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THE DEEPWATER ECOSYSTEM OF THE CONTINENTAL SHELF SLOPE AND SEAMOUNTS OF THE ROCKALL TROUGH: A REPORT ON THE ECOLOGY AND BIODIVERSITY BASED ON FRS SCIENTIFIC SURVEYS

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SUMMARY

Since 1996 FRS has been developing deep-water research in the area to the west of Scotland beyond the continetal shelf break. In 2007 a three year project began with the aim of drawing the information together under the framework of the ecosystem approach to marine management. This report reviews the hydrography, ecosystem and fisheries of the region. It also documents FRS information sources available and summarises recent multidisciplinary investigations in the region. Preliminary analyses of physical and biological data that FRS has collected are presented to illustrate the approaches and scope that the project will develop over its course. Checklists of fish and invertebrate species are presented for reference. The concepts behind developing indicators for monitoring the ecosystem are discussed.

1. INTRODUCTION AND AIMS

Over the last twelve years FRS has developed a deep-water research programme. A substantial body of information now exists for trawl survey data, biological sampling, TV observations and hydrography. In 2007, a 3 year roame research project (MF0763: Ecosystem approach to conservation and contaminant status of Scottish Deepwater fish: EcoSDeep) was initiated to draw this information together and develop this area of science. The rational behind the project is that understanding the health status of ecosystems and minimising the decline of priority species and habitats is central to a sustainable strategy for the marine environment. The deep-water marine environment has emerged as a global conservation issue (Davies *et al*. 2007) since the discovery of cold-water coral reefs (Friewald & Roberts 2006) and the mounting evidence that deep-water fish are highly vulnerable to exploitation (Koslow *et al*. 2000; Gordon 2003).

To the north-west of Scotland lies a remarkable deep water ecosystem that has a long-history of scientific study. More recently the region has been exploited for fishing. There is a consensus of scientific opinion that many of the deepwater fish stocks have declined and are now outside safe biological limits (ICES WGDEEP). In addition there is evidence that bottom trawling is heavily impacting the benthic fauna, particularly the reef-forming corals (ICES WGDEC) and there is evidence that the accumulation of anthropogenic pollutants is a growing concern for the ecosystem (Mormede & Davies 2001). Consequently, the deepwaters are now recognised as priority marine habitat and a number of EU sites are being considered as special areas of conservation.

MF0763 is a joint research effort between the Fisheries Management programme and the Aquatic Environment programme of FRS. This report will deal with the fisheries science and marine ecology of the region. Contaminant and pollutant aspect of the project will be reported separately. Technical aspects of the survey will be also documented separately as part of a deep-water survey manual scheduled to be produced later in the year. The overall aim of this report is to provide a summary of the state of research at FRS and present some preliminary data and analyses to illustrate the scientific scope of the project. As full analyses and tests of significance have yet to be carried out, the results presented should be treated as tentative at this stage.

The specific aims of this report are to:

1. to provide the background to the region in terms of the FRS survey, hydrography, marine ecology and fisheries;

2. report recent hydrographical observations from the seamounts in the region;

3. describe patterns of fish diversity and abundance with depth on the shelf slope based on the FRS survey;

4. provide a comprehensive fish species check-list based on the FRS survey;

5. report on the recent FRS fish surveys on the shelf slope and adjacent seamounts and banks;

6. describe the by-catch of invertebrate fauna from the survey;

7. suggest ways of developing a set of indicators of ecosystem health and diversity for future monitoring.

2. THE FRS DEEPWATER SURVEY

The FRS deep-water survey dates back to 1996 although strictly comparable data are available from 1998 onwards with the advent of the current research vessel FRV *Scotia*. From 1998 through 2004 a biannual survey covered a core area from between 55 to 59 ° N with a depth stratification at 500, 1000, 1500 and 1800 m (Figure 1). Additional stations have also been trawled at intermediate depth strata, most notably at 750m. A list of trawl stations and the years in which each has been repeated is given in Appendix 1. The survey takes place in September and is usually in the region of 14 days. In addition to trawling the survey undertook night-time TV surveys of the abundance of Norway lobster (*Nephrops norvegicus*) burrows. Historically FRS has also had an interest in the hydrography of the region and over the years has collected CTD data from the Rockall Trough.

From 2005 the survey became annual and while retaining its core survey stations on the shelf slope began to expand its geographic scope to the eastern flank of Rockall bank and to the Anton Dohrn seamount and Rosemary bank. The survey became more multidisciplinary undertaking hydrographic deployments and collaborating with JNCC and the DTI with TV/video surveys over Rockall and the seamounts for the purposes of habitat mapping. In 2006 the Marine Institute in Ireland began a similar survey along the southern shelf slope, collaborating with FRS to undertake a number of comparative fishing hauls. In May 2007 an exploratory survey was undertaken to Rockall, the Anton Dohrn seamount and Rosemary bank to trial new trawl stations undertake hydrographic measurements and trial Methot net sampling. The September 2007 survey was completed as normal with additional stations fished for comparison with the Marine Institute and trawl stations and TV drop-frame work undertaken on Rosemary bank. In 2008 in addition to the September survey, a gear trial cruise is planned for quantification of net performance, instrumentation and survey quality assurance. From 2008 FRS and the Marine Institute will, under the auspices of ICES, coordinate their deep-water surveys (Planning Group for the NE Atlantic Continental Slope Survey). From 2009 they will form part of an international shelf-slope survey that extends from approximately 50 ° N to 59 ° N.

In addition to FRS research there has been intermittent research interest in the shelf slope since the 1970's by CEFAS (Bridger 1979), SAMS, the French and the Germans (reviewed by Gordon 2003). More recently the Department of Trade and Industry (DTI) undertook geophysical surveys of Rockall, the Anton Dohrn Seamount and Rosemary bank collecting swathe bathymetry information and conducting habitat mapping using video and sidescan sonar (Jacobs, 2006).

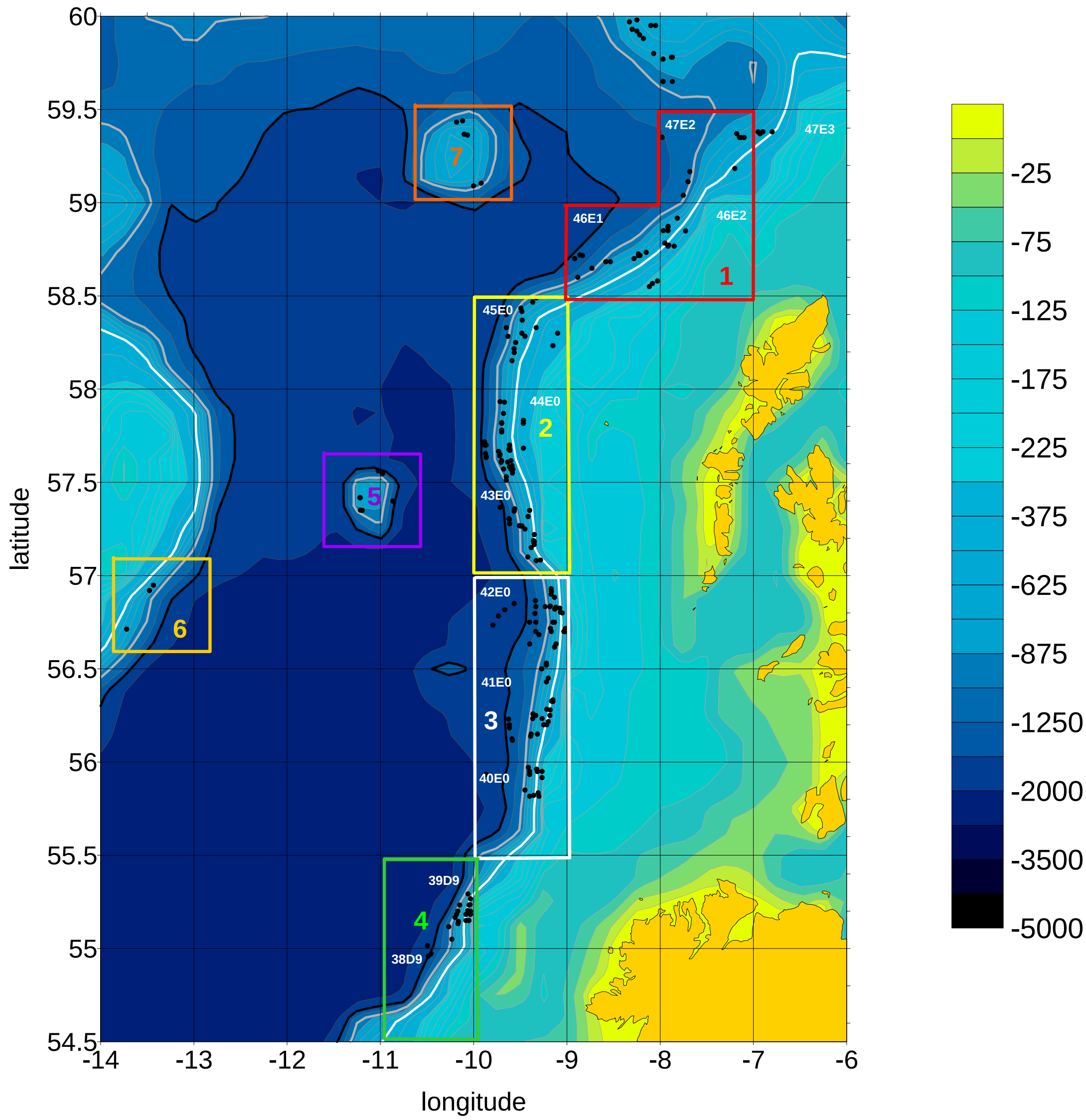


Figure 1: The FRS deep-water survey area. Bathymetry scale to right (500, 1000, and 1500 m isobaths are shown in white, grey and black respectively). Areas 1 to 4 comprise the shelf slope survey. Within each area trawl stations (black circles) are indicated, the main depth strata being 500, 1000, 1500 and 1800 m. ICES statistical rectangle numbers (e.g. 43E0) are given for the shelf slope survey area. Areas 5 (Anton Dohrn seamount), 6 (Rockall slope) and 7 (Rosemary bank) are also indicated.

3. DEEPWATER FISHERIES IN THE REGION

Species of commercial interest found on the upper shelf slope (<750m) include hake (*Merlucius merlucius*), torsk (*Brosme brosme*), ling (*Molva molva*), angler fish (*Lophius piscatorius*) and greater argentine (*Argentina silus*). There is also a pelagic fishery over the slope for blue whiting (*Micromesistius poutassou*). Below 750m, blue ling (*Molva dypterygia)*, orange roughy (*Hoplostethus atlanticus*) and deepwater redfish (*Sebastes marinus mentella*) are targeted with deep-water sharks, e.g. the leaf-scale gulper shark (*Centrophorus squamosus*) taken as by-catch. The exploitation of the shelf slope goes back to German trawlers that began targeting spawning aggregations of blue ling in the Rockall Trough in the mid 1970s (Gordon 2001; Gordon *et al*. 2003). The French joined the blue ling fishery and in the process established a year-round bottom trawl fishery for roundnose grenadier (*Coryphaenoides rupestris*), black scabbardfish (*Aphanopus carbo*) and deepwater sharks. The introduction of TACs in 2001 forced a number of UK vessels out of the fishery leaving only a handful to prosecute the deep-water either by trawling or long-lining. Thus the deep-waters economic significance to the UK fishing industry as a whole was much reduced. Currently the main trawl fishery is French with minor landings of deep-water species being made by UK and Irish vessels. There is little of commercial value at depths greater than 1500m. Photographs of the above mentioned species are shown in Figure 2.

In addition to the deep-water bottom trawl fishery there is also a static gear fishery. Norwegian long-liners fish along the edge of the shelf slope for ling and torsk. There is also a UK and Spanish long-line fishery for hake, ling and torsk with a by-catch of other deep-water species, such as blue ling and sharks. In the late 1990's Spanish vessels operated extensive deep-water gillnets targeting monkfish and sharks (Hareide *et al*. 2005). This practice was highly criticized for its indiscrimant by-catch and high discard rate and has now been banned in European waters.

In the other regions of the area, monkfish is targeted on the deeper slopes of Rockall bank. Blue ling aggregates to spawn on the Anton Dohrn seamount and Vessel Monitoring System (VMS) data show the seamount is targeted during May (ICES WGDEC 2007). Deep-water redfish and blue ling are targeted on Rosemary bank. French trawlers discovered large aggregations of orange roughy on the Hebridean seamount in the early 1990's, however landings declined dramatically after a couple of years. It is likely the other seamounts were also targeted, but little information on this fishery was ever documented. Orange roughy is now mainly confined to areas south of the study area where it has been targeted by Irish trawlers.

Although no formal assessments are made of deepwater stocks, CPUE data from FRS surveys suggest declining abundance in many species especially the sharks (ICES WGDEEP 2007). Landings of all the major commercial species have declined in the last decade. ICES WGDEEP advises that most species are outside safe biological limits and it seems likely that quotas for several species, e.g. orange roughy will be completely phased out over the next few years.

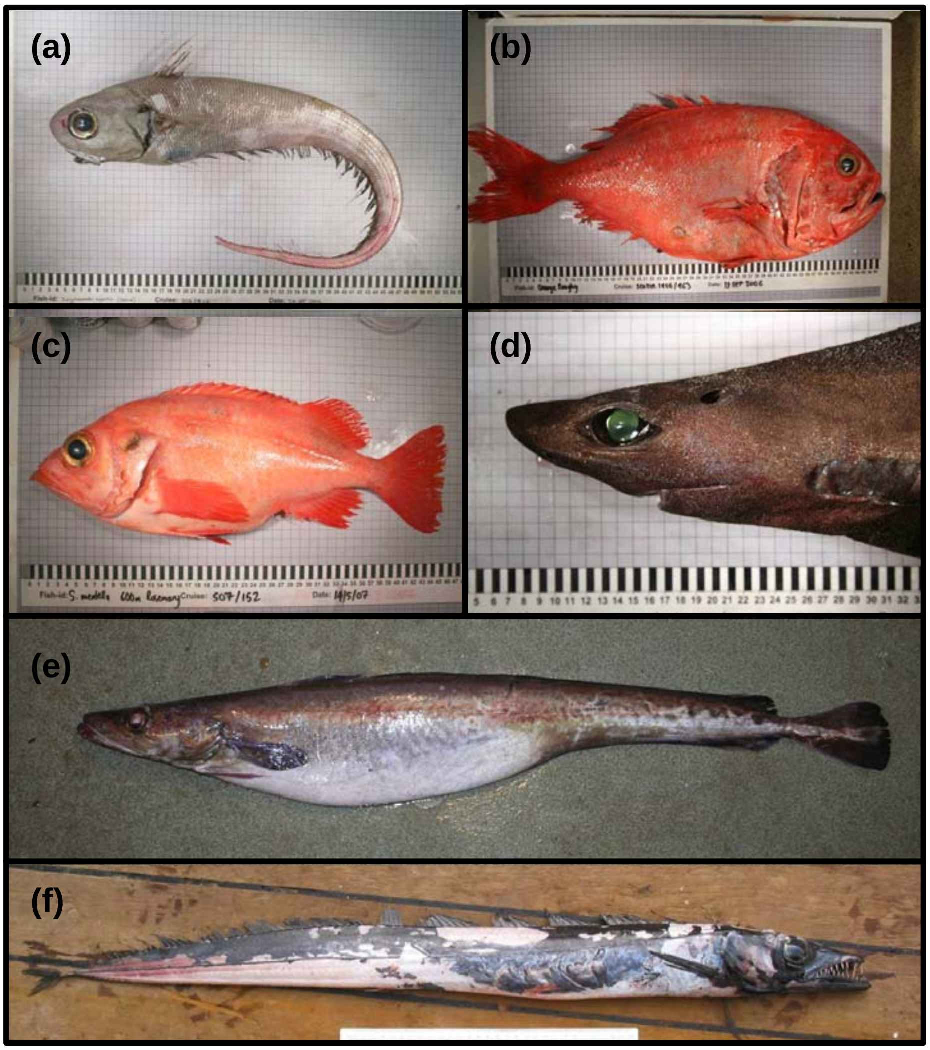


Figure 2: Deepwater species (a) roundnose grenadier, (b) orange roughy, (c) deepwater redfish, (d) leafscale gulper shark, (e) blue ling (approx. length = 120 cm), and (f) black scabbardfish.

