

Cruise Report - GRL2017_01

Sensitive Ecosystem Assessment and ROV Exploration of Reef (SEAROVER)

Irish Lights Vessel *Granuaile*

July 3rd – 23rd 2017



An Roinn
Cultúir, Oidhreachta agus Gaeltachta
Department of
Culture, Heritage and the Gaeltacht



Roinn Cumarsáide, Gníomhaithe
ar son na hAeráide & Comhshaoil
Department of Communications,
Climate Action & Environment



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



EUROPEAN MARITIME AND
FISHERIES FUND



Ireland's European Structural and
Investment Funds Programmes
2014-2020

Co-funded by the Irish Government
and the European Union

Document Summary

TITLE

Sensitive Ecosystem Assessment and ROV Exploration of Reef Survey Report 2017

AUTHORS

O'Sullivan D., Leahy Y., Guinan J. & Shipboard Scientific Party.

REFERENCE

O'Sullivan D., Leahy Y., Guinan J. & Shipboard Scientific Party (2017). Sensitive Ecosystem Assessment and ROV Exploration of Reef Survey Report 2017. Cruise Report prepared by INFOMAR and the Marine Institute, Galway, Ireland to the Department of Agriculture, Food and the Marine, the European Maritime and Fisheries Fund and the National Parks and Wildlife Service.

CONTACT

Advanced Mapping Services	National Parks & Wildlife Service,
Ocean Science and Information Services	Flood Street,
Marine Institute, Rinville	Galway.
Oranmore, Galway, H91R673	

ACKNOWLEDGEMENTS

The authors would like to acknowledge and thank all those who contributed to the July 2017 survey aboard the Irish Lights Vessel (ILV) *Granuaile* especially Captains Dermot Gray & Harry McClenahan and their respective ship crews. Particular thanks goes to Research Vessel Operations at the Marine Institute and the ROV team at P&O Maritime for their tireless efforts to keep the ROV serviced and survey ready. A special word of thanks to Dr. Louise Allcock of National University of Ireland, Galway (NUIG) for pre-survey advice and the provision of equipment and Dr. Kerry Howell of Plymouth University for her participation in the survey.

CONTENTS

EXECUTIVE SUMMARY	4
1. Introduction.....	6
1.1 Objectives	7
2. Methods.....	8
2.1 Survey Vessel.....	8
2.2 Site Selection	8
2.3 Remotely Operated Vehicle	10
2.4 Real-time video data acquisition and processing	11
2.5 CTD Sampling	12
3. Results.....	12
3.1 ROV dive summary	12
3.2 Sample Images	16
3.3 Site Summaries	19
3.4 Cruise Log.....	46
3.5 Species List	51
4. Conclusions.....	53
5. References.....	54

EXECUTIVE SUMMARY

A requirement exists to quantify the abundance and distribution of offshore biogenic and geogenic reef habitats in Irish waters to fulfil Ireland's legal mandate and to generate baseline data from which appropriate monitoring systems can be established. To address this an extensive offshore reef survey of Ireland's Northwest Continental margin was commissioned by the National Parks and Wildlife Service (NPWS), funded by the European Maritime and Fisheries Fund (EMFF), and coordinated and led by INFOMAR (Integrated Mapping for the Sustainable Development of Ireland's Marine Resources) and Ireland's Marine Institute.

The objectives of the survey were 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.

A survey, Sensitive Ecosystem Assessment and ROV Exploration of Reef (SeaRover), took place in July 2017 aboard the ILV *Granuaile* equipped with the Marine Institute's remotely operated vehicle (ROV) *Holland 1* and a multidisciplinary team of scientists to observe seabed features and biological associations along the northwest continental shelf. 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 the northwest shelf edge of Ireland's continental slope 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 seabed mapping data and analysis of micro-plastics within deep-water sediment.

Survey transects were pre-selected following a consultation process between the Marine Institute and the 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 included, canyons and canyon walls, gullies, escarpments, ridges, carbonate mounds and cobble fields.

A total of 50 transects were surveyed. The vessels travelled 1900 km, 127 hours were spent sampling and recording HD video on the seabed. The ROV travelled 135 km vertically and collected 147 biological specimens and 49 sediment samples. In addition the survey:

- Discovered previously unknown Vulnerable Marine Ecosystems (VMEs) under UN Charter consisting of xenophyophores (large unicellular organisms) and sea-pens.
- Identified biologically sensitive Annex 1 reef-forming, cold-water coral species (*Lophelia pertusa* and *Madrepora oculata*) at numerous locations.
- Recorded a third species of cold-water coral, *Solenosmilia variabilis* forming reefs at depths previously unrecorded (>1600m).
- Explored habitats previously undocumented on Ireland's north-west continental shelf e.g. canyons, underwater sea-mountains, steep cliff faces and rock-overhangs and an escarpment feature over 160 km during 4 separate dives.
- 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 have contributed to the provision of conservation objectives for the offshore Special Areas of Conservation (SAC) work carried out by NPWS. Additionally the findings will ensure the Department of Agriculture, Food and Marine (DAFM) have fulfilled their obligation to map vulnerable fisheries resources. The survey data acquired improves our understanding of the extent of sensitive ecosystems in Irish waters and underlying geomorphology and it broadens our understanding of the ecological requirements for these environments in support of sustainable management of Ireland's marine resources. Furthermore, it establishes a need to build on the data collected to date, to help target future mapping of reef habitat, and commit to further study in other areas of Ireland's offshore. This will ensure 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.

Keywords:

Geogenic, biogenic, reef, Irish continental margin, cold-water coral, *Lophelia pertusa*, *Solenosmilia variabilis*

1. Introduction

Reef habitats are thought to be widespread in Irish offshore waters although there is a paucity of data concerning their exact distribution and abundance (Forde et al. 2017). Offshore reefs (> 200 m) generally consist of hard substrate that support diverse communities of flora and fauna and are geogenic or biogenic in origin. Geogenic reefs are comprised of exposed rocky substrate ranging in size from localised boulder and cobble fields to large scale geological formations, including seamounts and escarpments. Biogenic reefs are typically formed by the accumulation of dead or living hard bodied animals including cold-water coral species that can, over geological time, form large carbonate mounds and/or complex colonies. Reef systems provide colonising opportunities for planktonic invertebrate larvae, act as sheltered nurseries for juvenile fish, encourage species diversity and are vital in promoting healthy ecosystem functioning in the deep-sea. Typical animals include anemones, sponges, crustaceans, corals, echinoderms and fish.

These habitats are sensitive to natural stochastic events because the fecundity and recovery rates of many deep-sea species are low (Forde et al. 2017). Anthropogenic effects, particularly bottom-trawl fishing, are also harmful and result in habitat fragmentation and a reduction in the ecological quality of the habitat (Airolidi et al. 2008). 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), commonly known as the Habitats Directive and is therefore offered protection. Under this directive which was transposed into Irish Law as the European Communities (Birds and Natural Habitats) Regulations 2011 (S.I. No. 477/2011) each EU member state is obliged to 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. The report also identified significant data gaps relating to the area, range, structure and function and potential pressure components within the assessment (NPWS 2013).

A requirement to quantify the abundance 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 DAFM, EMFF & NPWS and coordinated and led by INFOMAR and Ireland's Marine Institute.

The survey team employed the Marine Institute's ROV *Holland 1* to collect high definition video footage and where possible, biological samples. Areas of focus included seabed features comprising of sea-mounds, canyons and escarpments as well as areas of low fishing effort that will allow scientists to study the health of these sensitive ecosystems. The survey revisited the North-west Porcupine Bank SAC which had been previously surveyed in 2009 (Guinan & Leahy 2009) and other areas within the site were explored 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 of geogenic and biogenic reef habitat along the northwest shelf edge of Ireland's continental margin using a ROV with HD video. Secondary objectives were the collection of biological and sediment samples where possible. Biological sampling included the collection of whole specimens where appropriate and/or tissue samples for genetic analysis. The findings of the survey were also to assist investigations into species population dynamics and marine biodiversity with a view to cataloguing novel species which may identify and develop natural products and other biomaterials for application in areas such as drug discovery and biomedical research. Sediment samples were obtained to ground-truth INFOMAR seabed mapping datasets and to analyse micro-plastics within deep-water sediment.

2. Methods

2.1 Survey Vessel

The ILV *Granuaile* was chartered as the platform to assess the distribution of geogenic and biogenic reef formations along Ireland's northwest continental slope. 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.

2.2 Site Selection

Ireland's continental margin 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. The survey area extends approximately 560 km from the Rockall Bank to south of the Hebrides Terrace Seamount. This varied topography is ideal for cold-water coral reef habitat as the canyons and gullies offer suitable terrain for attachment while up-wellings, a feature of these systems, ensure a rich food source. In order to survey such a large geographical area systematically certain criteria were employed to identify smaller survey units or transects.

The criteria were 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 of canyon systems, 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:

- NPWS - In order to increase the knowledge base for the national assessment of offshore reef required under Article 17 of the Habitats Directive an extensive desktop report and supporting GIS was commissioned by NPWS (Forde et al. 2017). The report collated existing spatial data on offshore reef habitat and included scientific data from previous surveys. It was extensively consulted for the current survey.
- INFOMAR - The national seabed mapping programme INFOMAR and the Irish National Seabed Survey (INSS) provided the offshore bathymetry data to help target seabed features associated with cold-water coral reef.
- Atlas of the deep-water seabed: Ireland (Dorschel et al. 2010).
- Fisheries Ecosystem Advisory Services (FEAS) at the MI - Historical fisheries data comprised of electronic Vessel Monitoring System (VMS) logbook data from all boats fishing in Irish waters from 2005 to 2015. The data indicates where fishing effort is concentrated and reveals those areas in which no fishing is evident.
- Plymouth University – Predictive modelling of species distributions has indicated the possible presence of various vulnerable ecosystems (*Lophelia pertusa* reefs, *Pheronema carpenneri* aggregations, xenophyophore aggregations) at a variety of scales 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 30 priority target areas and 15 non-priority areas were identified and named T01 – T45. Seven additional areas were identified and surveyed during the cruise (T46 – T52). The transects and their locations are shown in Figure 1.

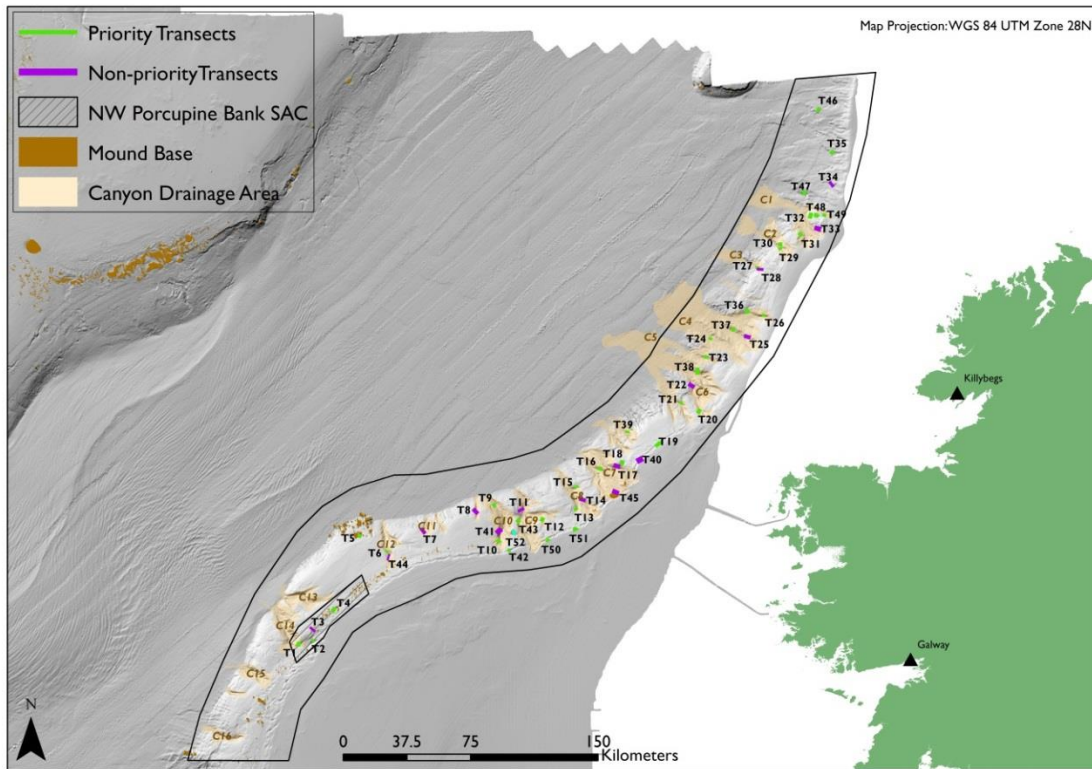


Figure 1. Location of SeaRover 2017 survey transects at Ireland's continental shelf margin.

2.3 Remotely Operated Vehicle

The Marine Institute's ROV *Holland 1*, is a SMD Quasar Hydraulic work-class 100 hp hydraulic vehicle which can dive to a maximum depth of 3000 m. The vehicle is operated from a dedicated launch and recovery system. This consists of a winch carrying 3500 m of main lift wire plus an A frame. An optional Tether Management System was not used in this survey. A series of floats are attached to the umbilical to reduce the effect of ship motion on the ROV as it descends to the bottom (~ 30 m/min). The submersible is then flown along a pre-determined transect line from a dedicated control container which can hold two pilots and three scientists. A separate spares and workshop container is also carried on the vessel.

The ROV has two manipulators for sample collection, a spatially correspondent 7-function Schilling Orion and a 5-function Schilling Rigmaster. A retractable tool sled carries sample drawers for stowage and sampling tools (push-cores and scoops). Additional tools can be developed to suit different sampling needs as required. A range of sensors, including sonar, altimeter, depth, gyrocompass and doppler log are also fitted.

The vehicle is fitted with a variety of cameras, including one high-definition television camera (recording in 1080 i resolution), up to 7 phase alternating line video cameras plus a 5 mega-pixel digital stills camera which can be 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 and has a USBL 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 (<http://ofop.texel.com>). OFOP reads a variety of position data and formats including data from the Global Acoustic Positioning System (GAPS) underwater navigation system. The software was installed on a PC in the ROV container and observations logged to individual dive protocols during ROV operations. OFOP records position data and observations logged to each protocol.

To allow the logging of information in real time OFOP requires the creation of button files. These files were compiled from a number of sources including the knowledge of the scientists on board. This provides 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. The buttons used on this survey replicated those used on a previous ROV offshore reef survey conducted aboard the R.V. Celtic Explorer (Guinan & Leahy 2009) and included a number of descriptors indicating anthropogenic disturbance. Faunal groupings were left at high taxonomic level for real time logging to achieve more consistent identification through-out the cruise. Only those species which were likely to be accurately identified from real-time video feed were included in the button files.

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 CTD's and thermosalinographs.

3. Results

3.1 ROV dive summary

The *Granuaile* was operational for 78.9% of the survey duration. The *Holland 1* spent 130 hours sampling at depth (see Table 1). In total the survey generated over 6.5 TB of data including the recording of 5.75 TB of HD video footage (Table 2).

A total of 50 dives were successfully completed over the duration of the survey. These were allocated transect numbers T01 – T52 but did not include T07 and T44. The location, depth, duration and relevant samples taken during each dive are described in (Table 3). The ROV can travel 30 m /min vertically taking approximately 32 minutes to descend/ascend 1000 m. In total, 135 km were covered vertically. The deepest dive recorded seabed at 2545 m which was the operational limit of the ROV with the available umbilical cable aboard for this survey. The shallowest dive was 521 m (T51). There were 14 dives in the depth range 500 m – 999 m; 9 dives between 1000 – 1499 m; 15 between 1500 – 1999 m; 11 between 2000 m – 2499 m and one >2500 m. The largest change in seabed elevation between depth at start and end of dive was 704 m at T46.

