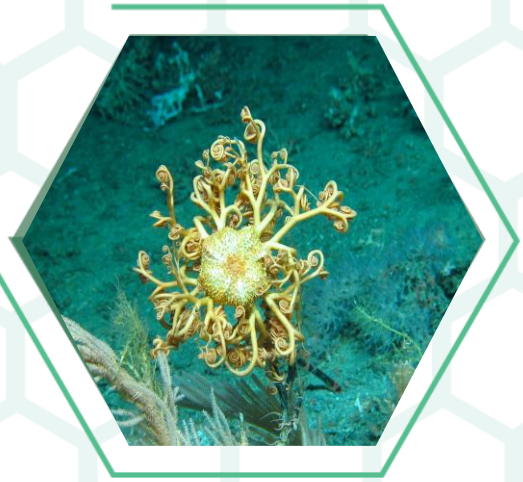
EMFF Operational Programme 2014-2020

Marine Biodiversity Scheme

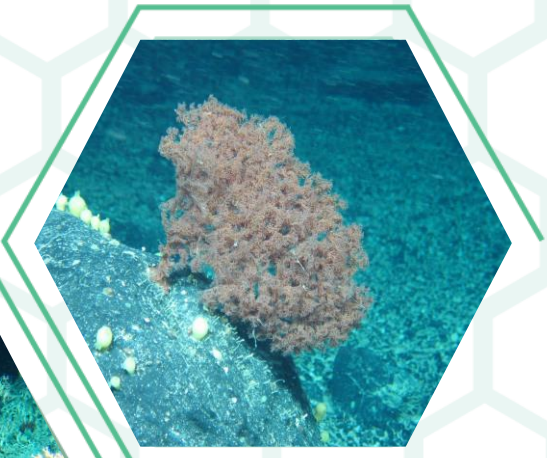
Assessment of Fisheries / Habitat interaction on offshore reefs

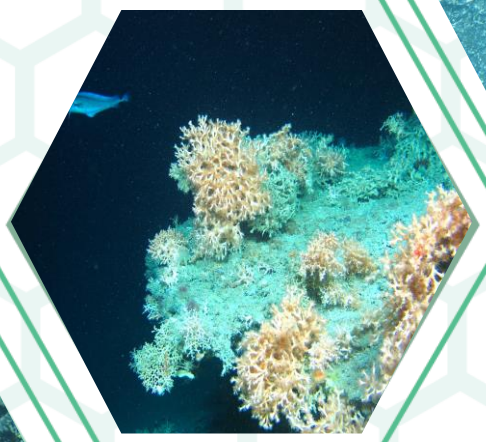


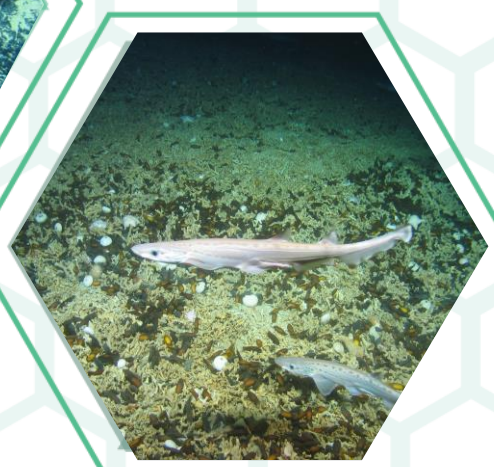
EMFF Off-shore Reef Survey

SEAROVER Cruise Report

2018







Authors: O'Sullivan D, Leahy Y, Healy L & the Shipboard Scientific Party

Marine Institute
Foras na Mara

Marine Biodiversity Scheme

Sustainable Development of Fisheries Fostering the Implementation of the Integrated Marine Policy

EMFF Offshore Reef Survey

Sensitive Ecosystem Assessment and ROV Exploration of Reef

SEAROVER 2018 Cruise Report

Irish Lights Vessel *Granuaile*

July 2nd – 22nd 2018

Ireland's EU Structural and Investment Funds Programmes 2014 - 2020
Co-funded by the Irish Government and the European Union

An Roinn Talmhaíochta, Bia agus Mara
Department of Agriculture, Food and the Marine

EUROPEAN UNION
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An Roinn Cultúir, Oidhreachta agus Gaeltachta
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Marine Institute

INFOMAR
Integrated Mapping for the Sustainable Development of Ireland's Marine Resource

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CONTENTS

Figures & Tables

EXECUTIVE SUMMARY

This report presents preliminary findings of a 2018 offshore reef survey of Ireland's Northwest continental margin and Rockall Bank. The survey is part of an extensive three year project, beginning 2017, that is coordinated and led by Ireland's Marine Institute and INFOMAR (Integrated Mapping for the Sustainable Development of Ireland's Marine Resources) and funded by the European Maritime and Fisheries Fund (EMFF) Marine Biodiversity Scheme and the National Parks and Wildlife Service (NPWS).

The objectives of the project are to implement the EMFF's Marine Biodiversity Scheme - Natura Fisheries by mapping offshore reef habitats with a view to protecting them from deterioration due to fishing pressures. The reef project aligns with sub-article 6.2 of the Habitats Directive (EC 92/43/EEC) which requires member states to take measures to avoid deterioration of protected habitats. The overarching aim is to quantify the abundance and distribution of offshore biogenic and geogenic reef habitat in Irish waters to fulfil Ireland's legal mandate and to generate baseline data from which appropriate monitoring of Reef habitat within Special Areas of Conservation (SAC) can be established. The initial survey in July 2017 (O'Sullivan et al. 2017) primarily focussed on the Continental margin west and northwest of Ireland.

The second survey leg took place in July 2018 aboard the ILV *Granuaile*. The survey vessel was equipped with the Marine Institute's remotely operated vehicle (ROV) *Holland 1* to observe seabed features and biological associations along the northwest continental shelf and the eastern flank of the Rockall Bank. The *Holland 1* employs high-definition (HD) camera, various composite video feeds and a robotic arm to facilitate sample collection. The primary scientific objective was to map the distribution and abundance of geogenic and biogenic reef habitat along two separate survey areas with HD video. Secondary objectives included the collection of biological samples for genetic and population analysis and the collection of sediment cores for ground-truthing acoustic seabed mapping data and analysis of micro-plastics within deep-water sediment.

Following methodologies established during 2017, survey transects were pre-selected in consultation with National Parks and Wildlife Service. Selection criteria included depth range, areas of highly sloping terrain, geographical spatial discreteness, historical fishing activity, historical scientific studies and the presence or absence of certain target

geomorphological features which include canyons and canyon walls, escarpments and carbonate mounds.

Fifty two transects were surveyed. The vessels travelled 2173 km, 119 hours were spent sampling and recording HD video on the seabed. The ROV surveyed 119.75 km of seafloor whilst collecting 34 biological specimens and 44 sediment samples. In addition the survey:

- Identified biologically sensitive Annex 1 reef-forming, cold-water coral species (*Lophelia pertusa* and *Madrepora oculata)* at numerous locations.
- Identified a potentially novel species of Antipatharia (Black Coral) of the Genus Stauropathes at three separate locations and species of Octocoral & Black Coral previously unrecorded in Irish waters.
- Observed rare specimens of Hydroids and Relicanthids previously unrecorded in the northeast Atlantic.
- Recorded essential habitat within an SAC, evidenced by a large school of blackmouth catshark, *Galeus melastomus,* in association with large numbers of egg-cases.
- Sightings of the rare Roughskin sail shark, *Oxynotus paradoxus* on the Porcupine and Rockall Bank.
- Explored geological features previously undocumented on Ireland's north-west continental shelf e.g. canyons, steep cliff faces and rock-overhangs.
- Provided biological samples to the Marine Biodiscovery programme at NUI Galway and the DeepLinks project at Plymouth and Oxford University to study the ecological diversity of the North Atlantic Ocean.

The findings of the SeaRover survey will contribute to the provision of conservation objectives for the offshore Special Areas of Conservation (SAC) work carried out by NPWS and will fulfil the Department of Agriculture, Food and Marine (DAFM) obligations to map vulnerable fisheries resources. The survey data will improve our understanding of the extent of sensitive ecosystems in Irish waters and broadens our understanding of the ecological requirements for these environments in support of the sustainable management of Ireland's marine resources.

Keywords: Offshore reef habitat, Irish continental margin, cold-water coral, *Lophelia pertusa*, *Galeus melastomus*

1. Introduction

Offshore reef is an Annex I habitat (Habitat Code: 1170) under the European Union (EU) Directive on the conservation of Habitats, Flora and Fauna (92/43/EEC) and is therefore afforded protection under this directive. Commonly known as the Habitats Directive, this directive which was transposed into Irish Law as the European Communities (Birds and Natural Habitats) Regulations 2011 (S.I. No. 477/2011), requires that each EU member state introduce a range of measures for the protection and monitoring of the conservation status of habitats and species listed in Annex I, II & IV of the directive. In its most recent report Ireland's Department of Arts, Heritage and the Gaeltacht assessed the Annex I habitat Reef as Unfavourable/Bad with an on-going decline (NPWS 2013). The report also identified significant data gaps relating to the Area, Range, Structure & functions and potential pressures within the assessment.

A requirement to quantify the quality and distribution of offshore reef habitat in Irish waters to fulfil Ireland's legal mandate and to generate baseline data from which appropriate monitoring procedures could be established, was identified as high priority by NPWS. In response to this requirement an extensive offshore reef survey of Ireland's northwest continental shelf edge was commissioned and funded by EMFF, DAFM & NPWS and coordinated and led by Ireland's Marine Institute and INFOMAR and subsequently named SeaRover (Sensitive Ecosystem Assessment & ROV Exploration of Reef).

The survey team employed the Marine Institute's ROV *Holland 1* to collect high definition video footage, biological and sediment samples. Areas of focus included seabed features comprising of sea-mounds, canyons and escarpments as well as areas of low fishing effort to allow study on the health of these sensitive ecosystems. The survey revisited the North-west Porcupine Bank and Rockall Bank SACs which had been previously surveyed in 2009 (Guinan & Leahy 2009) and also explored additional adjacent areas for the first time. This data will be used to set site specific conservation objectives for this SAC, for monitoring purposes and to evaluate change due to anthropogenic activities.

1.1 Objectives

The primary objective of SeaRover was to map the distribution and quantify the extent and quality of geogenic and biogenic reef habitat within Ireland's EEZ using a ROV with HD video and to collect biological and sediment samples where possible. The findings of the survey will assist investigations into species population dynamics and marine biodiscovery with a view to cataloguing novel species which may be used to identify and develop natural products and other biomaterials for application in areas such as drug discovery and biomedical research. Secondary objectives include the collection of sediment samples to ground-truth INFOMAR acoustic backscatter data and a separate study by National University of Ireland Galway (NUIG) to analyse the levels of micro-plastics within benthic sediment.

2. Methods

Survey methods were developed during the initial NPWS ROV survey in 2009 and refined during SeaRover 2017 (further details in O'Sullivan et al. 2017).

2.1 Survey Vessel

The ILV *Granuaile* was chartered for 21 days in July 2017 and again July 2018. The multifunctional vessel is 79 m in length, 2625 t and fitted with a Class 1 dynamic positioning linked to a satellite-based navigation system. For the duration of the survey the onboard conference room was used as a working scientific party base whilst the back deck housed two storage containers fitted as a wet lab for scientific sample processing and two containers for the ROV control centre and workshop and also the launch and recovery platform for the ROV itself including hydraulic A-frame & winch. In 2018 additional cable was added to extend the operational depth of the ROV to 3000 m.

2.2 Site Selection

Whilst the 2017 survey area extended continuously along the continental margin (from south of the Hebrides Terrace Seamount to north of the Porcupine Bank), two distinct areas were surveyed in 2018. Leg 1 explored the South-east Rockall Bank SAC and the eastern slope of the Rockall Bank within Ireland's EEZ .The Rockall Bank rises along the western flank of the Rockall Basin from ~2500 m to 500 m. Bathymetric data suggests the presence of geomorphological features of interest including canyons and carbonate mounds. Guinan & Leahy (2009) recorded biogenic and geogenic reef formations on the bank which were used to guide the 2018 survey. The second leg extended the 2017 survey area south along the Porcupine Bank at the continental margin. This area is characterised by steep slopes and canyon systems incising the shelf at ~150 m extending down-slope to the floor of the Rockall Basin at ~3000 – 4000 m (Sacchetti et al. 2012). In addition, features of interest evident in the bathymetric data were surveyed on the continental shelf extending eastward into the Hovland Mound SAC within which four transects were carried out.

Search criteria, employed to identify smaller survey units or transects, were determined in 2017 and repeated here. Namely to target areas of:

- steeply sloping terrain
- historically low fishing effort which are more likely to be ecologically preserved.
- historically low scientific studies/surveys.