4. HYDROGRAPHY AND TOPOGRAPHY OF THE REGION

4.1 The Shelf Slope

The European continental shelf slope or shelf break (hereafter referred to as the shelf slope) represents a major oceanographic and ecological discontinuity in the NE Atlantic. It divides the shelf sea ecosystem to the east from the deep ocean environment to the west. The area of shelf slope that this study will examine lies to the west of Scotland extending from the Wyville-Thomson ridge (approx. 60 ° N) south to the Porcupine bank (approx. 54 ° N) (Figure 1). The shelf slope runs approximately NNE-SSW, falling away sharply from the Hebridean shelf sea ecosystem (generally less than 200m depth) into the Rockall Trough (1000-3000m deep). The shelf slope is very sharply defined in shallow water depths of 140-200 metres when the sea-bed gradient suddenly increases from on average less than 0.1 degrees to between 2 to 14 degrees. Large volumes of sediments have been deposited and in some place form distinct sedimentary fans. The slope levels out again between 1000 m in the far North and nearer 2500 m in the south. The gradient of the slope is locally variable, but overall increases toward the south.

The surface hydrography of the area is dominated by 2 major surface currents, the North Atlantic Current (NAC) which originates from the anti-cyclonic Sub-Tropical Gyre and the Slope Current which originates off the Iberian Peninsula. The warm, salty NAC moves north-eastward across the Rockall Plateau, through the Rockall Trough and toward the Färoe-Shetland Channel. The Slope Current flows northward along the upper shelf slope down to a depth of at least 700 m although its speed and precise direction can vary significantly from year to year (Holliday 2000). It eventually flows across the Wyville-Thomson Ridge and into the Faroe-Shetland Channel where it mixes with the NAC and the cold sub-polar waters of the Norwegian Sea. The deep waters (< 1000 m) of the Rockall trough are of different origin (Labrador Sea water), have different properties and show complex dynamics especially when in proximity to the banks and seamounts of the area.

The water column is thermally stratified in the summer and autumn down to a depth of at least 200 m. Surface temperatures can be a high as 14 ° C in September (the time of the FRS survey). Below the thermocline, temperatures for a given depth stay reasonably constant all year round, decreasing almost linearly from around 9 ° C at 500m, 7 ° C at 1000m and 4 ° C at 1500m. Deeper than this the rate of decrease with depth slows reaching 3.5 ° C at 1800m (Figure 3). There is a very gradual rise in temperature as latitude decreases at 500m, but below this the change in temperature is negligible relative to the changes in relation to depth.

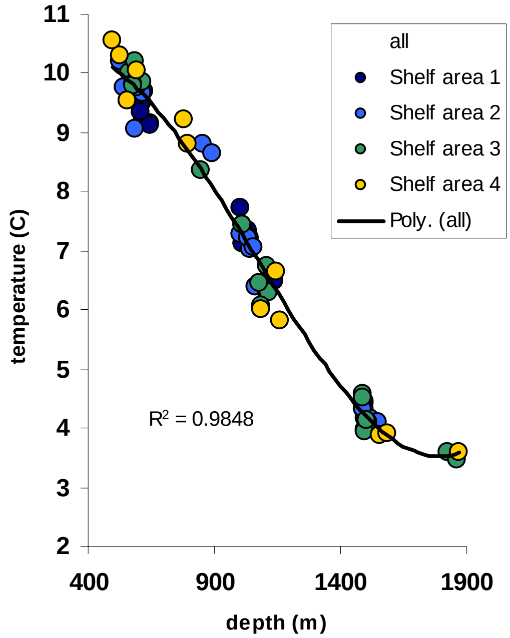


Figure 3: Bottom temperature on the shelf slope recorded by a StarOddi temperature and pressure logger attached to the headline of the trawl during September surveys of 2005, 2006 and 2007 (n = 70 measurements). Shelf areas numbers refer to regions in Figure 1.

4.2 The Rockall Trough and Rockall Plateau

To the west of the shelf slope the area is a topographically and hydrographically complex deep ocean environment. The Rockall Trough runs between the shelf slope and the Rockall plateau, being delimited to the north by Lousy and Färoe Banks and the Wyville-Thomson Ridge. At its northern end the trough is approximately 1200 m deep and, as is runs south, it gradually deepens to over 3000 m off the Porcupine bank. The Rockall trough undergoes deep winter convection that occurs due to the intense winter storms that can mix the water column to over 600m depth. The deep water is fresher and the currents are more complex forming gyres and local eddies around topographic features. At the Northern limit of the Rockall Trough, cold, fresher waters from the Norwegian Sea can spill over the Wyville Thompson ridge and cascade into the Rockall Trough adding further heterogeneity to the deep water mixing (Sherwin & Turrell 2005). The thermal profile of the Rockall trough is generally similar to that of the shelf edge with the temperature decreasing at depths > 1800 m to a minimum of around 2.5 ° C. The Rockall plateau, a large mass of continental crust rising abruptly to the surface, lies some 250 km to the west of the shelf slope. The bank is effectively an isolated shelf sea some 300 km long and 100 km wide. Towards the north of the centre of the plateau lies an outcrop of granite that breaks the surface forming the 19 m pinnacle that lends its name to the bank. The western side of the Rockall Bank has a gentler slope down to the Rockall-Hatton basin. The plateau is characterised by anomalously high density water and a cyclonic circulation pattern (Ellett 1986). The water on the bank is generally fresher and cooler than that to the east in the Rockall Trough. This may be caused by deep upwelling around the bank and winter cooling of the surface waters of the bank. A deep-water current originating in part from the Faroe-Shetland channel moves south along the east margin of Rockall Bank.

4.3 Seamounts of the Rockall Trough

Between Rockall and the shelf slope, the trough is punctuated by several seamounts of volcanic origin (the Anton Dohrn and Hebridean Terrace Seamounts and Rosemary bank). Further to the north and west of the trough there are several other seamounts (Bill Bailey's bank, Lousy bank and George Bligh bank). The abrupt topography of seamounts means that they interact and disrupt the currents of the deep oceans generating mesoscale (localised) hydrodynamic patterns such as eddies, votices, upwellings and cascades. These act to enhance water column mixing and often as a consequence seamounts are associated with enhanced biological productivity (White *et al*. 2007). Tidal flows also tend to be amplified over seamounts due to the compression of the flow over the top of the seamount. Hard substrate, high flow rates and enhanced productivity are considered the main environmental conditions that favour the formation of hard and soft coral reef formation. Seamounts are renowned sites of cold water corals and in turn coral reef environments may provide nursery areas for fish populations (Costello *et al*. 2005). Consequently seamounts become hotspots of biological activity right up the food chain to top predators such as sharks and marine mammals. This report deals only with the Anton Dohrn Seamount and Rosemary bank.

4.3.1 The Anton Dohrn Seamount

This flat-topped seamount or 'guyot' (Jones *et al* 1974; 1994; Jacobs 2006) is volcanic and has been dated to approximately 71-65 Ma (O'Conner *et al*. 2000). It is sub-circular in shape and surrounded by a shallow 'moat' or trench best developed to the NW. The summit is approximately 45 km across with steep flanks rising from about 2,200m depth to 850m in the NW and 1200m to the SE (Figure 4 a). The gently domed summit is at its shallowest 531 m and covered by thick sediment above the igneous core. Rock outcrop is exposed to the NW of the centre of the summit, with the rest of the summit consisting of sands and gravel. A few small parasitic volcanoes are found around the base of the seamount. There are several reports of eddy formation and enhanced current flows in the vicinity of the seamount (Ellet *et al* 1986). In 2005 FRS started a more detailed hydrographical survey of the seamount. A series of CTD dips across a N-S transect of the seamount at approximately 11 ° W were undertaken by FRS in May 2006 and 2007. The data suggest enhanced mixing over the seamount, especially downstream of the summit (Figure 4 b c).

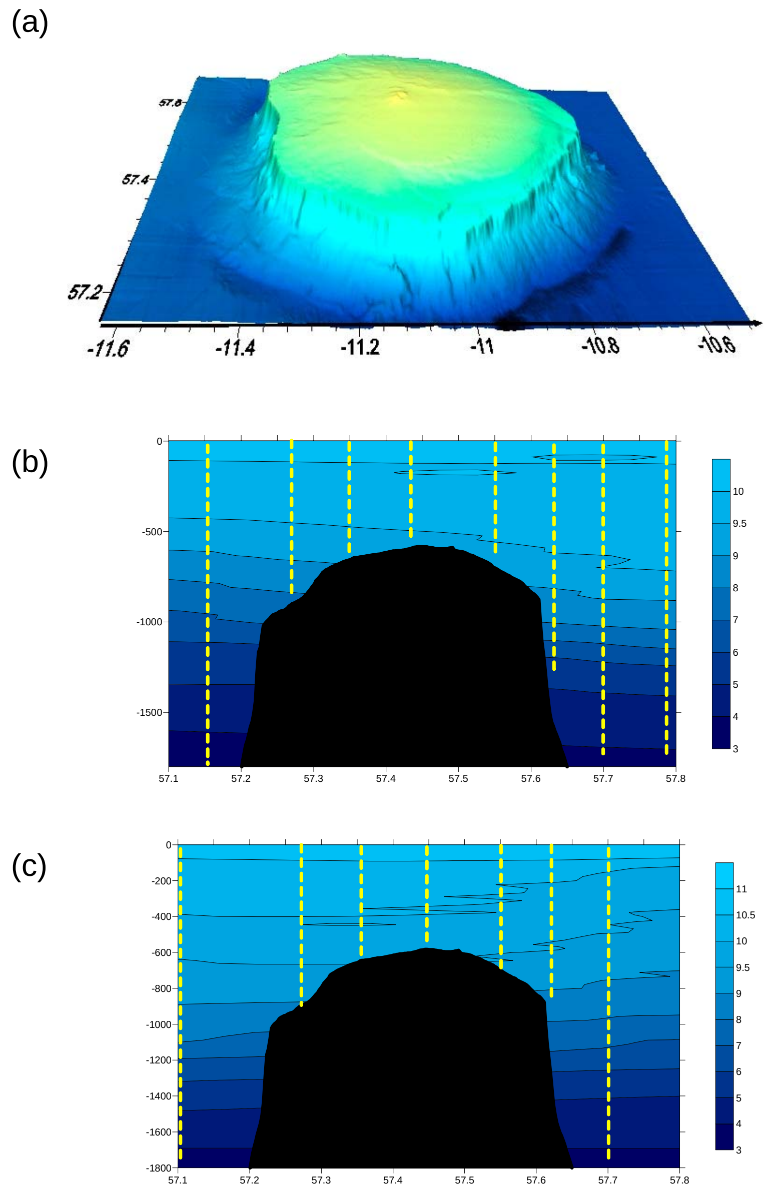


Figure 4: (a) 3-D visualistaion of the Anton Dohrn seamount generated by Voxler software from swathe bathymetry (data courtesy of C. Jacobs NOC). (b) Thermal profile across the the N-S axis of the Anton Dohrn seamount based on CTD casts (yellow dashed lines) taken in May of 2006. (c) The same profile plot based on CTD data collected in May of 2007. Note vertical scales between (a) and (b, c) are different and not to scale.

In September 2005 a mooring with current meter and temperature sensor was deployed on the summit of the seamount. Upon retrieval the mooring failed to release and was considered lost until it was returned by a fisherman 2 years later. The temperature data were recovered (Figure 5a), but the current metre data indicated a failed deployment. Mean temperature was 9.75 ° C with a standard deviation of 0.15 ° C and a range from 9.18 ° C to

10.14 C °. Daily variation could be a high as 0.5 ° C suggesting enhanced hydrodynamic activity. An analysis of the autocorrelation in the data suggested a strong tidal influence (Figure 5b). This is congruent with physical predictions that tidal waves may become amplified over the summits of seamounts.

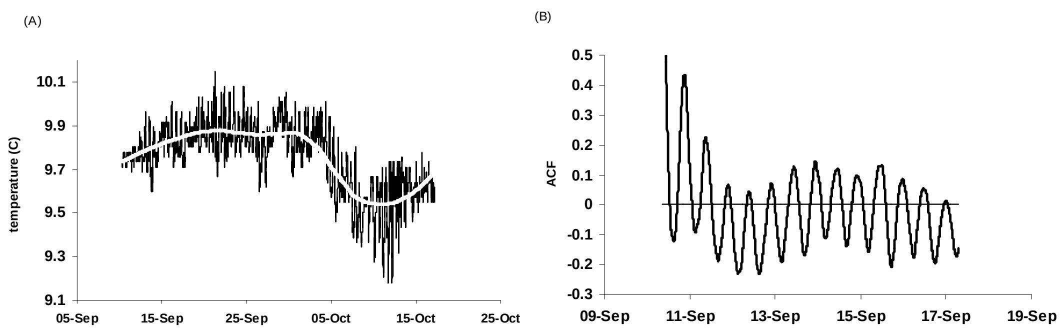
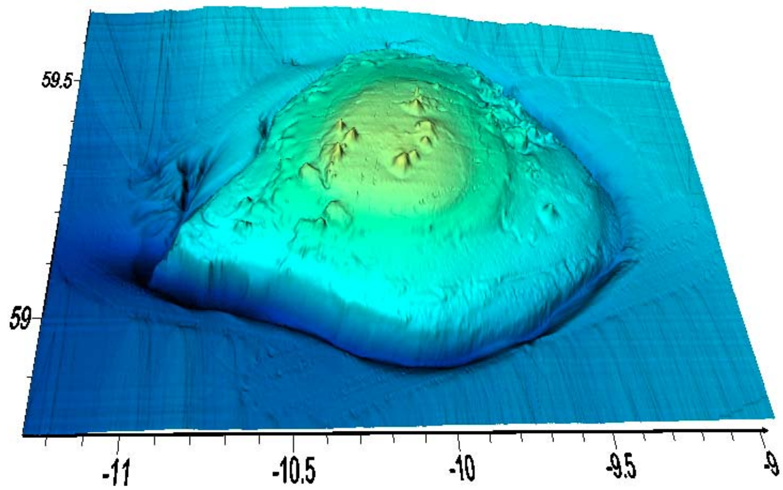


Figure 5: Data from mooring at approximately 550 m on the summit of the Anton Dohrn seamount for a period of approximately 6 weeks in September-October 2005. (a) raw temperature data with smoother showing long term average. (b) autocorrelation function analysis showing strong tidal periodicity in the data.

4.3.2 Rosemary Bank

This seamount is also volcanic and approximately the same age as Anton Dohrn Seamount. It is 60-80 km at the base across although the conical topographic profile means the summit is in the region of 10km across. It is surrounded by a moat (300 m deep in places) out of which it rises from between 1,700-2,200m to 321m below sea level (Howe *et al*. 2006; Jacobs 2006). Apart from the eastern flank, the walls of this seamount are steep (~ 20°) rising to approximately 900m on the northern flank and to 1,400m on the southern. The topography indicates distinct lower and upper summit areas (Figure 6a). Numerous pinnacles or (volcanic cones) are evident on the lower summit particularly on the eastern and western flanks of the seamount. The upper summit area is also studded by numerous volcanic cones, some up to 150m height and 300m across the base. In 2004 a CTD transect approximately N-S across the bank was made the results of which are presented in Figure 6b. Unlike Anton Dohrn, there is little to suggest enhanced mixing or turbulence over the bank.

(a)



(b)

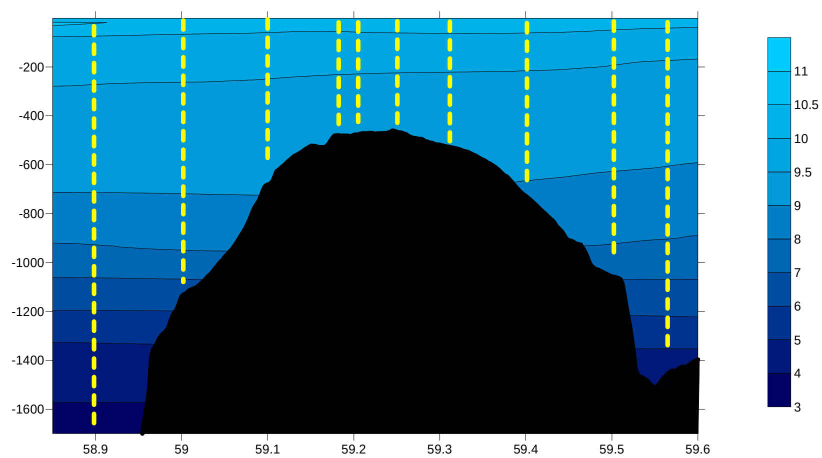


Figure 6: (a) 3-D visualisation (generated by Voxler) of Rosemary bank based on swathe bathymetry data (data courtesy of C. Jacobs, NOC). (b) Thermal profile across the N-S axis of Rosemary bank based on CTD casts (yellow dashed lines) taken in May of 2004. Note vertical scales of (a) and (b) are different and not to scale.