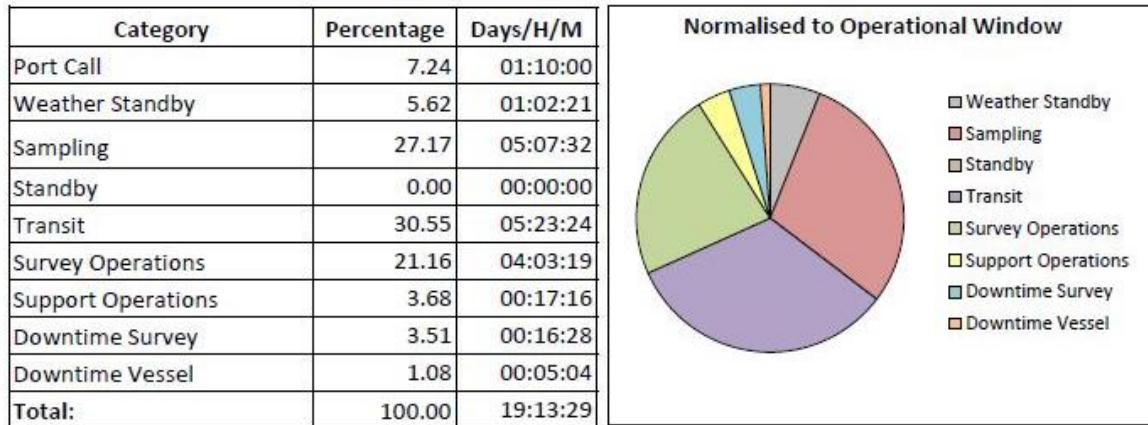


Table 1. Cumulative SeaRover survey statistics. ‘Survey Operations’ indicate combined deployment and recovery time of ROV. ‘Sampling’ refers only to ROV time on the seafloor. Actual ROV time in water is the sum of both, i.e. 48.33% or 9 d 10 h and 51mins.

Camera	Recording format / view	Hours	File Size	No. of Images
HD Video	High definition forward facing	127	5.75 TB	-
Composite 1	Digi-stills	227	867 GB	-
Composite 2	Pilot	227	867 GB	-
Composite 3	Downward facing	227	867 GB	-
Images	High definition stills	-	7.93 GB	6185

Table 2. Summary statistics for video footage and images captured during 50 individual ROV transects.

Dive*	Transect^ #	Date	Start Point (Bottom)	Depth (m) Start	End Point (Bottom)	Depth (m) End	ROV (mins)	Sampling (mins)	Total Dive (mins)	Samples Collected
449	1	04/07/2017	53.48517 ; -14.46499	1088	53.50437 ; -14.46929	902	103	143	246	No
450	2	04/07/2017	53.51182 ; -14.34328	783	53.51999 ; -14.32752	694	50	157	207	<i>Cidaris, Lophelia</i>
451	3	04/07/2017	53.57952 ; -14.32942	739	53.56969 ; -14.34322	760	74	103	177	No
452	4	05/07/2017	53.68846 ; -14.13423	723	53.67 ; -14.15367	673	70	226	296	Sediment, <i>Cidaris, Lophelia, Madrepora,</i>
453	5	05/07/2017	54.07463 ; -13.9052	2262	54.06017 ; -13.90277	2113	58	309	367	Sponges, coral, Chrysogorgiid
454	6	05/07/2017	53.98756 ; -13.65767	1849	53.97431 ; -13.66755	1493	145	124	269	No
455	9	06/07/2017	54.21642 ; -12.67254	2545	54.20863 ; -12.69998	2410	76	345	421	Echinoids
456	10	06/07/2017	54.01212 ; -12.64413	1380	54.02283 ; -12.6655	1330	111	132	243	Sediment
457	42	07/07/2017	53.971 ; -12.578	625	53.96483 ; -12.57297	681	49	183	232	No
458	43	07/07/2017	54.11365 ; -12.46096	1973	54.12527 ; -12.47903	1667	139	183	322	Sediment scoop, coral, glass sponge
459	12	07/07/2017	54.07512 ; -12.28733	1652	54.12025 ; -12.26162	1370	58	152	210	Sediment
460	13	07/07/2017	54.17104 ; -11.94295	1442	54.18025 ; -11.95705	1307	100	130	230	No
461	14	08/07/2017	54.21272 ; -11.89346	1770	54.22526 ; -11.88423	1461	114	147	261	No
462	15	08/07/2017	54.28473 ; -11.93304	2043	54.29487 ; -11.94225	1893	100	147	247	Sediment
463	16	08/07/2017	54.37209 ; -11.72084	2184	54.39045 ; -11.71145	1859	171	119	290	Sediment, sea pen
464A	17	08/07/2017	54.3799 ; -11.56919	1802	54.39236 ; -11.56193	1508	115	167	282	No
464B	18	09/07/2017	54.39599 ; -11.52577	1281	54.40813 ; -11.51077	900	152	124	276	No
465	39	09/07/2017	54.56207 ; -11.4542	2460	54.5719 ; -11.4487	2232	187	110	297	Sediment
466	21	09/07/2017	54.704 ; -10.953	2090	54.71141 ; -10.94723	1881	155	121	276	Sediment
467	22	10/07/2017	54.80414 ; -10.83389	2287	54.78553 ; -10.85502	2090	194	181	375	Sediment, sea pen, sea whip, coral
468	38	10/07/2017	54.85001 ; -10.78145	2245	54.87182 ; -10.7814	2008	171	104	275	Sediment
469	23	10/07/2017	54.93273 ; -10.7013	2070	54.94975 ; -10.6922	1818	149	123	272	Sediment
470	24	10/07/2017	55.0436 ; -10.64116	2215	55.03333 ; -10.64608	2201	176	90	266	No
471	37	11/07/2017	55.06645 ; -10.42712	1940	55.08929 ; -10.42885	1730	148	126	274	No
472	36	11/07/2017	55.15474 ; -10.28677	1609	55.17643 ; -10.29345	1492	67	210	277	Sediment
473	26	11/07/2017	55.13445 ; -10.14249	1102	55.14845 ; -10.13477	800	80	190	270	Sediment, <i>Cidaris</i>

Table 3. Completed ROV *Holland 1* dives (26) 4th - 11th July, 2017. * 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
474	35	13/07/2017	55.96181 ; -9.3807	981	57.83778 ; 9.40511	962	90	166	256	Sediment
475	46	13/07/2017	56.21438 ; -9.47448	1894	56.20982 ; 9.492	1190	100	88	188	Sediment
476	34	13/07/2017	55.79983 ; -9.43205	857	55.80737 ; -9.4115	688	76	127	203	<i>Stichopathes</i> sp.
477	47	14/07/2017	55.76937 ; -9.69971	1650	55.77423 ; -9.67515	1575	130	141	271	Sediment, sea pen, sponges
478	32	14/07/2017	55.63235 ; -9.6468	1369	55.65513 ; -9.63398	1310	105	196	301	Sediment
479	48	14/07/2017	55.6527 ; -9.60558	1063	55.64577 ; -9.57912	949	94	132	226	Sea pen
480	49	15/07/2017	55.65272 ; -9.50527	795	55.63595 ; -9.51418	577	58	125	183	Sediment
481	33	15/07/2017	55.56455 ; -9.5887	968	55.58255 ; -9.57652	688	43	144	187	Sediment, sea pen
482	31	15/07/2017	55.5633 ; -9.75382	967	55.54467 ; -9.7388	962	108	171	279	Sediment
483A	29	15/07/2017	55.49245 ; -9.95135	1509	55.48438 ; -9.9391	1176	72	145	217	No
483B	30	16/07/2017	55.49843 ; -9.93922	1562	55.65205 ; -9.94085	1376	157	159	316	<i>Solenosmilia</i> , sponge sp., glass Sponge
485	27	17/07/2017	55.38753 ; -10.16853	1976	55.39622 ; -10.16598	1873	146	119	265	Echinoids, anemone, sediment
486	28	17/07/2017	55.3796 ; -10.1436	1667	55.38782 ; -10.14165	1564	142	97	239	Sediment
487	25	17/07/2017	55.03035 ; -10.30628	1520	55.04213 ; -10.29302	1250	111	184	295	<i>Solenosmilia</i> , sponge
488	20	18/07/2017	54.6675 ; -10.77825	1328	54.64888 ; -10.79947	975	91	303	394	<i>Lophelia</i> , <i>Pheronema</i> , sponge, Sediment
489	21	18/07/2017	54.51082 ; -11.16768	739	54.4991 ; -11.16862	664	63	172	235	No
490	40	18/07/2017	54.42678 ; -11.33323	748	54.41912 ; -11.33947	643	69	304	373	Sediment
491	45	18/07/2017	54.26503 ; -11.57697	956	54.25553 ; -11.58493	746	75	224	299	Sediment, <i>Lophelia</i> , <i>Madrepora</i> , Sponge
492	50	19/07/2017	54.02823 ; -12.22525	650	54.01538 ; -12.22413	483	79	179	258	Sediment, <i>Lophelia</i>
493	51	19/07/2017	54.06728 ; -11.98398	527	54.06633 ; -11.97767	516	31	134	165	No
494	11	20/07/2017	54.1768 ; -12.442	2357	54.18723 ; -12.45015	2140	154	111	265	Sediment
495	8	20/07/2017	54.18937 ; -12.83448	2377	54.18423 ; -12.85242	2107	205	177	382	Sediment, sponge
496	41	20/07/2017	54.0627 ; -12.6356	1905	54.07282 ; -12.65245	1446	224	147	371	Sediment, sponge
497	52	21/07/2017	54.05447 ; -12.51088	1099	54.07128 ; -12.52292	899	222	94	316	Sponge, <i>Madrepora</i> , <i>Pheronema</i>

Table 3 contd. Completed ROV *Holland 1* dives (24) 13th – 21st July, 2017. * Sequential ROV dive number; ^ non-sequential transect number.

3.2 Sample Images

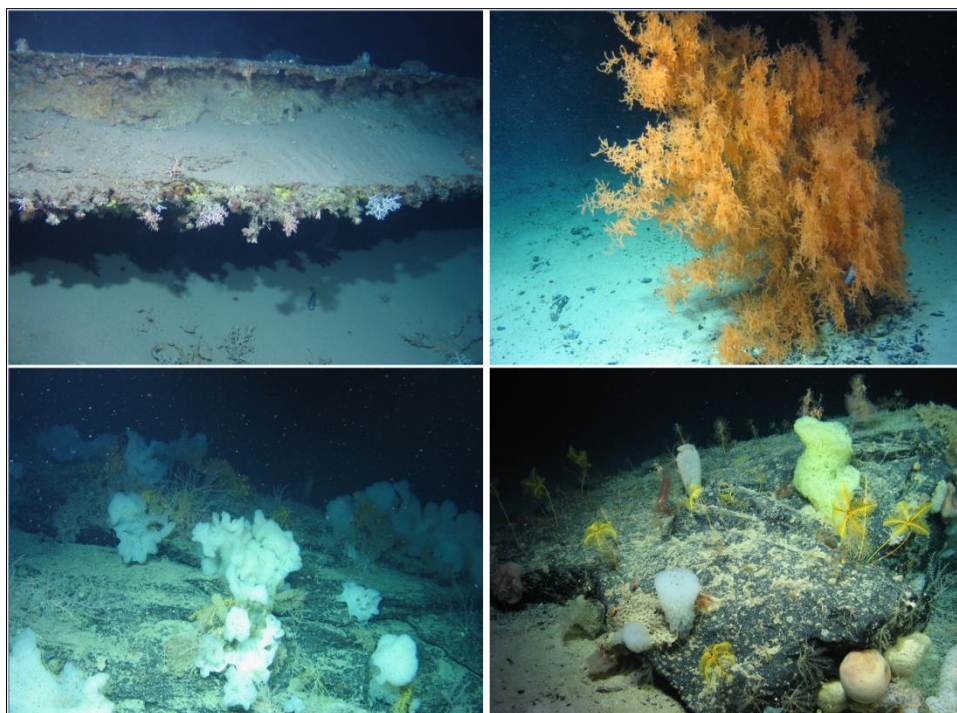


Figure 2. Top Left (TL): A rock overhang at 2000 m with coral, brittlestars, anemones with a sea-urchin (*Cidaris cidaris*) and a grenadier beneath. Top Right (TR): Black coral (*Leiopathes* sp.) estimated at over 2 m tall. Bottom Left (BL): Glass sponge garden. Bottom Right (BR): Stalked crinoids, an assortment of sponges and mobile feather star species.

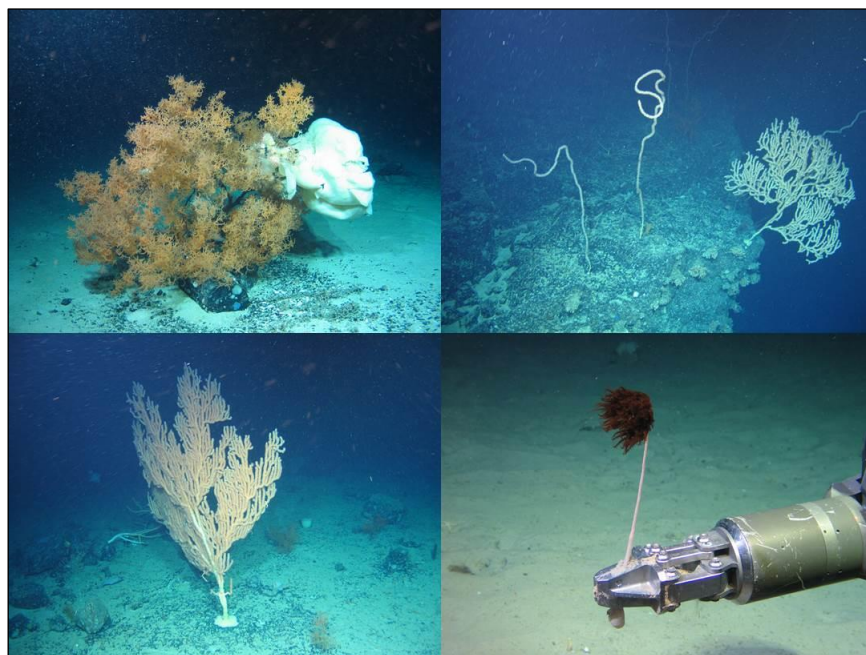


Figure 3. TL: *Leiopathes* sp. and sponge. TR & BL: Bamboo coral. BR: A sea pen sample in the ROV robotic arm.

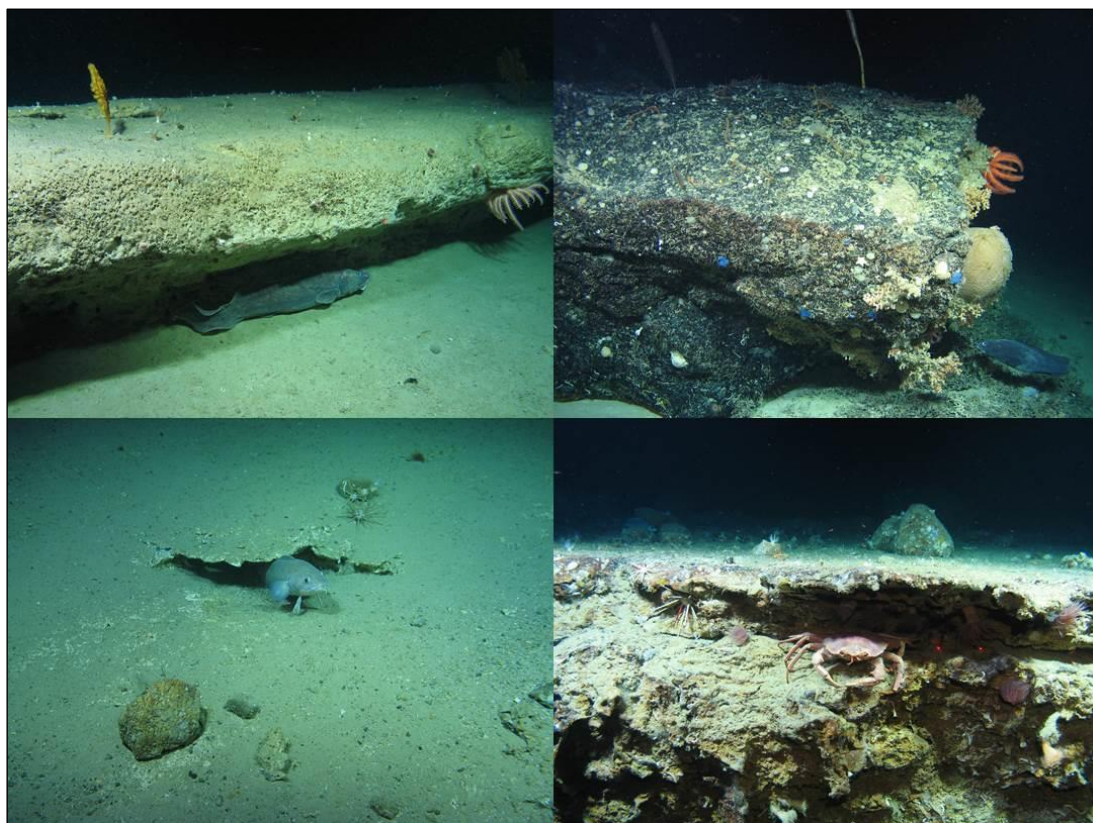


Figure 4. Rock outcrop and overhangs provide refuge for a host of animals.