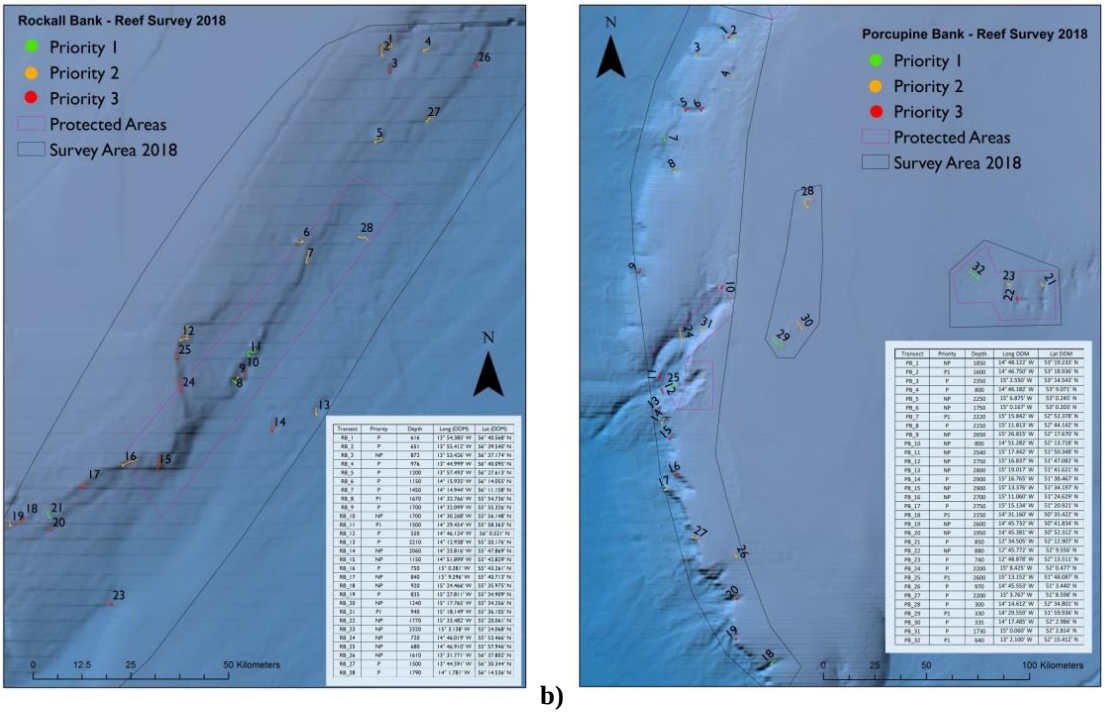
Additionally target areas would:

- be spatially discrete along the shelf-edge giving a full geographic spread.
- contain the presence of one or more target morphological features identified with cold-water coral reef habitat including terraces, gullies, steep-sided canyon walls, escarpments, ridges, mounds and cobble fields.

A Geographic Information System (GIS) spatial database was created in ArcMap 10.2 and populated with known records from a number of sources. These sources were:

- Irish National Seabed Survey (INSS) - provided offshore bathymetry data used to target seabed features associated with cold-water coral reef and made available through the national seabed mapping programme INFOMAR.
- NPWS - commissioned an extensive desktop report and supporting GIS (Forde et al. 2017). The report collated existing spatial data on offshore reef habitat and included scientific data from previous surveys and was extensively consulted for the current survey.
- FEAS (Marine Institute) – provided historical fisheries data comprised of electronic Vessel Monitoring System (VMS) logbook data from all boats fishing in Irish waters from 2005 to 2015 which indicates where fishing effort is concentrated.
- Atlas of the deep-water seabed: Ireland (Dorschel et al. 2010).
- Marine Biology and Ecology Research Centre, University of Plymouth - predictive modelling of species distributions has indicated the possible presence of various Vulnerable Marine Ecosystems (VMEs) including *Lophelia pertusa* reefs, *Pheronema carpenteri* aggregations and xenophyophore / seapen aggregations within the survey area (Ross & Howell 2013; Ross et al. 2015). Some of these areas were chosen in order to validate the predictive models and assess their performance.

Based on the above criteria 28 target areas (RB01 – RB28) were identified on the Rockall Bank of which 22 were surveyed (Figure 1a). During the second leg on the Porcupine Bank, 30 sites from 32 initial target sites of interest (PB01 – PB32) were surveyed and are described in Figure 1b. Dives completed in 2017 and those transects proposed for study in 2018 are shown in Figure 2.



a) **b)**

Figure 1. Pre-survey SeaRover 2018 target transects on a) the Rockall Bank & b) Porcupine Bank.

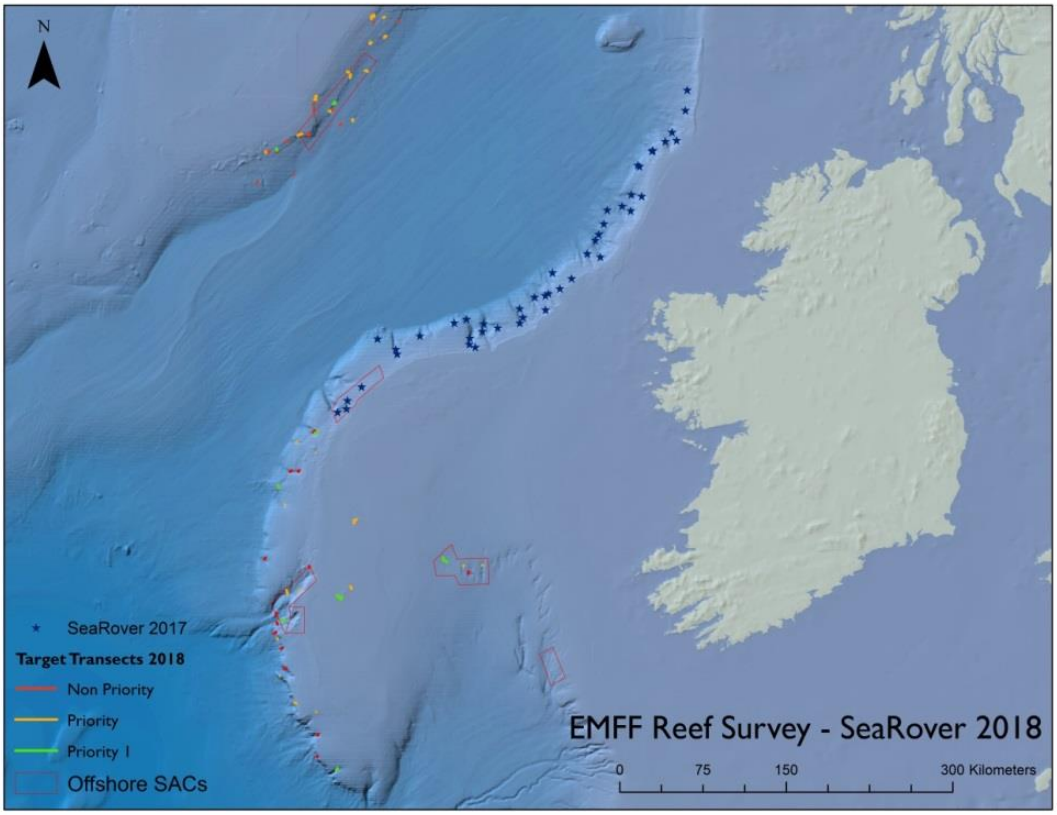


Figure 2. Location of completed 2017 survey transects (navy stars) and proposed 2018 transects within the northeast Atlantic.

2.3 Remotely Operated Vehicle

The Marine Institute's ROV *Holland 1* is a SMD Quasar Hydraulic work-class 100 hp hydraulic vehicle. The vehicle is operated from a dedicated launch and recovery system consisting of a winch carrying 4000 m of main lift wire plus an A frame. An additional 1000 m of cable was fitted since the 2017 survey which increased maximum depth range to 3000 m. The ROV descends at ~ 30 m/min and is flown along a pre-determined transect line 1-2m above the seabed. A range of sensors, including sonar, altimeter, depth, gyrocompass and doppler log are also fitted.

The ROV has two manipulator arms for sample collection and a retractable tool sled carries sample drawers for stowage and sampling tools (push-cores and scoops). The vehicle is fitted with a high-definition television camera (recording in 1080i resolution), up to 7 phase alternating line video cameras plus a 5 mega-pixel digital stills camera fitted with a flash. Illumination for the cameras is primarily provided by two 400 W hydrargyrum medium-arc iodide lights.

The ROV underwater positional information is recorded using an Ultra Short Baseline (USBL) system with a transponder/responder fitted onto the ROV frame. The USBL system calculates the position of the ROV by measuring the range and bearing from a vessel-mounted transceiver to an acoustic transponder. In addition to an acoustic transceiver and in-water transponders, the USBL system includes attitude sensors for the accurate determination of vessel pitch, roll and heading.

2.4 Real-time video data acquisition and processing

Ocean Floor Observation Protocol (OFOP) is a software package developed to facilitate real-time visual observations of video data acquired during the deployment of ROVs and TV-sled tows. OFOP reads a variety of position data including the Global Acoustic Positioning System (GAPS) underwater navigation system. Biological observations are logged to individual dive protocols during ROV operations.

Button Files provide the user with a list of geomorphological and biological groupings as well as species which can be used to identify and characterise habitat types from the video footage. OFOP 'button files' were edited to account for survey knowledge and practise acquired during the 2009 and 2017 surveys (Guinan & Leahy 2009, O'Sullivan et al. 2017). Faunal groupings were left at high taxonomic level to achieve more consistent identification through-out the cruise and only those species which were likely to be present and accurately identified were included. A number of descriptors indicating anthropogenic disturbance were also employed.

2.4 Sediment Sampling

Sediment samples were gathered opportunistically by the ROV but generally at the beginning of each dive. A 30 cm long hollow tube with a diameter of 8 cm is used to extract a sediment core which can be recovered to the surface. Cores can only be extracted in areas of primarily muddy sediment. Coarse sand may not be retained in the core whilst areas of harder ground might prevent penetration of the core into the seafloor.

Duplicate samples were taken where possible. One sample is used to ground-truth acoustic backscatter data collected by INFOMAR. It is not necessary to retain any layers within the sediment core and instead the entire sample is analysed onboard (colour, sorting, clade, biogenics composition) and retained for Particle Size Analysis (PSA) at a later date.

A second duplicate core sample was retained and sliced into 5 cm sub-samples for analysis into the proliferation of micro-plastics within benthic sediments in NUIG.

2.5 CTD Sampling

Conductivity, temperature and depth (CTD) measurements were acquired directly from the ROV using SBE Data Processing software which consists of modular, menu-driven routines for converting, editing, processing, and plotting of oceanographic data acquired with Sea-Bird profiling CTDs and thermosalinographs.

3. Results

3.1 ROV dive summary

The *Granuaile* was operational for 88.2% of the survey duration. The *Holland 1* spent 119 hours sampling at depth (see Table 1) and generated 6.54 TB of data including 5.63 TB of HD video footage (Table 2).

Cumulative Survey Statistics

Category	Percentage	Days/H/M
Port Call	4.05	00:19:30
Weather Standby	0.00	00:00:00
Sampling	24.68	04:22:56
Standby	0.00	00:00:00
Transit	39.00	07:19:58
Survey Operations	24.51	04:22:08
Support Operations	1.96	00:09:27
Downtime Survey	3.08	00:14:51
Downtime Vessel	2.72	00:13:07
Total:	100.00	20:01:59

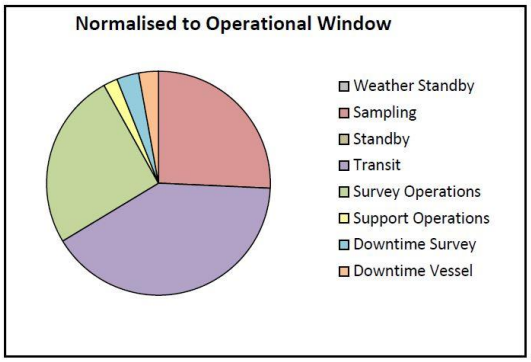


Table 1. Cumulative SeaRover survey statistics. 'Survey Operations' (deployment and recovery time), 'Sampling' refers to ROV time on the seafloor. Actual ROV time in water is the sum of both.

Camera	Recording format / view	Hours	File Size	No. of Images
HD Video	High definition forward facing	119	5.63 TB	-
Composite 1	Digi-stills	119	856 GB	-
Composite 2	Pilot	119	856 GB	-
Composite 3	Downward facing	119	856 GB	-
Images	High definition stills	-	26.4 GB	~20 000

Table 2. Summary statistics for video footage and images captured during 52 individual ROV transects.

The ROV can travel 30 m /min vertically taking approximately 32 minutes to descend/ascend 1000 m. In total, 142 km were covered vertically. The deepest dive recorded seabed at 2921 m (PB34), the operational limit of the ROV with the available umbilical cable aboard for this survey is 3000 m. The shallowest dive was 337 m (PB30). The number of dives in each depth

range are described in Table 3. There were nine dives > 2500 m compared to one in 2017. Two dives were less than 500 m whereas the shallowest depth surveyed in 2017 was 625 m.

Depth Range	2017	2018	
	Porcupine	**Rockall**	**Porcupine**
0 - 500	0	0	2
500 - 1000	14	8	8
1000 - 1500	9	6	0
1500 - 2000	15	6	4
2000 - 2500	11	2	8
2500 - 3000	1	0	8

Table 3. Comparison of depth range of surveyed transects in 2017 and 2018.

52 dives were completed over the duration of the survey including 22 on the Rockall Bank and 30 on the Porcupine. Thirty four biological samples were taken and forty four sediment samples were recovered in duplicate. The location, depth, duration and relevant samples taken during each dive are described in Table 4.