In May 2007 a temperature and pressure logger attached to the headline of the trawl and onto the methot net (section 7.2) provided the basis for a direct comparison of temperature at depth for Rockall, the Anton Dohrn Seamount, Rosemary bank, and the adjacent shelf edge (Figure 7). There was however little indication of any significant thermal differences between the areas apart from what might be expected on the basis of latitude (Anton Dohrn being marginally warmer than Rosemary bank).

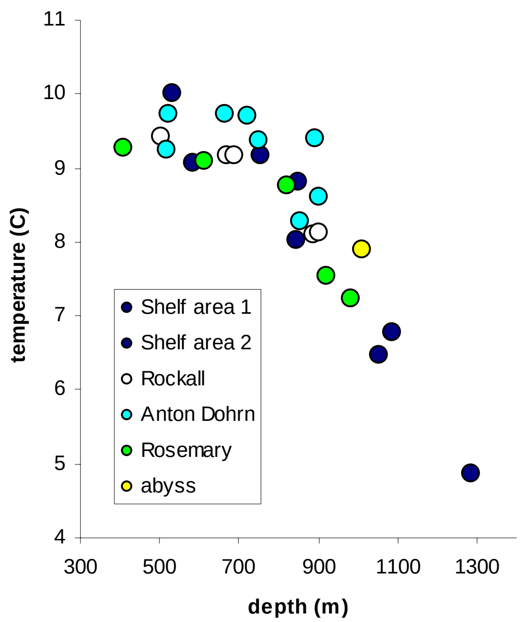


Figure 7: Temperature at depth recorded by a data logger attached to the headline of the trawl or the methot net during the May 2007 survey.

5. FISH ASSEMBLAGES AND DIVERSITY

Deepwater fishes are generally considered to be those species that spend the majority of time at depths exceeding 400 m (Gordon 2001). In general, deep-water fish assemblages are sub-divided into the midwater mesopelagic (shallower than 1000m) and bathypelagic species (deeper than 1000m) and the near bottom benthopelagic species.

Many deep-water species are long lived and late-maturing. The extreme case is orange roughy which live to well over 100 years old and do not attain first maturity before an age of 25 (Allain & Lorance 2000). A more typical deepwater species is the roundnose grenadier which is estimated to live up to 60 years and attains first maturity at around age 10 (Allain & Lorance 2000). Some species such as black scabbard are estimated to be faster growing and have a lifespan of 15 years or less (Morales Nin *et al*. 2002). However, much uncertainty lies in the aging protocols of deepwater species and for many there are no estimates available.

Trawl surveys predominantly sample the benthopelagic species, however, meso- and bathypelagic species are found in benthic trawl surveys, having been caught during deployment and retrieval of the gear. As such it is not an adequate means of sampling the mesopelagic community and thus abundance estimates cannot be made for these species.

5.1 The Shelf Slope

The shelf slope is a highly stratified environment due to the steep environmental gradients (light, temperature and depth). It is home to a diverse assemblage of benthic and benthopelagic fish that differs markedly from those found on the adjacent shelf (Gordon *et al*. 1995). The most prolific families of teleost fish species represented include the Gadidae (codfishes), Macrouridae (grenadiers), Meluccidae (hakes), Moridae (Morid codfishes), Scorpaenidae (redfish), Synaphobranchidae (cutthroat eels), Alepocephalidae (smoothheads), Argentinidae (Argentines), Trichuridae (scabbard fish) and Zoarcidae (eelpouts). In addition to the teleosts, a diverse group of elasmobranch species (sharks and rays) and rabbitfishes or chimaeras (Holocephalids) are an important component of the shelf slope ecosystem.

On the upper continental slope there are many species that extend from the outer continental shelf into deeper water including anglerfish, bluemouth (*Helicolinus dactylopterus*), greater argentine, ling, torsk, and hake. As these species are also found in coastal waters they are not strictly deepwater species, however, they are an important component of the shelf slope ecosystem. The upper slope is also inhabited by species that spend their whole adult life in deepwater such as the blue ling, greater forkbeard (*Phycis blennoides*), deepwater redfish and the rabbit fish (*Chimaera monstrosa*). On the mid slope (deeper than 750 m) the important species whose distribution extends to the lower slope depths (1800m) include the roundnose grenadier, black scabbard fish, the orange roughy, Baird's smoothhead (*Alepocepahlus bairdi*), the cut-throat eel (*Synaphobranchus kaupi*) and a number of deepwater sharks (for example, *Centrophorus squamosus, Centrosymnus coeleolepis*). At depths greater than 1500 m overall abundance shows a marked decrease (Figure 8).

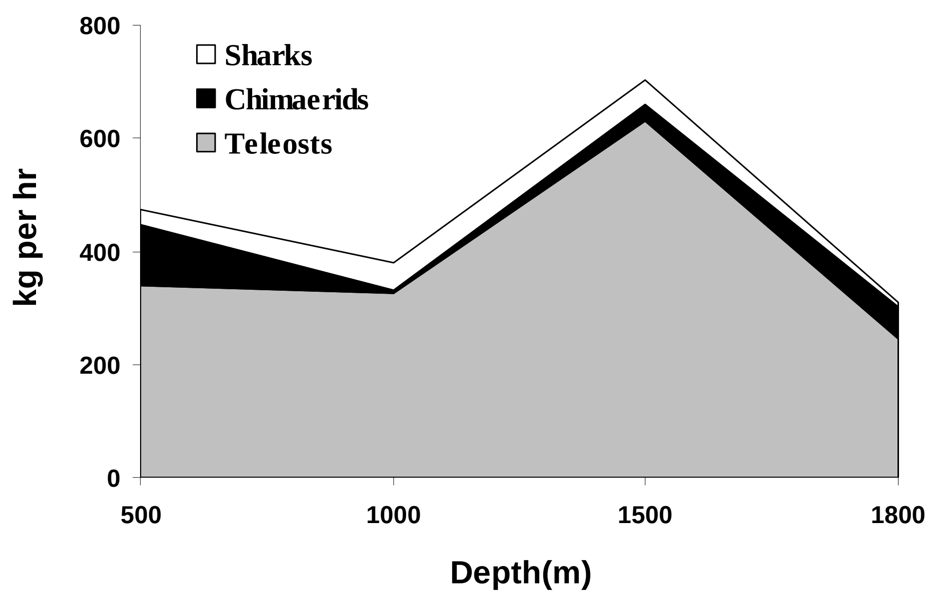


Figure 8: Patterns of abundance (catch per unit effort) for the three major classes of fish species found on the shelf slope (based on FRS survey data 1998 - 2006).

The FRS deepwater survey consistently samples the shelf slope at 500m, 1000m, 1500 m and 1800m depth. In addition trawl stations have also been undertaken at intermediate depths (750 m). A list of station details with temporal coverage is given in Appendix 1. A total of 185 species have been identified to date and a further few remain unidentified with several species still awaiting full formal descriptions. A full check list of species for the shelf slope is given in Appendix 2. From the total, 119 species are classified as benthic or benthopelagic, 44 are meso-, epi- or bathypelagic. The remaining 25 species are shelf species (not true deepwater species) but since they have been recorded in water depths exceeding 400m they are included here. A selection of deepwater species is shown in Figure 9.

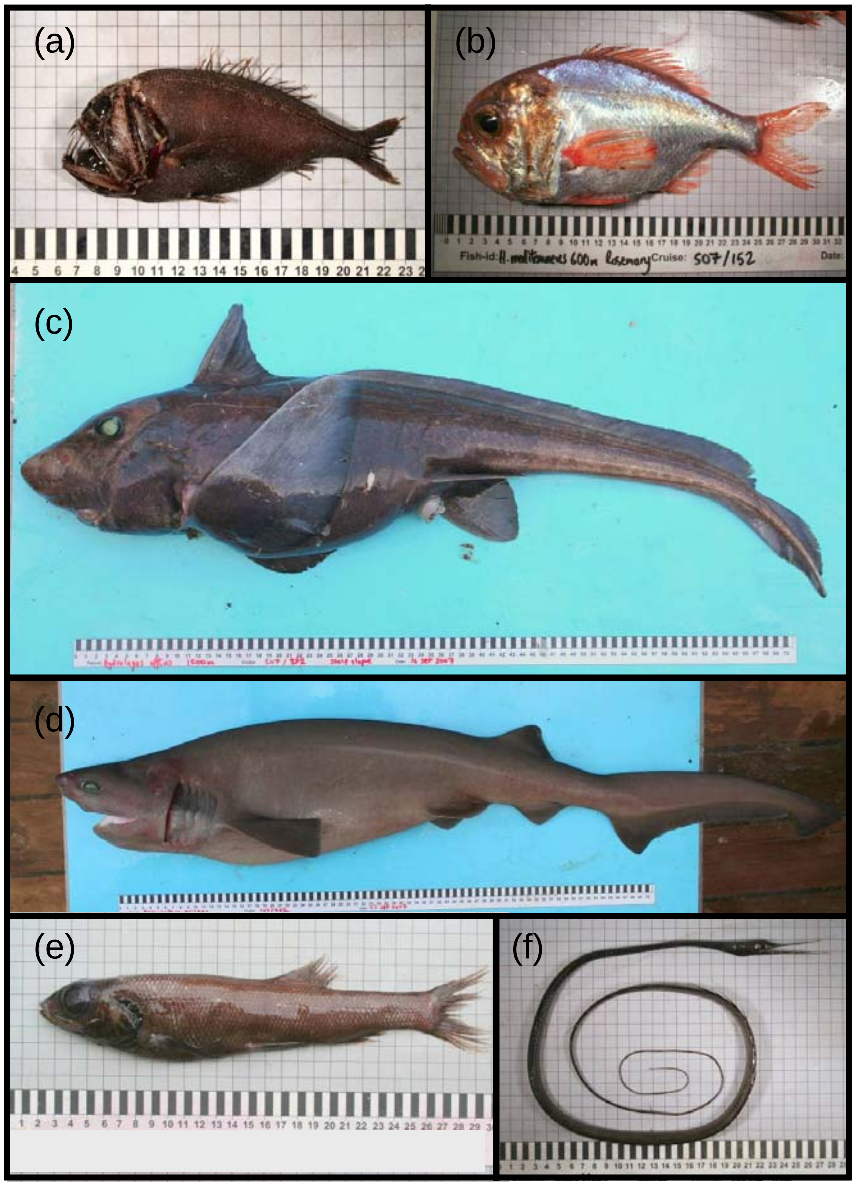


Figure 9: Diversity of fish species from the FRS deep-water survey. (a) Fangtooth, *Anoplogaster cornuta* (1000m), (b) silver roughy, *Hoplostethus mediterraneus* (600m), (c) Smalleye rabbitfish, *Hydrolagus affinis* (1500 m), (d) Six-gilled shark (*Hexacanthus griseus*) (500m), (e) smallscale smoothhead*,* *Bathytroctes microlepis* (1800 m), (f) snipe eel, *Nemichthys scolopaceus* (1000m).

To establish how species composition varies with depth all data up until 2006 for each depth strata were summarised into percentage compositions by families and or genera and species (Figure 10).

At 500 m the gadoids (blue whiting, silvery pout and greater forkbeard) make up the highest percentage of the catch, followed by bluemouth, argentines, rabbitfish (*Chimaera monstrosa*) and grenadiers (*Ceolorynchus coelorhynchus* and *Coryphaenoides laveis*). Sharks present include the velvet belly (*Eptomerus spinax*) and the bird-beak dogfish (*Deania calceus*).

At 1000m there is a dramatic change compared with 500 m with the catch now dominated by grenadiers (mainly *Coryphanoides rupestris* and *Nezumia aequlis*), smoothheads (mainly *Alepocepahlus bairdi*), Morids (mainly *Lepidion equus*) and the black scabbard (*Aphanopus carbo*). Several larger species of shark are found at this depth including *Centrophorus squamosus*, *Centrosymnus coeleolepis* and *Centrosymnus crepidator. Chimarea montrosa* is less common at this depth, but other species of the order are well represented especially *Hydrolagus mirabilis.*

At 1500m the assemblage is now dominated by grenadiers (mainly *Coryphanoides rupestris*, but also a number of other species including the spearsnout grenadiers, *Coelorhyncus labiatus* and *Trachyrhincus murrayi*). The smooth heads and cut-throat eel (*Synaphobranchus kaupi*) make up the next most abundant groups. The cat-sharks of the genus *Apristurus* are well represented at this depth. Two larger species of rabbit fish (*Hydrolagus affinis* and *Hydrolagus pallidus*) are consistently found albeit at relatively low numbers. A range of rarer species such as *Halosaurus machrochir*, *Cataetyx laticeps* and the deepwater rays are found at this depth.

At 1800m several species appear in greater number including the rabbit fish *Hydrolagus affinis* and *H. pallidus.* The mix of macrourid species changes with *Chalinura mediternaenus* and Coryphanoides *guentheri* peaking in abundance. *Apristurus* species are the most prevalent elasmobranchs at this depth. It should be noted that comparatively few hauls have been undertaken at 1800m and that given the strong relationship between species diversity and sampling effort (section 8) data for this depth strata should be considered tentative.

There are likely to be latitudinal patterns across the area. A number of species found in the far north are never recorded from the far south. Spatial analyses of the data will be undertaken over the course of the project. As depth and temperature are strongly correlated it will be critical to assess whether distribution patterns can be better explained on the basis of both factors. This is now possible since from 2005 a data logger has recorded temperature at depth for all tows. A key quality of the data base is that it forms a time series. Temporal patterns will be investigated as part of developing indicators of ecosystem health (see section 8). Ultimately a full factorial approach (time, space depth and temperature) will be used to describe patterns of abundance and diversity.

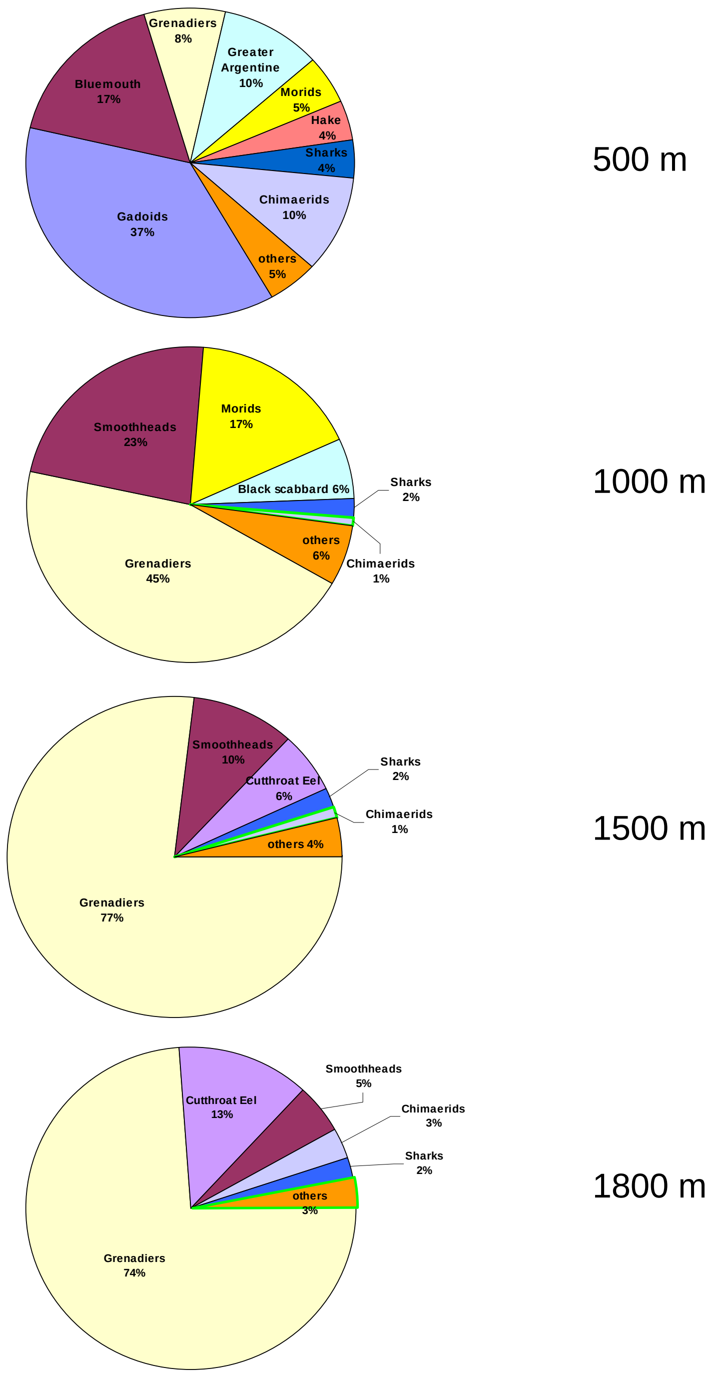


Figure 10: Catch composition (numbers per unit effort) at 500 m, 1000, 1500 and 1800 depths.