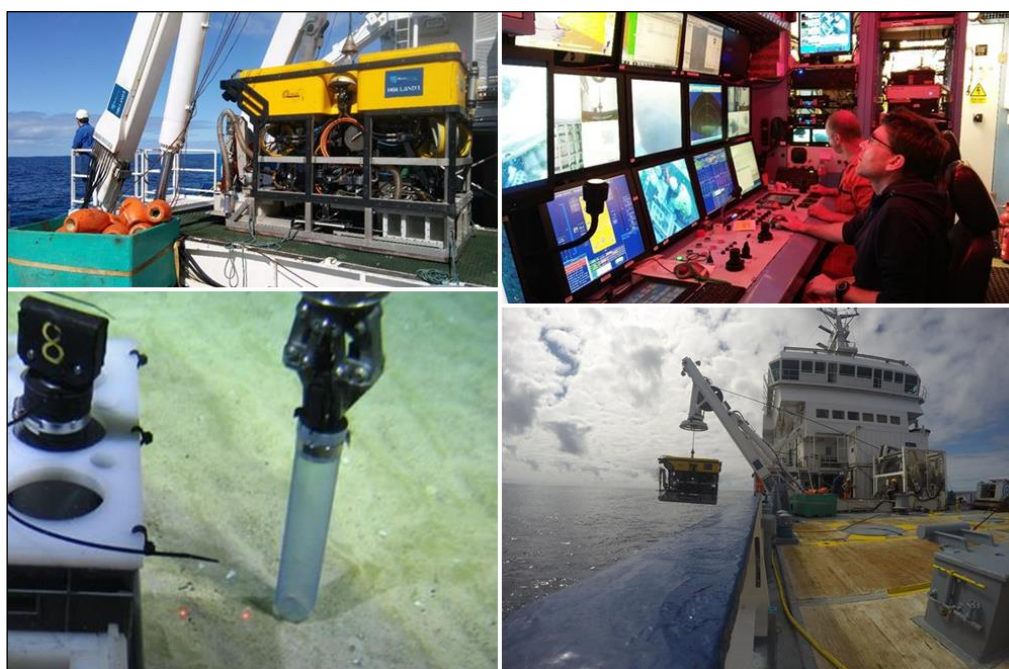


Figure 5. TL: ROV *Holland I*. TR: ROV control shack. BL: Sediment sampling at depth. BR: *Holland I* being deployed from the ILV *Granuaile*.



Figure 6. TL & TR: A pencil urchin (*Cidaris cidaris*) and reef forming cold water coral (*Lophelia pertusa*).
BL & BR: Reef-forming, *Solenosmilia variabilis* at previously unrecorded depths (>1600) on a geogenic structure (pillow lava).



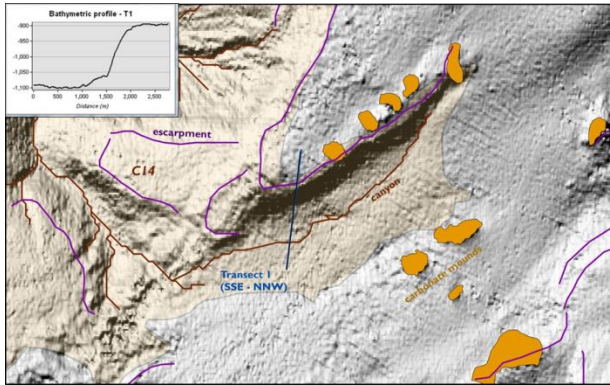
Figure 7. The SeaRover scientific party.

3.3 Site Summaries

Transect 01

Features of interest: canyons, escarpments

Depth: 1103 – 893 m

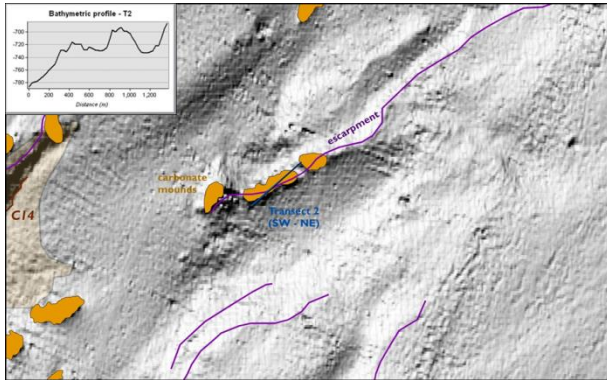


This area is at the southernmost end of the Northwest Porcupine Bank SAC. The canyon floor is comprised of coarse and rippled sand with some individual boulders. The side of the canyon is very steep in parts, forming cliffs and distinct overhangs (cliffs and boulders) particularly towards the upper parts of the canyon. The top of the canyon is characterised by soft sediment with the occasional rock outcrop. In the deeper parts of the canyon grenadiers, northern cut-throat (*Synaphobranchus kaupii*) and *Lepidion eques* are present and the bamboo coral *Acanella arbuscula* occurs sporadically. Moving up the slope sponges, including *Phakellia* sp., *Aphrocallistes* sp. and encrusting forms, corals such as *Drifa* sp., *Lepidisis* sp. and gorgonians occur. *L. eques*, rays and sharks were also recorded. On steeper slopes the fauna includes anemones, brisingids, the occasional *Acanella* sp., *Stichopathes* sp., zoanthids and *Chimera* sp. The stony coral *Lophelia pertusa* occurs further up the canyon flanks with *Lepidisis* sp., *Acanthogorgia* sp., glass sponges and thorny black corals. A variety of black corals including *Leiopathes* sp., *Stichopathes* sp., bamboo corals and clumps of *L. pertusa* occur in areas of the steep slope with *Chirostylus* sp. regularly found in association with the *Leiopathes* sp. Crinoids are common while the soft coral *Anthomastus* sp. is occasionally present. On the hard steep inclines with overhangs oreos and *Lepidion eques* are common as are *L. pertusa* and crinoids. *Madrepora oculata* is first recorded further up the slope. Here coral rubble is more prevalent and amongst it glass sponges, crinoids, *Stichopathes* sp. and cerianthids occur. Towards the top of the canyon slope rocks are colonised by the bamboo *Bathypathes* sp. and *Parantipathes* sp. are present along with numerous crinoids. The echinoid, cf. *Calveriosoma fenestratum* is first recorded among clumps of *M. oculata*. At the top of the canyon reef areas appear as diverse as on the canyon slope, clumps of *L. pertusa* are present and rock outcrops are colonised by glass sponges, *Leiopathes* sp., *Parantipathes* sp., and *Gorgonocephalus* sp. The blackbelly rosefish was observed while echiurans are seen on the soft sediment away from the canyon.

Transect 02

Features of Interest: canyon, escarpments, carbonate mounds

Water Depth: 785 – 684 m



This transect was previously undertaken during the 2009 Offshore Reef Survey (Guinan & Leahy 2009) and a repeat dive on this transect was carried out during the current study to monitor change, if any, over time. A thin layer of soft sediment (coarse sand with pebbles) over harder ground is

apparent at the base of the mound. Further up the slope the sediment is coarse with occasional rocks and dropstones. The hydroid coral, *Pliobothrus symmetricus*, occurs on stones and rocks. The echinoid *Cidaris cidaris* is common while *cf. Calveriosoma fenestratum* occurs occasionally. The northern cutthroat eel and *Lepidion eques* are also present.

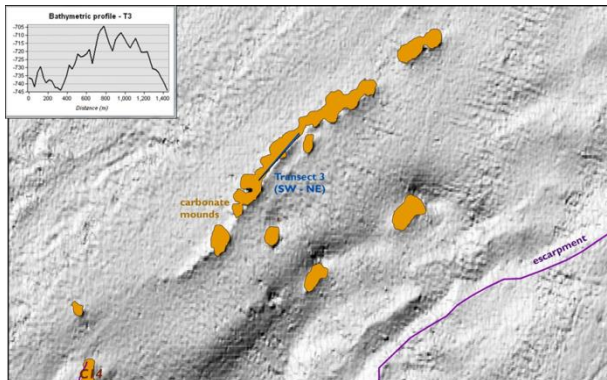
Moving up the canyon the incline is steeper; initially the fauna is sparse but diversity increases on reaching areas of coral rubble and areas of live *Lophelia pertusa*. Species such as *Bathypathes* sp., *Chirostylus* sp., *C. cidaris*, *P. symmetricus* and *cf. C. fenestratum* are recorded here, fish species include *L. eques*. Continuing up the slope *L. pertusa* becomes denser. The northern cutthroat eel, *L. eques*, the blackbelly rosefish, *P. symmetricus*, bamboo coral and the crab *Chaecon* sp. occur among the reef. In the patches of soft sediment cerianthids are evident. A dense area of reef continues over the top of the steep slope and many fish are evident in the water column. A long gully is present in which approximately 20 blackbelly rosefish are gathered, the substrate is featureless sand. The substrate on the subsequent incline is thought to be carbonate with a thin veneer of fine sediment.

Moving up the steep slope after this gully the density of *L. pertusa* increases and is at its densest towards the top of the incline. Two colour morphologies, white and orange, of *L. pertusa* are present here. Crinoids, echinoids, anemones, including hormanthid anemones are present. Further up the slope there are very dense patches of coral rubble, with cerianthids and the occasional clump of live *Lophelia*. Continuing up this slope the clumps of *Lophelia* reef increase in size and become denser, with *Anthomastus* sp., anemones and bamboo corals occurring amongst the reef.

Transect 03

Features of Interest: carbonate mounds

Water Depth: 753 – 704 m



This transect occurs along a series of mounds. The substrate varies moving over the mound from sand with pebble and stones at the base to carbonate sediment, terraces and cliffs. The density of stony corals increases from small single clumps to large dense patches, with occasional coral

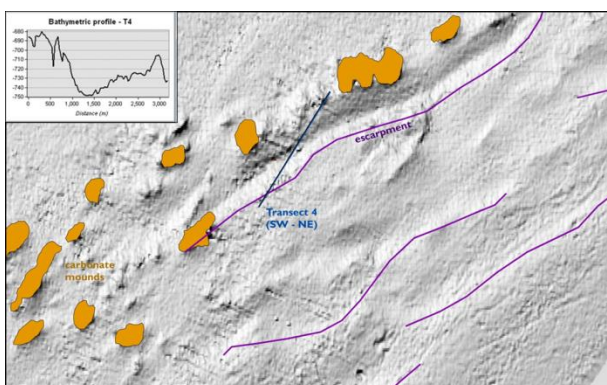
rubble. Both *Lophelia pertusa* and *Madrepora oculata* are present, and in some areas both the orange and white morphologies are seen together. Where these coral areas are less dense cerianthids occur in between the clumps.

Throughout this site the fish *Lepidion eques*, the echinoids *cf. Calveriosoma fenestratum* and *Cidaris cidaris* are common, with both *C. cidaris* and black cerianthids present in very dense patches on occasion. Other species include the hydroid coral *Pliobothrus symmetricus*, the black corals (*Bathypathes* sp., *Parantipathes* sp. and *Stichopathes* sp.) echiurans and the ophiuroid *Gorgonocephalus* sp.

Transect 04

Features of Interest: escarpment

Water Depth: 751 – 668 m



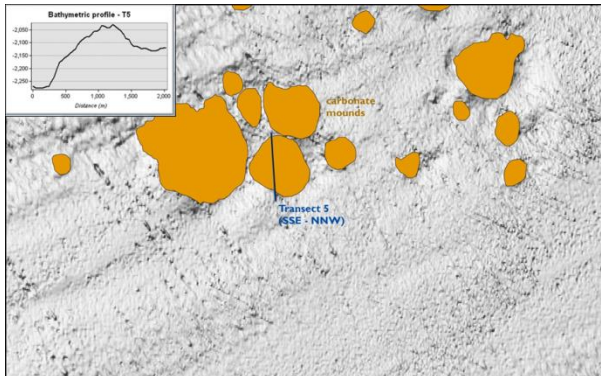
This site is at the north eastern end of the North-west Porcupine Bank SAC. The substrate varies from soft sediment to rippled sand. Where there are dropstones or hard substrate the coral hydroid *Pliobothrus symmetricus* occurs. The echinoid *Cidaris cidaris* is present throughout, however

conspicuous fauna is sparse. Fish species which occur here are the blackbelly rosefish *Lepidion eques*, northern cutthroat eels (*Synaphobranchus kaupii*), chimerids, sharks and monkfish (*Lophius* sp.).

Transect 05

Features of Interest: carbonate mound

Water Depth: 2280 – 2026 m



This site is distinguished by fields of large glass sponges and bamboo coral which predominate along the sides and top of the mound. With the exception of some chimerids, few fish are recorded here.

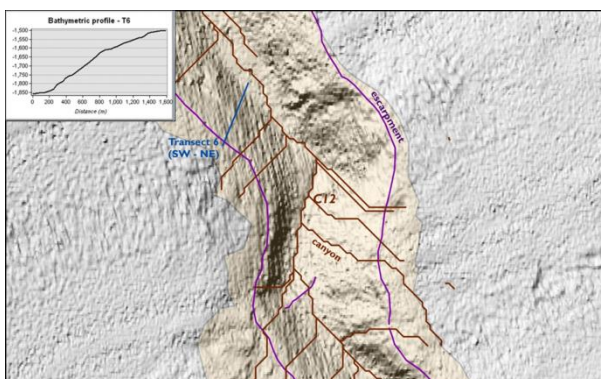
Soft ground transitioned from sand with pebbles and dropstones to rippled sand at the base of the mound. Here the fauna is generally sparse except for a variety of sea pens species and dense aggregations of xenophyophores. Elsewhere on the mound the obvious fauna on the soft ground is a sea pen species and a holothurian.

Lower down on the slope stalked crinoids, sponges (including glass, large globular varieties and encrusting forms) and cup corals are evident while black corals (*Parantipathes* sp. and *Bathypathes* sp.) occur on harder ground. The upper half of the mound is dominated by extensive fields of large glass sponges and thin white bamboo coral (*cf. Isididae* sp. from Howell & Davies 2010). The variety of corals includes Chrysogorgiid sp., *Euplectella* sp. and very long specimens of the bamboo coral *Lepidisis* sp. Among these sponge and coral fields a number of elasmobranch egg cases were noted.

Transect 06

Features of Interest: canyon, escarpment

Water Depth: 1858 – 1499 m



At the base of the canyon the sediment is sandy sediment with some pebbles and the occasional rock. The fauna here consists of xenophyophores, a variety of sea pens species and anemones, including cerianthids. Occasional ophiuroids and bamboo coral *Acanella* sp. and holothurian

are present on the soft sediment. Rock or exposed bedrock where it occurs is colonised by encrusting sponges and Stylasterid corals and on occasion brisingids. Fish species include eels and chimerids.

On the flanks of the canyon whip-like *Stichopathes* sp. are common; the ground is steep with hard ground in the form of stones, rocks and occasional exposed bedrock. Ophiuroids, glass sponges, *Acanella* sp. and bamboo coral are noted here with sea pens, holothurians and cerianthids occurring in the sediment. Continuing up slope barnacles are numerous on any available hard ground, the black corals *Bathypathes* sp. and *Parantipathes* sp. are also present.