Dive*	Transect^ #	Date	Start Point (Bottom)	Depth (m) Start	End Point (Bottom)	Depth (m) End	ROV (mins)	Sampling (mins)	Total Dive (mins)	Samples Collected
526	RB02	04/07/2018	56°39.449; -13°55.407	660	56°40.41; -13°52.53	489	275	169	289	Sediment
527	RB03	04/07/2018	56°38.076; -13°53.249	805	56°38.99; -13°53.71	830	254	201	381	Sediment, Coral
528	RB26	04/07/2018	56°39.878; -13°33.377	1604	56°40.60; -13°37.804	1589	267	144	264	Coral
529	RB27	05/07/2018	56°30.225; -13°44.330	1525	56°30.539; -13°44.270	1498	286	165	285	Sediment, Coral
530	RB28	05/07/2018	56°14.893; -14°01.248	1775	56°14.50; -14°01.39	1762	248	114	174	Sediment, Anemone
531	RB06	05/07/2018	56°13.991; -14°16.048	1164	56°14.987; -14°17.36	811	239	154	274	Coral
532	RB07	05/07/2018	56°11.682; -14°14.740	1380	56°12.305; -14°14.577	1322	221	105	165	Sediment, Coral
533	RB13	06/07/2018	55°50.33; -14°13.13	2236	55°50.73; -14°13.01	2175	299	126	246	Sediment, Coral
534	RB11	06/07/2018	55°58.876; -14°28.107	1556	55°59.48; -14°28.014	1115	323	214	394	No
535	RB09	06/07/2018	55°55.081; -14°32.07	1677	55°54.815; -14°32.977	1527	66	101	167	Coral, Sponge
535	RB08	06/07/2018	55°54.815; -14°32.977	1700	55°54.934; -14°33.537	1442	59	79	138	Sediment, Rock
536	RB12	06/07/2018	56°01.508; -14°45.298	574	56°02.289; -14°44.967	508	187	133	253	Sediment
537	RB24	06/07/2018	55°54.33; -14°46.32	707	55°53.782; -14°46.43	660	187	127	247	Sediment
538	RB15	07/07/2018	55°43.515; -14°49.656	1248	55°44.542; -14°50.243	890	222	121	241	Sediment, Sponge
539	RB16	07/07/2018	55°43.759; -14°57.837	872	55°43.72; -14°58.62	831	163	97	157	No
540	RB17	07/07/2018	55°40.458; -15°09.250	875	55°40.575; -15°09.827	724	183	120	240	Sponge ,Coral
541	RB20	07/07/2018	55°34.264; -15°17.777	1222	55°34794; -15°18.076	1047	196	111	171	Sediment
542	RB21	08/07/2018	55°36.199; -15°18.350	934	55°36.797; -15°18.839	834	210	134	254	Coral, Sponge
543	RB18	08/07/2018	55°35.980; -15°24.473	877	55°35.458; -15°25.169	879	274	149	269	Sediment, Gorgonian
544	RB29	08/07/2018	55°17.101; -16°21.553	1212	55°17.364; -16°21.043	1195	234	129	249	Sponge, Coral Skeleton?
545	RB30	08/07/2018	55°31.178; -15°31.899	1095	55°31.889; -15°32.443	838	210	121	241	Sediment, Coral
546	RB23	09/07/2018	55°24.056; -15°03.091	2308	55°25.548; -15°03.375	2252	468	317	617	Sediment, Anemone, Sponges

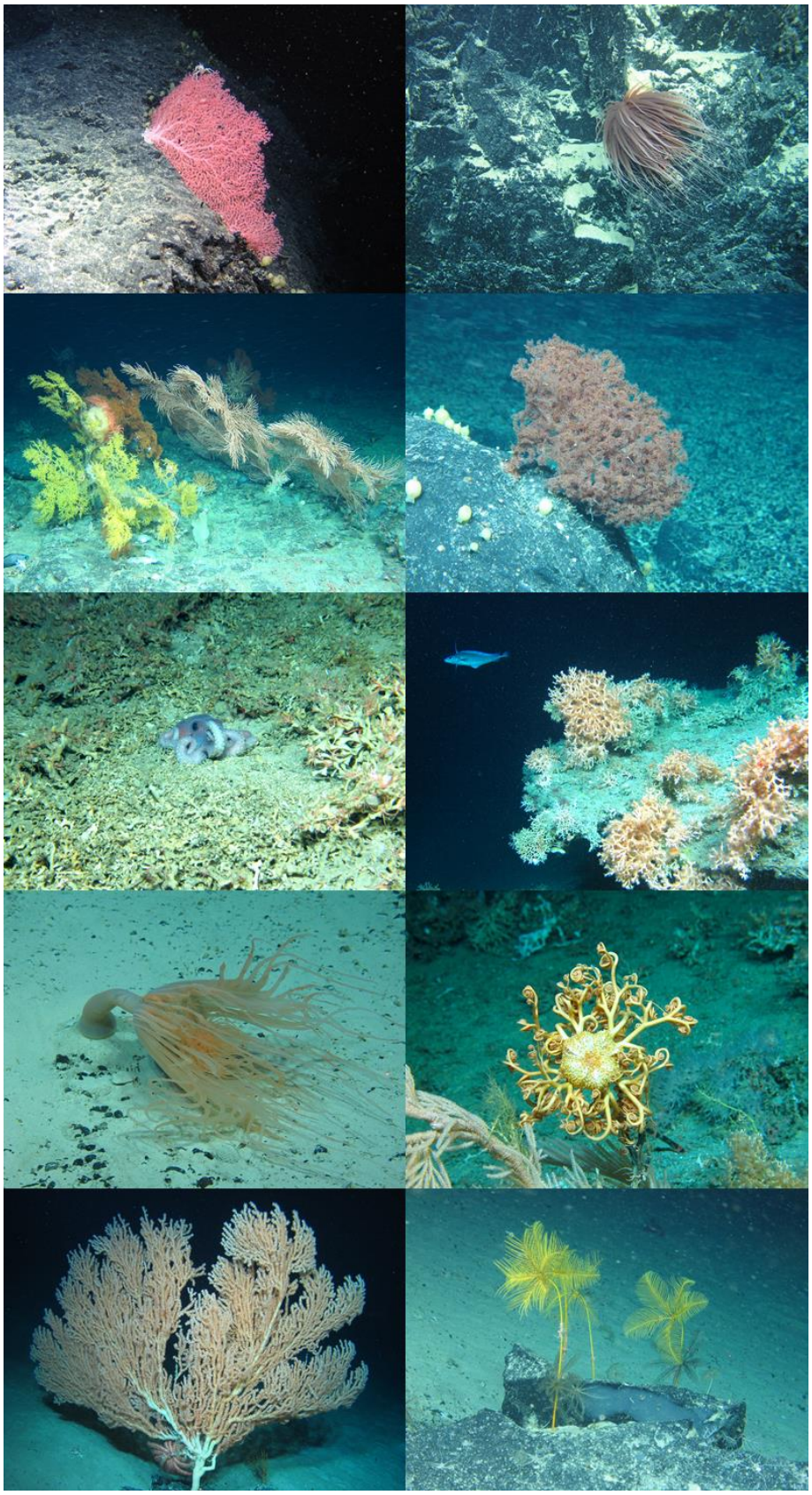
Table 4. Completed ROV *Holland 1* dives on Rockall Bank (22) 4th - 11th July, 2018. * Sequential ROV dive number; ^ non-sequential transect number.

Table 4 contd. Completed ROV *Holland 1* dives on Porcupine Bank (30) 13th – 21st July, 2018. * Sequential ROV dive number; ^ non-sequential transect number.

Dive*	Transect^ #	Date	Start Point (Bottom)	Depth (m) Start	End Point (Bottom)	Depth (m) End	ROV (mins)	Sampling (mins)	Total Dive (mins)	Samples Collected
547A	PB01	12/07/2018	53°19.246; -14°48.126	1852	53°19.784; -14°47.214	1687	66	198	264	Sediment
547B	PB02	12/07/2018	53°19.087; -14°46.219	1548	53°19.135; -14°44.745	1262	54	148	202	Sediment, Callagorgid
548	PB03	12/07/2018	53°14.548; -15°02.518	2367	53°14.690; -15°01.241	2105	190	129	319	Sediment, Anemone
549	PB05	13/07/2018	53°00.221; -15°06.852	2270	53°00.790; -15°05.496	1982	166	178	344	Sediment, *Freyella* sp.
550	PB07	13/07/2018	55°52.451; -15°15.846	2201	55°53.457; -15°15.928	2043	158	133	291	Sediment, Echinothuridae sp.
551	PB08	13/07/2018	52°44.152; -15°11.786	2122	52°44.657; -15°10.255	1857	129	166	295	Sediment
552	PB09	14/07/2018	52°17.678; -15°26.011	2674	52°18.192; -15°26.299	2456	213	133	346	Sediment
553	PB24	14/07/2018	52°00.422; -15°08.340	2257	52°00.966; -15°08.597	2177	100	155	255	Sediment
554	PB11	15/07/2018	51°.50.349; -15°17.441	2535	51°51.141; -15°17.407	2433	122	224	346	Sediment, 2 Cup Coral species
555	PB25	15/07/2018	51°48.084; -15°13.124	2533	51°48.137; -15°11.908	2010	154	253	407	Sediment
556	PB14	15/07/2018	51°38.450; -15°16.871	2839	51°39.323; -15°15.938	2490	194	281	475	Sediment, Unknown Coral
557	PB17	16/07/2018	51°20.920; -15°15.120	2739	51°21.100; -15°14.540	2336	189	265	454	Sediment, Fossil Coral
558	PB27	16/07/2018	51°08.590; -15°03.746	2114	51°08.270; -15°02.757	1789	186	137	323	Sediment, Shell, Sponge
559	PB19	16/07/2018	50°41.845; -14°45.731	2591	50°42.024; -14°45.161	2067	111	232	343	Sediment, Bacterial Mat
560	PB18	17/07/2018	50°35.420; -14°31.141	2137	50°35.936; -14°30.322	1914	161	112	273	Sediment, Xenophyophore
561	PB20	17/07/2018	50°52.284; -14°45.366	1946	50°52.577; -14°44.932	1719	138	74	212	Sediment
562	PB33	17/07/2018	50°05.610; -14°35.841	766	50°05.752; -14°35.042	738	62	125	187	Sediment
563	PB34	17/07/2018	50°54.620; -14°54.065	2921	50°54.893; -14°54.049	2845	179	60	239	Sediment
564	PB16	18/07/2018	51°24.626; -15°11.056	2717	51°25.041; -15°10.307	1898	189	213	402	Sediment, *Acanella* sp.
565	PB13	18/07/2018	51°41.691; -15°18.956	2786	51°42.023; -15°18.205	2476	204	130	334	Sediment
566	PB35	19/07/2018	51°51.686; -15°07.222	2000	51°51.990; -15°06.707	1678	153	213	366	Sediment, *Stauropathes* sp., Sponge
567	PB36	19/07/2018	51°51.725; -15°01.819	952	51°52.003; -15°01.657	799	93	119	212	Sediment
568	PB31	19/07/2018	52°02.000; -15°00.000	1722	52°02.515; -14°58.844	1497	136	171	307	Sediment, Yellow encrusting sponge
569	PB10	19/07/2018	52°13.710; -14°51.286	800	52°14.343; -14°51.398	670	87	128	215	Sediment
570	PB29	20/07/2018	51°59.920; -14°29.540	340	52°00.053; -14°28.741	319	48	107	155	Sediment
571	PB30	20/07/2018	52°02.992; -14°17.481	337	52°03.509; -14°18.091	295	48	110	158	Sediment
572	PB32	20/07/2018	52°16.841; -13°05.591	657	52°17.607; -13°04.888	586	158	119	177	Sediment
573	PB23	20/07/2018	52°13.528; -12°48.919	737	52°13.625; -12°49.399	596	167	126	193	Sediment

574	PB22	21/07/2018	52°09.551; -12°45.771	865	52°09.920; -12°45.871	692	64	103	167	Sediment, *Lophelia pertusa*
575	PB21	21/07/2017	52°12.902; -12°34.511	829	52°13.547; -12°34.643	667	80	133	213	Sediment

3.2 Sample Images



From left to right:

-An Octocoral species, *Corallium*, not previously recorded in Irish waters.
-Relicanthid -previously classed as Anemones. Very little is known about their ecology and they are rare in Irish waters.

-Multiple species form a coral garden at 2000 m.
-Black coral, *Stauropathes*, may be a new species.

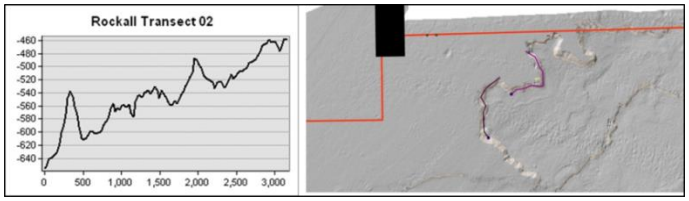
-Octopus on degraded coral substrate.
-The stony coral *Lophelia pertusa,* forms ideal reef habitat for the Lepidion fish.

-A rare giant Hydroid (species unknown).
-Ophiuroid Basket star, *Gorgonocephalus* sp.