5.2 Rockall, the Anton Dorhn Seamount and Rosemary Bank

In 2006 and 2007 a number of exploratory trawls were made with the aim of describing and quantifying the fish fauna of the seamounts and banks (Table 1). Approximately 3 hours of trawling was undertaken on each seamount or bank at depths between 500-900 m.

TABLE 1

Trawl stations on the seamounts and banks

locality	stats square	station	lat shot	Long shot	lat haul	long haul	2005	2006	2007
Anton Dohrn	43D9	5_AD_1	57°24.00	-10°52.00	57°19.00	-10°55.00	X		
Anton Dohrn	43D8	5_AD_2	57°25.12	-11°13.06	57°22.77	-11°11.75		✓	✓
Anton Dohrn	43D8	5_AD_3	57°21.01	-11°11.69	57°20.76	-11°9.07		✓	✓
Anton Dohrn	43D8	5_AD_4	57°33.68	-11°1.43	57°32.84	-10°58.86		✓	✓
Rockall	42D5	6_ROC_1	56°35.47	-14°1.59	56°32.59	-14°4.85		✓	
Rockall	42D6	6_ROC_2	56°42.77	-13°43.26	56°40.04	-13°47.62		✓	
Rockall	42D6	6_ROC_3	56°56.91	-13°26.03	56°55.74	-13°28.06			✓
Rockall	42D6	6_ROC_4	56°55.18	-13°28.52	56°53.85	-13°30.14			✓
Rosemary	47D9	7_RB_1	59°5.39	-10°0.10	59°6.00	-9°56.89			✓
Rosemary	47D9	7_RB_2	59°21.75	-10°3.93	59°22.18	-10°7.52			✓
Rosemary	47D9	7_RB_3	59°26.34	-10°7.11	59°26.02	-10°10.39			✓

For each seamount/bank hauls were combined and an overall value of numbers of fish per hour calculated for each species. For comparison a baseline value for each species (numbers per hour) from the shelf slope was calculated for comparable depths (500-1000m). A sub-set of results are presented in Table 2 for the species that were captured at a rate of more than 5 per hour. The number of hauls is small and insufficient for any rigorous analysis especially with respect to patterns of diversity; however, it is worth pointing out some broad trends in the data and interesting observations.

On Rockall (n = 4 hauls) the numerically most dominant species (aside from the mesopelagic *Xenodermichthys copei*) was *Chimaera monstrosa* (Table 2) with numbers approximately twice that typically observed on the shelf slope. Witch (*Glyptocephalus cynoglossus*) was surprisingly common, although this is likely a reflection of the small number of hauls. Roundnose grenadier and black scabbard appeared to be less common than on the shelf slope.

On Anton Dohrn (n = 6 hauls) the most abundant species was the black scabbard (*Aphanopus carbo*) with more than three times that typically observed on the shelf slope. *Chimarea monstrosa* was also captured in almost as high numbers. There was little sign of large numbers of blue whiting or roundnose grenadier both of which are dominant species on the shelf slope. Also of note is the relatively high number of monkfish (5 per hour which is approximately twice that of the shelf slope) and shark species (*Denia calceus* and *Crentosymus crepridator*). Interestingly the *C. crepidator* were exclusively female and in advanced stages of pregnancy.

On Rosemary bank (n = 6 hauls), as with the shelf slope, blue whiting was the numerically dominant species. Both Baird's smoothhead (*Alepocephalus bairdii*) and roundnose grenadier were also found in large numbers. Also of note were the relatively high numbers of deepwater redfish. Two species, the silver roughy (*Hoplostethus mediterraneus)* and the spookfish (*Opisthoproctus soleatus*) were recorded or the first time.

TABLE 2

Numbers per hour of species that were sampled during exploratory seamount trawling. All hauls combined for each region. Shelf slope data refer to overall average numbers per hour from hauls between 500-1000m from all shelf slope stations. Species code refer to Appendix 2.

Shelf slope		Rockall bank		Anton Dohrn		Rosemary bank	
species	**n p h**	**species**	**n p h**	**species**	**n p h**	**species**	**n p h**
BWH	238	XCI	194.0	BSC	155.3	BWH	181.3
RNG	176	CHI	163.3	CHI	154.2	SMO	171.0
LEQ	142	NAE	109.0	NAE	109.0	HAF	140.7
BLM	140	LEQ	62.3	LEQ	107.5	RNG	130.7
CHI	86	WIT	45.7	SPI	44.4	LEQ	114.7
GAR	77	BLM	23.0	HAF	22.8	NAE	86.3
COC	60	SPI	23.0	SHS	19.4	GAR	73.7
SMO	59	HAF	20.3	MOR	13.7	CHI	68.0
NAE	56	VBE	18.7	SPO	11.8	BSC	53.0
BSC	37	COC	17.7	CCR	6.1	SPO	34.7
XCI	36	BSE	15.3	VBE	5.7	BLF	22.0
SPO	33	HMI	13.0	ANG	5.3	COC	14.7
HAF	32	RNG	12.3	XCI	4.9	CCR	13.7
HAK	29	SHS	10.7	COC	4.2	SMM	12.3
GFO	23	BUL	9.7	BWH	3.4	MOR	11.3
WIT	21	CCR	6.3	LAM	1.9	BSE	8.3
BMD	17	MOR	5.3	SMM	1.9	SYK	7.3
VBE	11	SMO	5.0	GFO	1.5	BLI	5.3
TMU	9	ANG	3.3	MSE	1.5	XCI	5.0
SYK	7	SYK	3.3	OMM	1.5	SPI	5.0
HMA	6	BSC	3.0	SYK	1.5	LAU	5.0
CCR	5	BMD	2.7	BUL	1.1	SHS	3.7
BSE	5	CHS	2.7	RNG	1.1	BUL	3.7

6. INVERTEBRATE FAUNA, METHOT NET SAMPLING AND HABITAT MAPPING

6.1 Coral By-catch

Hard and soft corals are occasionally taken as by-catch in the trawl. All occurrences are photographed, recorded and the species identified. Some of the coral species encountered during the survey are shown in Figure 11. All corals identified to date are presented in Appendix 3. Of particular note was the occurrence of *Lophelia pertusa* on the Anton Dohrn seamount at a depth of approximately 800 m and the occurrence of a black coral and *Madrepora oculata* at a depth of 1800m in area 4 of the shelf slope. No by-catch of corals was taken on Rosemary bank. The by-catch of coral is obviously undesirable. An ethical code of conduct is currently being developed for deepwater surveys with the aim of minimising the chances of trawling in sensitive areas.

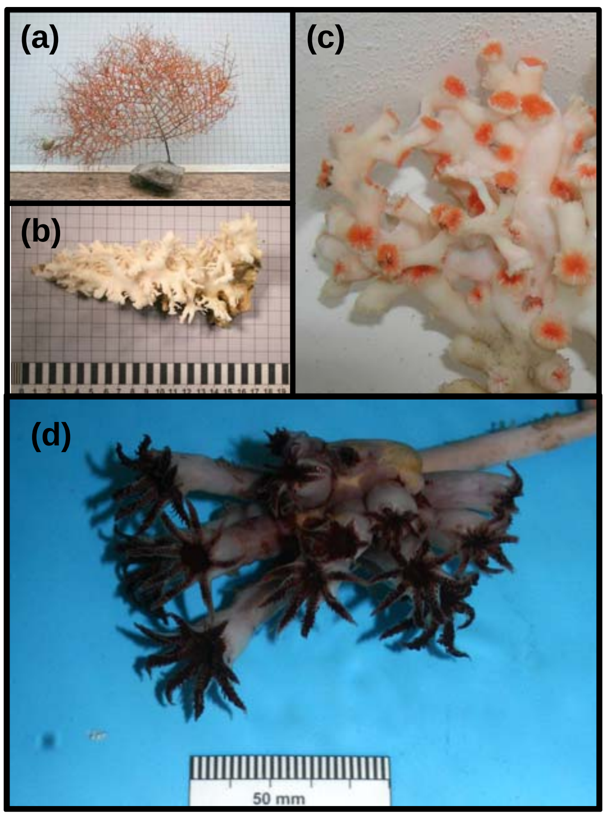


Figure 11: Specimens of Cnidaria (corals) from the deepwater survey (a) a black coral preliminarily identified as *Stauropathes arctica* (Family:Schizopathidae) from 1800 m (Shelf slope Area 4). (b) an unidentified lace coral (Family: Stylasteridae) from 600 m (Rockall). (c) *Lophelia pertusa* (Family: Caryophyllidae) from 800 m (Anton Dohrn seamount). (d) a seapen, *Umbellula lindahli* (Family: Pennatulacea) from 1500 m (Shelf slope).

6.2 Invertebrate By-catch

All other benthic and or invetrbrate by-catch is collected, identified when possible and records kept of numbers. Any unidentifiable specimens are retained for reference and further invesigation. The by-catch includes deep-water squid and octopus, prawns and crabs, sea-urchins and sea-cucumbers, seastars, sponges and bivalves. A selection of species is shown in Figure 12a and b and a full list of all species identified to date is given in Appendix 3.

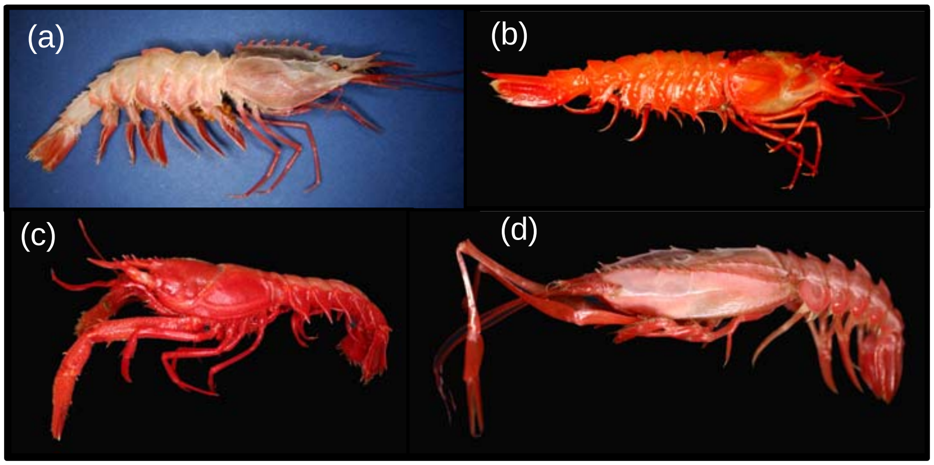


Figure 12a: Specimens of crustaceans from the deepwater survey. (a) *Sabinea hystrix* (1500 m), (b) *Glyphocrangon longirostris* (1800 m), (c) *Nephropsis atlantica* (1000 m), (d) *Stereomastis sculpa* (1000 m)

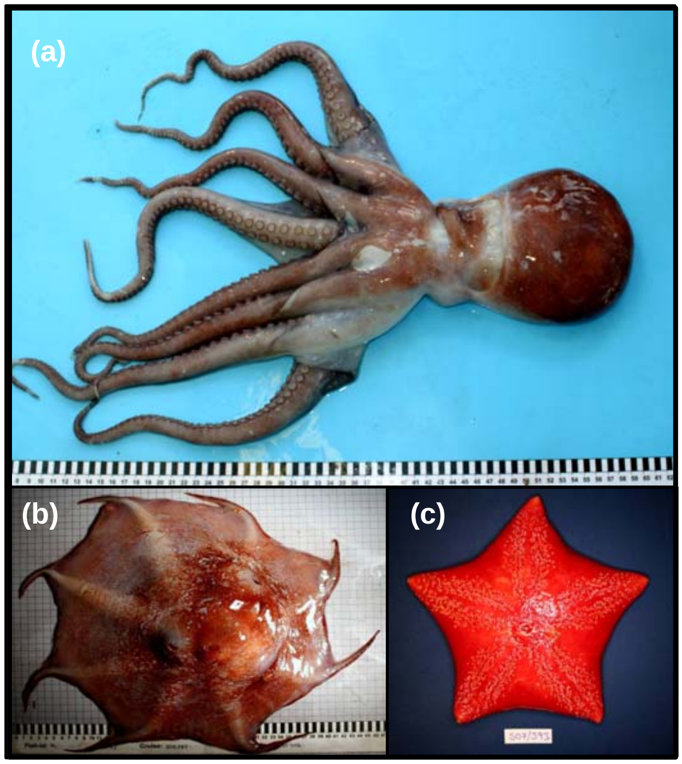


Figure 12b: Specimens of deep-water cephalopods from the survey (a) *Benthoctopus normani* from 1500 m (b) *Opisthoteuthis massyae* from 1000 m and (c) a deep-water seastar *Chondraster grandis* from 1000 m.

6.3 Methot Net Sampling

As the mesopelagic community is not adequately sampled by bottom trawling we sought to trial methot netting as an alternative sampling method. The methot net used has a circular opening of 1.8 m diameter which tapers to a fine mesh collection bag. It is towed obliquely down and then up forming a 'V' shaped profile through the water column. The survey was designed to compare the meso/bathypelagic community of the shelf slope with the seamounts and banks. Thirteen deployments of the methot net were made in May 2007. Deployments were made at night and during the day. On Rockall a daytime and night time deployment was made to a depth of 900 m above a depth of 1000 m. Five deployments were made across the Anton Dohrn seamount; on the southern edge, on the summit and on the northern edge. The summit was sampled both during the night and day. A single control deployment was made to 1000 m at a site between the Anton Dohrn seamount and Rosemary bank in the middle of the Rockall Trough (2000 m deep). Two deployments were made over Rosemary bank and 3 deployments were made on the shelf slope. Fish species were sorted from invertebrates and preserved in alcohol later to be identified to family.

Adult specimens of the following families were identified Myctophidae (latern fish), Gonostomatidae, Stomidae, Sygnathidae (pipefish), Photichthyidae, Melamphaidae, Sternoptychidae (hatchet fish). Larvae or small juveniles of the following families were identified; Alepocephalidae, Paralepididae, Phycidae, Gadidae, Sygnathidae, Scopthalmidae, Microstomidae, Triglidae, Anguillidae, Bathylagidae, Callionymidae, Bothidae. A number of specimens remain unidentified. Many of the larvae were thus shelf species rather than deepwater species and most likely captured in the upper 200m of the water column. An initial comparison of numbers of fish (larvae and adults) captured per hour suggest that the seamounts and banks are associated with a higher density of mesopelagic fish and ichthyoplankton than the shelf slope and the open waters of the Rockall Trough (Table 3). The invertebrate component of the sample was frozen and remains to be sorted and identified. Further points of interest included a large Omistrephid squid captured in the deployment in the Rockall Trough. Several specimens of Melamphaidae and Myctophidae were collected in very fine condition and will be preserved as reference material.

TABLE 3

Numbers of fish per hour captured by methot net sampling in each area.

Area (number deployments)	Average no fish per hour
Rockall Trough (n = 1)	57
Anton Dohrn (n = 5)	80
Rockall Bank (n = 2)	92
Rosemary bank (n = 2)	141
Shelf slope (n = 3)	52

The survey showed that methot net is a potentially useful means of assessing the mesopelagic community and has given some interesting preliminary data. In the future a means of separating the upper water column component from the deep-water column should be sought. This problem may be resolved through the use of the dual methot net that has twin collection bags that can opened at different depths.

6.4 TV Surveys and Habitat Mapping

In 2005 in conjunction with JNCC and the DTI Strategic Environmental Assessment (Area 7), TV drop-frame surveys were made of Rockall and the Anton Dohrn seamount (Narayanaswamy *et al*. 2006). In 2006 and 2007 the drop-frame TV survey was continued on Rockall. In 2007 for the first time several deployments were made on Rosemary bank. A list of FRS TV deployment details is given in appendix 4.

On Rockall bank areas of hard substrata on the eastern flank were colonised by encrusting sponges and bryozoans and there was some evidence of live coral (*Lophelia pertusa)*. The northwest region had greater colonies of *Lophelia pertusa*. Footage taken in 2007 on the south-east edge at around 400 m depth revealed extensive tracts of exposed bed-rock forming gullies and reef habitat and harbouring colonies of sponges and corals.

On the Anton Dohrn seamount much of the footage from the summit was of featureless sand and sediment. Localised exposures of bedrock were colonised by barnacles, brachiopods and bryozoans, but there were no signs of corals.

On Rosemary Bank theTV footage has not yet been analysed, although initial observation suggest extensive outcrops of exposed bedrock and the presence of soft corals (gorgonians).