Above 1700m coral rubble and a small clump living *Lophelia pertusa* occurs. Barnacles, encrusting sponges and *Stichopathes* sp. are also noted. The substrate here is that of steep coarse sand with occasional rocks. Sea pens are abundant and also present are ophiuroids and the occasional xenophyophore. A variety of sea pens including *Pennatula* sp. and *Umbellula* sp. are common on soft sediment and the corals include *Stichopathes* sp. and *Parantipathes* sp., *Leiopathes* sp. and *Lepidisis* sp. On rock with a fine sediment overlay small clumps stone coral *Madrepora oculata* occur along with the black corals.

An area dominated by xenophyophores and sea pens *cf. Pennatula* predominate occurs on the side of the canyon in soft sediment. Ophiuroids and holothurians also occur and where there is hard substrate it is colonised by black corals barnacles and a variety of sponges including encrusting forms. Further up the canyon side hard substrate is colonised by a variety of sponges and corals, both stalked and motile crinoids and occasionally clumps of the stone coral *L. pertusa* and coral rubble. Fish species appear to be more prevalent here and include Oreos, eel-like fish and grenadiers.

On a series of terraces and cliffs of varying height black corals, *Leiopathes* sp. and *Stichopathes* sp. are present along with both stalked and motile crinoids. On the ledges areas of living and dead *L. pertusa* occur; here a variety of sponges including glass sponges and large erect sponges are present along with anemones, including *cf. Bolocera*.

The overhangs are colonised by stalked and motile crinoids, Stylasteridae sp. and black corals. Grenadiers are also observed here.

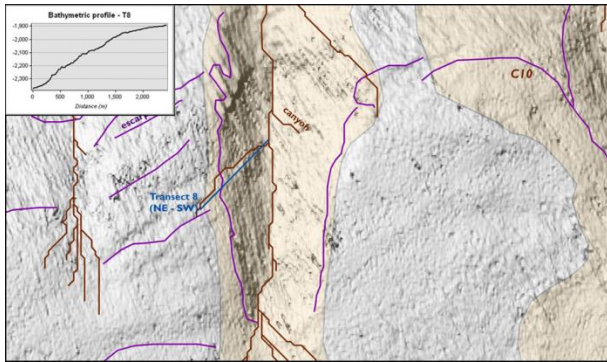
Towards the top of the canyon flank the sediment is that of soft fine sand moving. The fauna here is dominated by cerianthid anemones and xenophyophores. Fish species particularly grenadiers appear to be more common here. On the occasional rock living and dead *L. pertusa* occur.

Transect 07
Not surveyed

Transect 08

Features of interest: canyon, escarpment

Water Depth: 2378 – 1883 m

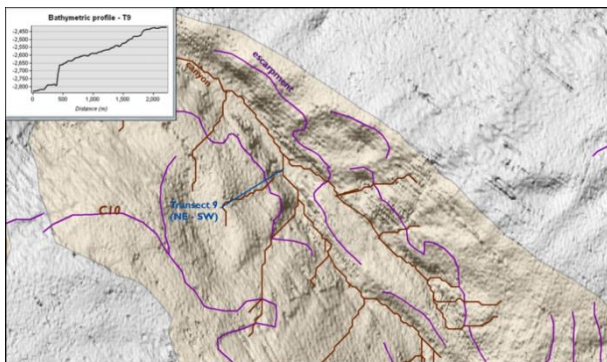


The canyon floor contains coarse sediment leading to a series of carbonate cliffs and ledges covered in a thin layer of soft sediment. Very small white echinoids, *cf. Echinus* sp. are present on the canyon floor; stalked crinoids are very common as are holothurians, *Benthogone* sp. The white holothurian *Mesothuria intestinalis*, and *Holothuroidea* sp. 2 (from Howell & Davies 2010) occur at 2100 m. On hard ground black corals, *Bathypathes* sp. and *Leiopathes* sp. are common as are sponges, globular and encrusting forms are recorded as well as glass sponges, including *Euplectella* sp. Barnacles and cup corals are occasionally present on hard substrate. A delicate chrysogorgiid coral was observed at 2100 m. With the exception of the occasional eel and grenadier there is a paucity of fish species here.

Transect 09

Features of Interest: canyon, escarpment

Water Depth: 2830 – 1672 m



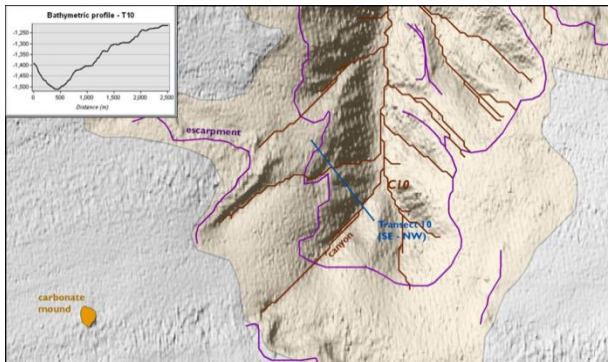
As the ROV reached the end of its umbilical at 2557 m without reaching the sea floor it travelled 500 m mid-water to reach the side of the canyon. The sea floor on this slope is that of sandy sediment; the fauna consists of holothurians, including some *Mesothuria intestinalis* and echinoids including a small

white *cf. Echinus* sp. and *Spatangus* sp.

Transect 10

Features of Interest: canyon, escarpment

Water Depth: 1516 – 1212 m



Soft sediment covers the canyon floor and contains sea pens (incl. *Umbellula* sp.), cerianthids, echinoids, glass sponge (*Hyalonema* sp.) and white holothurians cf. *Holothuroidea* sp. 2 (from Howell & Davies 2010). On the steep canyon slope fauna is sparse consisting of cerianthids, echinoids,

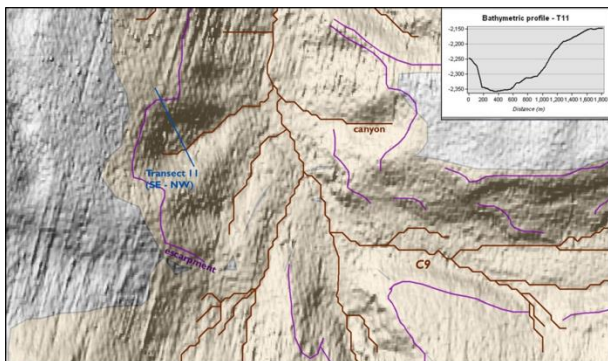
anemones and large sea pens; here burrows are also visible. On the downward slope burrows and cerianthids continue to occur but the fauna is dominated by a variety of sea pen species. The sponge *Hyalonema* sp. is present. Where rocks are present bamboo coral and sponges occur. Fish species are abundant and include grenadiers, sharks and a number of orange roughly.

As the ground rises again the substrate transitions from sand and rocks to rocks and steep cliffs with sediment overlay. Black coral including *Parantipathes* sp., *Stichopathes* sp. and *Leiopathes* sp. and glass sponges, some with yellow zoanthids, are present. On cliffs and overhangs, small clumps of the coral *Solenosmilia variabilis* occur, along with anemones including an unidentified smooth column hormanthid anemone, crinoids, bamboo coral, *Stylasterid* sp. and sponges.

Transect 11

Features of interest: canyon, escarpment

Water Depth: 2358 – 2146 m



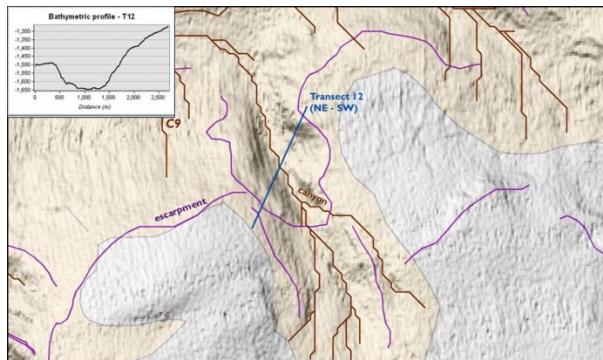
The soft sediment is dominated by stalked crinoids, ophiuroids, echinoids, sea pens and holothurians. A 50 m tall carbonate cliff with burrows has several large sponges colonising it. On the top of the cliff the substrate is once again soft substrate with a higher abundance of stalked crinoids, sea

pens and ophiuroids.

Transect 12

Features of Interest: canyon, escarpments

Water Depth: 1652 – 1270 m



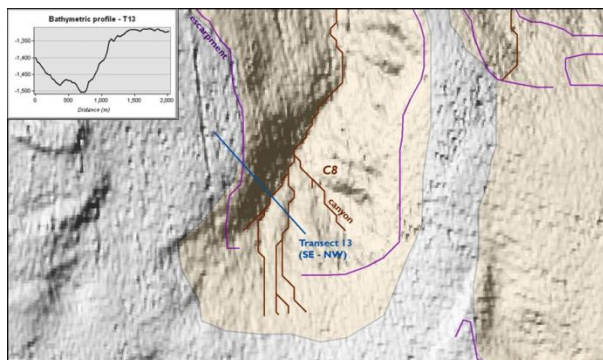
This canyon had a sharp 100 m precipice on its northern slope; the floor is sandy with evidence of bioturbation. The southern slope is a 250 m steep incline with cliffs and vertical walls, at 1400 m the slope becomes more gradual with fine sandy sediment.

At the top of the northern slope are large bamboo corals, while further down this slope the stony coral *Solenosmilia variabilis* and the black coral *Stichopathes* sp. (straight form) occur. The fauna of the southern slope comprises sponges, including glass sponges, ophiuroids and crinoids with occasional sea pens, echinoids and the black corals *Leiopathes* sp. and *Bathypathes* sp. Large numbers of grenadier are present through-out, as are eel-like fish, oreos and a small orange roughy.

Transect 13

Features of Interest: canyon, escarpments

Water Depth: 1506 – 1311 m



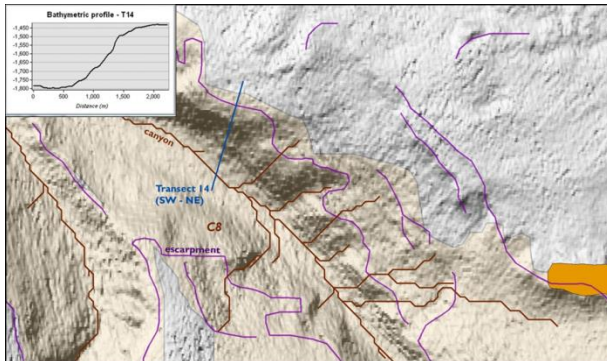
The canyon has a ridge along the bottom approximately 40 m in height. The substrate is primarily soft sediment with areas of rock outcrop. Hard ground is colonised by glass and encrusting sponges while the soft ground largely contained xenophyophores, Aphroditidae sp. and the occasional

cerianthid anemone. Grenadiers are common along the canyon floor; invertebrate fauna is similar to that observed on the ridge. The canyon wall is steep and terraced; the bivalve *Acesta excavata* is present in the crevices as are small clumps of the stony coral species *Solenosmilia variabilis*. Mobile and stalked crinoids, glass sponges and the black coral *Leiopathes* sp. are commonly recorded on the hard ground with *Benthoctopus* sp. seen on one of the ledges. Grenadiers are common with the occasional orange roughy and oreo. Over the crest of the canyon soft sediment containing xenophyophores is prevalent and among these a single glass sponge *Pheronema carpenteri* is recorded.

Transect 14

Features of Interest: canyon, escarpments

Water Depth: 1800 – 1427 m



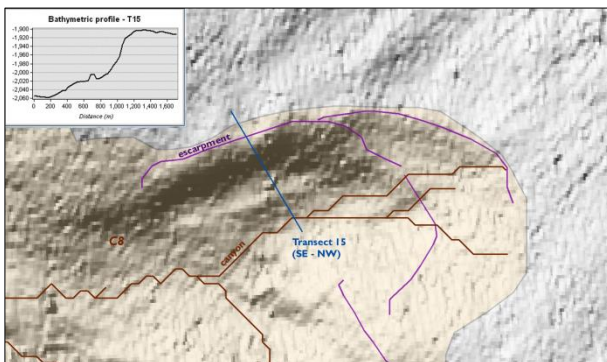
The substrate of the canyon floor (1800 m) is soft sediment with pebbles. Xenophyophores are common here with the occasional sea pen. Towards the side of the canyon the sediment is rippled, sand waves occur at the foot of the canyon wall. A terraced wall begins at 1750 m and contains

dense areas of *Solenosmilia variabilis*; midway up this terrace very large bamboo corals occur. Several species of sea pens are noted throughout the sediment, pebbles and rocks of the terraces. The black coral *cf. Parantipathes* sp. is frequent on the cliffs and terraces. Brisingids and anemones are present among the stone coral *Madrepora oculata*; brisingids also occur in clusters on rocks. On a 500 m hard incline, sponges are frequent as are the black coral *Stichopathes* sp., anemones and the occasional stalked crinoid. Common fish species included grenadier and oreos. Coral species, including the stony corals *M. oculata* and *S. variabilis* and black corals are abundant.

Transect 15

Features of Interest: canyon, escarpments

Water Depth: 1800 – 1427 m



The substrate at the bottom of this canyon is that of sand, this is occasionally rippled with coarser sediment in these ripples. Conspicuous fauna is sparse and includes cerianthids, sea pens, echinoids and holothurians. The occasional rock is colonised by brisingids, bamboo coral and

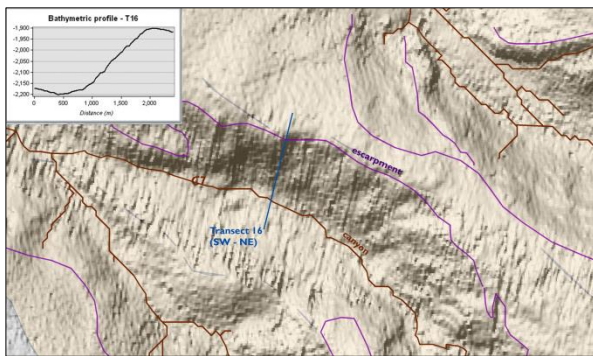
encrusting and glass sponges. Moving up slope sea pens become more frequent in species and number. Continuing further up slope the ground becomes steeper and coarser; the sea pens are less frequent. Hard ground in the form of small rocks and stones is more apparent and is colonised by brisingids, bamboo corals, crinoids and a variety of sponges.

Carbonate substrate which on occasion is steep and forms cliffs is colonised by a wide variety of sponges and corals including *Parantipathes* sp., *Leiopathes* sp., *Bathypathes* sp., *Lepidisis* sp., as well as *Stichastrella* sp., stalked crinoids and brisingids. Towards the top of the feature the layer of fine sediment appears thicker; the fauna consists of a variety of sea pens, some echinoid species and a few xenophyophores.

Transect 16

Features of Interest: canyon, escarpments

Water Depth: 2204 – 1901 m



At the foot of the slope at approximately 2170 m the substrate is that of mixed sediment. There is a lot of marine snow which continued throughout this site. The fauna is dominated by ophiuroids and small white echinoids with occasional holothurians and stalked crinoids. There is evidence of

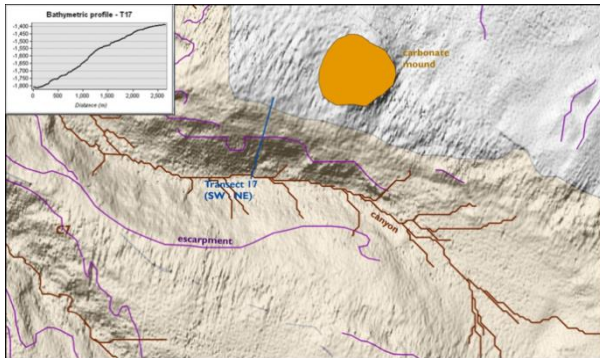
bioturbation. The slope consists of areas carbonate sediment interspersed with areas of mixed sand. The carbonate substrate forms terraces, cliffs and pavements; it is on occasion overlaid with a fine layer of sediment. On all substrates small to medium rocks occur, sometimes forming the predominant substrate type.