-Bamboo coral, *Jasonisis* sp..
-Bright yellow Crinoid *Anachalypsicrinus nefertiti* sp. (a type of featherstar).

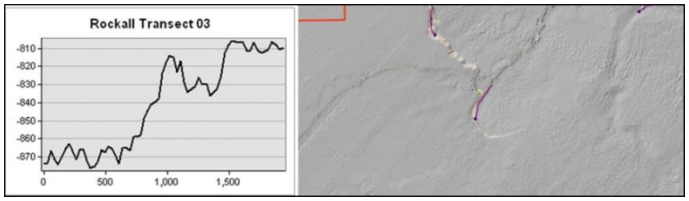
3.3 Site Summaries

3.3.1 Rockall Bank



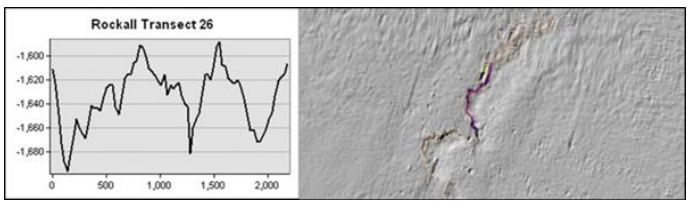
Priority. Features: Mound, Escarpment Water depth: -651 m. TL: 1.3km.
SOL: 13° 55.412' W 56° 39.540' N

Initially the substrate is soft sandy sediment with numerous shrimp like species evident in the water column. The benthic community is composed of anemones, the echinoderms *Cidaris cidaris* and *Stichastrella rosea*, the fish *Lepidion eques*,and hermit crabs. The blue mouth redfish is common. Occasional species include the echinoid *Hygrosoma* sp. and the holothurian *Benthogone rosea.* There are some escarpments and vertical walls, as well as boulders. Coral rubble (*Lophelia pertusa*) is also present.



Non Priority. Features: Escarpment. Water depth: -872 m. TL: 1.5km.
SOL: 13° 53.426' W 56° 37.174' N

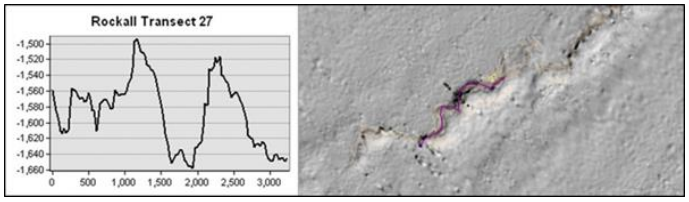
Hard sea bed with scattered rocks, boulders which became vertical at points with exposed bedrock and escarpments. *Lophelia* and *Madrepora* are abundant in extensive coral rubble fields. Common species include rabbit fish, eels, cerianthids, holothurians, googly eyed cod and echiurans. Echiurans are numerous on carbonate outcrops. The fly trap anemone, *Phelliactis hertwigi*, the spiny scorpion fish and lamellate sponge occur. The holothurian, cf. *Laetmogone*, are numerous on the featureless sediment, small white urchins and cerianthids are also present. Towards the end of the dive there are areas of carbonate outcrops and rough ground interspersed with soft featureless sand with many small eels and numerous chimeras.



Not Priority. Features: Escarpment. Water depth: -1610 m. TL: 2 km.
SOL: 13° 31.771' W 56° 37.802' N

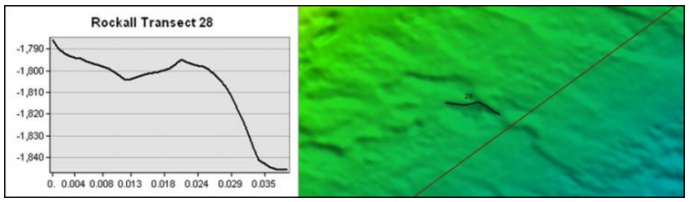
Dive begins on a coral garden amongst gorgonian corals, including *Paramuricea* sp. and *Jasonisis* sp., and abundant lamellate sponges. Later another coral garden occurs on primarily degraded *Solenosmilia* reef transitioning to healthy *Solenosmilia* reef with 25-50% living

coral. A variety of coral species include the gorgonian *Paramuricea*, bamboo corals *Jasonisis*, *Lepidisis* sp., *Keratosis* sp., and *Eknomisis* sp.,the black coral *Parantipathes* sp. and pink morphotypes of the gorgonian *Paragorgia* sp. with snake stars. Some fishing gear is observed. On carbonate terraces there are blue encrusting sponge and sea pens at the base of the incline and also *Ophiomuseum lymani, Parantipathes* sp., *Stichopathes* sp. and *Anthomastus* sp. On the *Solenosmilia* rubble there are massive white and yellow sponges and encrusting yellow and blue forms. On the soft ground the fauna consists of *Anthomastus* sp., *Stichopathes* sp. and cup corals. On the cliff are encrusting sponges of the blue, yellow and grey varieties occur.



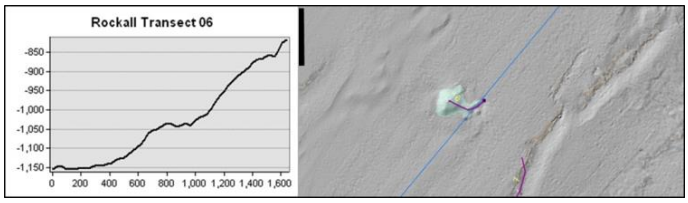
Priority. Features: Escarpment, Comparative Biology. Water depth: -1500 m. TL: 3 km
SOL: 13° 44.591' W 56° 30.344' N

Xenophyophores and scattered sponges (glass, fan-shaped), with *Acanella* sp., sea pens and *Stichopathes* common on soft sediment. Fish species included grenadiers, eels, sharks and chimeras. At the base of a large cliff coral rubble (*Solenosmilia)* was apparent and the oyster, *Aceste excavate*, was present on the steep incline and super-abundant. A community of sponges, tunicates, large brisingids and fish were present under overhangs. Ground continued as slightly undulating soft sediment with boulders and moved onto large rubble mound with living *Solenosmilia* and increasing numbers of gorgonians and sponges. On soft ground *Ophiomuseum lymani* is very common. Coral rubble occurs on carbonate sediment with mud overlay. A coral field is present with the densest areas of reef on the cliff edges and steep inclines. In these areas the associated fauna includes large lamellate and cup sponges, brisingiids, *Paramuricea* sp., *Parantipathes* sp., *Eknomisis* sp., *Keratoisis* sp., *Bathypathes* sp., *Phanopathes* sp. and *Jasonisis* sp. with urchins and ophiuroids on and amongst the reef. Heavy marine snow was a feature of this site.

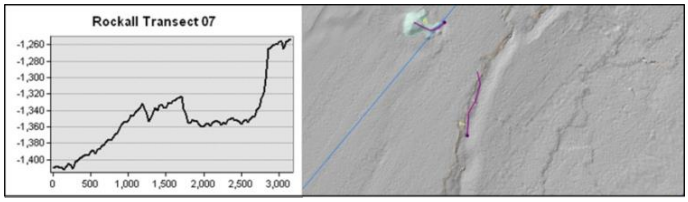


Priority. Features: Escarpment, Selected by NPWS. Water depth: -1790 m. TL: 2.6 km.
SOL: 14° 1.781' W 56° 14.536' N

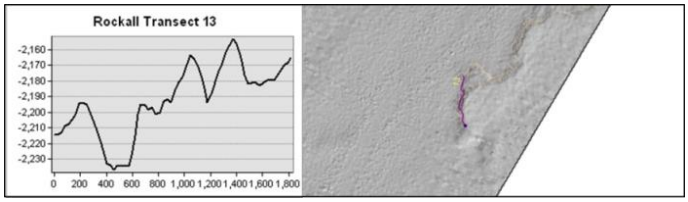
A feature of this dive is a strong current with heavy marine snow. The seafloor consists of areas of soft sediment with occasional rock outcrops and stony coral clumps. The faunal community is the same throughout namely, *Paramuricea* sp., ophiuroids, cerianthids, sea pens and *Anthomastus* sp. Other less frequently encountered species include the black corals *Stichopathes* sp., *Stauropathes* sp. and *Bathypathes* sp. and the sea pen *Pennatula aculeata*. A steep ledge of carbonate substrate is colonised by encrusting sponges and *Solenosmilia*.



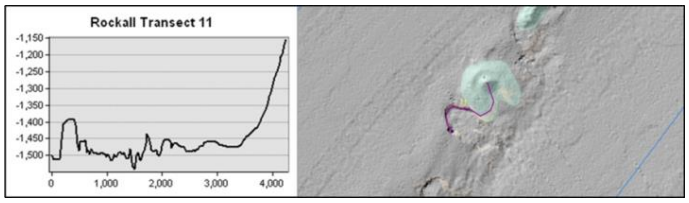
Priority. Features: Ridge, Mound, straddles SAC, Pinnacle mapped in SORBEH cruise.
Water depth: -1150 m. TL: 1.4. SOL: 14° 15.935' W 56° 14.055' N
Sponge aggregations and gorgonians are common with a number of large white sponges and patches of coral. Coral rubble is evident on the entire transect. Approaching a mound summit the ground comprises of thick coral reef, with increasing presence of *Lophelia pertusa* and *Madrepora oculata* compared to the base of the mound where *Solenosmilia* is very common. There are many fish present including monkfish, blue-mouth rose fish, *Lepidion eques* as well as large crabs, *Chaecon affinis* and spider crabs. Overall the site is noted for all three species of stony reef.



Priority. Features: Escarpment, Ridge, SAC. Water depth: -1450 m. TL: 3.1 km.
SOL: 14° 14.944' W 56° 11.158' N
Xenophyophore fields on soft sediment with sponge aggregations (lamellate, encrusting and lobose) are common throughout.The sponge *Pheromone carpenteri* occurs occasionally (approximately 10 throughout the dive). *Solenosmilia* reef occurs on top of a small carbonate mound. Corals included *Paramuricea* sp. were observed, with several large *Eknomisis* sp. and *Leiopathes* sp. present towards the end of the dive on carbonate sediment with mud overlay.

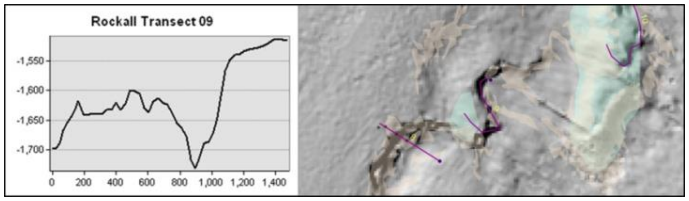


Priority. Features: Fished, Escarpment. Water depth: -2210 m. TL: 1.8 km.
SOL: 14° 12.938' W 55° 50.176' N
The first half of this dive is flat soft sediment with little conspicuous fauna with the exception of a few anemones, including burrowing forms and *Phelliactis* sp., the soft coral *Anthomastus* sp., incirrate octopus and grenadiers. Drop stones play host to cup corals, encrusting sponges, *Anthomastus* sp., and the anenome *Actinerus* sp. The presence of a vertical chalk-like wall with mud overlay saw an increase in species richness. Here lots of brisingiids, small sponges, echinoids, ophiuroids, encrusting sponges, cup corals, *Acanella* sp., gorgonian fans with associated snake stars and the squat lobster *Munida* sp. Heavy marine snow occurred throughout this dive, making visibility poor in some areas.



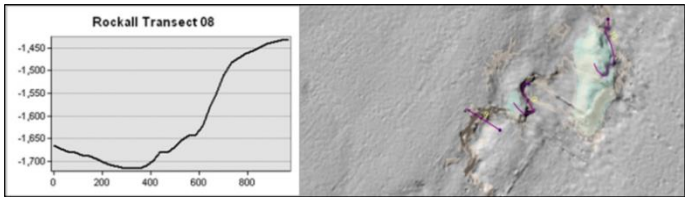
Priority 1. Features: Ridge, Escarpment, Mound, SAC Water depth: -1500 m. TL: 4.3 km.
SOL: 14° 29.454' W 55° 58.363' N

Depression with *Solenosmilia variabilis* reef and rubble (*Acesta excavata* shells) with brittle stars, encrusting sponges, cup corals and sponges. Fauna (*Solenosmilia* and *A. excavata)* are more abundant up slope. Brisingiids, anemones, crinoids, echinoid urchins, grenadiers, eels and serpulid tubes Orange roughy hide among the coral. On top of the cliff there is a reef and coral garden with living *Solenosmilia*, *Stichopathes* sp., *Parantipathes* sp. and mature gorgonians such as *Eknomisis* sp. and *Paramuricea* sp. Oreo fish and *Galeus melastomus* are seen on top of the cliff among the reef.