7. DEVELOPMENT OF INDICATORS OF DEEP-WATER ECOSYSTEM 'HEALTH'

Fishing affects demersal marine communities via the following ways; the selective removal of target species, the selective removal of larger individuals, the bycatch of non-target species and habitat modification. The end result can be changes in overall biomass, species composition and size structure (Bianchi *et al*. 2000). In order to evaluate such effects it must be possible to measure the state of the ecosystem, detect differences among measures of its state, and determine whether those differences are actually due to the impact of fishing (Rice 2000). Thus the adoption of an ecosystem approach to fisheries management requires the development of "indicators" or metrics of "ecosystem health". Over the course of MF0763, the aim is develop a set of indicators of diversity and size composition. A short review of approaches is presented with discussion of the specific application to the deepwater ecosystem.

7.1 Diversity Indicators

An intuitive and simplistic measure of biodiversity is the number of species recorded in a given area. However, the probability of species being captured, especially rare species depends largely on sampling effort. Figure 13 shows that the relationship between species number and sampling intensity for each of the depth strata in the FRS deep-water survey. Clearly, species diversity increases with effort indicating that not enough sampling has been undertaken even after 10 years. However, this is in part due to the fact that while the trawl samples mainly the benthopelagic community, it also samples the bathy- and mesopelagic community as the net descends and ascends. This problem may be partially resolved by excluding mesopelagic species. The deepwater environment, however, is very diverse and biologically connected over much larger geographic ranges than the shelf sea ecosytems. Thus there is always a small chance of sampling previously unrecorded rare species.

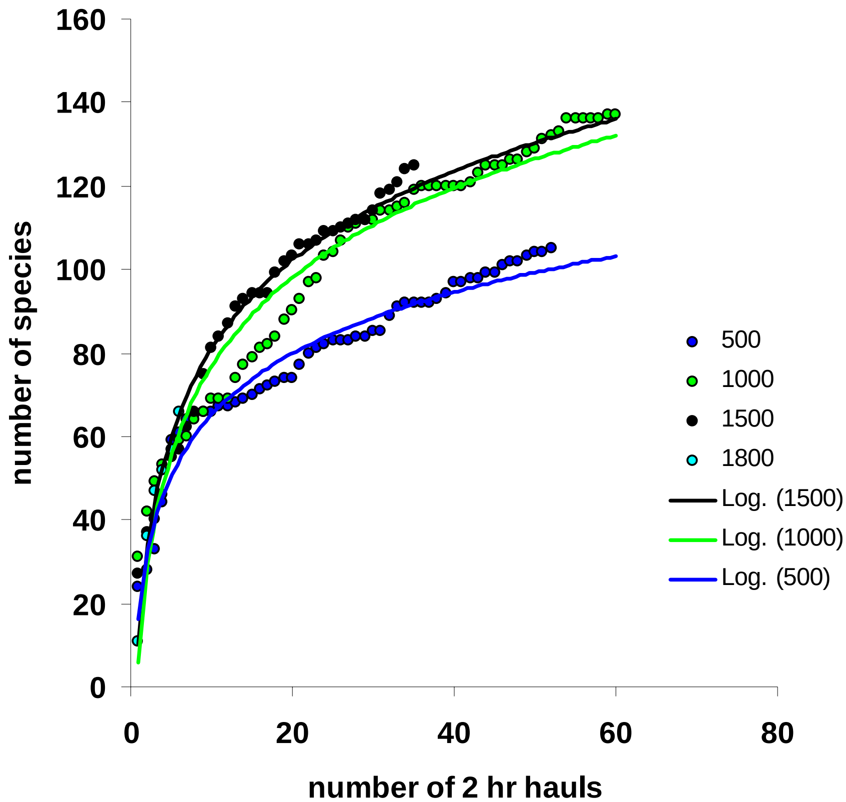


Figure 13: Species diversity as a function of sampling effort (number of 2 hour hauls) for each depth stratum.

Diversity is however more than just how many species are present in an ecosystem (species richness); it is also a function of how similar their abundances are (species evenness). Numerous indices of species diversity have been proposed and used and these tend to lie along a continuum from indices of species richness to indices of species evenness (Magurran 1988). One of the most commonly applied is the Shannon index which captures both components of diversity, increasing with additional species and with species evenness. Thus when the Shannon index is calculated for each depth stratum for the FRS deepwater survey, the 1000 m depth stratum scores highest (H' = 2.46) due to its high species diversity and relatively high species evenness. However, although species diversity is least at 500 m, the Shannon index for this depth stratum (H' = 2.39) is actually higher than at 1500 m (H' =1.78) because at 1500 m the species are much less evenly distributed. The suitability of the Shanon index and other indices based on for example taxonomic affinity will be investigated over the course of the project. A dedicated software package (Primer E) will also be used to investigate patterns of biodiversity.

7.2 Size-Based Indicators

Body size is of fundamental ecological significance. At the population level, fishing acts to remove the larger individuals, which leads to decrease in mean length or weight. This can have serious consequences at individual, community, ecosystem and evolutionary scales

(Hildrew *et al*. 2007). It is therefore imperative to be able to assess size changes. There are many means of analyzing trends in size frequency data. Simple changes in mean length or weight or maximum size can be informative. However it often necessary to understand how the entire size frequency distribution is being afftected. For example, the roundnose grenadier (*Coryphaenoides rupestris*) is one of the species targeted by commercial trawlers. From the FRS deep-water database there are preliminary indications that the size structure of the population has been impacted by fishing since the year 2000 (Figure 14) despite only a small change in the mean length of fish in 2000 (12.8 cm) compared to that in 2008 (12.4 cm). In the upper modal group (lengths 7 cm through 25 and above) comprised mainly of sub-adults and adults, when compared side by side it is clear that there were relatively more large fish (> 13 cm) and relatively less small fish (<13 cm) in 2000 than in 2007.

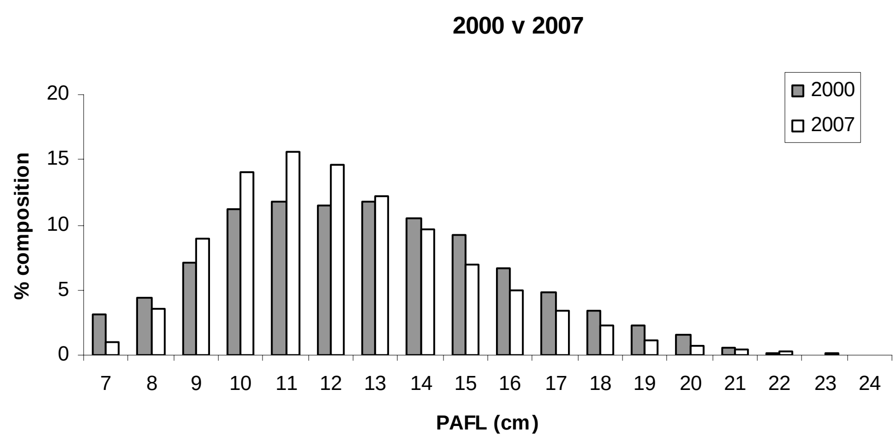


Figure 14: Size frequency distributions (percentage composition) of upper mode *Coryphaenoides rupestris* in 2000 (n = 13905) and 2007 (n= 17534).

More complex size-spectra indicators deal with the relationship between abundance and body size (Haedrich & Barnes 1997; Shin *et al*. 2005). As fishing selectively harvests the larger individuals of an assemblage, and increases the mortality rate for all sizes this causes the slope of this relationship to increase. Both theory and empirical data suggest that the slope and intercept of the size spectrum are useful metrics of impacts of fishing on fish assemblages. Such an approach will developed over the course of the project.

8. CONCLUDING REMARKS

The deep-water area to the northwest of Scotland is a unique and diverse ecosystem. The FRS deepwater survey database has built up into a valuable time series that will allow analysis of the ecosystem and how it has been affected by the impact of fishing. Set against the broader background of information on hydrography, habitat types and invertebrate fauna there is the opportunity to fully embrace an ecosystem approach to the management of this area. The preliminary analyses from the recent surveys which have collected information from the seamounts suggests that they are indeed dynamic ecosystems that may well differ from the shelf slope. Preliminary investigations of the main data-base from the shelf slope suggest there is much spatial and temporal variability to be accounted for. This is the raw material for developing indicators of the state of the ecosystem and how it is responding to fishing. Over the course of the project, further field observations will be made and more comprehensive analyses made of the data.

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10. APPENDICES

APPENDIX 1

Table of trawl stations. Tick = surveyed in that year. X = foul tow. Old station refers to pre-2008 station numbers. New station refer to stations numbers from 2008 onward. Seamount trawl stations at foot of table together with comparison shelf slope trawl stations.

Area code	locality	stats square	old station	new station	lat shot	long shot	lat haul	long haul	1998	2000	2002	2004	2005	2006	2007
1	North Flannan	46E2	35	1_NF_500	58°46.33	-7°54.46	58°48.36	-7°52.03		X	✓			✓	✓
1	North Flannan	46E2	36	1_NF_1000	58°52.38	-7°54.94	58°56.48	-7°45.28		✓	✓			✓	
1	**NW Flannan**	**46E1**	**2**	**1_NWF_500**	**58°43.52**	**-8°14.01**	**58°44.43**	**-8°0.36**	✓	✓	✓	✓	✓	✓	
1	**NW Flannan**	**46E1**	**34**	**1_NWF_1000**	**58°38.91**	**-8°43.88**	**58°36.45**	**-8°54.67**		✓	✓		✓	✓	
1	**NW Flannan**	**46E1**	**33**	**1_NWF_1500**	**58°43.17**	**-8°51.69**	**58°46.34**	**-8°41.14**		✓			✓	✓	
2	**N St Kilda**	**45E0**	**4**	**2_NSK_500**	**58°11.76**	**-9°33.91**	**58°17.94**	**-9°27.05**	✓	✓	✓	✓	✓	✓	✓
2	**N St Kilda**	**45E0**	**5**	**2_NSK_1000**	**58°25.83**	**-9°38.95**	**58°32.23**	**-9°34.80**	✓	✓	✓		✓	✓	✓
2	**N St Kilda**	**45E0**	**6**	**2_NSK_1500**	**58°26.05**	**-9°29.61**	**58°29.65**	**-9°18.19**		✓	✓		✓	✓	✓
2	**W St Kilda**	**44E0**	**8**	**2_WSK_500**	**57°40.64**	**-9°37.34**	**57°33.90**	**-9°34.34**	✓	✓	✓	✓	✓	✓	✓
2	**W St Kilda**	**44E0**	**9**	**2_WSK_1000**	**57°30.70**	**-9°39.05**	**57°37.45**	**-9°43.06**		✓	✓	✓	✓	✓	✓
2	**W St Kilda**	**44E0**	**10**	**2_WSK_1500**	**57°39.29**	**-9°52.39**	**57°46.13**	**-9°52.98**		✓	✓	✓	✓	✓	✓
2	**S St Kilda**	**43E0**	**29**	**2_SSK_500**	**57°10.60**	**-9°21.32**	**57°3.99**	**-9°16.60**	✓	✓		✓	✓	✓	✓
2	**S St Kilda**	**43E0**	**12**	**2_SSK_1000**	**57°21.49**	**-9°33.70**	**57°14.86**	**-9°28.96**		✓		✓	✓	✓	✓
2	**S St Kilda**	**43E0**	**13**	**2_SSK_1500**	**57°16.69**	**-9°36.84**	**57°22.41**	**-9°42.85**		✓		✓	✓	✓	✓
3	**N Vidal bank**	**42E0**	**25**	**3_NVB_500**	**56°49.53**	**-9°4.70**	**56°43.94**	**-9°2.13**	✓	✓	✓	✓	✓	✓	✓
3	**N Vidal bank**	**42E0**	**27**	**3_NVB_1000**	**56°43.00**	**-9°10.66**	**56°49.58**	**-9°10.49**	✓	✓	✓	✓	✓	✓	✓

3	**N Vidal bank**	**42E0**	**26**	**3_NVB_1500**	**56°47.80**	**-9°20.58**	**56°42.04**	**-9°26.87**		✓	✓	✓	✓	✓	✓
3	N Vidal bank	42E0	28	3_NVB_750	56°55.00	-9°10.00	56°49.00	-9°6.00	✓	✓	✓				
3	**N Vidal bank**	**42E0**	**47**	**3_NVB_1800**	**56°44.09**	**-9°47.67**	**56°49.02**	**-9°40.79**			✓	✓	✓	✓	
3	**Central Vidal bank**	**41E0**	**21**	**3_CVB_500**	**56°19.59**	**-9°9.92**	**56°13.57**	**-9°12.71**		✓	✓	✓		✓	✓
3	**Central Vidal bank**	**41E0**	**23**	**3_CVB_1000**	**56°8.33**	**-9°23.37**	**56°15.19**	**-9°21.13**		✓	✓	✓		✓	✓
3	**Central Vidal bank**	**41E0**	**24**	**3_CVB_1500**	**56°13.81**	**-9°37.52**	**56°7.28**	**-9°37.18**		✓	✓	✓		✓	✓
3	Central Vidal bank	41E0	22	3_CVB_800	56°14.00	-9°16.00	56°8.00	-9°17.00		✓	✓	✓			
3	S Vidal bank	40E0	18	3_SVB_500	55°50.09	-9°18.49	55°57.53	-9°16.69		✓	✓	✓		✓	
3	S Vidal bank	40E0	20	3_SVB_1000	55°58.27	-9°24.83	55°52.79	-9°28.65			✓	✓	✓	✓	
3	S Vidal bank	40E0	19	3_SVB_750	55°57.73	-9°19.57	55°54.55	-9°21.33		✓	✓	✓		✓	
3	S Vidal bank	40E0		3_SVB_1800	55°56.00	-9°52.00	55°51.00	-9°51.00			✓				
4	**North Donegal**	**39D9**	**14**	**4_ND_500**	**55°12.21**	**-10°3.72**	**55°6.05**	**-10°6.89**		✓	✓	✓		✓	✓
4	**North Donegal**	**39D9**	**15**	**4_ND_1000**	**55°8.72**	**-10°9.79**	**55°15.56**	**-10°7.70**		✓	✓	✓		✓	✓
4	**North Donegal**	**39D9**	**16**	**4_ND_1500**	**55°7.00**	**-10°16.00**	**55°13.00**	**-10°17.00**		✓	✓	✓			
4	North Donegal	39D9		4_ND_750	55°17.57	-10°3.68	55°23.45	-9°59.84						✓	
4	South Donegal	38D9		4_SD_1500	54°57.59	-10°29.11	54°53.48	-10°36.79						✓	✓
4	South Donegal	38D9		4_SD_1800	55°0.92	-10°29.72	55°58.27	-10°39.83							✓
	SEAMOUNTS														
5	Anton Dohrn	43D9		5_AD_1	57°24.00	-10°52.00	57°19.00	-10°55.00					X		
5	Anton Dohrn	43D8		5_AD_2	57°25.12	-11°13.06	57°22.77	-11°11.75						✓	✓
5	Anton Dohrn	43D8		5_AD_3	57°21.01	-11°11.69	57°20.76	-11°9.07						✓	✓

5	Anton Dohrn	43D8		5_AD_4	57°33.68	-11°1.43	57°32.84	-10°58.86						✓	✓
2	W St Kilda	44E0		2_WSK_850	57°49.00	-9°42.00	57°43.00	-9°42.00					✓		✓
2	S St Kilda	43E0	48	2_SSK_800	57°9.00	-9°23.00	57°16.00	-9°28.00	✓				✓		
6	Rockall	42D5		6_ROC_1	56°35.47	-14°1.59	56°32.59	-14°4.85						✓	
6	Rockall	42D6		6_ROC_2	56°42.77	-13°43.26	56°40.04	-13°47.62						✓	
6	Rockall	42D6		6_ROC_3	56°56.91	-13°26.03	56°55.74	-13°28.06							✓
6	Rockall	42D6		6_ROC_4	56°55.18	-13°28.52	56°53.85	-13°30.14							✓
7	Rosemary bank	47D9		7_RB_1	59°5.39	-10°0.10	59°6.00	-9°56.89							✓
7	Rosemary bank	47D9		7_RB_2	59°21.75	-10°3.93	59°22.18	-10°7.52							✓
7	Rosemary bank	47D9		7_RB_3	59°26.34	-10°7.11	59°26.02	-10°10.39							✓
1	West Lug	47E2		1_WL_1000	59°2.37	-7°45.13	59°8.51	-7°39.34		✓				✓	✓

APPENDIX 2

Table of all fish species recorded from the FRS deep-water survey, split according to whether species are benthic-benthopelagic, mesopelagic or shelf-sea groups. Ticks = recorded at that depth. 750 = recorded from 750 m.