On carbonate substrate stalked crinoids are common throughout, brisingids are occasionally very common where there are rocks or boulders. Ophiuroids and a variety of holothurians are present throughout the site. Midway along the slope corals species occur, these included *Leiopathes* sp., *Parantipathes* sp. A variety of sea pens also occur throughout the slope. Moving over the top of the slope in mixed sediment the fauna is dominated by xenophyophores and sea pens, holothurians and corals such as *Bathypathes* sp., *Leiopathes* sp. and *Antipathes* sp. are present. Stalked crinoids and brisingids also occur here.

Transect 17

Features of Interest: canyon, escarpments

Water Depth: 1870 – 1391 m



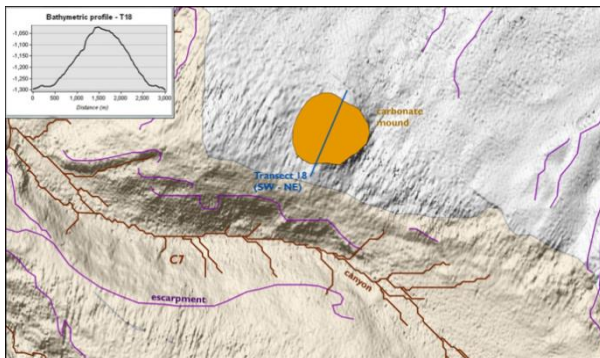
The floor of the canyon slopes gently upwards from 1870 m; terraces are present from 1700 m to the top of the canyon at 1400 m. The ground is generally soft interspersed with hard cliffs. Where hard substrate is present black corals, including *Leiopathes* sp., glass sponges and cup corals

are numerous; crinoids and ophiuroids are also present here. Numerous brisingids are present and a large anemone, cf. *Bolocera* sp. At 1650 m a *Solenosmilia variabilis* reef is evident. Barnacles are common along here with what appears to be sabellid tubes. At the top of the canyon rocks and boulders are colonised by barnacles, glass sponges and black corals. Marine litter (plastic water cup) is recorded here.

Transect 18

Features of Interest: carbonate mounds

Water Depth: 1296 – 1008 m



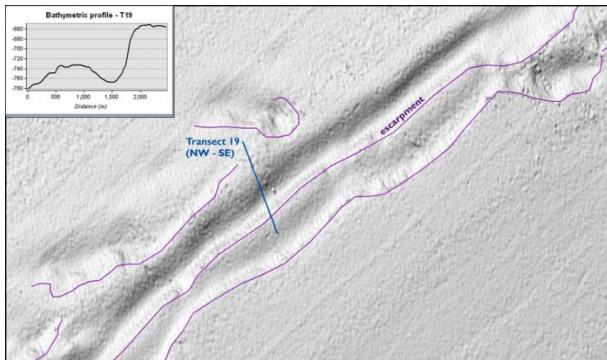
At the base of the mound the substrate is coarse, gravelly sand with occasional xenophyophores and the bamboo coral, *Acanella arbuscula*. The hard ground of boulders and bedrock is colonised by barnacles and encrusting sponges. There are large numbers of orange roughy, grenadiers

and sharks including many juveniles. An extensive amount of fragmented dead coral reef rubble occurs here.

Transect 19

Features of interest: escarpment

Water Depth: 781 – 650 m



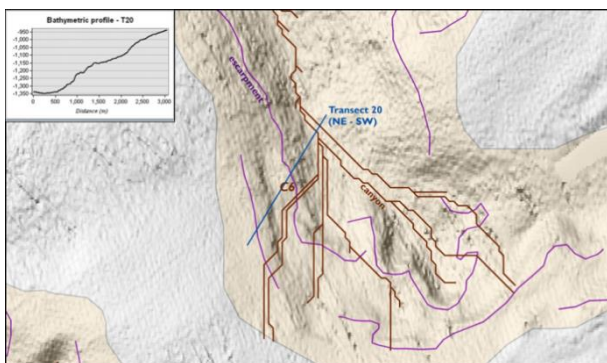
This dive follows the escarpment feature for approximately 200 m before moving southwest and moving up slope again. The seafloor is initially that of soft sediment with the only obvious fauna consisting of the echinoid *cf. Calveriosoma fenestratum*. Moving up slope the substrate gradually

transitions to become coarser with pebbles, stones and boulders more prevalent. The carbonate escarpment contains various sized overhangs and the carbonate sediment appears to contain bore holes in some places. The holothurian *Psolus squamatus* is common on stones and in some places is very dense. Serpulid worms and encrusting sponges are common on stones and rocks. Dropstones are present on the carbonate terrace. *Lepidion eques* and the blackbelly rosefish are common thorough out, with occasional occurrence of hormanthid anemones.

Transect 20

Features of interest: canyon, escarpment

Water Depth: 1351 – 971 m



Soft substrate of the canyon floor is dominated by xenophyophores, sea pens, echinoids, *Acanella* sp., eels and grenadiers. On the slope dropstones are colonised by sponges, *Hyalonema* sp., and anemones, transitioning into an area of coral rubble and stones where small glass sponges and soft

coral are more common. At the base of a distinct 30 m high carbonate pinnacle *Solenosmilia variabilis* is recorded while at its pinnacle sponges and soft corals occur.

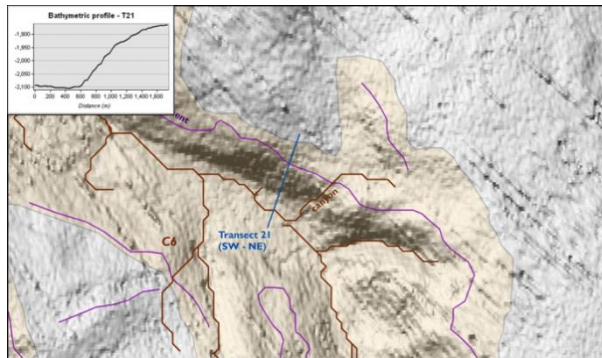
Moving along a steep rock cliff the bivalve *Acesta excavate*, sponges and clumps of *S. variabilis* occur. In an area of boulders with bamboo corals, the black coral *Leiopathes* sp. along with very large specimens of sponges are present. There is a wide diversity of species here including ophiuroids, hormanthid anemones, the soft coral *Anthomastus* sp., hydroids,

pycnogonids *Galatheidae* sp. and echinoids, including *Cidaris cidaris*. These boulder areas alternate with areas of soft sediment to the top of the canyon, the latter containing xenophyophores and sponges.

Transect 21

Features of Interest: canyon, escarpments

Water Depth: 2105 – 1864 m



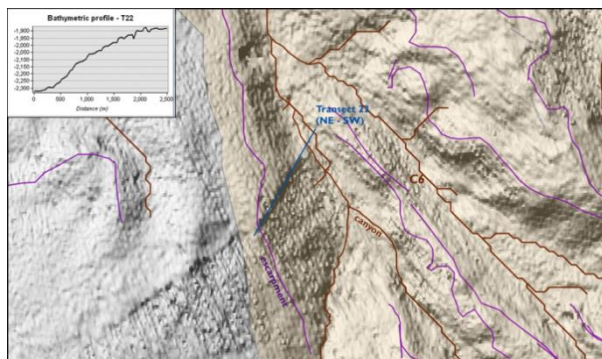
The substrate of the canyon floor appears very fine, soft sediment continues up the canyon flank before transitioning to exposed bedrock with small terraces and overhangs. This slope is very steep on occasion. From 2000 m depth the slope incline shallows, from here the substrate is soft to the top of

the canyon. Heavy marine snow is an aspect of this canyon. Asteroids, echinoids, sea pens, black corals including *Bathypathes* sp. are common throughout the canyon. Brisingids, mobile and stalked crinoids, hydrozoans and cup corals and hormanthid anemones are present here sporadically. Some of the less conspicuous fauna include shrimp, hermit crabs, glass sponges and encrusting sponges.

Transect 22

Features of Interest: canyon, escarpments

Water Depth: 2322 – 1873 m



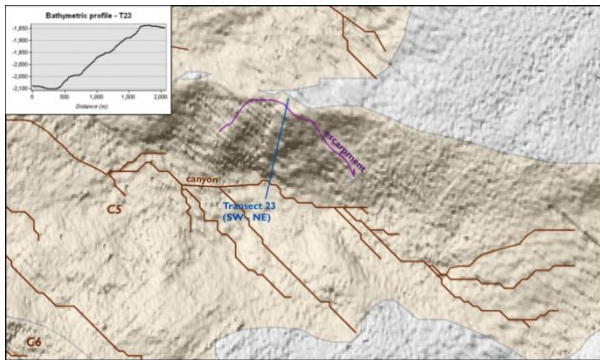
The substrate of the canyon floor is soft with carbonate substrate on the slope. At 2200 m the slope is steep and terraced and appears to be carbonate sediment with a thin veneer of sediment. Below 2230 m the fauna consists of holothurians and the echinoid *Echinus* sp., above this as the ground becomes harder,

fine stalked crinoids and ophiuroids are the dominant species. At 2225 m in soft substrate fine stalked crinoids continue to be plentiful, along with sea pens and ophiuroids. On the upper slopes the soft coral *Anthomastus grandiflorus* and a variety of anemones including cerianthids and hormanthid anemones occur.

Transect 23

Features of Interest: canyon, escarpments

Water Depth: 2102 – 1837 m

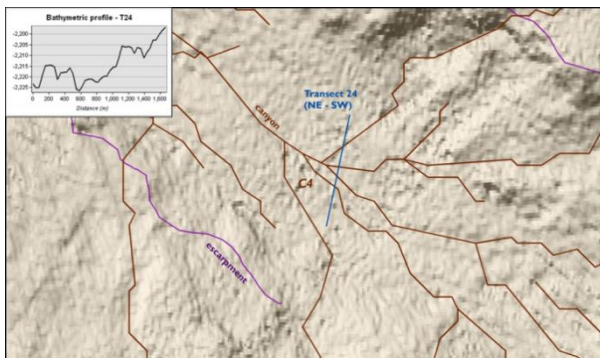


This canyon is mostly comprised of soft sediment substrate. On carbonate ledges less than 2 m in height brisingids and chrysogorgiid occur. Soft sediment shows signs of bioturbation; the conspicuous fauna included stalked crinoids, echinoid species including *Phormosoma placenta*.

Transect 24

Features of Interest: canyon

Water Depth: 2227 – 2192 m



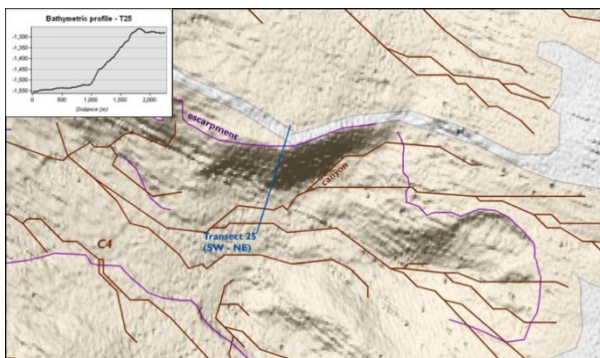
The system ranges from 2215 m to 2202 m and the substrate is largely that of soft sediment. Conspicuous fauna are sparse and primarily include sea pens, cerianthids and grenadiers with some whip corals *Stichopathes* sp. towards the top of the feature. Numerous deep bowl shaped

depressions (1-2 m deep) are evident in one area with grenadiers found at the base. One such trench-like depression ran into the canyon system. These features occur between 55° 02.22503 N 10° 38. 6428 W and 55° 02.1843 N, 10° 38.6706 W.

Transect 25

Features of interest: canyon, escarpment

Water Depth: 1555 – 1253 m



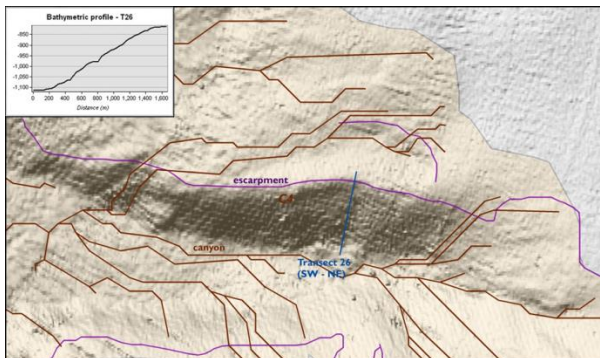
A dramatic canyon wall rising from 1521 m to 1250 m and consisting of spectacular geological and biological features is present here. The substrate of the canyon floor is soft sediment and is inhabited by cup corals,

cerianthids, xenophyophores, ophiuroids and echinoids. Fish species such as grenadier, eels and sharks including lantern sharks, are common here. On the slope soft sediment gives way to stone/pebble fields before reaching a series of ledges and rock overhangs. Brisingids, ophiuroids and cup corals attach to the top and sides of 10-20 m long horizontal ridges. The ridges, 1 to 2 m in height, are noteworthy and may in fact be old seabed. There is litter and plastic in the sediment and trawl marks are evident in areas of apparent decreased faunal diversity. *Solenosmilia variabilis* is frequent throughout but develops into a large reef formation at the canyon summit; much of this is dead but continues to support a rich reef fauna. Common species include corals such as bamboo coral, *Acanella arbuscula*, *Bathypathes* sp., *Anthomastus* sp., cup corals and a variety of sea pens. Sponges, including glass sponges, are particularly prevalent among this *Solenosmilia* reef.

Transect 26

Features of Interest: canyon, escarpments

Water Depth: 1120 – 813 m



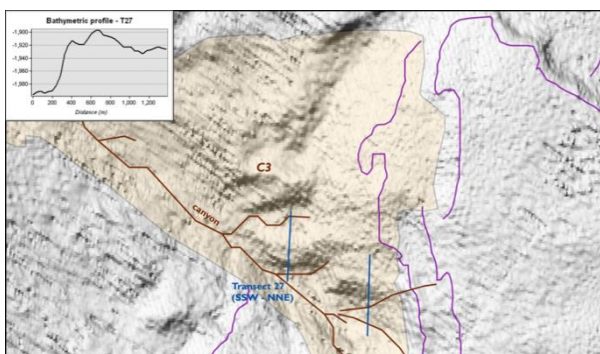
The sediment is soft and the fauna is predominantly echinoids, cup corals, the bamboo coral *Acanella arbuscula* and occasionally the asteroid *cf. Stichastrella rosea*. Anemone assemblages are dense throughout, as well as cup corals these include cerianthids, halcampoids,

hormanthid and interesting sun-shaped anemones. Large black solitary *cf.* hydroids are also present. The echinoid *cf. Phormosoma placenta* are plentiful as are sea pens; evidence of what is presumed to be crustacean burrows is widespread. Several large monkfish specimens were observed.

Transect 27

Features of Interest: canyon

Water Depth: 2004 – 1897 m



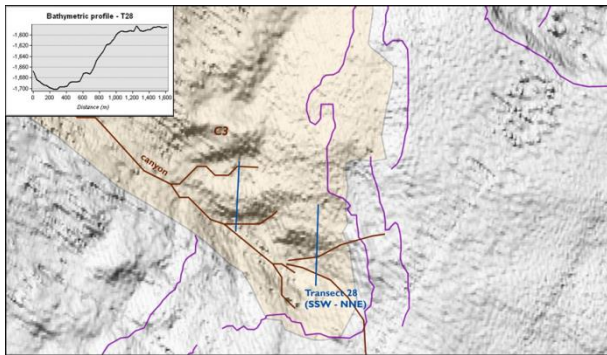
At 1976 m a steep feature with soft sediment and/or carbonate gravel at its base rises 50-60 m high; the face of this feature appears to

be that of carbonate rock. Brisingids abound on a prominent ledge and overhang. At the apex of the feature and beyond the substrate is that of very fine material; fauna is sparse consisting of *cf. Echinus* sp., sea pens and cerianthids. Occasional patches of carbonate rock are visible under a thin veneer of sediment. The carbonate substrate becomes more exposed with the increasing steepness of the terrain; it transitions on to carbonate gravel. Another solid rock feature, 50 m in height and with an overhang at its apex is present. Fauna is again sparse with occasional asteroids, echinoids and ophiuroids. The sediment and fauna is similar to that seen at the bottom of the feature. The remainder of the ground is featureless sediment with the echinoids *cf. Phormosoma* sp. A large fishing net was observed.