Priority. Features: Ridge, Wall, Escarpment, Mound, SAC. Water depth: -1700 m. TL: 1.5 km.
SOL: 14° 32.099' W 55° 55.326' N

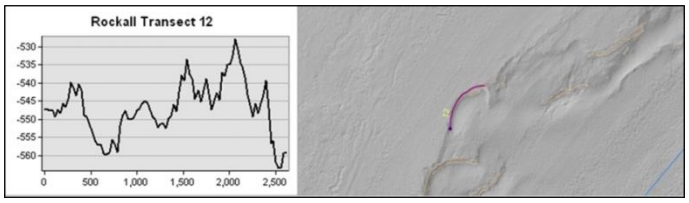
The start of this dive has coral rubble and *Solenosmilia* colonies across rocky hard bottom. Gorgonians are abundant with brisingiids, encrusting sponges, *Anthomastus* sp., *Bathypathes* sp. and small glass sponges. This faunal community continued until a steep vertical cliff with some areas populated with of large patches of blue sponge, the stone coral *Solenosmilia*, the oyster *Acesta excavata*, (both living and dead), the soft coral *Anthomastus* sp. and brisingiids. Other areas of the cliff are relatively bare, with *Stichopathes* species protruding from crevasses in the rock. On the top of cliff, among the rubble, are large numbers of sponges and corals e.g. *Jasonisis* sp., *Solenosmilia* and *Bathypathes* sp. Coral rubble is evident for entire dive.



Priority 1. Features: Wall, Escarpment, 2009, SAC. Water depth: -1670 m. TL: 1km.
SOL: 14° 32.766' W 55° 54.736' N

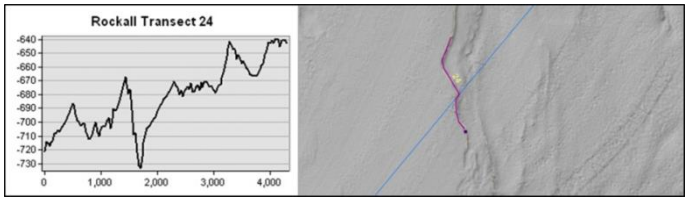
On soft sediment at the beginning of the dive cup corals, cerianthids, eels and grenadiers occur. This transitioned to more broken hard ground with small soft corals are evident and the occasional clump of *Solenosmilia*. While ascending a hard incline fauna is initially scarce but

continuing up slope coral rubble and living *Solenosmilia* become more common and form an extensive reef. Brisingiids, *Leiopathes* sp., *Acanella* sp., *Parantipathes* sp. are all evident along with associated fauna, sponges and fish. The oyster *Acesta excavata* is abundant. Over the top of a wall the ground is again soft sediment with occasional *Stichopathes* sp., ophiuroids and cup corals.



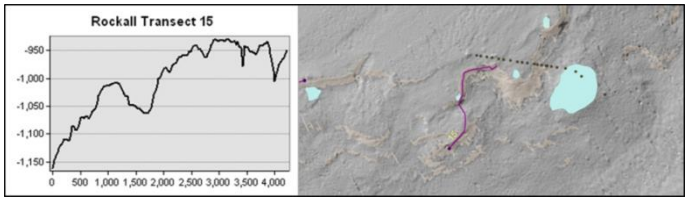
Priority. Features: Escarpment, Ridge. Water depth: -550 m. TL: 2.6 km
SOL: 14° 46.124' W 56° 0.521' N

Relatively flat seafloor comprised of soft sediment, with low faunal diversity; the most conspicuous fauna being the echinoid *Cidaris cidaris.* This ground transitioned to coarse sediment comprised of pebble/cobbles with desmosponges, anemones, *Cidaris cidaris* and holothurians. Abandoned fishing gear caught on boulders and ledges is observed. A vertical ledge with the stony corals, *Madrepora* and *Lophelia*, desmosponges, anemones and cushion stars are also observed. Numerous large hydrozoans (*Stylaster* sp.) are observed on bedrock formations. Terraces occur with *Cidaris*,desmosponges, and some encrusting sponges. Sea bed levelled out again and faunal diversity decreased sharply.



Non Priority. Features: Escarpment, Ridge, Straddles SAC. Water depth: -720 m. TL: 4 km
SOL: 14° 46.019' W 55° 53.466' N

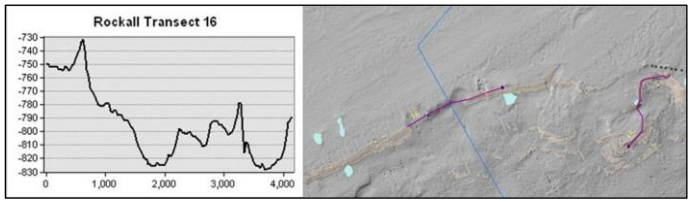
Rock outcrops, boulders and pebble strewn substrate with *Lophelia* and/or *Madrepora* forming large reefs in some areas. Corals are common and include *Leiopathes* sp. and *Bathypathes* sp., bamboo corals and large gorgonians, as are fish species including grenadiers, *Lepidion eques*, eels and monkfish. There is a variety of fan-shaped sponges along with blue and yellow encrusting sponge. A large grouper shark is observed.



Non Priority. Features: Escarpment, Mound, SAC. Water depth: -1150 m. TL: 4 km
SOL: 14° 51.899' W 55° 42.829' N

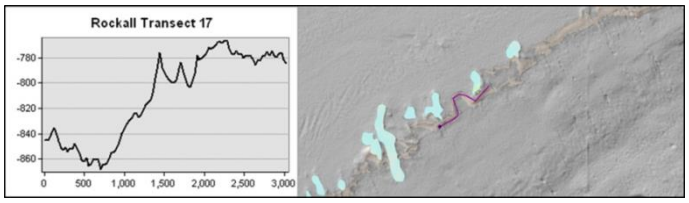
Dive begins on soft sediment with some coral gravel. *Acanella* sp., cup corals and occasional cerianthids are present. Rocks hosting encrusting and lamellate sponges and xenophyophores become abundant where soft sediment occurs. The ground transitions to stony reef where

black corals, including *Leiopathes* sp., *Phanopathes* sp., *Dendrobathypathes* sp. and *Stichopathes* sp. are frequent. Exposed bed rock contains black corals, anemones, glass sponges including Venus flower basket *Euplectella aspergillum*. A final transition to soft sediment with pebbles with encrusting sponges and urchins occurs. Two large boulders with *Leiopathes* sp. and black plastic rubbish are observed at end of transect.



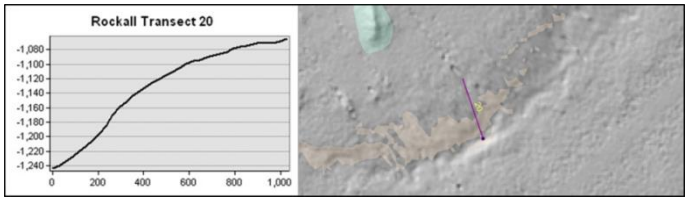
Priority. Features: Escarpment, Straddles SAC. Water depth: -750 m. TL: 4.1 km
SOL: 15° 0.381' W 55° 43.261' N

The seafloor is comprised of coral gravel and cobbles with no conspicuous epifauna. *Lophelia pertusa/Madrepora oculata* co-dominate with encrusted sponges on boulders. On cobbles and boulders with sparse coral gravel/rubble porifera, actiniaria, *Stichopathes cf. gravieri* and *Cidaris cidaris* are present. Towards end of dive the substrate changes to sand/gravel/sparse pebbles/cobbles/boulders. Porifera, mixed coral and Cirripedia species dominate on hard substrata and sparse *C. cidaris* as well as *Araesoma fenestratum* dominate the soft bottom substrate.



Not Priority. Features: Escarpment, Mound. Water depth: -840 m. TL: 3 km
SOL: 15° 9.296' W 55° 40.713' N

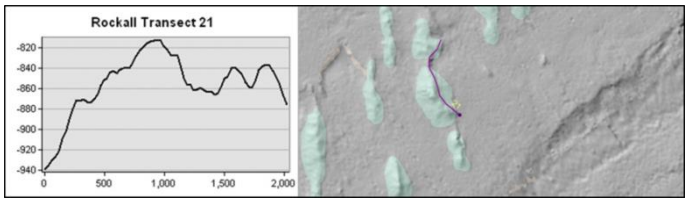
The site is characterised by coral rubble and reef throughout although live coral is rarely above 25%. A steep incline extends from 870 m to 750 m and associated fauna include *Bathypathes* sp., *Acanella* sp., *Stichopathes* sp., stalked crinoids, cup corals, sponges, the Venus flower basket *Euplectella aspergillum* and a small gorgonian. *Leiopathes* sp.is frequent throughout. The squat lobster *Munida* sp. and ophiuroids are common among the rubble as are grenadiers and codfish.



Non Priority. Features: Escarpment. Water depth: -1240 m. TL: 1 km
SOL: 15° 17.765' W 55° 34.256' N

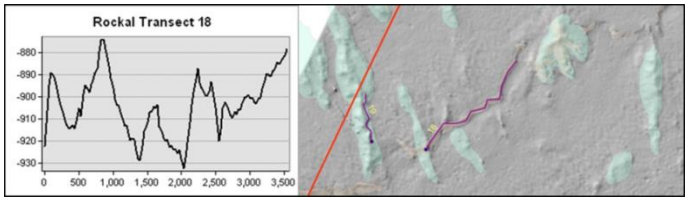
Mainly biogenic sediment. Sponges are frequent at this site including glass sponges, mainly *Aphocallistes* and *Pheronema*. Moving up slope *Leiopathes*, *Paragorgia* and *Eknomisis* are

evident as are orange roughy. Pebble and soft sediment substrate at the top of slope with more glass sponges, stylasterids and orange roughy.



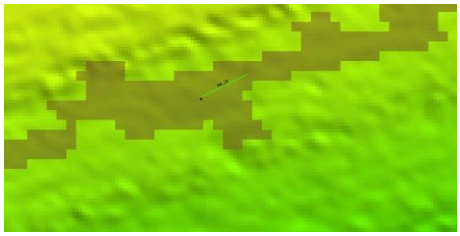
Priority 1. Features: Mound, Ridge. Water depth: -940 m. TL: 2 km
SOL: 15° 18.149' W 55° 36.105' N

Coral rubble evident throughout this site. White glass sponges are common and a single vase sponge observed. *Madrepora* and *Lophelia* present and increase in abundance moving upslope. Large colonies of these species are observed on top of dead corals on occasion forming full reefs with > 25% living. Motile crinoids and *Cidaris cidaris* are frequent throughout as are *Leiopathes* sp., *Bathypathes* sp., and *Stichopathes* sp. Towards the end of the dive a series of 8-10 ridges covered in dead/living coral reef are observed.



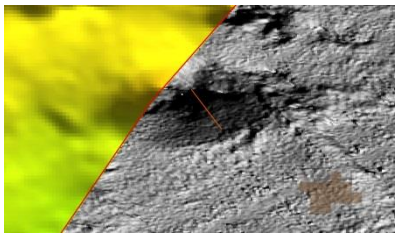
Not Priority. Features: Mound, Escarpment. Water depth: -920 m. TL: 3.5 km
SOL: 15° 24.466' W 55° 35.975' N

Transect begins on a gentle downslope with coral reef comprising of *Lophelia* and *Madrepora* (<10 % living) and rubble/gravel areas. The motile crinoids are common throughout. Rocks and bedrock protrusions are frequent and primarily hosted *Leiopathes* sp. but *Bathypathes* sp., *Phanopathes* sp., *Chrysopathes* sp. are observed. Frequently observed *Aphrocallistes beatrix*, cathedral sponges and Venus flower basket.



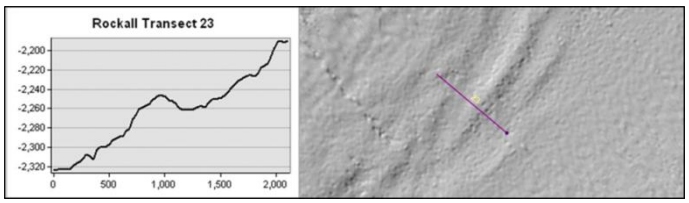
RB29. Priority. Features: Predicted *Pheronema* habitat. Water Depth: -1219 m.TL: 2.1 km
SOL: -16°21.553 W 55°17.101 N

Rippled sand with gravel/pebbles on flat/gently downhill. Vision obscured at times due to the suspended sediment/sand cloud, possible strong currents. Epifauna sparse, which includes gastropods and *Polymastia sp.* Unidentified white sponge in abundance and *Pheronem*a is present. Soft sediment with some pebbles and occasional boulders dominated throughout the dive with encrusting sponges and barnacles. Overall fauna is sparse.



RB30. Priority. Features: Carbonate Mound. Water Depth: -1125 m. TL: 1.3 km
SOL: -15°31.899 W 55°31.178 N

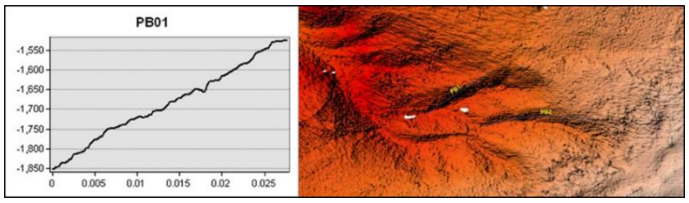
Mixed substrate with some biogenic sponge components, pebbles, cobbles and boulders. Many sponges are evident, especially *Aphrocallistes beatrix* and *Geodia* sp. along with mixed lamellate and encrusting forms. Transition to sponge reef with *Aphocallistes beatrix* as main framework. Fauna include the gorgonians, *Leiopathes* sp. and *Koehlermetra* sp. Transition to *Lophelia/Madrepora* reef (~25% living) with few or no *A. beatrix* present and occasional gorgonians (*Leiopathes* sp. and *Koehlermetra* sp.).