Benthic - Benthopelagic species									
code	class	order	family	species	common name	500m	1000m	1500m	1800m
AAF	Actinopterygii	Albuliformes	HALOSAURIDAE	*Aldrovandia affinis*	*Aldrovandia affinis*				✓
ALD	Actinopterygii	Albuliformes	HALOSAURIDAE	*Aldrovandia phalacra*	Aldrovandia phalacra			✓	
HAM	Actinopterygii	Albuliformes	HALOSAURIDAE	*Halosauropsis macrochir*	Halosauropsis macrochir			✓	✓
VPR	Actinopterygii	Anguilliformes	NETTASTOMATIDAE	*Venifica proboscidea*	Whipsnout sorcerer			✓	
DAE	Actinopterygii	Anguilliformes	SYNAPHOBRANCHIDAE	*Histiobranchus bathybius*	Deepwater arrowtooth eel			✓	
IBL	Actinopterygii	Anguilliformes	SYNAPHOBRANCHIDAE	*Ilyophis blachei*	Ilyophis blachei			✓	
SNE	Actinopterygii	Anguilliformes	SYNAPHOBRANCHIDAE	*Simenchelys parasitica*	Snubnosed eel		✓		
SYK	Actinopterygii	Anguilliformes	SYNAPHOBRANCHIDAE	*Synaphobranchus kaupi*	Cut-throat Eel	✓	✓	✓	✓
BDE	Actinopterygii	Beryciformes	BERYCIDAE	*Beryx decadactylus*	Alfonsino	✓			
ORO	Actinopterygii	Beryciformes	TRACHICHTHYIDAE	*Hoplostethus atlanticus*	Orange Roughy		✓	✓	
HME	Actinopterygii	Beryciformes	TRACHICHTHYIDAE	*Hoplostethus mediterraneus*	Silver roughy	✓			
BER	Actinopterygii	Gadiformes	GADIDAE	*Antonogadus macrophthalmus*	Big-eyed Rockling		✓		
TOR	Actinopterygii	Gadiformes	GADIDAE	*Brosme brosme*	Torsk	✓	✓		
SRO	Actinopterygii	Gadiformes	GADIDAE	*Gaidropsarus argentatus*	Silvery Rockling	✓			
TBR	Actinopterygii	Gadiformes	GADIDAE	*Gaidropsarus vulgaris*	Three-bearded Rockling	✓	✓		
BLI	Actinopterygii	Gadiformes	GADIDAE	*Molva dypterygia*	Blue Ling	✓	✓	✓	
GFO	Actinopterygii	Gadiformes	GADIDAE	*Phycis blennoides*	Greater Forkbeard	✓	✓		✓
MGR	Actinopterygii	Gadiformes	MACROURIDAE	*Chalinura mediterranea*	Mediterranean grenadier		✓	✓	
COC	Actinopterygii	Gadiformes	MACROURIDAE	*Coelorhynchus coelorhynchus*	Hollowsnout Rat tail	✓	✓		
SSG	Actinopterygii	Gadiformes	MACROURIDAE	*Coelorhynchus labiatus*	Spear-snouted grenadier		✓	✓	✓
GGR	Actinopterygii	Gadiformes	MACROURIDAE	*Coryphaenoides guentheri*	Gunther's grenadier	✓	✓	✓	✓
RNG	Actinopterygii	Gadiformes	MACROURIDAE	*Coryphaenoides rupestris*	Round Nosed Grenadier	✓	✓	✓	✓
GLO	Actinopterygii	Gadiformes	MACROURIDAE	*Gadomus longfilis*	Threadfin Grenadier		✓	✓	
MLA	Actinopterygii	Gadiformes	MACROURIDAE	*Malacocephalus laevis*	Softhead Rat tail	✓	✓		
NAE	Actinopterygii	Gadiformes	MACROURIDAE	*Nezumia aequalis*	Smooth Rat tail	✓	✓	✓	
RTG	Actinopterygii	Gadiformes	MACROURIDAE	*Nezumia sclerorhynchus*	Roughtip Grenadier		✓	✓	
TMU	Actinopterygii	Gadiformes	MACROURIDAE	*Trachyrhynchus murrayi*	Murray's Rat tail		✓	✓	

LYB	Actinopterygii	Gadiformes	MERLUCCIDAE	*Lyconus brachycolus*	Lyconus brachycolus		✓		
HAK	Actinopterygii	Gadiformes	MERLUCCIDAE	*Merluccius merluccius*	Hake	✓	✓		
ARO	Actinopterygii	Gadiformes	MORIDAE	*Antimora rostrata*	Antimora or Blue Hake	✓	✓	✓	✓
HAF	Actinopterygii	Gadiformes	MORIDAE	*Halargyreus johnsonii*	Halargyreus johnsonii		✓	✓	
LLA	Actinopterygii	Gadiformes	MORIDAE	*Laemonema latifrons*	Laemonema latifrons		✓	✓	
LEQ	Actinopterygii	Gadiformes	MORIDAE	*Lepidion eques*	Lepidion eques	✓	✓	✓	
MOR	Actinopterygii	Gadiformes	MORIDAE	*Mora moro*	Mora	✓	✓	✓	
BAN	Actinopterygii	Lophiformes	LOPHIIDAE	*Lophius budegassa*	Black-bellied Angler	✓			
ANG	Actinopterygii	Lophiformes	LOPHIIDAE	*Lophius piscatorius*	Angler (Monk fish)	✓	✓	✓	
BSE	Actinopterygii	Notacanthiformes	NOTACANTHIDAE	*Notacanthus bonapartei*	Bonaparte's Spiny Eel	✓	✓	✓	✓
CSE	Actinopterygii	Notacanthiformes	NOTACANTHIDAE	*Notacanthus chemnitzii*	Chemnitz's Spiny Eel	✓	✓	✓	✓
RSE	Actinopterygii	Notacanthiformes	NOTACANTHIDAE	*Polyacanthonotus rissoanus*	Risso's Spiny Eel	✓	✓	✓	✓
AAG	Actinopterygii	Osmeriformes	ALEPOCEPHALIDAE	*Alepocephalus agassizi*	Agassiz's smooth-head			✓	✓
AAU	Actinopterygii	Osmeriformes	ALEPOCEPHALIDAE	*Alepocephalus australis*	Southern Atlantic smooth-head			✓	✓
SMO	Actinopterygii	Osmeriformes	ALEPOCEPHALIDAE	*Alepocephalus bairdii*	Smoothhead	✓	✓	✓	✓
LSM	Actinopterygii	Osmeriformes	ALEPOCEPHALIDAE	*Alepocephalus rostratus*	Lesser Smoothhead		✓		
BAM	Actinopterygii	Osmeriformes	ALEPOCEPHALIDAE	*Bajacalifornia megalops*	Big-eyed smoothhead			✓	✓
BMI	Actinopterygii	Osmeriformes	ALEPOCEPHALIDAE	*Bathytroctes microlepis*	Smallscale smoothhead				✓
LSH	Actinopterygii	Osmeriformes	ALEPOCEPHALIDAE	*Conocara macroptera*	Longfin smooth-head			✓	✓
MUC	Actinopterygii	Osmeriformes	ALEPOCEPHALIDAE	*Conocara murrayi*	Murrays Smoothead		✓	✓	✓
RAA	Actinopterygii	Osmeriformes	ALEPOCEPHALIDAE	*Rouleina attrita*	Softskin smooth-head		✓	✓	✓
MSH	Actinopterygii	Osmeriformes	ALEPOCEPHALIDAE	*Rouleina maderensis*	Madeiran smooth-head		✓	✓	
GAR	Actinopterygii	Osmeriformes	ARGENTINIDAE	*Argentina silus*	Greater Argentine	✓	✓		
BCU	Actinopterygii	Osmeriformes	SEARSIIDAE	*Barbantus curvifrons*	Palebelly searsid			✓	
HAN	Actinopterygii	Osmeriformes	SEARSIIDAE	*Holtbyrnia anomala*	Bighead searsid			✓	✓
HOM	Actinopterygii	Osmeriformes	SEARSIIDAE	*Holtbyrnia macrops*	Bigeye searsid			✓	✓
MSE	Actinopterygii	Osmeriformes	SEARSIIDAE	*Normanichthys operosus*	multipore searsid		✓		
PAP	Actinopterygii	Osmeriformes	SEARSIIDAE	*Platytroctes apus*	Legless searsid			✓	
SSI	Actinopterygii	Osmeriformes	SEARSIIDAE	*Sagamichthys schnakenbecki*	Schnakenbeck's searsid		✓	✓	
KSE	Actinopterygii	Osmeriformes	SEARSIIDAE	*Searsia koefoedi*	Koefoed's searsid		✓		
JCA	Actinopterygii	Perciformes	ANARHICHADIDAE	*Anarhichas denticulatus*	Jelly Cat			✓	
BUL	Actinopterygii	Perciformes	APOGONIDAE	*Epigonus telescopus*	Bullseye	✓	✓	✓	
CLA	Actinopterygii	Perciformes	BYTHITIDAE	*Cataetyx laticeps*	Cataetyx laticeps (rubber fish)			✓	✓
JSC	Actinopterygii	Perciformes	GEMPYLIDAE	*Nesiarchus nasutus*	Johnson's Scabbardfish	✓	✓		

SGR	Actinopterygii	Perciformes	OPHIDIDAE	*Spectrunculus grandis*	Spectrunculus grandis				✓
BSC	Actinopterygii	Perciformes	TRICHIURIDAE	*Aphanopus carbo*	Black Scabbardfish	✓	✓	✓	
BSC	Actinopterygii	Perciformes	TRICHIURIDAE	*Benthodesmus elongatus*	Frostfish	✓			
LAT	Actinopterygii	Perciformes	ZOARCIDAE	*Lycodes atlanticus*	Lycodes atlanticus	✓	✓	✓	
EEE	Actinopterygii	Perciformes	ZOARCIDAE	*Lycodes esmarkii*	Esmark's Eelpout		✓	✓	✓
LPA	Actinopterygii	Perciformes	ZOARCIDAE	*Lycodes pallidus*	Lycodes pallidus		✓		
LYF	Actinopterygii	Perciformes	ZOARCIDAE	*Lycodonus flagellicauda*	Lycodonus flagellicauda		✓	✓	
POB	Actinopterygii	Perciformes	ZOARCIDAE	*Pachycara obesa*	Pachycara obesa			✓	
WIT	Actinopterygii	Pleuronectiformes	PLEURONECTIDAE	*Glyptocephalus cynoglossus*	Witch	✓		✓	
GHA	Actinopterygii	Pleuronectiformes	PLEURONECTIDAE	*Reinhardtius hippoglossoides*	Greenland Halibut			✓	
FME	Actinopterygii	Pleuronectiformes	SCOPTHALMIDAE	*Lepidorhombus boscii*	Four-spot Megrim	✓	✓		
MEG	Actinopterygii	Pleuronectiformes	SCOPTHALMIDAE	*Lepidorhombus whiffiagonis*	Megrim	✓	✓		✓
BDU	Actinopterygii	Scopeliformes	CHLOROPHTHALMIDAE	*Bathypterois dubius*	Spiderfish	✓	✓	✓	✓
BFE	Actinopterygii	Scopeliformes	SYNODONTIDAE	*Bathysaurus ferox*	Bathysaurus ferox		✓	✓	✓
PBA	Actinopterygii	Scorpaeniformes	LIPARIDIDAE	*Paraliparis bathybius*	Paraliparis bathybius	✓	✓	✓	
PAS	Actinopterygii	Scorpaeniformes	PSYCHROLUTIDAE	*Cottunculus thomsonii*	Pallid sculpin	✓	✓	✓	
BLM	Actinopterygii	Scorpaeniformes	SCORPAENIDAE	*Helicolenus dactylopterus*	Blue-mouth	✓	✓		
RED	Actinopterygii	Scorpaeniformes	SCORPAENIDAE	*Sebastes marinus marinus*	Deep-water Redfish (marinus)	✓			
SMM	Actinopterygii	Scorpaeniformes	SCORPAENIDAE	*Sebastes marinus mentella*	Deep-water Redfish (mentella)	✓			
NHA	Actinopterygii	Scorpaeniformes	SCORPAENIDAE	*Sebastes viviparus*	Norway Haddock	✓			
BFI	Actinopterygii	Zeiformes	CAPROIDAE	*Capros aper*	Boar Fish	✓			
FBF	Actinopterygii	Zeiformes	OREOSOMATIDAE	*Neocyttus helgae*	False Boarfish		✓	✓	
FCA	Elasmobranchii	Carcharhiniformes	PSEUDOTRIAKIDAE	*Pseudotriakis microdon*	False Catshark		✓		
AAP	Elasmobranchii	Carcharhiniformes	SCYLIORHINIDAE	*Apristurus aphyodes*	Pale Catshark		✓	✓	✓
ALA	Elasmobranchii	Carcharhiniformes	SCYLIORHINIDAE	*Apristurus laurussonii*	Iceland Catshark		✓	✓	✓
AMA	Elasmobranchii	Carcharhiniformes	SCYLIORHINIDAE	*Apristurus madierensis*	Madeirian catshark			✓	
AMN	Elasmobranchii	Carcharhiniformes	SCYLIORHINIDAE	*Apristurus manis*	Ghost catshark			✓	✓
AME	Elasmobranchii	Carcharhiniformes	SCYLIORHINIDAE	*Apristurus melanoasper*	Rough skin catshark			✓	
AMI	Elasmobranchii	Carcharhiniformes	SCYLIORHINIDAE	*Apristurus microps*	Small eyed catshark			✓	✓
BMD	Elasmobranchii	Carcharhiniformes	SCYLIORHINIDAE	*Galeus melastomus*	Black Mouthed Dogfish	✓	✓		✓
GMU	Elasmobranchii	Carcharhiniformes	SCYLIORHINIDAE	*Galeus murinus*	Mouse catshark		✓	✓	
SGS	Elasmobranchii	Hexanchiformes	HEXANCHIDAE	*Hexanchus griseus*	Six Gilled Shark	✓			
BCA	Elasmobranchii	Rajiformes	RAJIDAE	*Breviraja caerulea*	Blue ray	✓	✓	✓	✓
SKA	Elasmobranchii	Rajiformes	RAJIDAE	*Dipturus batis*	Skate	✓	✓		

RBA	Elasmobranchii	Rajiformes	RAJIDAE	*Raja bathyphila*	Deepwater Ray		✓	✓	✓
RBI	Elasmobranchii	Rajiformes	RAJIDAE	*Raja bigelowi*	Bigelow's ray		✓	✓	✓
RJE	Elasmobranchii	Rajiformes	RAJIDAE	*Raja jensenii*	Jensens ray			✓	✓
KRA	Elasmobranchii	Rajiformes	RAJIDAE	*Raja kreffti*	Krefft's ray			✓	
RAK	Elasmobranchii	Rajiformes	RAJIDAE	*Raja kukujevi*	Raja kukujevi		✓		
FRA	Elasmobranchii	Rajiformes	RAJIDAE	*Rajella fyllae*	Fylla's Ray	✓	✓	✓	
CGR	Elasmobranchii	Squaliformes	CENTROPHORIDAE	*Centrophorus granulosus*	Centrophorus granulosus				
LSQ	Elasmobranchii	Squaliformes	CENTROPHORIDAE	*Centrophorus squamosus*	Leafscale Gulper Shark	✓	✓	✓	✓
SHS	Elasmobranchii	Squaliformes	CENTROPHORIDAE	*Deania calceus*	Shovelnosed Shark	✓	✓	✓	
DCH	Elasmobranchii	Squaliformes	DALATIDAE	*Scymnorhinus (Dalatias) licha*	Darkie Charlie	✓		✓	
CFA	Elasmobranchii	Squaliformes	ETMOPTERIDAE	*Centroscyllium fabricii*	Black dogfish		✓	✓	
EPR	Elasmobranchii	Squaliformes	ETMOPTERIDAE	*Etmopterus princeps*	Greater lantern shark		✓	✓	✓
VBE	Elasmobranchii	Squaliformes	ETMOPTERIDAE	*Etmopterus spinax*	Velvet Belly	✓	✓		
PSH	Elasmobranchii	Squaliformes	SOMNIOSIDAE	*Centroscymnus coelolepis*	Portuguese Shark		✓	✓	
CCR	Elasmobranchii	Squaliformes	SOMNIOSIDAE	*Centroscymnus crepidater*	Longnose velvet dogfish	✓	✓	✓	✓
SRI	Elasmobranchii	Squaliformes	SOMNIOSIDAE	*Scymnodon ringens*	Knifetooth dogfish		750		
LSS	Elasmobranchii	Squaliformes	SOMNIOSIDAE	*Somniosus rostratus*	Lesser sleeper shark		750		
CHI	Holocephali	Chimaeriformes	CHIMAERIDAE	*Chimaera monstrosa*	Rabbit Ratfish	✓	✓	✓	✓
HMI	Holocephali	Chimaeriformes	CHIMAERIDAE	*Hydrolagus affinis*	Smalleye rabbitfish		✓	✓	✓
HYA	Holocephali	Chimaeriformes	CHIMAERIDAE	*Hydrolagus mirabilis*	Large-eyed Rabbitfish	✓	✓	✓	
HPA	Holocephali	Chimaeriformes	CHIMAERIDAE	*Hydrolagus pallidus*	Hydrolagus pallidus		✓	✓	✓
HRA	Holocephali	Chimaeriformes	RHINOCHIMAERIDAE	*Hariotta raleighana*	Bentnose rabbitfish		✓	✓	✓
RAT	Holocephali	Chimaeriformes	RHINOCHIMAERIDAE	*Rhinochimaera atlantica*	Straightnose rabbitfish			✓	
WHH	Myxini	Myxiniformes	MYXINIDAE	*Myxine ios*	White Headed Hagfish		✓	✓	
Epipelagic, Mesopelagic and Bathypelagic species									
DOE	Actinopterygii	Anguilliformes	DERICHTHYIDAE	*Nessorhamphus inglofianus*	Duckbill oceanic eel		✓	✓	
SBD	Actinopterygii	Anguilliformes	SERRIVOMERIDAE	*Serrivomer brevidentatus*	Black sawtoothed eel			✓	
SBE	Actinopterygii	Anguilliformes	SERRIVOMERIDAE	*Serrivomer beani*	Bean's sawtoothed eel	✓	✓	✓	✓
SEE	Actinopterygii	Anguilliformes	NEMICHTHYIDAE	*Nemichthys scolopaceus*	Snipe Eel	✓	✓	✓	
CHS	Actinopterygii	Ateleopodiformes	CHAULIODONTIDAE	*Chauliodus sloani*	Sloan's Viperfish		✓	✓	
MNI	Actinopterygii	Ateleopodiformes	MALACOSTEIDAE	*Malacostus niger*	Malacostus niger	✓	✓	✓	
LBA	Actinopterygii	Aulopiformes	PARALEPIDIDAE	*Notolepis rissoi*	Lesser Barracudina				
PAA	Actinopterygii	Aulopiformes	PARALEPIDIDAE	*Paralepis atlantica*	Paralepis atlantica			✓	
ACO	Actinopterygii	Beryciformes	ANOPLOGASTERIDAE	*Anoplogaster cornuta*	Fangtooth		✓	✓	✓