Transect 28

Features of Interest: canyon

Water Depth: 1702 – 1583 m



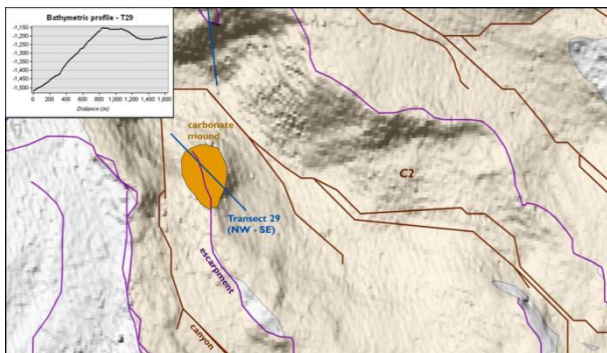
The substrate at this site is that of soft, featureless sand on a steep to very steep incline. The echinoid *Echinoidea* sp. 4 (from Howell & Davies 2010), is the most common species throughout; grenadier are present in low numbers. Small dense patches the elpidiid holothurian occur

between 1660 m and 1630 m depth. Large burrows, one of which is occupied by a galatheid are first observed at 1630 m. At the top of the slope two species of sea pens *Umbellula* sp. and *Kophobelemnon* sp. are present.

Transect 29

Features of Interest: canyon, escarpment, carbonate mound

Water Depth: 1523 – 1145 m



The soft sediment floor of the canyon contains burrows, presumed to be those of galatheids; echinoids and holothurians are also present here. A large rock cliff with block-like boulders at right angles to each other occurs at the base of the mound. The

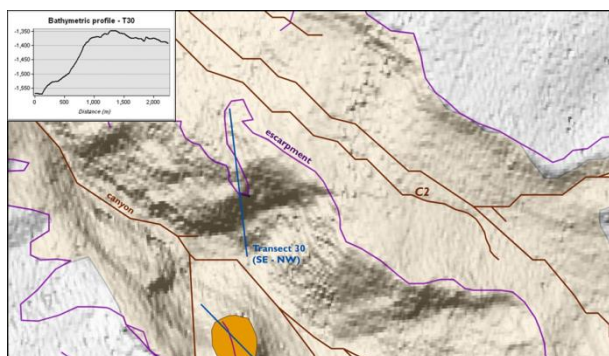
boulders are colonised by the stony coral *Solenosmilia variabilis* and the bivalve *Acesta excavates*. These bivalves are particularly dense in crevices and overhangs. The terrain is terraced with soft sediment on the horizontal steps. Cliff and rock are colonised by a variety of corals, including black, bamboo, gorgonian and soft corals. The smooth column hormanthid anemone is common here. Fish species include grenadiers, oreos and numerous orange roughy, some very small in size.

At 1370 m the seafloor is comprised of carbonate sediment and cliffs of carbonate substrate approximately 10 m in height. These carbonate areas are interspersed with fine, dark grey to black sediment. The carbonate is sparsely colonised with encrusting sponges but diverse fauna are found where hard rock occurs and includes, the glass sponge *Aphrocallistes* sp., cup sponges and black and bamboo corals. Oreos, including a juvenile, are very common. Numerous white sponge covered with yellow zoanths are frequent on the mound slope while white hydrozoan coral is very plentiful on the mound top. The variety and density of sponges implies this location is a sponge field. Discarded rope/fishing line was observed at this site.

Transect 30

Features of Interest: canyon, escarpments

Water Depth: 1577 – 1348 m

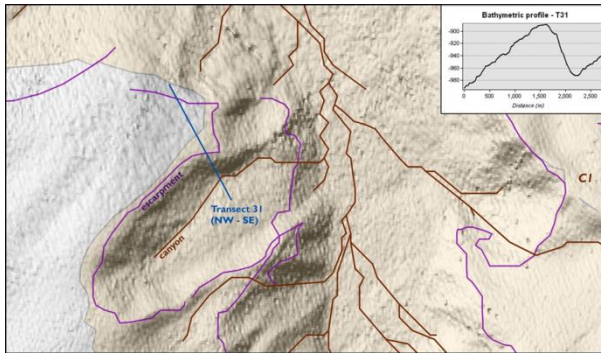


A lot of biological activity was observed in the water-column above soft sediment. The seafloor is colonised by xenophyophores and sea pens. Three distinct patches of the small elpidiid holothurians are noted. Gullies and rock outcrops occur at the base of the canyon. Fishing debris (nets/ropes/line) is present in this area as are large chimerids. A large boulder, approx. 10 m² was observed in a depression, carbonate rock formations in the form of large towers and spires also observed, all colonised by yellow and blue encrusting sponges. The ground transitions from soft to sandy to rocky area with barnacles before xenophyophores and sea-pen assemblages reappear along with small orange roughy.

Transect 31

Features of Interest: canyon, escarpments

Water Depth: 990 – 887 m

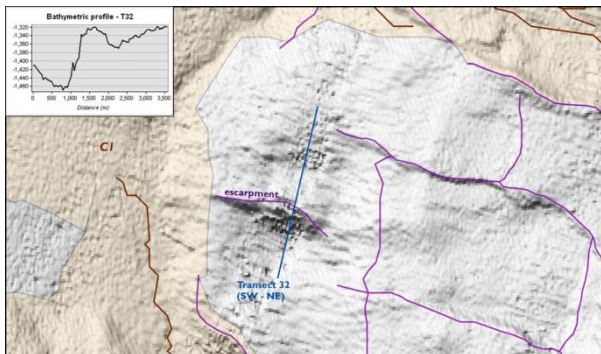


The sediment on the canyon floor is sandy with ripples and scattered coarse substrate. Echinoids, cerianthids, grenadiers, small eels, *Lepidion eques* and purple anemones dominate but are sparsely distributed. Sharks and a large ling are present. Dropstones and rocks occur towards the upper slopes of the canyon sides. Moving down the far side of the feature the substrate is that of rocks and pebbles. Most of the rocks are colonised by large barnacles. The sediment at the base of the feature is that of flat featureless sand.

Transect 32

Features of Interest: canyon, escarpments

Water Depth: 862 – 687 m

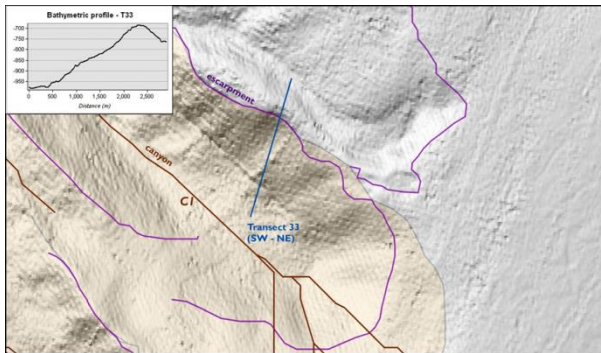


Predominantly soft sediment is recorded at this site. At both the beginning and end of the transect xenophyophores are very common with the mid-section dominated by *Galatheidae* burrows; echinoid species are observed at the start of the transect only. Towards the top of a steep incline bamboo corals including *Acanella* sp. are common, along with a variety of sea pen species. Grenadiers, usually round-nosed, and northern cutthroat eel are present throughout; a few orange roughy are present at the base of the incline. Sharks, chimerids and a few rays including a great lantern shark and the brentnose rabbitfish are present. Areas of hard ground are minimal here. Significant littering (30 sightings) is apparent and includes plastic, fish-lines and netting. Pilot whales and gannets were observed from the vessel.

Transect 33

Features of Interest: canyon, escarpments

Water Depth: 967 – 679 m

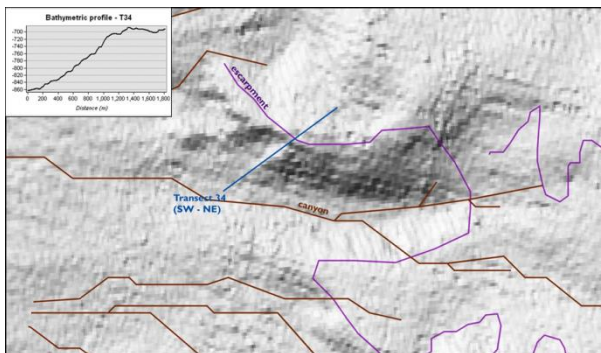


The substrate is mainly soft sediment with occasional pebble fields, stones and boulders. Sea pen and xenophyophore aggregations occur on the canyon floor, on the canyon flank the fauna is characterised largely by anemones. Large numbers of *Epizoanthus pagophilus* are present and the occasional hormanthid anemone; patches of the small Clypeasterid echinoid, or sea biscuit, are noted. Fish species include eel-like fish, grenadiers and a black scabbard; burrows occupied by *cf. Nephrops* sp. are observed. Trawl marks are in evidence here, indicating historic fishing activity; where trawl marks occur the absence of xenophyophores and sea pens is noted.

Transect 34

Features of Interest: canyon, escarpments

Water Depth: 862 – 687 m

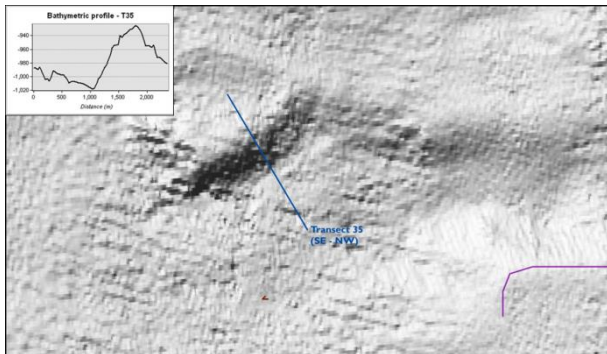


The substrate is predominantly rippled sand with some stones and pebbles. No obvious fauna is visible on the very steep incline (730 m). Echinoids are present at the base of the canyon with *c.f. Echinus* sp. being common. *Epizoanthus pagophilus* and its symbiotic hermit crab *Parapagurus pilosimanus* are evident at the base of the canyon but are not observed on the side of the canyon. White smooth column hormanthid anemones occur regularly. Further up the slope, large anemones are present on the sand. A distinct dense patch of the small dark anemones are evident here; this is different from other sites where they tend to be scattered widely over a large area. Northern cut-throat eels are present throughout but are more common at the base of the slope. Greater forkbeards are recorded on the mid to upper slope. The hydroid *Pliobothrus symmetricus* occurs on the stony ground towards the top of the canyon. An unusual depression feature was noted at this site.

Transect 35

Features: Unidentified

Water Depth: 988 – 921 m



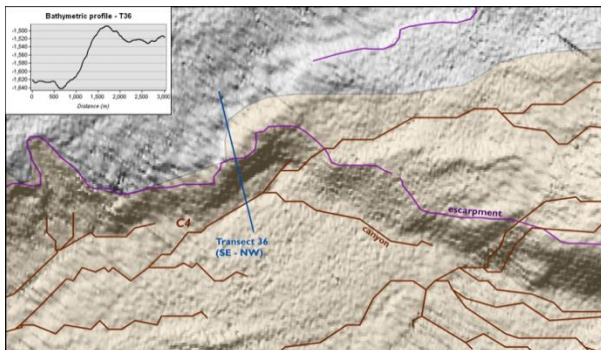
The substrate is mainly sandy featureless sediment while coarse ground with stones, pebbles and occasional rocks is more common where the incline is gentle. The predominant fauna are cerianthids and a pale pink anemone which occur in the sediment. A red echinoid, *Echinoid* sp. is recorded

here for the first time in this survey. *Galatheidæ* burrows are quite prominent in some areas. The hydrozoan *Pliobothrus symmetricus* is present on the rocks towards the top of the feature. *Benthoctopus* sp. is also recorded here.

Transect 36

Features of Interest: canyon, escarpments

Water Depth: 1644 – 1488 m



The canyon contains a variety of substrates and a moraine feature; the fauna reflects this variability. A greater apparent biomass compared to neighbouring canyon systems (5 & 6) is evident. On the canyon floor the sediment is soft leading onto coarse sediment at the canyon base and on the

incline. Patches of carbonate outcrops are evident on the slope and canyon crest. A series of sharp ridges interspersed with soft sediment describe the terrain.

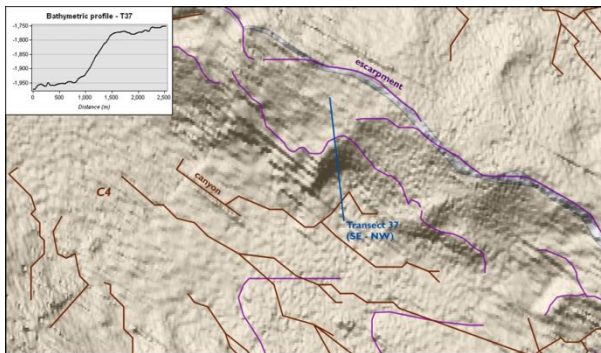
In soft sediment holothurians and xenophyophores are the most conspicuous fauna, with cerianthids occurring occasionally. The starfish *Zoroaster fulgens* is present, as are hermit crabs carrying one or two anemones are very common. On stones, pebbles or small rocks barnacles prevailed, even on otherwise soft sediment. At 1600 m small clumps of *Solenosmilia variabilis* occur and grow in abundance towards the upper slope of the ridges eventually forming a distinct reef. Sponge fields consisting of a variety of sponges are evident as are black, gorgonian and bamboo corals, crinoids and brisingids. Specimens of the

octocoral *Paramuricea* sp. with squat lobsters *Chirostylus* sp. are noted. Fish abundance is generally low here; grenadiers occur throughout the site, with oreos confined to areas of reef. Species of interest include a leafscale gulper shark, 1 orange roughy and a ray. There are also areas of large burrows which appear to be associated with Galatheids

Transect 37

Features of Interest: canyon, escarpments

Water Depth: 1979 – 1742 m



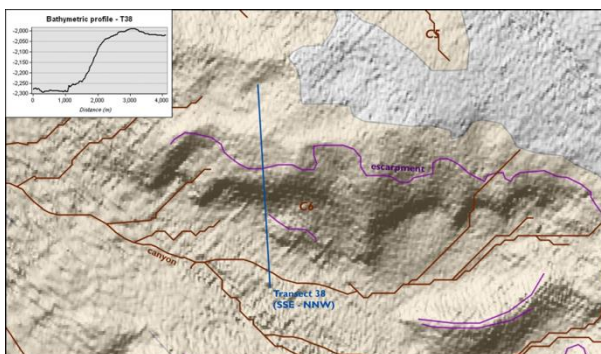
The substrate in this canyon is sandy sediment with some evidence of bioturbation. Ophiroids and holothurians are ubiquitous with sea pens occurring infrequently as are small echinoids (*cf. Echinus*), occasionally in dense patches. The warty variety of hormanthid anemone is also

present here.

Transect 38

Features of Interest: canyon, escarpments

Water Depth: 2307 – 1989 m



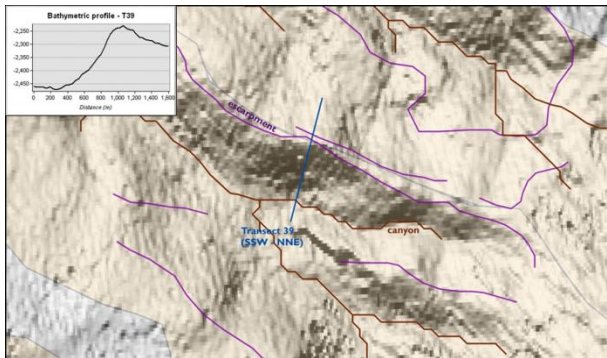
Soft grey sediment is the predominant substrate on the canyon slope; fauna is not conspicuous here. At 2230 m to 2210 m small elpidiid holothurians are observed. Above 2160 m a number of different species of sea pen are evident. Large numbers of fine stalked crinoids occur from 2140 m.