Not Priority. Features: Rise, Depth. Water depth: -2320 m. TL: 2.1 km
SOL: 15° 3.138' W 55° 24.068' N

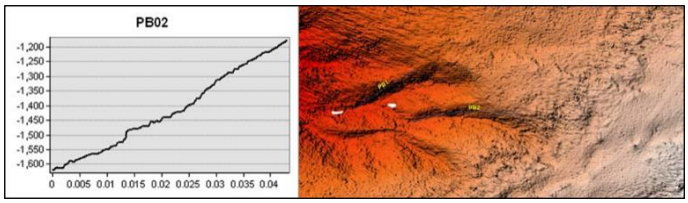
Poor visibility with extreme levels of marine snow. Soft sediment with occasional rocks and an area of large rocks. The benthic community is composed of urchins, ophiuroids and stalked crinoids. Glass sponges and interesting *Pheronema*-type sponges are also common.

3.3.2 Porcupine Bank



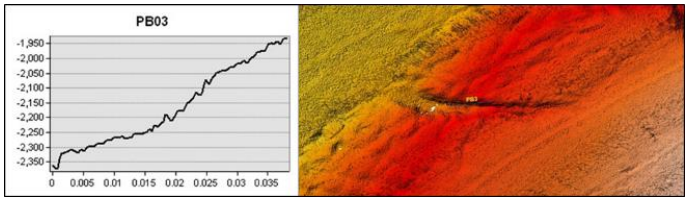
Not Priority. Features: Canyon, Ridge. Water depth: -1850 m. TL: 2.4 km
SOL: 14° 48.122' W 53° 19.233' N

Predominantly soft sediment, pronounced bioturbation with deep burrows and troughs throughout. Sediment appears to be carbonate with mud overlay. Small carbonate outcrops occasionally throughout dive. Most abundant fauna are small sea pens, cerianthid anemones, *Stichopathes, Radicipies gracilis*, eels and the echinoid *Phormosoma placenta* (more abundant towards 2nd half of dive). Occasionally *Phelliactis hertwigii*, *Leiopathes* sp., *Actinernus* sp., grenadiers and *Lepidion eques* are seen. One large ray and *Graneledone verrucosa* octopus observed. Heavy marine snow at this site causing poor visibility at stages. A large pod of pilot whales is observed at the surface.



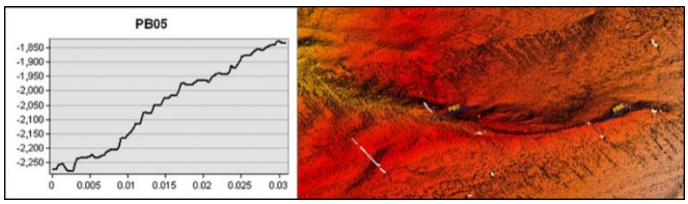
Priority 1. Features: Canyon. Water depth: -1600 m. TL: 2.9 km
SOL: 14° 46.750' W 53° 18.936' N

Predominantly soft sediment with bioturbation and burrows. Vertical cliffs and large boulders are occasionally apparent throughout the dive. Two main benthic communities are associated with soft, sandy sediment and hard sediment, rocks and ledges. Fauna commonly seen on soft sediment include sea pens, cerianthids, corallimorph anemones, holothurians, *Radicipes gracilis* and *Phormosoma placenta*. Fauna seen on harder ground, including cliffs and boulders include sponges (encrusting and hexactinellids), *Stichopathes*, *Parantipathes* sp., cup corals, *Leiopathes* sp. and *Bathypathes* sp. Eels and grenadiers are seen throughout the dive. A number of elasmobranch species were also seen, possibly *Galeus* spp. and S*qualiformes* spp. Of interest is the frequent occurrence of hermit crabs with zoanthids.



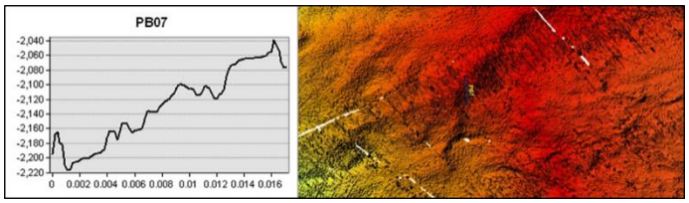
Priority. Features: Ridge, Wall. Water depth: -2350 m. TL: 2.7 km
SOL: 15° 2.550' W 53° 14.543' N

Areas of rippled sand, shell hash and carbonate sediment form the main substrate with a vertical carbonate cliff towards the end of the dive. Shell hash is very dense in some areas with little faunal associations. Sea pens, holothurians and echinoid urchins are observed throughout. Hard substrate, carbonate sediment and cliffs are species poor consisting of crinoids, glass sponges, the occasional cup coral and ophiuroids. Fish abundance and diversity are also low, the occasional grenadier, eel and Alepocephalidae spp.



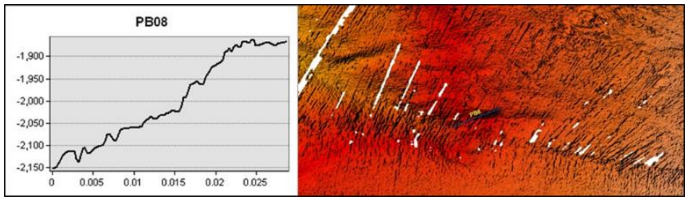
Non Priority. Features: Deep Canyon Wall. Water depth: -2250 m. TL: 2.2 km
SOL: 15° 6.875' W 53° 0.245' N

Mud and rippled soft sediment throughout the dive with burrows visible in areas. Black angular rocks with encrusting sponges, Ophiuroids and cup corals encountered occasionally. The most abundant species are echinoid urchins, stalked crinoids, holothurians, grenadiers and brisingids. There is a large wall with very little fauna, at the top of the wall soft muddy sediment returned. Species of interest include a small octopus and the anemone *Actinerus* sp.



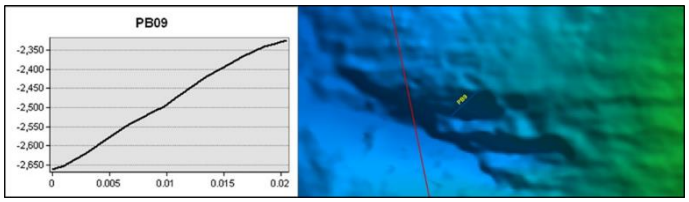
Priority 1. Features: Deep Rise. Water depth: -2220 m. TL: 2 km
SOL: 15° 15.842' W 52° 52.378' N

Marine snow obscured visibility at this site. Primarily soft sediment with pebbles and waves of shell hash in places and very little fauna. Stalked crinoids most prominent species throughout. Occasional drop stones/ rocks have encrusting sponges, ophiuroids and crinoids. Overall species numbers and diversity is poor.



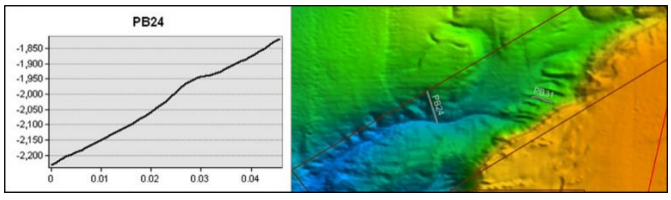
Priority. Features: Ridge, Wall. Water depth: -2150 m. TL: 2.1 km
SOL: 15° 11.813' W 52° 44.142' N

Soft sediment over much of the dive with areas of complex burrows and barnacle hash. Echinouthuridae spp. and *Phormosoma placenta* urchins are numerous at the beginning of the dive. Sea pens and xenophyophores throughout the dive, the latter become more numerous as the ROV ascended upslope. Rock outcrops have encrusting and glass sponges. Towards the end of the dive a variety of corals are seen including *Acanella* sp., *Bathypathes* sp., *Paramuricea* sp. and *Leiopathes* sp..

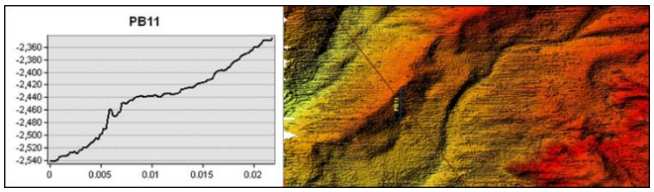


Non Priority. Features: Very Deep wall, Ridge, Canyon. Water depth: -2650 m. TL: 1.8 km
SOL: 15° 26.815' W 52° 17.670' N

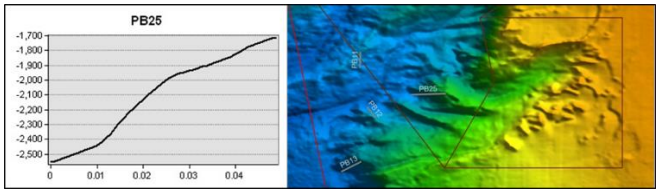
Marine snow visible through dive. Soft rippled sediment with waves of shell hash and large number of elpidiids seen throughout. Rocky outcrops seen occasionally with sponges, gorgonian corals and cup corals with brisingiids attached. Large carbonate wall with mud overlay and black drop stones. The wall is generally species poor with the occasional glass sponges, sea whip and brisingiid. Rippled soft sediment is apparent after the crest of the wall. Species of note included the deepsea lizardfish, *Bathysaurus ferox,* and the hydroid *Branchiocerianthus imperator*.



Priority. Features: NPWS selected. Water depth: -2200 m. TL: 1.8 km
SOL: 15° 8.425' W 52° 0.477' N
Flat muddy sediment throughout the dive with heavy marine snow, creating poor visibility towards the end. Elpidiids, *Anthomastus* sp., brittlestars and sea pens are common. Occasional eels, grenadiers, a slick head and a ray are encountered. Burrows, possibly formed by large crabs are also seen regularly. Plastic pollution is evident.

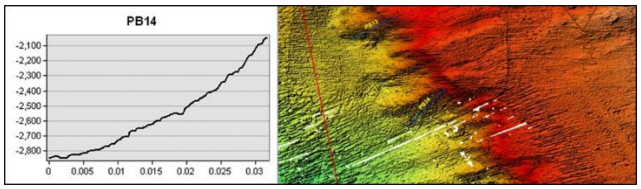


Non Priority. Features: Straddles SAC, depth, mound. Water depth: -2540 m. TL: 2.4 km
SOL: 15° 17.442' W 51° 50.348' N
Muddy sediment with burrows and bioturbation throughout. Most frequent benthic species include sediment dwelling cup corals and sea pens. Species abundance and diversity is low throughout this dive. Some eels, grenadiers and a ray are seen.

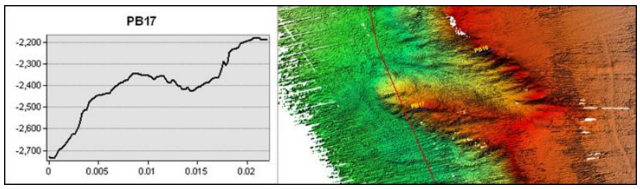


Priority 1. Features: NPWS selected. Water depth: -2600 m. TL: 3.4 km
SOL: 15° 13.152' W 51° 48.087' N

Soft sediment with cup corals, the occasional *Anthomastus* sp. and sea pens are observed here. Evidence of infauna is noted due to the presence of bioturbation, burrows and mounds. Circular markings in sediment are common. High densities of *Echinus* sp. of all sizes were noted locally. On a steep black cliff with mud overlay species richness is poor. Some holothurians, asteroids, ophiuroids, sponges and stalked crinoids are observed. *Bathypathes* sp. and *Lepidisis* sp. are observed in very low numbers. This area is species poor. Heavy marine snow reduced visibility towards the end of the dive. Species of note are the sea pen *Distichoptilum gracile* and anemones *Corallimorpharia* spp.

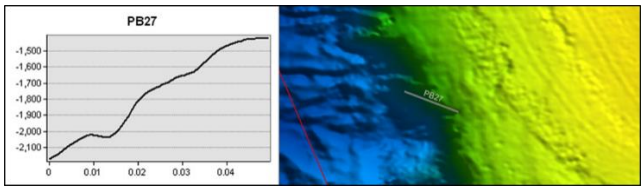


Priority. Features: Very deep rise. Water depth: -2900 m. TL: 2.8 km
SOL: 15° 16.765' W 51° 38.467' N
Soft sediment with black stones and rocks. Chrysogorgiids, brisingiids and small sponges associated with rocks. Large waves of barnacle hash with low densities of elpidiids and asteroids cover areas of sediment. Steep rocky incline with black drop stones, crinoids, sponges, chrysogorgiid, *Bathypathes* and brisingiids. Species to note unknown black coral (sampled).