DAR	Actinopterygii	Beryciformes	DIRETMIDAE	*Diretmus argenteus*	Diretmus argenteus		✓		
PCA	Actinopterygii	Beryciformes	MELAMPHAIDAE	*Poromitra capito*	Poromitra capito		✓		
SBI	Actinopterygii	Beryciformes	MELAMPHAIDAE	*Scopelogadus beanii*	Scopelogadus beanii	✓		✓	✓
MEM	Actinopterygii	Beryciformes	MELAMPHAIDAE	*Melamphaes microps*	*Melamphaes microps*		✓		
RLO	Actinopterygii	Cetomimiformes	RONDELITIIDAE	*Rondeletia loricata*	Red mouth whale fish			✓	
AAS	Actinopterygii	Clupeiformes	STERNOPTYCHIDAE	*Argyropelecus aculeatus*	Argyropelecus aculeatus		✓		
AGI	Actinopterygii	Clupeiformes	STERNOPTYCHIDAE	*Argyropelecus giga*	Giant hatchet fish		✓		
AHE	Actinopterygii	Clupeiformes	STERNOPTYCHIDAE	*Argyropelecus hemigymnus*	Argyropelecus hemigymnus	✓	✓		
HAT	Actinopterygii	Clupeiformes	STERNOPTYCHIDAE	*Argyropelecus olfersi*	Hatchetfish	✓	✓	✓	✓
SPO	Actinopterygii	Gadiformes	GADIDAE	*Gadiculus argenteus thori*	Silvery Pout	✓	✓		
BWH	Actinopterygii	Gadiformes	GADIDAE	*Micromesistius poutassou*	Blue Whiting	✓	✓	✓	
MZU	Actinopterygii	Gadiformes	MELANONIDAE	*Melanonus zugmayeri*	Melanonus zugmayeri		✓		
DEA	Actinopterygii	Lampridiformes	TRACHIPTERIDAE	*Trachipterus arcticus*	Dealfish	✓	✓		
CHO	Actinopterygii	Lophiformes	CERATIIDAE	*Ceratias holboelli*	Deep sea angler fish		✓		
BAE	Actinopterygii	Osmeriformes	BATHYLAGIDAE	*Bathylagus euryops*	Goiter blacksmelt		✓	✓	✓
OPS	Actinopterygii	Osmeriformes	OPISTHOPROCTIDAE	*Opisthoproctus soleatus*	Spook fish		✓		
POP	Actinopterygii	Perciformes	CARISTIIDAE	*Platyberyx opalescens*	*Platyberyx opalescens*		✓	✓	
BLF	Actinopterygii	Perciformes	CENTROLOPHIDAE	*Centrolophus niger*	Blackfish	✓	✓		
CNR	Actinopterygii	Perciformes	CHIASMODONTIDAE	*Chiasmodon niger*	Chiasmodon niger	✓	✓	✓	
HOS	Actinopterygii	Perciformes	MORONIDAE	*Howella sherborni*	Howella sherborni		✓	✓	
MAT	Actinopterygii	Perciformes	ZOARCIDAE	*Melanostigma atlanticum*	Melanostigma atlanticum	✓	✓	✓	✓
PEE	Actinopterygii	Saccopharyngiformes	EUPHARYNGIDAE	*Eurypharynx pelecanoides*	Pelican eel			✓	
ALB	Actinopterygii	Scopeliformes	ALEPISAURIDAE	*Alepisaurus brevirostris*	Lancet fish			1200	
LSP	Actinopterygii	Scopeliformes	MYCTOPHIDAE	*Lampadena speculigera*	Lampadena speculigera		✓		
MYC	Actinopterygii	Scopeliformes	MYCTOPHIDAE	*Lampanyctus crocodilus*	Lampanyctus crocodilus	✓	✓		✓
NOE	Actinopterygii	Scopeliformes	MYCTOPHIDAE	*Notoscopelus elongatus*	Notoscopelus elongatus	✓			
SLE	Actinopterygii	Scopeliformes	NOTOSUDIDAE	*Scopelosaurus lepidus*	Scopelosaurus lepidus		✓	✓	✓
BIN	Actinopterygii	Scopeliformes	SCOPELARCHIDAE	*Benthalbella infans*	Zugmayer's pearleye		✓		
BOA	Actinopterygii	Stomiformes	ASTRONESTHIDAE	*Borostomias antarcticus*	Borostomias antarcticus		✓	✓	
GBA	Actinopterygii	Stomiformes	GONOSTOMATIDAE	*Gonostoma bathyphilum*	Gonostoma bathyphilum			✓	
GOE	Actinopterygii	Stomiformes	GONOSTOMATIDAE	*Gonostoma elongatum*	Gonostoma elongatum		✓	✓	
TRM	Actinopterygii	Stomiformes	MELANOSTOMIIDAE	*Trigonolampa miriceps*	Trigonolampa miriceps		✓		
POC	Actinopterygii	Stomiformes	PHOTOICHTHYIDAE	*Polymetme corythaeola*	Polymetme corythaeola	✓			
SBF	Actinopterygii	Stomiformes	STOMIIDAE	*Stomias boa ferox*	Stomias boa ferox	✓	✓	✓	✓

XCI	Actinopterygii	Osmeriformes	ALEPOCEPHALIDAE	*Xenodermichthys copei*	Bluntsnout Smooth-head	✓	✓	✓	✓
Shelf species									
CEE	Actinopterygii	Anguilliformes	CONGRIDAE	*Conger conger*	Conger Eel	✓			
LAR	Actinopterygii	Clupeiformes	ARGENTINIDAE	*Argentina sphyraena*	Lesser Argentine	✓			
COD	Actinopterygii	Gadiformes	GADIDAE	*Gadus morhua*	Cod	✓			
HAD	Actinopterygii	Gadiformes	GADIDAE	*Melanogrammus aeglefinus*	Haddock	✓			
LIN	Actinopterygii	Gadiformes	GADIDAE	*Molva molva*	Ling	✓	✓		
SAI	Actinopterygii	Gadiformes	GADIDAE	*Pollachius virens*	Saithe	✓			
NPO	Actinopterygii	Gadiformes	GADIDAE	*Trisopterus esmarki*	Norway Pout	✓			
PCO	Actinopterygii	Gadiformes	GADIDAE	*Trisopterus minutus*	Poor Cod	✓			
HMA	Actinopterygii	Perciformes	CARANGIDAE	*Trachurus trachurus*	Horse Mackerel (Scad)	✓			
PEF	Actinopterygii	Perciformes	CARAPIDAE	*Echiodon drummondi*	Pearlfish	✓			
MAC	Actinopterygii	Perciformes	SCOMBRIDAE	*Scomber scombrus*	Mackerel	✓			
LRD	Actinopterygii	Pleuronectiformes	PLEURONECTIDAE	*Hippoglossoides platessoides*	Long Rough Dab	✓			
HAL	Actinopterygii	Pleuronectiformes	PLEURONECTIDAE	*Hippoglossus hippoglossus*	Halibut	✓			
CDA	Actinopterygii	Pleuronectiformes	PLEURONECTIDAE	*Limanda limanda*	Common Dab	✓			
LSO	Actinopterygii	Pleuronectiformes	PLEURONECTIDAE	*Microstomus kitt*	Lemon Sole	✓			
PLA	Actinopterygii	Pleuronectiformes	PLEURONECTIDAE	*Pleuronectes platessa*	Plaice	✓			
SSN	Actinopterygii	Scorpaeniformes	LIPARIDIDAE	*Liparis liparis*	Sea Snail		✓		
GGU	Actinopterygii	Scorpaeniformes	TRIGLIDAE	*Eutrigla gurnardus*	Grey Gurnard	✓			
SPI	Actinopterygii	Sygnathiformes	SYGNATHIDAE	*Entelurus aequoreus*	Snake Pipefish	✓	✓	✓	✓
LSD	Elasmobranchii	Carcharhiniformes	SCYLIORHINIDAE	*Scyliorhinus canicula*	Lesser Spotted Dogfish	✓			
TRA	Elasmobranchii	Rajiformes	RAJIDAE	*Raja clavata*	Thornback Ray	✓			
SAR	Elasmobranchii	Rajiformes	RAJIDAE	*Leucoraja circularis*	Sandy Ray	✓			
SRA	Elasmobranchii	Rajiformes	RAJIDAE	*Leucoraja fullonica*	Shagreen Ray	✓			
CRA	Elasmobranchii	Rajiformes	RAJIDAE	*Leucoraja naevus*	Cuckoo Ray	✓			
SPU	Elasmobranchii	Squaliformes	SQUALIDAE	*Squalus acanthias*	Spurdog	✓	✓		

APPENDIX 3

Invertebrate species identified to date from the FRS deepwater survey.

Phylum	Class	Order	Family	Genus	Species
Annelida	Polychaeta	Eunicida	Eunicidae	*Eunice*	*norvegica/pennata*
Annelida	Polychaeta	Phyllodocida	Aphroditidae	*Aphrodita*	*aculeatea*
Annelida	Polychaeta	Phyllodocida	Aphroditidae	*Laetmonice*	*filicornis*
Annelida	Polychaeta	Phyllodocida	Aphroditidae	*Laetmonice*	*producta*
Annelida	Polychaeta	Phyllodocida	Polynoidae	*Harmothoe*	*fraser-thompsoni*
Cnidaria	Hexacorallia	Actiniaria	Hormathiidae	*Adamsia*	*carciniopadus*
Cnidaria	Hexacorallia	Antipatharia	Antipathidae	*Parantipathes*	*hirondelle*
Cnidaria	Hexacorallia	Antipatharia	Schizopathidae	*Stauropathes*	*arctica*
Cnidaria	Hexacorallia	Scleractinia	Caryophylliidae	*Lophelia*	*pertusa*
Cnidaria	Hexacorallia	Scleractinia	Caryophylliidae	*Stephanocyathus*	*moseleyanus*
Cnidaria	Hexacorallia	Scleractinia	Flabellidae	*Flabellum*	*alabastrum*
Cnidaria	Hexacorallia	Scleractinia	Oculinidae	*Madrepora*	*oculata*
Cnidaria	Hexacorallia	Zoanthidea	Epizoanthidae	*Epizoanthus*	*paguriphilus*
Cnidaria	Octocorallia	Pennatulacea	Umbellulidae	*Umbellula*	*lindahli*
Crustacea	Anomura	Decapoda	Lithodidae	*Lithodes*	*maja*
Crustacea	Anomura	Decapoda	Lithodidae	*Neolithodes*	*grimaldii*
Crustacea	Anomura	Decapoda	Paguridae	*Pagurus*	*carneus*
Crustacea	Anomura	Decapoda	Paguridae	*Pagurus*	*prideaux*
Crustacea	Anomura	Decapoda	Parapaguridae	*Parapagurus*	*pilosimanus*
Crustacea	Brachygnatha	Decapoda	Geryonidae	*Chaceon*	*affinis*
Crustacea	Brachygnatha	Decapoda	Geryonidae	*Geryon*	*trispinosus*
Crustacea	Brachygnatha	Decapoda	Majidae	*Rochinia*	*carpenteri*
Crustacea	Brachygnatha	Decapoda	Portunidae	*Bathynectes*	*maravigna*
Crustacea	Brachygnatha	Decapoda	Xanthidae	*Monodaeus*	*couchi*
Crustacea	Brachyura	Decapoda	Cancridae	*Cancer*	*bellianus*
Crustacea	Brachyura	Decapoda	Atelecyclidae	*Atelecyclus*	*rotundatus*

Crustacea	Brachyura	Decapoda	Cancridae	*Cancer*	*pagurus*
Crustacea	Dromiacea	Decapoda	Homolidae	*Paromola*	*cuvieri*
Crustacea	Malacostraca	Decapoda	Aristeidae	*Aristeus*	*antennatus*
Crustacea	Malacostraca	Decapoda	Aristeidae	*Plesiopenaeus*	*edwardsiansa*
Crustacea	Malacostraca	Decapoda	Calocarididae	*Calocaris*	*macandreae*
Crustacea	Malacostraca	Decapoda	Crangonidae	*Sabinea*	*hystrix*
Crustacea	Malacostraca	Decapoda	Galatheidae	*Munida*	*tenuimana*
Crustacea	Malacostraca	Decapoda	Galatheidae	*Mundinopsis*	*curvirostra*
Crustacea	Malacostraca	Decapoda	Galatheidae	*Munida*	*sarsi*
Crustacea	Malacostraca	Decapoda	Glyphocrangonidae	*Glyphocrangon*	*longirostris*
Crustacea	Malacostraca	Decapoda	Nephropidae	*Nephropsis*	*atlantica*
Crustacea	Malacostraca	Decapoda	Nephropidae	*Nephrops*	*norvegicus*
Crustacea	Malacostraca	Decapoda	Oplophoridae	*Acanthephyra*	*pelagica*
Crustacea	Malacostraca	Decapoda	Oplophoridae	*Acanthephyra*	*purpurea*
Crustacea	Malacostraca	Decapoda	Oplophoridae	*Ephyrina*	*figueirai*
Crustacea	Malacostraca	Decapoda	Pandalidae	*Dichelopandalus*	*bonnieri*
Crustacea	Malacostraca	Decapoda	Pandalidae	*Atlantopandalus*	*propinquus*
Crustacea	Malacostraca	Decapoda	Pasiphaeidae	*Pasiphaea*	*tarda*
Crustacea	Malacostraca	Decapoda	Pasiphaeidae	*Pasiphaea*	*multidentata*
Crustacea	Malacostraca	Decapoda	Pasiphaeidae	*Parapasiphae*	*sulcatifrons*
Crustacea	Malacostraca	Decapoda	Pasiphaeidae	*Pasiphaea*	*sivado*
Crustacea	Malacostraca	Decapoda	Polychelidae	*Polycheles*	*granatulatus*
Crustacea	Malacostraca	Decapoda	Polychelidae	*Polycheles*	*grimaldii*
Crustacea	Malacostraca	Decapoda	Polychelidae	*Stereomastis*	*sculpa*
Crustacea	Malacostraca	Decapoda	Polychelidae	*Polycheles*	*typhlops*
Crustacea	Malacostraca	Decapoda	Sergestidae	*Sergia*	*robusta*
Crustacea	Malacostraca	Decapoda	Sergestidae	*Sergestes*	*arcticus*
Crustacea	Malacostraca	Lophogastrida	Gnathophausiidae	*Gnathophausia*	*gigas*
Crustacea	Malacostraca	Lophogastrida	Gnathophausiidae	*Gnathophausia*	*zoea*
Crustacea	Maxillopoda	Pedunculata	Poecilasmatidae	*Poecilasma*	*kaempferi*