Gorgonian corals and the black coral *Stichopathes* sp. are present at the top of the canyon. Burrow complexes were a notable feature at this site.

Transect 39

Features of Interest: canyon, escarpments

Water Depth: 2473 – 2227 m

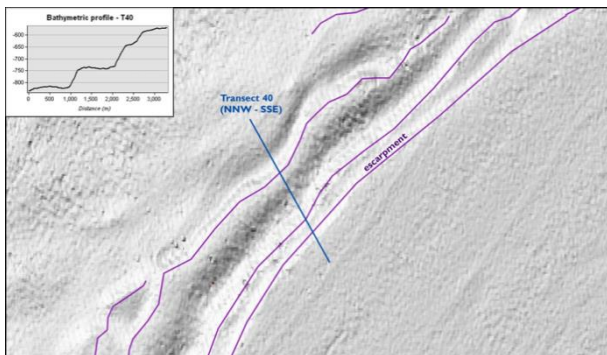


Marine snow carried on a fast down slope current making visibility poor at times. From the canyon floor up to 2460 m the substrate is featureless carbonate rock with a thin overlay of sediment. A 10 m high carbonate cliff appeared at 2443 m with the only conspicuous fauna being stalked crinoids. Above this cliff the canyon slope is terraced with steep sediment inclines interspersed with carbonate cliffs. The common fauna on the canyon floor and up to 2400 m are holothurians and the small echinoid, *cf. Echinus* sp. On the chalk carbonate substrate stalked crinoids are the most prevalent fauna. In the terrace sediment there are burrows, at least some of which are occupied by galatheids. At the top of the canyon black coral is prevalent. Fish are not common here with only occasional grenadier recorded. Large aggregations of small elpidiid holothurians are evident between 2460 m - 2455 m.

Transect 40

Features: escarpment

Water Depth: 835 – 569 m



This site is characterised by carbonate sediment in the form of cliffs, ledges and overhangs. The substrate of the canyon floor is that of fine soft sediment with some coarse sediment and the occasional stones or rock. On the side of the canyon the ground is carbonate with varying amounts of a fine sediment overlay; this is interspersed with cliffs which vary in height from 1 m -1.5 m to 0.5 m in height. Overhangs are also variable with some being very prominent while others are less pronounced. The terraces vary in their degree of steepness and also in the substrate; some are soft sediment which others have exposed carbonate outcrops. Occasional rocks are a present on most terraces.

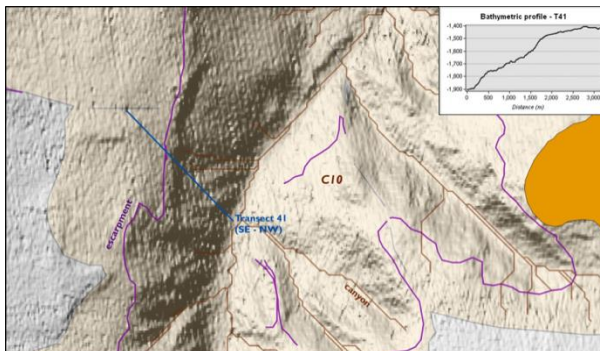
The echinoid *Cidaris cidaris* and fish species *Lepidion eques* are common throughout this site. The holothurian *Psolus* sp. is commonly observed in the deeper areas while the variety of anemone species increases moving up the slope. Where areas of featureless sediment occur the conspicuous fauna consists of *C. cidaris*, occasional anemones and holothurians. On the terraces it reflects the amount of hard and/or soft substrate. In the deeper areas the fauna is dominated by *Psolus* sp., *C. cidaris*, *Stylasteridae* sp. and a variety of encrusting sponges. In shallower areas *Psolus* sp. ceases to be recorded and the variety of anemones appears to increase.

Cliff faces are colonised by *Stylasteridae* sp., encrusting sponges and serpulids and occasionally cerianthids are recorded here too. Burrows, in places occupied by galatheids, are present. Small clumps of the stone coral *Lophelia pertusa* are noted in the deeper parts of the canyon slope. On overhangs dense beds of the cup coral *Desmophyllum* sp. occur, among these a variety of small anemone-like fauna are noted. Tubes *cf.* sabellid tubes are also present. Where the overhang is very prominent the fauna is very rich and a strong current is in evidence. On the shallowest of these overhangs fishing material was observed.

Transect 41

Features of interest: canyon, escarpment

Water Depth: 1911 – 1400 m



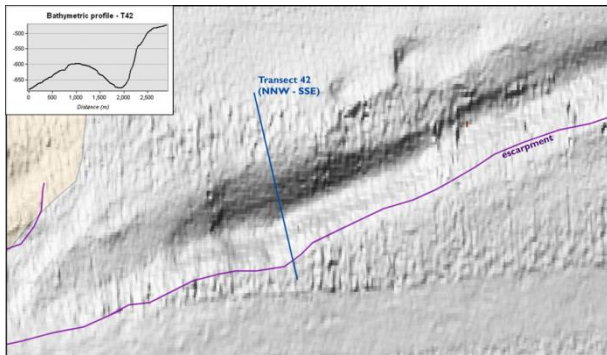
The sediment of the canyon floor is soft and the fauna consists of anemones, echinoids, holothurians and fish. Along slope soft sediment gives way to large stones and boulders with anemones, black coral, sponges, crinoids and starfish. Rich diversity of fauna is present on all hard substrates.

Coral species include *Bathypathes* sp., *Leiopathes* sp., *Parantipathes* sp., and *Gorgonacea* sp. Further up slope sharp rocky outcrops are colonised by large coral specimens. The bedrock rises steeply to form vertical walls colonised by numerous sponge species, the corals *Stichopathes* sp. and *Lepidisis* sp., crinoids and anemones including hormanthid anemones. The sea pen, *Distichoptilum gracile*, normally seen on soft ground is also present here. A sheer 100 m vertical cliff wall contains *Solenosmilia variabilis* coral rubble but no evidence of living reef. Overall *S. variabilis* is very common throughout this site. Evidence of variable underwater currents is noted through this site.

Transect 42

Features of Interest: escarpment

Water Depth: 681 – 473 m



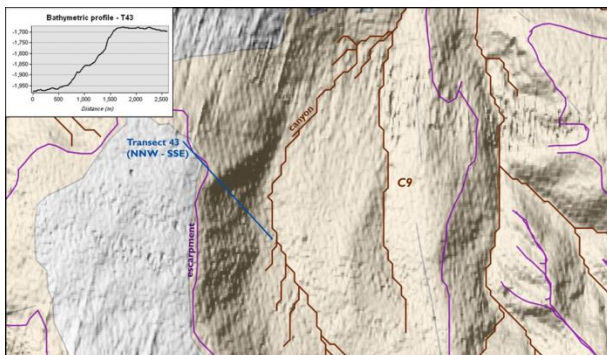
This site is characterised by carbonate sediment in the form of platforms, cliffs, ledges and overhangs. A large amount of biological material is evident in the water column. Throughout the site the hydroid coral, *Stylasterid* sp., is common on any available hard substrate; the echinoid

Cidaris cidaris is ubiquitous throughout. Initially *Madrepora oculata* and *Lophelia pertusa* are present as small clumps, progressing up slope the density and size of the clumps increase. Areas of cliffs and overhangs have particularly dense clumps of these corals. Both white and orange colour morphotypes of these corals appear alongside each other. The undersides of overhangs have dense beds of *Desmophyllum* sp.; among these cup corals small hydroids and sabellids occur. Large sponges are present midway along the slope. Fish species noted at this site include *Lepidion eques*, blackbelly rosefish, northern cut-throat eels, greater forkbeards and chimerids.

Transect 43

Features of Interest: canyon, escarpments

Water Depth: 1986 – 1672 m



The substrate on the canyon floor is comprised of cobbles and pebbles with areas of coarse sand. The side of the canyon is initially steep bedrock leading to terraces of cliff interspersed with steep inclines of soft sediment; terracing starts at around 1930 m. On the lower reaches of the canyon

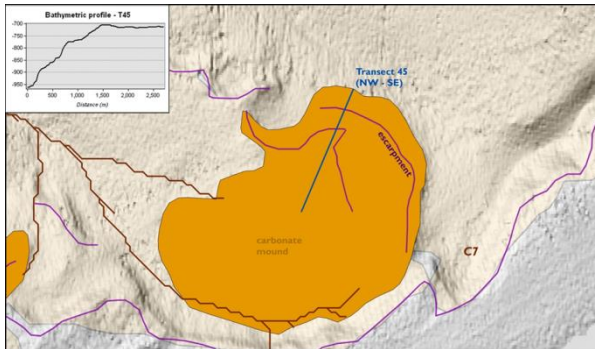
wall stalked crinoids and encrusting sponge are common. The coral *Solenosmilia variabilis* is present towards the top of the canyon; it is interspersed with glass sponges at the top and on the surrounding seafloor. Terraces at 1930 m and 1819 m are characterised by interesting fossilised barnacle plates.

T44 Not surveyed

Transect 45

Features of interest: carbonate mound, escarpment

Water Depth: 969 – 701 m



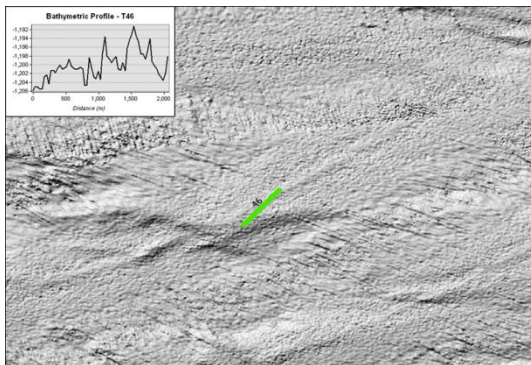
The substrate here is that of carbonate sediment and is colonised by numerous bamboo and black coral species. Very large specimens *Drifa* sp. are present and the echinoids, including *Cidaris cidaris*, are ubiquitous. Small clumps of stony coral, predominantly *Madrepora oculata*, are also

present throughout.

Transect 46

Features: predicted sponge field

Water Depth: 1894 – 1190 m



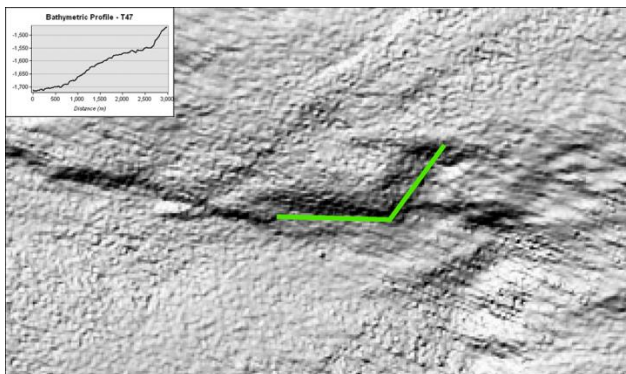
This additional site was identified as one with a high probability of containing a *Phenomena carpenteri* sponge field. The sea floor here is that of soft sediment and there is evidence of bioturbation. Holothurians are common; also present are sea pens, echinoids, the bamboo coral *Acanella* sp. and *galatheid* burrows. Small

chimerids (possibly juveniles) were observed as was a single white ray. No sponges were recorded here.

Transect 47

Features: Unknown

Water Depth: 1692 – 1575 m

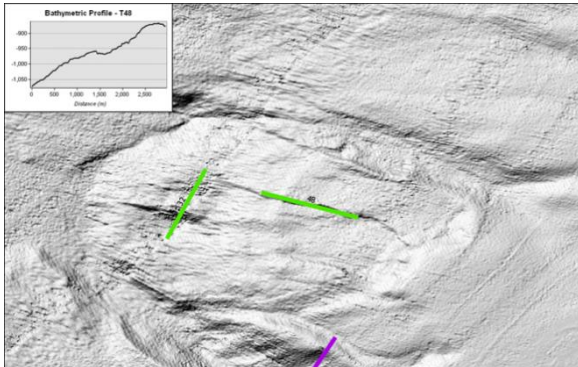


The substrate is largely soft, bioturbated sediment; where stones and rocks are present small white sponges occur. An area of rippled sand is present for 500 m midway along the transect. The bamboo coral *Acanella* sp., asteroids, echinoids and grenadiers are the most common

species recorded here.

Transect 48

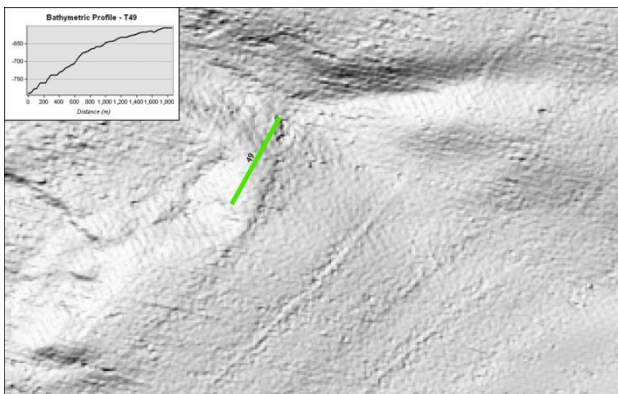
Features of Interest: predicted *Lophelia* reef
Water Depth: 1063 – 949 m



The feature here is a steep vertical incline of soft sediment beginning at 972 m. The initial dense beds of xenophyophores give way to sporadic individuals. The faunal assemblage is characterised by sea pens, with *Pennatula* sp. occurring in very dense patches on occasion and are densest at ~ 980 m. Other species of sea pen are also observed within these beds. Fish species included the northern cut-throat, grenadiers, chimerids, ling and sharks. Trawl marks and fishing debris (lines/rope) are evident throughout the site.

Transect 49

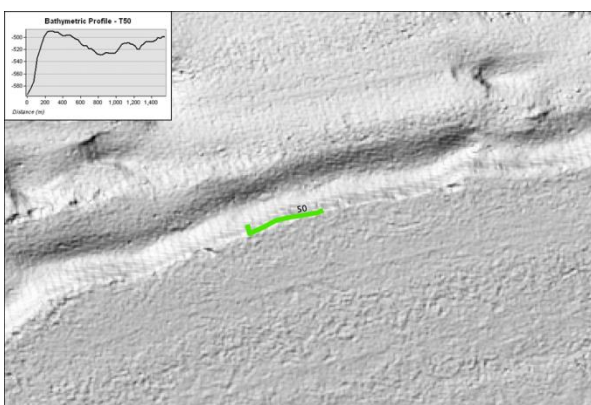
Features of Interest: predicted *Lophelia* reef
Water Depth: 795 – 758 m



The seafloor is initially soft, flat rippled sediment dominated by small black and large purple cerianthids. Further up the slope there is evidence of bioturbation and large complex burrows. *Lepidion eques*, grenadiers, scorpion fish, monkfish and sea pens are evident. Ling appeared in association with localised ridges.

Transect 50

Features of interest: escarpment
Water Depth: 670 – 484 m



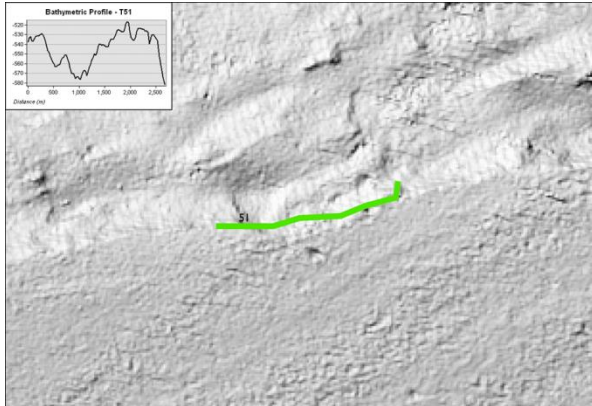
This site has an escarpment which appears to run for 100 m. Extensive *Lophelia* reef is found on vertical cliffs. The feature contains a series of ridges with high diversity of fauna including anemones, ophiuroids, crinoids,

brisingids, asteroids, crabs, galatheids and hermit crabs. In some areas the echinoid *Cidaris cidaris* occurs in large numbers. Fish species include oreos, grenadiers, monkfish, blackbelly rosefish and black scabbard.