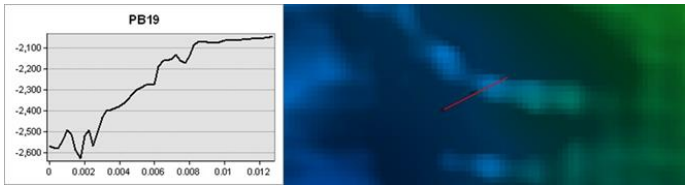
Priority. Features: Deep Canyon. Water depth: -2750 m. TL: 1.6 km
SOL: 15° 15.134' W 51° 20.921' N

Boulders, possibly basalt, are frequent initially before the appearance of a large cliff with sediment overlay. The cliff is species poor at base with small white sponges, stalked crinoids and fan corals. Moving up-face species become more abundant and diverse with a wide variety of sponge, chrysogorgiids, *Anachalypsicrinus Nefertiti*, *Leiopathes* sp., *Bathypathes* sp., *Lepidisis* sp., brisingids and *Porania pulvillus*. Large areas of fossilised cup corals are seen attached to the cliff. Species of note include a *Hyalonema* sponge.



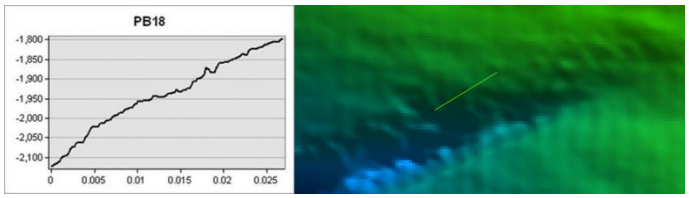
Priority. Features: Deep Water, NPWS selected. Water depth: -2200 m.TL: 4 km
SOL: 15° 3.767' W 51° 8.598' N

Terrain alternates between soft sediment with occasional drop stones to areas of rock incline with mud overlay. On the soft sediment there are some signs of bioturbation, infaunal burrows and tracks but conspicuous fauna are sparse (occasional xenophyophore and *Phenomena carpenteri).* The hard rock inclines include stalked crinoids, *Leiopathes* sp., *Bathypathes* sp., *Parantipathes* sp., *Hyalonema* spp., *Anachalypsicrinus nefertiti* and serpulid tubes. Pillow lava seen towards the end of the dive. A bacterial mat (web-like structure) on dead cup corals was observed and sampled. Coral rubble and small pieces of living *Solenosmilia* are observed towards the top of the cliff. Species of note include: the oyster *Acesta excavata*, the whip coral *Radicipes gracilis* and the holothurian *Psolus squamatus*, ascidians, serpulid tubes, cirrate octopus, eels, chimerids.



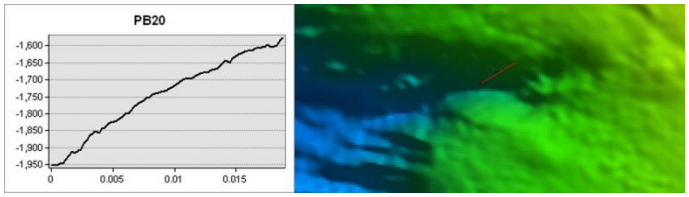
Priority. Features: Canyon Wall. Water Depth: -2600 m. TL: 1 km.
SOL: 14° 45.732' W 50° 41.834' N

Relict cup corals with web like material, possibly bacterial in origin, and ophiuroids observed on a black cliff face. Areas of cliff-face free from relict cup corals had serpulid tubes, stalked crinoids, *Hyalonema* spp., *Lepidisis* sp., *A. nefertiti* and brisingiids. Very little coral species but occasional *Bathypathes* sp. and *Telopathe*s sp. observed. Soft sediment at top of cliff contained xenophyophore field. Species of note include scale worm, *Anthomastus* sp. and a large number of *Hyalonema* spp.



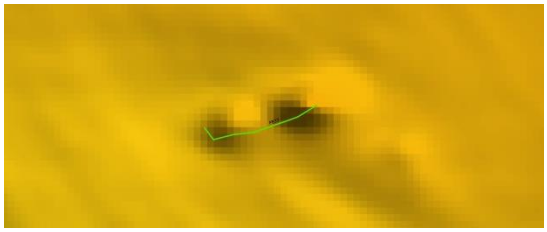
Priority 1. Feature: Ridge. Water depth: -2150 m. TL: 2.2 km
SOL: 14° 31.160' W 50° 35.422' N

Soft sediment with pebbles throughout the dive,drop stones frequent in places. Common species include echinoid urchins, xenophyopores and holothurians. Most species are found on or attached to stone/ hard substrate including stalked crinoids, encrusting sponges, serpulids, sponges and black corals. Species of interest include *Stauropathes* (sampled), the echiuran *Bonellia viridis* and an unknown, and potentially novel, giant hydroid.



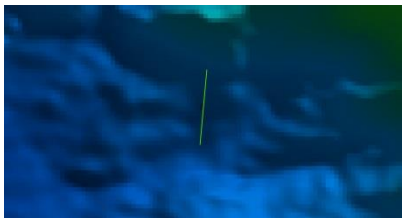
Not Priority. Feature: Canyon. Water depth: -1950 m. TL: 1.5 km
SOL: 14° 45.381' W 50° 52.312' N

Dive begins on soft sandy sediment with barnacle hash. In areas this barnacle harsh aggregates to create large waves. Occasional xenophyopores, ophiuroids and echinoid urchins are seen among the barnacle harsh. A large carbonate wall is observed on this dive, species poor with individual *Chrysogorgiidae* sp. and encrusting sponges along the wall. Towards the end of the dive there are well distributed clumps of *Solenosmilla variabilis*.



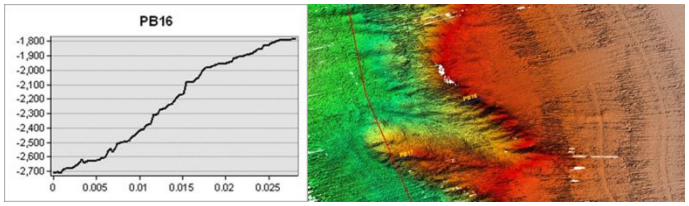
PB33. Priority. Feature: Mounds. Water Depth: 700 m. TL: 1.0 km.
SOL: -14°35.841 W 50°05.610 N

Coral rubble (<10% living *Madrepora)* with stalked anemones, C*idaris cidaris* and urchins occurs here. Other fauna include the soft coral *Anthomastus* sp., the crab *Bathynectes* sp., holothurians, and juvenile scabbard fish. On soft sediment with pebbles and coarse sand, *C. cidaris*, *Calveriosoma gracile* and holothurians are noted. The occasional drop stone is colonised by stylasterids. Fish species include monkfish, blackmouth cat shark and *Lepidion eques*.



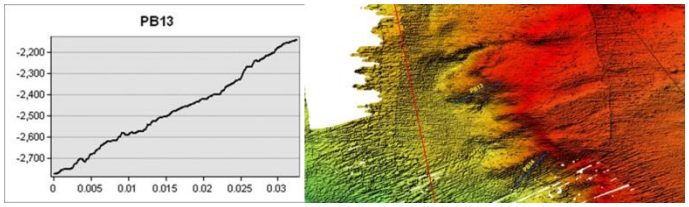
PB34. Non-priority. Feature: Depth. Water Depth: 2994 m. TL: 1.1 km.
SOL: -14°54 065 W 50°54.620 N

Marine snow occasionally reduces visibility at base of target slope with organic matter widespread on the sea floor. Strong currents are evident moving across the slope. Grenadiers are seen on occasion.



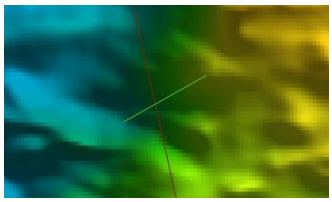
Not Priority. Feature: Deep Canyon Rise. Water Depth: -2700 m. TL: 2 km
SOL: 15° 11.060' W 51° 24.629' N

At the base of target slope there is muddy substrate with pebble fields and the occasional boulder. Holothurians are present on the soft ground while *Anachalypsicrinus nefertiti*, *Bathycrinidae* spp. and stalked crinoids occur on the boulders. Upslope these boulders host sparse epifauna including stalked sponge and stalked crinoids. Further upslope on vertical/very steep bedrock intersperse with mud the holothurian *Peniagone* sp., the ophiuroid *Ophiomuseum lymani* and cup-corals dominate with sub-fossil coral (recorded on vertical wall at this site). A geogenic reef garden contains *Keratoisis* sp. (fine-branching) and a lamellate sponge. Further up slope the substrate is muddy with sparse epifauna including bamboo coral *Acanella arbuscula* and occasional boulders and bedrock.



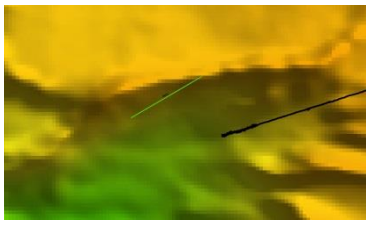
Not Priority. Features: Very Deep Ridge. Water Depth: -2800 m. TL: 2.5 km
SOL: 15° 19.017' W 51° 41.621' N

The seafloor contains rippled mud/pebble and cobble fields on gentle upslope with occasional areas of bedrock/carbonate/cobbles. On the upslope *Chrysogorgiidae* sp. and brisingiids are noted. The stalked crinoid *Anachalypsicrinus nefertiti* is common on dense pebble/cobble fields. Yellow sponges are also observed here. A potentially new species of the black coral *Stauropathes* sp. and of the soft coral *Corallium* sp. was observed.



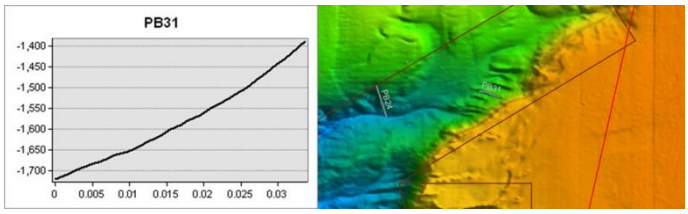
PB35. Not priority. Features: SAC Boundary Water Depth: 2000 m. TL: 1.6 km.
SOL: -15°07.222 W 51°51.686 N

Primarily mud on a moderate to steep slope with sparse epifauna, including the sea pen *Distichoptilum gracile* and the echinoid *Phormosoma placenta*. Possible sub-fossil serpulidae sp. and sub-fossil scleractinians on vertical to sloping carbonate. Mud/pebble and cobble fields with the stalked crinoid *Anachalypsicrinus nefertiti* and the soft coral *Chrysogorgiidae* sp. on boulders transitions to steep mud slope and carbonate/sloping wall with sparse epifauna including *Leiopathes* sp. and *cf Halcampoididae* sp. Continuing upslope sea pens, echinoids, the corals *Stauropathes arctica* and *Telopathes* sp., and the sponge *Asconema* sp. are common. Sponges and stalked crinoids co-dominate on bedrock towards the end.



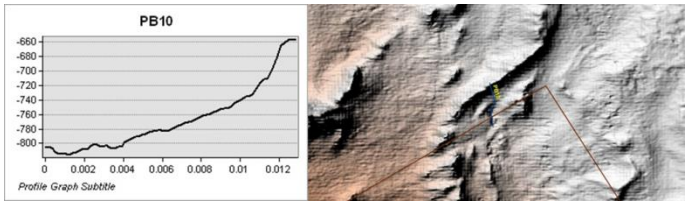
PB36. Not priority. Features: SAC. Water Depth: 952 m. TL: 1.4 km.
SOL: -15°01.819 W 51°51.725 N

Cobble and gravel/rubble present with *Lophelia pertusa* and *Leiopathes* sp. occurred. Coral rubble is interspersed with mud, the echiuran *Bonellia viridis* dominates on moderate muddy slope. Discarded fishing rope observed. Moving up slow the substrata moves to bedrock crust with epifauna including scleractinians and zoantharians. *Leiopathes* sp., *Stichopathes* sp., sponges and sparse epifauna are encountered where the slope is steeper. On a very steep slope with a vertical wall a new species of Goosefish Lophiidae is encountered.



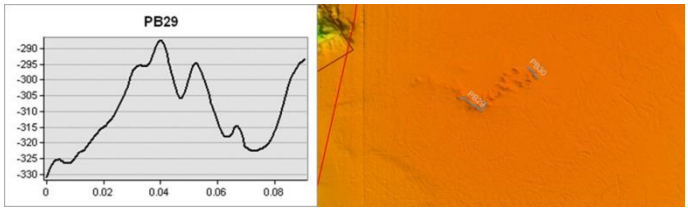
Priority. Features: Canyon Wall, Deep, NPWS selected. Water depth: -1730 m. TL: 2.4 km
SOL: 15° 0.060' W 52° 2.814' N

The seafloor here is that of muddy sediment and a carbonate wall with the corals *Stichopathes* sp., *Paramuricea* sp. and *Eknomisis* sp. dominant. *Solenosmilia variabilis* occurs on a boulder/cobble sediment with mud; sponge aggregations on this coral. On a steep mud slope with occasional cobbles, *Paramuricea* sp., *Radicipes* sp. and *Ophiomuseum lymani* co-dominate. Mud with scattered cobbles, boulders and coral reef hosts *Leiopathes* sp., sponges, *brisingiids*, *Paragorgia* sp. and *Jasonisis* sp. Fishing rope and net were observed on the sea floor towards the top of the slope.