Echinodermata	Asteriodea	Brisingida	Brisingidae	*Brisinga*	*endecacnemus*
Echinodermata	Asteriodea	Brisingida	Brisingidae	*Brisingella*	*coronata*
Echinodermata	Asteriodea	Forcipulatida	Asteriidae	*Stichastrella*	*ambigura*
Echinodermata	Asteriodea	Forcipulatida	Asteriidae	*Stichastrella*	*rosea*
Echinodermata	Asteriodea	Forcipulatida	Zoroasteridae	*Zoroaster*	*fulgins*
Echinodermata	Asteriodea	Notomyotida	Benthopectinidae	*Benthopecten*	*simplex*
Echinodermata	Asteriodea	Notomyotida	Benthopectinidae	*Pontaster*	*tenuispinus*
Echinodermata	Asteriodea	Paxillosida	Astropectinidae	*Astropecten*	*irregularis*
Echinodermata	Asteriodea	Paxillosida	Astropectinidae	*Bathybiaster*	*vexillifer*
Echinodermata	Asteriodea	Paxillosida	Astropectinidae	*Leptoptychaster*	*arcticus*
Echinodermata	Asteriodea	Paxillosida	Astropectinidae	*Persephonaster*	*patagiatus*
Echinodermata	Asteriodea	Paxillosida	Astropectinidae	*Plutonaster*	*bifrons*
Echinodermata	Asteriodea	Paxillosida	Astropectinidae	*Psilaster*	*andromeda*
Echinodermata	Asteriodea	Paxillosida	Luidiidae	*Luidia*	*sarsi*
Echinodermata	Asteriodea	Paxillosida	Radiasteridae	*Radiaster*	*tizardi*
Echinodermata	Asteriodea	Valvatida	Goniasteridae	*Plinthaster*	*dentatus*
Echinodermata	Asteriodea	Valvatida	Goniasteridae	*Pseudarchaster*	*gracilis*
Echinodermata	Asteriodea	Valvatida	Poraniidae	*Chondraster*	*grandis*
Echinodermata	Asteriodea	Valvatida	Poraniidae	*Porania*	*pulvillus*
Echinodermata	Asteriodea	Valvatida	Poraniidae	*Poraniomorpha*	*hispidia*
Echinodermata	Asteriodea	Velatida	Pterasteridae	*Diplopteraster*	*multipes*
Echinodermata	Asteriodea	Velatida	Solasteridae	*Solaster*	*endeca*
Echinodermata	Echinoidea	Cidaroida	Cidaridae	*Cidaris*	*cidaris*
Echinodermata	Echinoidea	Echinoida	Echinidae	*Echinus*	*acutus*
Echinodermata	Echinoidea	Echinothuroida	Echinothuriidae	*Calveriosoma*	*fenestratum*
Echinodermata	Echinoidea	Echinothuroida	Echinothuriidae	*Calveriosoma*	*hystrix*
Echinodermata	Echinoidea	Echinothuroida	Echinothuriidae	*Hygrosoma*	*petersii*
Echinodermata	Echinoidea	Echinothuroida	Echinothuriidae	*Phormosoma*	*placenta*
Echinodermata	Echinoidea	Echinothuroida	Echinothuriidae	*Sperosoma*	*grimaldii*
Echinodermata	Echinoidea	Spatangoida	Spatangoida	*Spatangus*	*raschi*

Echinodermata	Holothuroidea	Aspidochirotida	Stichopodidae	*Stichopus*	*tremulus*
Echinodermata	Holothuroidea	Elasipodida	Laetmogonidae	*Benthogone*	*rosea*
Echinodermata	Holothuroidea	Elasipodida	Laetmogonidae	*Laetmogone*	*violacia*
Echinodermata	Oiphiroidea	Ophiurida	Ophiuridae	*Ophiopleura*	*inermis*
Echinodermata	Stelleroidea	Euryalida	Gorgonocephalidae	*Gorgonocephalus*	*caputmedusae*
Mollusca	Bivalva	Ostreoida	Pectinidae	*Pseudamussium*	*septumradiata*
Mollusca	Cephalopoda	Octopoda	Cirrotheuthidae	*Stauroteuthis*	*syrtensis*
Mollusca	Cephalopoda	Octopoda	Opisthoteuthidae	*Opisthoteuthis*	*massyae*
Mollusca	Cephalopoda	Octopoda	Grimpoteuthidae	*Grimpoteuthis*	*wuelkeri*
Mollusca	Cephalopoda	Octopoda	Octopodidae	*Bathypolypus*	*bairdii*
Mollusca	Cephalopoda	Octopoda	Octopodidae	*Benthoctopus*	*normani*
Mollusca	Cephalopoda	Octopoda	Octopodidae	*Eledone*	*cirrhosa*
Mollusca	Cephalopoda	Octopoda	Octopodidae	*Granelodone*	*verrucosa*
Mollusca	Cephalopoda	Sepoilida	Sepiolidae	*Neorossia*	*caroli*
Mollusca	Cephalopoda	Teuthida	Onychoteuthidae	*Onychoteuthis*	*banksii*
Mollusca	Cephalopoda	Teuthida	Ommastrephidae	*Todarodes*	*sagittatus*
Mollusca	Cephalopoda	Teuthida	Ommastrephidae	*Todaropsis*	*eblanae*
Mollusca	Cephalopoda	Teuthida	Histioteuthidae	*Histioteuthis*	*bonellii*
Mollusca	Cephalopoda	Teuthida	Cranchiidae	*Teuthowenia*	*megalops*
Mollusca	Gastropoda	Cephalaspidea	Scaphandridae	*Scaphander*	*lignaris*
Porifera	Choristida	Astrophorida	Geodiidae	*Geodia*	*barreti*
Porifera	Demospongiae	Hadromerida	Suberitidae	*Suberites*	*pagurorum*

APPENDIX 4

Table of FRS TV survey deployments undertaken on Rockall, Anton Dohrn and Rosemary bank.

Run id	Target/Aim	Area	Sledge/ D-Frame	Date	Time (GMT)	Start lat N (decimal)		Start lon W (decimal)		Stop lat N (decimal)		Stop lon W (decimal)	
COR0501	Trawled Coral	NW Rockall	Sledge	04/09/2005	21:37	58	10.8960	13	57.1590	58	10.6200	13	57.4630
COR0502	Trawled Coral	NW Rockall	Sledge	04/09/2005	22:59	58	9.3210	14	3.4780	58	8.8330	14	3.9780
COR0503	Trawled Coral	NW Rockall	Sledge	05/09/2005	00:23	58	8.8950	14	6.5480	58	8.6010	14	6.8780
COR0504	Trawled Coral	NW Rockall	Sledge	05/09/2005	01:36	58	6.3500	14	12.1430	58	6.0970	14	12.6540
COR0505	Trawled Coral	NW Rockall	Sledge	05/09/2005	02:57	58	2.8980	14	17.2200	58	2.7350	14	17.6410
COR0506	JNCC side scan target	W Rockall	Drop Frame	05/09/2005	21:42	57	26.8110	14	43.9400	57	27.1950	14	43.4370
COR0507	JNCC side scan target	W Rockall	Drop Frame	05/09/2005	23:02	57	26.6140	14	39.1020	57	27.0150	14	38.4210
COR0508	JNCC side scan target	W Rockall	Drop Frame	06/09/2005	00:31	57	27.0270	14	38.7250	57	27.1310	14	38.4620
COR0509	JNCC side scan target	W Rockall	Drop Frame	06/09/2005	02:04	57	27.1720	14	38.5870	57	27.2800	14	38.3500
DW05901	Nephrops Grounds	SE Rockall	Sledge	06/09/2005	21:06	56	20.0810	14	24.6180	56	20.0500	14	25.4690
DW05902	Nephrops Grounds	SE Rockall	Sledge	06/09/2005	22:47	56	21.5570	14	22.1420	56	21.5320	14	22.8610
DW05903	Nephrops Grounds	SE Rockall	Sledge	07/09/2005	00:17	56	23.0420	14	22.4260	56	23.0260	14	23.3270
DW05904	Nephrops Grounds	SE Rockall	Sledge	07/09/2005	01:57	56	26.0200	14	18.7400	56	26.0160	14	19.6020
DW05905	Nephrops Grounds	SE Rockall	Sledge	07/09/2005	20:53	56	28.9580	14	14.9270	56	28.8830	14	15.5410
DW05906	Nephrops Grounds	SE Rockall	Sledge	07/09/2005	22:27	56	30.5650	14	12.1640	56	30.5240	14	12.6150
DW05907	Nephrops Grounds	SE Rockall	Sledge	07/09/2005	23:51	56	33.7140	14	8.1550	56	33.6540	14	8.8440
DW05908	Nephrops Grounds	SE Rockall	Sledge	08/09/2005	01:29	56	36.3910	14	4.8660	56	36.2510	14	5.3490
DW05909	Nephrops Grounds	SE Rockall	Sledge	08/09/2005	02:41	56	37.2780	14	4.4900	56	37.0880	14	5.0230
COR0510	JNCC side scan target	Rockall	Drop Frame	08/09/2005	19:50	57	28.2440	13	54.6350	57	28.3500	13	54.8970
COR0511	JNCC side scan target	Rockall	Drop Frame	08/09/2005	21:00	57	28.2690	13	50.0470	57	28.2390	13	49.8970
COR0512	JNCC side scan target	Rockall	Drop Frame	08/09/2005	22:40	57	28.1900	13	46.4830	57	27.6950	13	46.2680
COR0513	JNCC side scan target	Rockall	Drop Frame	09/09/2005	00:07	57	28.3600	13	37.5630	57	28.1220	13	37.5560
COR0514	JNCC side scan target	Rockall	Drop Frame	09/09/2005	01:17	57	28.4380	13	36.4220	57	28.3460	13	36.4310
COR0515	JNCC side scan target	E Rockall	Drop Frame	09/09/2005	03:22	57	28.9890	13	14.4040	57	28.6090	13	14.6360
COR0516	JNCC side scan target	E Rockall	Drop Frame	09/09/2005	18:09	57	29.1090	13	14.2550	57	28.9200	13	14.8800
COR0517	JNCC side scan target	E Rockall	Drop Frame	09/09/2005	19:46	57	29.0320	13	11.9450	57	28.9640	13	12.3730
COR0518	JNCC side scan target	E Rockall	Drop Frame	09/09/2005	21:40	57	29.1960	13	3.8550	57	29.1920	13	3.8600
COR0519	JNCC side scan target	E Rockall	Drop Frame	09/09/2005	22:32	57	29.1900	13	2.1530	57	29.0880	13	2.4210

COR0520	Alleged Coral Area	Anton Dohrn	Drop Frame	10/09/2005	11:49	57	26.1080	11	6.6840	57	26.1330	11	6.2660
COR0521	JNCC side scan target	Anton Dohrn	Drop Frame	10/09/2005	13:12	57	27.2190	11	6.8570	57	27.2400	11	6.5400
COR0522	Alleged Coral Area	Anton Dohrn	Drop Frame	10/09/2005	14:17	57	26.4930	11	7.5350	57	26.6790	11	6.8800
COR0523	Alleged Coral Area	Anton Dohrn	Drop Frame	10/09/2005	15:35	57	26.7400	11	8.3090	57	26.8170	11	8.1600
COR0524	Fish Tow Ground	Anton Dohrn	Drop Frame	10/09/2005	16:53	57	31.4230	11	11.6610	57	31.5070	13	6.3640
Rock_4	JNCC side scan target	N Rockall	Drop Frame	10/09/2006	21:53	57	56.7810	14	7.8240	57	56.9690	14	7.4590
Rock_1	JNCC side scan target	N Rockall	Drop Frame	10/09/2006	23:21	57	59.1300	14	2.8580	57	59.2440	14	2.7280
Rock_5	JNCC side scan target	N Rockall	Drop Frame	11/09/2006	01:21	57	58.0410	13	50.5920	57	57.9460	13	50.7000
Rock_3	JNCC side scan target	N Rockall	Drop Frame	11/09/2006	02:45	58	0.7610	13	39.1250	58	0.6250	13	39.2040
Rock_13	JNCC side scan target	E Rockall	Drop Frame	11/09/2006	21:51	57	0.3820	13	40.6770	57	0.3570	13	40.5930
Rock_22	JNCC side scan target	E Rockall	Drop Frame	11/09/2006	23:24	57	0.1850	13	26.9520	56	59.9620	13	26.3560
Rock_10	JNCC side scan target	E Rockall	Drop Frame	12/09/2006	01:14	57	9.1860	13	38.6140	57	8.9630	13	38.6200
Rock_11	JNCC side scan target	E Rockall	Drop Frame	12/09/2006	03:04	57	19.3520	13	34.0540	57	19.0830	13	33.7750
Rock_12	JNCC side scan target	E Rockall	Drop Frame	12/09/2006	04:20	57	13.5980	13	35.6110	57	13.4360	13	35.3470
RKB0701	JNCC side scan target	N Rockall	Drop Frame	07/09/2007	22:02	57	54.9633	13	52.0527	57	54.9197	13	52.2552
RKB0702	Cable adjustment	N Rockall	Drop Frame	08/09/2007	00:57	58	9.5890	13	23.0810	58	9.5160	13	22.6080
RKB0703	JNCC side scan target	N Rockall	Drop Frame	08/09/2007	04:13	57	55.0586	13	51.8612	57	54.9249	13	52.2631
RKB0704	JNCC side scan target	NE Rockall	Drop Frame	08/09/2007	20:20	57	53.3493	13	16.0005	57	53.0928	13	16.3794
RKB0705	JNCC side scan target	NE Rockall	Drop Frame	08/09/2007	21:50	57	47.6580	13	4.0997	57	47.4096	13	4.4431
RKB0706	JNCC side scan target	NE Rockall	Drop Frame	08/09/2007	23:54	57	49.1383	12	55.7936	57	48.8580	12	56.1830
RKB0707	JNCC side scan target	NE Rockall	Drop Frame	09/09/2007	03:19	57	40.5026	13	3.9953	57	40.1919	13	4.3075
RKB0708	JNCC side scan target	E Rockall	Drop Frame	10/09/2007	00:29	57	14.0568	13	1.3762	57	14.0949	13	1.5581
RKB0709	JNCC side scan target	E Rockall	Drop Frame	10/09/2007	02:14	57	10.4895	13	5.4842	57	10.6777	13	6.1368
RKB0710	JNCC side scan target	E Rockall	Drop Frame	10/09/2007	04:11	57	13.4512	13	21.6565	57	13.6081	13	22.1955
RKB0711	JNCC side scan target	E Rockall	Drop Frame	10/09/2007	23:17	57	36.4736	14	29.8721	57	36.3492	14	30.4816
RKB0712	JNCC side scan target	E Rockall	Drop Frame	11/09/2007	03:09	57	42.2702	14	26.4824	57	42.0328	14	26.9563
RKB0713	JNCC side scan target	E Rockall	Drop Frame	11/09/2007	20:29	56	44.4303	13	40.5377	56	44.2520	13	40.8987
RKB0714	JNCC side scan target	E Rockall	Drop Frame	11/09/2007	22:36	56	49.4353	13	41.0060	56	49.2071	13	41.5756
RKB0715	JNCC side scan target	E Rockall	Drop Frame	12/09/2007	00:03	56	51.4144	13	37.5004	56	51.2558	13	38.4958
RKB0716	JNCC side scan target	E Rockall	Drop Frame	12/09/2007	02:03	56	53.4660	13	33.0490	56	53.4160	13	34.9410
Rose07401	Pinnacles	Rosemary Bank	Drop Frame	26/09/2007	14:59	59	14.0176	10	21.0793	59	14.1118	10	21.1241
Rose07402	Pinnacles	Rosemary Bank	Drop Frame	26/09/2007	16:00	59	12.2554	10	22.4711	59	12.3963	10	22.1868
Rose07403	Pinnacles	Rosemary Bank	Drop Frame	26/09/2007	17:20	59	11.2470	10	23.5882	59	11.2954	10	23.4326

Rose07404	Pinnacles	Rosemary Bank	Drop Frame	26/09/2007	20:09	59	10.1998	10	31.5229	59	10.0674	10	31.9894
Rose07405	Pinnacles	Rosemary Bank	Drop Frame	26/09/2007	21:39	59	11.4822	10	31.3511	59	11.6047	10	31.0445