Transect 51

Features of interest: escarpment

Water Depth: 561 – 516 m



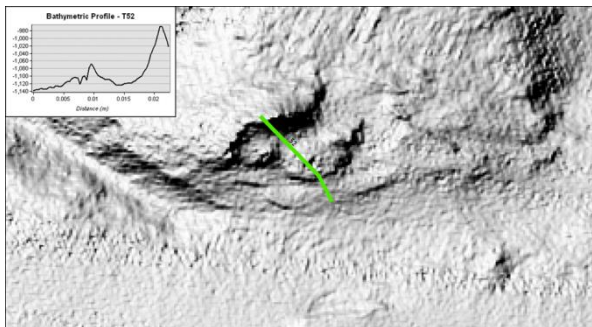
This escarpment feature is a continuation of that surveyed on T40 (to the northeast) and T50 (to the southwest). The ridges, which continue along either side of the transect, appear to be sandstone and include some walls over 5 m in height. Apart from the anemones on overhangs, *Cidaris cidaris* and some fish species including two conger eels,

fauna is sparse.

Transect 52

Features: Predicted *Pheronema* aggregations and *Lophelia* reef

Water Depth: 1099 – 899 m



Initially the substrate is soft sediment with an abundance of xenophyophores and the bamboo coral, *Acanella arbuscula*; black coral species *Bathypathes* sp. and *Leiopathes* sp. are also present. However, with the exception of a single clump of *Madrepora oculata*, no living stony coral is observed. A single juvenile *Pheronema carpenteri* is present at the beginning of the dive. Fish are abundant here with orange roughy, ling and sharks observed. A large amount of dead coral is evident towards the end of the dive.

3.4 Cruise Log

Thursday 29th June

Vessel mobilisation.

Sunday 2nd July

Mobilisation continues following SeaFest. Scientific party arrives (DOS – Chief Scientist, HMc, FOT & RR). DOS interviewed by SeaFest radio to promote survey objectives.

Monday 3rd July

Remaining scientists joined (YL, LH) and scientific compliment complete. 1000 hrs Safety Officer conducted routine safety tour of vessel. Scientists signed on as passengers. 1100 hrs scientific meeting to introduce scientists, crew and survey objectives as per Chief Scientist (David Lyons from NPWS attended). Watch details agreed and duties assigned. 1200 hrs Meeting with Captain and ROV team at to discuss survey plans. 1230 hrs Vessel cast-off and put to sea. Conducted pre-survey checks and preparations including dry lab/wet lab/stores/relevant procedures and protocols. Conditions fair with minimal swell/wind.

Tuesday 4th July

Surveyed three sites within the Northwest Porcupine SAC (Transect 01 – T03). Biological and sediment sampling conducted and processed in the wet-lab upon recovery of ROV. Encountered minor issues with protocols/SOPs. Evaluated and adapted as per survey conditions. Science team moved into shift watches (4 on - 8 off). Weather conditions are good with small swell and appear to be holding.

Wednesday 5th July

Fair weather with slight southwest swell. 3 dives completed (T04 – T06). The second dive was particularly interesting as we discovered a large coral/sponge garden. Science team had a briefing after lunch to discuss work flow and plans. Survey operations suspended to allow vessel to rendezvous with Coastguard Helicopter and airlift an injured crew member (precautionary).

Thursday 6th July

Re-joined survey at 1346 hrs and ROV deployed (T09) to maximum depth limit (~2500 m) but failed to find a target 'wall'. ROV found bottom at 1726 m after 3.5 hrs blue transit. ROV recovered at 2047 hrs and redeployed at T10 2233 hrs.

Friday 7th July

Three transects completed (T42, T43, T12) and T13 begun. Weather remained warm and sunny with only moderate swell allowed a combined 10 hrs 23 mins bottom sampling time.

Saturday 8th July

T13, T14, T15 & T16 completed and T17 started. A low pressure front tracked north of our position increasing wind speed to 25-30 knots, generating swell. Consequently, the pole used to hold the UW beacon for the ROV will not be lifted in these conditions adding to transit times.

Sunday 9th July

Completed T17, T18, T39 & T21. Conducted a 'blue water' transit between T17 and T18, i.e. the ROV was not recovered between dives as transit distance was < 2 km. Fresh wind in the morning with a southwest swell which fell away during the day. Some troubleshooting was necessary on the ROV but it was back in the water within an hour. The survey continues to push north.

Monday 10th July

Completed T22, T38, T23 & T24. A calm, still day which allowed biological and sediment sampling. Recorded video footage of ROV deployment/recovery. Began organising logistics ahead of Leg 1 port call.

Tuesday 11th July

Three dives completed (T37, T36 & T26). Calm, sunny conditions with a light breeze and moderate swell. ROV continues to work well. Following our last dive we began transit to Killybegs ahead of crew-change port-call. 26 sites successfully completed during Leg 1. Backed up and checked all data and logged/processed samples.

Wednesday 12th July

Port Call and handover in Killybegs. The ship's crew swapped out. Paddy O'Driscoll left the ROV team. FMG assisted with port-call and brought KH and ZC from Galway to replace RR and HMcC. The new science team had a full handover and briefing on the survey to date and plans for Leg 2. Chief Scientist met with incoming Captain and officers to discuss upcoming survey plan. Training began in relevant procedures following departure. KH to propose additional site locations based on predictive model.

Thursday 13th July

Resumed survey operations at 0844 hrs. Trained ZC & KH in survey procedures and protocols. The new vessel crew underwent training in deploying and recovering ROV. Completed T35 & T46 and begun T34.

Friday 14th July

The vessel was on weather standby for 4 hours as we struggled to maintain position. Transects 34, T47 & T32 were completed and T48 begun. Data back-up is up-to-date and the on-board team began reviewing footage. Third blog published. Four extra transits added to existing work package.

Saturday 15th July

Weather standby for 45 mins. Completed T48, T49, T33 & T31 and begun T29. Wet lab was cleaned and old samples removed. Data back-up continued. Slight problems with recovery of ROV after T33 but issue with winch/drum resolved. A low pressure front from the west is expected to impact on survey operations.

Sunday 16th July

Continued and completed T29. Undertook 'blue-water' transit to next transect (T30) without recovering ROV and resumed survey. The following dive was aborted when the ROV lost power on descent at 0851 hrs. The ROV was eventually recovered on deck under difficult conditions at 1004 hrs. Subsequent trouble-shooting revealed a corroded power input cable which was removed and cleaned. After numerous deck-checks the vehicle was deemed ready for water testing at 1355 hrs but a large pressure front had created unworkable weather conditions. The vessel was on weather standby through the rest of the day/night.

Monday 17th July

The ROV was cleared to launch following weather standby at 0600 hrs. ROV undertook 30 m wet-tests to ensure power supply was clean to the thrusters following failure yesterday. All worked well and no further problems reported. 3 more dives subsequently completed (T27, T28 & T25).

Tuesday 18th July

Mild swell but workable. The survey team tracked the same escarpment feature over three transits (T20, T19 & T40) and spent close to 12 hours recording geological features at depth. ROV team used GoPro camera to get footage of ROV at depth.

Wednesday 19th July

Completed T45, T50 & T51. Continued to track a prominent escarpment feature. Variable but workable weather.

Thursday 20th July

Three more transects completed (T11, T08 & T41). Minor break for weather this morning when the ROV couldn't launch but the swell passed in 30 minutes. Two dives were > 2000 m. Weather continued to hold and survey operations will proceed as planned before transit to Blacksod.

Friday 21st July

Final transect, T52 completed at 0700 hrs. Survey operations ceased due to weather and transit to Blacksod, Co. Mayo. Backed-up data, prepared survey reports, published final blogs, conducted general demobbing ahead of departure of main scientific party tomorrow. Weather increased considerably during the day. Arrived Blacksod 1800 hrs.

Saturday 22nd July

Final preparations for successful completion of survey. Back-ups and breakdown of survey gear. YL, FOT, LH, KH & ZC departed vessel at 1330 hrs and survey officially concluded. DOS remained aboard. Vessel due in Galway Wed 26th for demob proper.

Wednesday 26th July

Vessel arrived Galway at 0600 hrs. Demobbed ROV and support cabins. Demobbed remaining scientific gear (DOS, FOT, PC). Post-cruise meeting in conference room with science team (DOS, YL, JG), ROV crew, Vessel Captain, RVOPs and P&O Maritime. DOS conducted media interview to promote survey. Biological samples transported to Marine Institute for cold-storage (DOS). Survey Ends.

3.5 Species List

<i>Acanella arbuscula</i>	Cup corals
<i>Acanella</i> sp.	Cup sponges
<i>Acanthogorgia</i> sp.	<i>Desmophyllum</i>
<i>Acesta excavate</i>	<i>Distichoptilum gracile</i>
Anemone	<i>Drifa</i> sp.
Anemone (Hormanthid)	<i>Echinoidea</i> sp. 4
Anemone (Warty Hormanthid))	Echinoids
Anemone (White)	<i>Echinus</i> sp.
<i>Anthomastus grandiflorus</i>	Echiurans
<i>Anthomastus</i> sp.	Eels
<i>Aphrocallistes</i> sp.	Elasmobranch Egg-cases
<i>Aphrodite</i>	<i>Elpidiidae</i> sp.
Asteroids	<i>Epizoanthus paguriphilus</i>
Barnacles	<i>Epizoanthus</i> sp.
<i>Bathypathes</i> sp.	<i>Euplectella</i> sp.
<i>Benthoctopus</i> sp.	<i>Galatheidae</i> sp.
<i>Benthogone</i> sp.	<i>Gorgonacea</i> sp.
Black Scabbard (<i>Aphanopus carbo</i>)	<i>Gorgonocephalus</i> sp.
Blackbelly rosefish (<i>Helicolenus dactylopterus</i>)	Great lantern shark (<i>Etmopterus princeps</i>)
<i>Bolocera</i> sp.	Greater forkbeards (<i>Phycis blennoides</i>)
Brentnose rabbitfish (<i>Hariotta raleighana</i>)	Grenadier
Brisingids	Halcampoids
<i>Calveriosoma fenestratum</i>	<i>Helicolenus dactylopterus</i>
Caryophyllids	Hermit Crabs
Cerianthids	Holothurian
Cerianthids (Black)	Holothurian (Parorizid)
<i>Chaecon</i> sp.	Holothurian (white)
Chimerids	<i>Holothuroidea</i> sp.
Chimerids (juvenile)	<i>Holothuroidea</i> sp. 2
<i>Chirostylus</i> sp.	<i>Hyalonema</i> sp.
<i>Chrysogorgiid</i> sp.	Hydroids
<i>Cidaris cidaris</i>	<i>Isididae</i> sp.
Conger Eel (<i>Conger conger</i>)	<i>Kophobelemnon</i> sp.
Coral (Bamboo)	Lantern shark (<i>Etmopterus perryi</i>)
Coral (Black and Thorny)	Leafscale gulper shark (<i>Centrophorus squamosus</i>)
Coral (Black)	<i>Leiopathes</i> sp.
Coral (Gorgonian)	<i>Lepidion eques</i>
Coral (Hydrozoan)	<i>Lepidisis</i> sp.
Coral (Soft)	Ling (<i>Molva molva</i>)
Coral (Stony)	<i>Lophelia pertusa</i>
Coral (White Hydrozoan)	<i>Madrepora oculata</i>
Crabs	<i>Mesothuria intestinalis</i>
Crinoids	Monkfish (<i>Lophius piscatorius</i>)
Crinoids (Mobile)	<i>Nephrops</i> sp.
Crinoids (Stalked)	Northern Cutthroat eel (<i>Synphobranchus kaupii</i>)

Ophiuroids
Orange Roughy (*Hoplostethus atlanticus*)
Oreo
Paramuricea sp.
Parantipathes sp.
Parapagurus pilosimanus
Pennatula sp.
Phakellia sp.
Pheronema
Pheronema capenteri
Phormosoma placenta
Phormosoma sp.
Pliobothrus symmetricus
Psolus squamatus
Pycnogonids
Ray
Ray (White)
Sabellid Tubes
Sabellids
Scabbard
Scorpion Fish
Sea pens
Serpulid worms
Sharks
Shrimp
Solenosmilia variabilis
Solenosmilia variabilis(reef)
Spatangus sp.
Sponge
Sponge (Glass)
Sponge (Globular)
Sponge Field
Sponges (Blue Encrusting)
Sponges (Encrusting)
Sponges (Yellow Encrusting)
Starfish
Stichastrella rosea
Stichopathes sp.
Umbellula sp.
Xenophyophores
Zoanthids
Zoanthids (yellow)
Zoroaster fulgens

4. Conclusions

These are preliminary findings of research undertaken at the Irish continental margin to document sensitive biological habitats in relation to geomorphic features. The survey area encompasses the slopes and canyon systems along Ireland's western shelf edge, trending in a northeast-southwest direction. 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 have contributed to the provision of conservation objectives for the offshore Special Areas of Conservation (SAC) work carried out by NPWS. Additionally the findings will ensure the Department of Agriculture, Food and Marine (DAFM) have fulfilled their obligation to map vulnerable fisheries resources.

The combination of topography and water movement along the survey area is ideal for filter-feeding, cold-water coral species while constant food supply also promotes wider marine biodiversity along the shelf edge. Extensive coral reefs were observed along the sloping terrain that benefit from increased currents carrying particulate matter. The cold-water coral, *Solenosmilia variabilis* was observed forming reefs at previously unrecorded depths. Reef habitat and corals were less common in the north of the survey area where the slope is less pronounced and increased sediment is apparent. Instead alternative benthic habitats with xenophyophores and sea-pens were more common. The survey data improves our understanding of the extent of sensitive ecosystems in Irish waters and underlying geomorphology and it broadens our understanding of the ecological requirements for these environments in support of sustainable management of Ireland's marine resources.

Furthermore, it establishes a need to build on the data collected to date, to help target future mapping of reef habitat, and commit to further study in other areas of Ireland's offshore. This will ensure 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.

5. References

- Airoidi, L., Balata, D. & Beck, M. (2008) The Gray Zone: Relationships between habitat loss and marine diversity and their applications in conservation. *Journal of Experimental Marine Biology and Ecology* 366, 8-15.
- Forde, J., Allcock, L. & Grehan, A. (2017) *Reef Habitat in Irish Offshore Waters – A synthesis of current knowledge*. A report to the National Parks and Wildlife Service, Department of the Arts, Heritage and the Gaeltacht, Ireland.
- Guinan, J. & Leahy, Y. (2009) Habitat Mapping of Geogenic Reef in the Northeast Atlantic, CE0915 Survey Report 2009. Report prepared by the Marine Institute, Galway, Ireland and Geological Survey of Ireland to the Department of the Environment, Heritage and Local Governments National Parks and Wildlife Service.
- Dorschel, B., Wheeler, A., Monteys, X. & Verbruggen, K. (2010) Atlas of the Deep-Water Seabed – Ireland. Springer Netherlands. doi: 10.1007/978-90-481-9376-9
- Howell, K. & Davies, J. (2010) Deep-sea species image catalogue. DeepSeaCRU, Marine Biology and Ecology Research Centre, University of Plymouth. On-line version 2, 2016.
- NPWS (National Parks and Wildlife Service) (2013a). The Status of EU Protected Habitats and Species in Ireland. Habitat Assessments Volume 1. Version 1.1. Unpublished Report, National Parks & Wildlife Services. Department of Arts, Heritage and the Gaeltacht, Dublin, Ireland.
<https://www.npws.ie/sites/default/files/publications/pdf/Art17-Vol1-web.pdf>
- Ross, R.E. & Howell, K. (2013) Use of predictive habitat modelling to assess the distribution and extent of the current protection of “listed” deep-sea habitats. *Diversity and Distributions Early View*, 19, 433–445.
- Ross, L. K., Ross, R. E., Stewart, H. & Howell, K. (2015) The influence of data resolution on predicted distribution and estimates of extent of current protection of three ‘listed’ deep-sea habitats. *PloS one*, 10: e0140061.