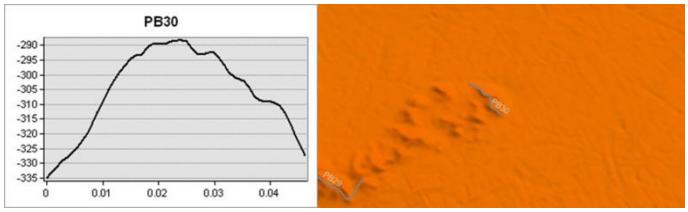
Not Priority. Features: SAC Boundary, Wall, Ridge. Water depth: -800 m. TL: 1.4 km
SOL: 14° 51.282' W 52° 13.718' N

A gentle mud upslope with *Cidaris cidaris* and a dense colony of small (<5 cm wide) brown anemones. Transitions to a gravel/mud sediment with sparse epifauna and isolated colonies of *Lophelia pertusa* (25-50% living). Many epifauna species are present on *L. pertusa* reefs. Occasional cobbles/boulders are colonised by *L. pertusa*, large cerianthids and the scleractinian *Flabellum* sp. are observed. Elsewhere the steep slope hosts mostly dead coral reefs (<1% living) on coarse sediment. When 25-50% living corals occur anemones and echinoids are present.



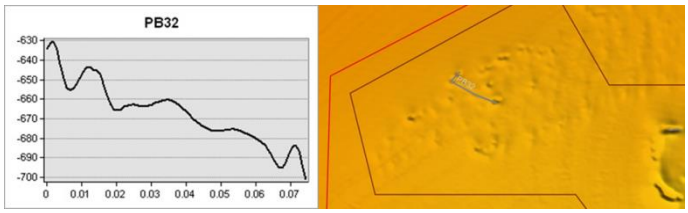
Priority 1. Features: Mounds, NPWS selected. Water depth: -330 m. TL: 8 km
SOL: 14° 29.559' W 51° 59.936' N

An upslope of muddy sediment with occasional cobbles and boulder. Large boulders host the anemone *Phelliactis* sp., the asteroid *Porania pulvillus* and the holothurian *Parastichopus tremulus*. A large shoal of Blue whiting is encounter towards the end of the dive.



Priority. Features: Mounds, NPWS selected. Water depth: -335 m. TL: 3.5 km
SOL: 14° 17.485' W 52° 2.986' N

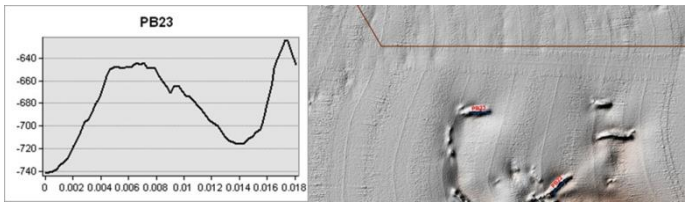
Muddy sediment with occasional cobbles and boulders and frequent crustaceans. The anemone *Phelliactis* sp., the asteroid *Porania pulvillus* and the holothurian *Parastichopus tremulus* and Serpulidae sp.



Priority 1. Features: Mounds, NPWS selected. Water depth: -640 m. TL: 6 km

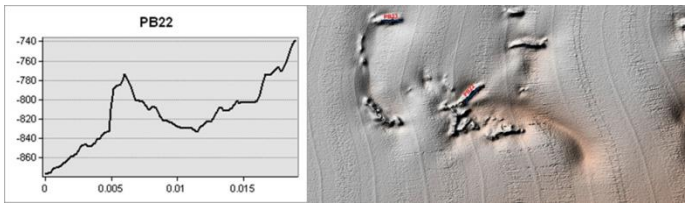
SOL: 13° 2.100' W 52° 15.412' N

A steep incline with mud and scattered cobbles. Fields of xenophyophore *Syringammina fragilissima* and organic debris are observed. A dead coral structure observed with sparse epifauna including Ceriatharia. Species found on living *Lophelia pertusa* reef include *Cidaris cidaris*, *Munida sarsi* and occasional echinoids. Towards the end of dive an extensive area of reef with <50% living was observed.



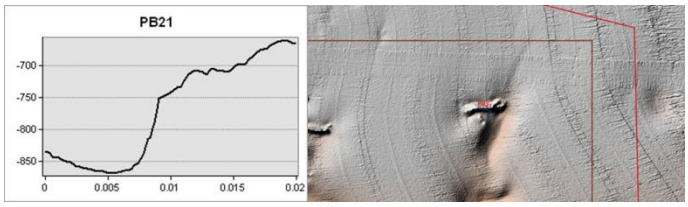
Priority. Features: SAC, Ridge. Water depth: -740 m. TL: 1.2km
SOL: 12° 48.878' W 52° 13.511' N

Initially a sloping muddy sediment with scattered gastropods; over the top of this slope, coral gravel and mud in which echinoids dominate. Blackmouth catshark are frequent over cobble/boulder field which occurs on a steep slope. Coral framework/coral gravel intersperse with areas of bedrock with crevices in the rock. In some area of this coral framework echinoids dominate. The large spider crab *Paramola cuvieri* was observed among the cobbles.



Not Priority. Features: SAC, Mound, Ridge. Water depth: -880 m. TL: 1.7km
SOL: 12° 45.772' W 52° 9.556' N

A steep muddy incline with small cobbles. Scattered *Lophelia pertusa* reefs become more dense, with up to 50% living. Coral gardens with *Stichopathes cf graviere*, *Leiopathes* sp. and *Ceriantharia* sp. were observed. Towards the end of the dive the coral reef becomes less common and the echinoid *Cidaris cidaris* occurs.



Priority. Features: SAC, Mound. Water depth: -850 m. TL: 1.7 km
SOL: 12° 34.505' W 52° 12.907' N

Muddy sediment on a flat to gently sloping gradient on which echinoids dominate. Species present include *Cidaris cidaris*, *Kophobelemnon stelliferum* and *Caryophyllia* sp. Areas of dense reef comprising of both *Lophelia pertusa* and *Madrepora oculata* occur. At the mound summit in particular this reef is dense and well established.

3.4 Survey Log

Thursday 28th June
Vessel mobilisation ahead of SeaFest. Scientific gear stowed and prepped. ROV mobilised.

Sunday 1st July
Mobilisation continues following SeaFest. Scientific party arrives DOS (Chief Scientist), LH, FOT, RR, SOB & PK.

Monday 2nd July
0630 Cast-off and transit to Rossaveal for ROV wet-test. Conducted safety tour. Prepped dry and wet lab for scientific operations. Team meeting to introduce scientists, crew and survey objectives. Watch details agreed and duties assigned. Meeting with Captain and ROV team at to discuss survey plans. All tests complete and crew aboard at 1700, commenced 30 hour transit.

Tuesday 3rd July
All day transit to Rockall Bank survey area. 1900 returned to rendezvous with Coastguard Rescue helicopter 118 for precautionary medi-evac of ill crew member. Resumed transit at 2230 for Rockall Bank.

Wednesday 4th July
0300 Arrived at first site and deployed ROV to seabed. Encountered technical issues with INS Nav string for 2 hours. 0602 issues resolved and commenced survey operations at RB02. 0631 ROV entangled in fishing trawler gill-nets after trawler failed to respond to radio comms. ROV disentangled and recovered to deck under difficult conditions. Minor damage to thruster casing and monofilament wrapped around umbilical resulting in 2.5 hours downtime. Surveyed and completed RB03 & RB26 in adjacent areas. Troubleshooting on OFOP to resolve navigation / Global Mapper output issues.

Thursday 5th July
Initial problems with INS Navigation data were resolved when INS feed into OFOP replaced with raw USBL from beacon. On-board systems and protocols refined and 4 sites surveyes (RB27, 28, 06, 07). Weather is fair with moderate swells / wind holding.

Friday 6th July
Good progress within the Rockall Bank SAC. Weather continues to hold. No problems reported with ROV or navigation data. Four dives completed RB13, 11, 09, 08.

Saturday 7th July
Excellent survey conditions and five dives completed; RB12, 24, 15, 16, 17. Total seabed time > 12 hours. Concluded SAC survey and continued south along Rockall Bank.

Sunday 8th July
Three sites completed RB20, 21 & 18. ROV tether became entangled on ascent from RB18. Deck-crane was used to recover the ROV under difficult conditions. Tether was terminated above / below damage and re-spliced. ROV was subsequently deployed and successfully tested after 10 hours downtime.

Monday 9th July
Completed RB29, 30 & 23. Recurring navigation data issues were apparent on the last dive and the ROV was tested before ascent. 2.5 hours downtime. Completed Leg 1 survey operations and began transit to Galway. Ensured all data is backed-up and wet-lab samples processed. 22 dives completed on Leg 1.

Tuesday 10th July
Continued transit to Galway ahead of Port Call. Labs cleaned, general maintenance and data back-up.

Wednesday 11th July
Port Call in Galway. SOB, RR & PK left the science team and replaced by YL, KH & LA. Ships crew changed out, ROV team remained. Lab supplies taken on and exemplar footage given to JG. Departed Galway at 1600, safety tour and science meeting. 20 hour transit to Porcupine Bank.

Thursday 12th July
Overall survey efficiency reduced as new crew / scientists learn procedures. Minor issues with ROV 'wrist' monitored. Weather excellent for survey with only slight swell. A very large pod of pilot whales (~100 animals) observed. Completed PB 01 & 02.

Friday 13th July
Systems working well. Longer dive times due to increased target depths reduce efficiency. Minor nav digi-still camera issues resolved. Completed PB03, 05 & 07.

Saturday 14th July
Wind increased to 25 knots and gusting 35 with 3-4 m swell. Longer transit times reduse survey progress. Completed PB08, 09 & 24. Entered SAC.

Sunday 15th July
High winds and swell made progress slow. Completed PB11, 25 & 14. PB14 is our deepest dive at 2839m. Recorded a number of coral species not previously observed in Irish waters, one may be entirely new to science.

Monday 16th July
Moving south along the Porcupine Bank, completed PB17 & 27. Longer transits at less speed due to weather reduce sampling time but represent excellent spatial coverage over survey area.

Tuesday 17th July
Began moving after completing southernmost survey site. Weather conditions improving. Completed PB19, 18, 20 & 33.

Wednesday 18th July
PB34, deepest dive to date at 2921 m, was aborted due to ROV nav input failure with 1 hour downtime. Completed PB16 before encountering recurring nav issues on PB13. Weather has significantly improved.

Thursday 19th July
Continued survey operations without any issues. Completed PB13, PB35, PB36 & PB31. Moving slowly east and within SAC.

Friday 20th July
Successful day, no issues. Completed PB10, PB29, PB30 & PB32.

Saturday 21st July
Survey operations completed with three final dives, PB23, 22 & 21. Leg 2 total of 30 dives and 52 for full survey. Full data QC and back-up, cleaning and demobbing of relevant equipment.

Sunday 22nd July
Vessel arrived Galway at 0600 hrs. Demobbed ROV, support cabins and scientific gear. Removed samples to cold storage in MI (DOS, FOT). Survey Ends.

4. Conclusions

These are preliminary findings of research undertaken at the Irish continental margin and the Rockall Bank to document sensitive biological habitats in relation to geomorphic features. The survey areas encompass the slopes and canyon systems along Ireland's western shelf edge, trending in a northeast-southwest direction and the north eastern Rockall Bank. In some cases the data is novel, being from previously undescribed canyon systems, elsewhere the survey built on existing knowledge. To better describe 'natural' habitats, areas with little historic anthropogenic interference were selected.

The findings of the SeaRover survey will contribute to the setting of site specific of conservation objectives by NPWS for the offshore Special Areas of Conservation (SAC) and will additionally contribute to fulfilling the Department of Agriculture, Food and Marine (DAFM) obligations to map vulnerable fisheries resources. The study will also be used within Descriptor 6 of the Marine Strategy Framework Directive (MSFD) which focusses on sea-floor integrity.

Sea-floor integrity reflects the characteristics (physical, chemical and biological) of the sea bottom. These characteristics delineate the structure and functioning of marine ecosystems, especially for species and communities living on the sea floor (benthic ecosystems).The combination of topography and water movement along the survey area is ideal for filter-feeders, such as cold-water coral species while constant food supply also promotes wider marine biodiversity along the shelf edge. Extensive coral reefs of the cold-water coral species (*Lophelia pertusa* and *Madrepora oculata*) were observed along the sloping terrain at numerous locations that benefit from increased currents carrying particulate matter. A third species of cold-water coral, *Solenosmilia variabilis* was recorded forming reefs at depths only previously recorded in 2017 (O'Sullivan et al. 2017).

In addition, there were numerous notable 'firsts' for Irish waters including the observation of species of octocoral and black coral, and rare specimens of hydroids and relicanthids. A novel Antipatherian (black coral) was recorded on two separate occasions and is potentially new to science. Finally, essential shark habitat was recorded within an SAC on the Porcupine Bank, as evidenced by a large school of blackmouth catshark, *Galeus melastomus*, in association

with large numbers of egg-cases and including sightings of the rare Roughskin sail shark, *Oxynotus paradoxus* on both the Porcupine and Rockall Banks.

The data will help target future mapping of reef habitat and inform further study in other areas of Ireland's offshore. This will significantly strengthen the availability of comprehensive biological baseline datasets critical to the formulation of future policy on the management and conservation of Ireland's deep-water resource.

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Further details available on www.emff.marine.ie

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