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Deepwater Trawl Survey Manual

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DEEPWATER TRAWL SURVEY MANUAL

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1. Introduction

Marine Scotland – Science uses FRV *Scotia* to undertake a deep-water trawl survey along the continental slope of the Rockall Trough (Neat *et al*. 2008). This survey area is situated some 100 km to the north and west of Scotland (Figure 1.1). The continental slope separates the shallow shelf seas (< 200 m) from the deep ocean plains (> 2000 m) and supports a diverse assemblage of fish, some of which are commercially exploited such as roundnose grenadier, blue ling, black scabbard, orange roughy and deepwater sharks.

1.1 Brief History of the Survey

Exploratory deepwater trawl surveys at MS-S were initiated in 1996 and 1997. Comparable time-series data became available from 1998 onwards with the advent of the current research vessel FRV Scotia. The broad aim of the survey is to collect fisheries-independent data on the fish populations of the deepwater slope west of the Hebrides. As with any new survey, there is often a period over which the survey develops both from a technical and a scientific perspective. The deep-water survey developed over a longer period than most owing to the fact that it was initially only run once every two years and because it is a technically challenging survey due to the great depths to which it samples. The purpose of this manual is to describe how the survey developed and, now the development phase is over, to document as precisely as possible the current (2010) protocols and methods that are considered standard.

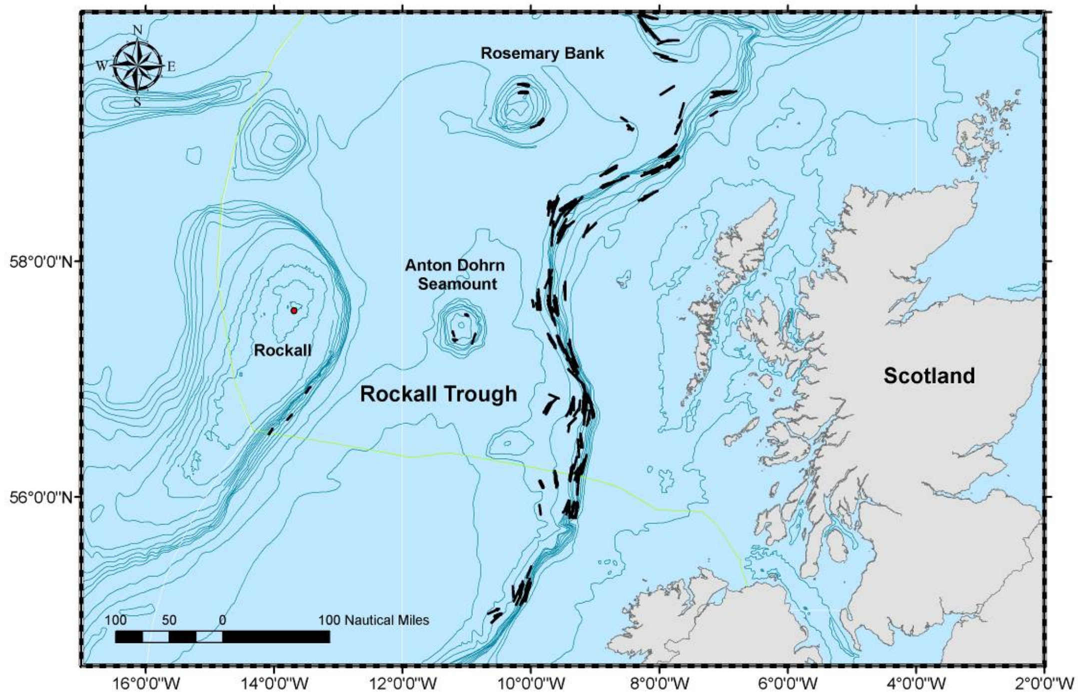

Figure 1.1: The trawl paths (black lines) that make up the MS-S deepwater survey (from 1996 through 2009). Depth contours and UK Fisheries limits (green line) are shown.

The survey covers a core area of the continental slope from between 55 to 59 ° N with the slope stratified by depth at 500, 1000, 1500 and 1800 m (Figure 1.1). Additional stations have also been trawled at intermediate depth strata, most notably at 750 m. The survey takes place in September and has a typical duration of 14 days. From 1998 through 2004 the survey was biannual. In the early years the survey was exploratory and the gear was designed on the basis of advice from the fishing industry. No formal gear trials were performed during this period, although much was learned about deepwater fishing. From 2005 the survey became annual and while retaining its core stations on the shelf slope, began to expand its geographic scope. By 2008 the survey had settled on a core survey area of the shelf slope and Rosemary Bank. In 2008 and 2009 a series of gear trials were completed, which have resulted in modifications that have increased the efficiency and quality of the survey.

In 2008 the ICES planning group PGNEACS (ICES 2008a) was formed to consider the future of deepwater surveys in the NE Atlantic. The main objective of PGNEACS is to develop a coordinated strategy for deepwater surveys involving Scotland, Ireland, France and Norway. It is partly in response to PGNEACS that a survey standard is required and this has been at the root of recent gear trial work and the development of this manual.

1.2 Need for Standardised Protocol

Any trawl survey needs to establish and document a series of standard operating protocols that address the following aspects; the objectives and design of the survey, the design, specification and construction of the net (drawings), the means of net rigging prior to survey, the fishing method and towing procedures, the means of monitoring the trawl during fishing, the means of processing the catch and species identification, and the means of data formatting, handling and storage. Each of these will be considered in turn.

1.3 Survey Objectives and Design

The main objective of the MS-S deepwater survey is to sample the populations of fish on the slope to enable the generation of indices of abundance, size and diversity which can be compared over time and space. There are secondary objectives such as identification and cataloguing of the mega-benthos and biological sampling for specific research projects. The survey is currently of a fixed-station design stratified by depth at 500, 1000, 1500 and 1750 m. The same stations are sampled each year. The range of depth either side of these strata is ± 100 m. The reason for depth stratification is related to the strong bathymetric patterns in species distributions and abundance. There are some stations at 750 m, but not in all areas because this part of the slope is particularly steep and difficult to trawl. Each ICES rectangle on the slope usually contains one tow in each depth stratum, apart from the 750 m stratum. There are gaps in this sampling strategy notably between 1100 m and 1400 m. However, there is some data to suggest the fish assemblage does not change markedly between such depths. Overall therefore the survey gives good representation of the slope community, although as it stands the lack of randomization prevents estimation of absolute numbers.

2. Technical Specification and Net Performance

2.1 The Design, Specification and Construction of the Net

In 1996 the Marine Laboratory tendered commercial net makers to supply a suitable trawl to be used to undertake the new deepwater survey. An important requirement in selecting the new deepwater survey trawl was that it had to be a working design already being used by the commercial fleet. The successful bid was from Jackson Trawls Limited, Peterhead, Scotland for their 460 single boat hopper trawl. The design incorporated many strengthening features such as guard meshes around the headline and fishing line along with tearing strips down the trawl's belly sheet constructed from high tenacity double PE twine (Figure 2.1). Another important feature is the netting panel cutting rates used in its design which simplify any minor repairs. Prior to being adopted as the Marine Laboratory's standard deepwater survey trawl a number of evaluation cruises were carried out to ensure that the trawl could be fished over the depth ranges being considered for the new survey.

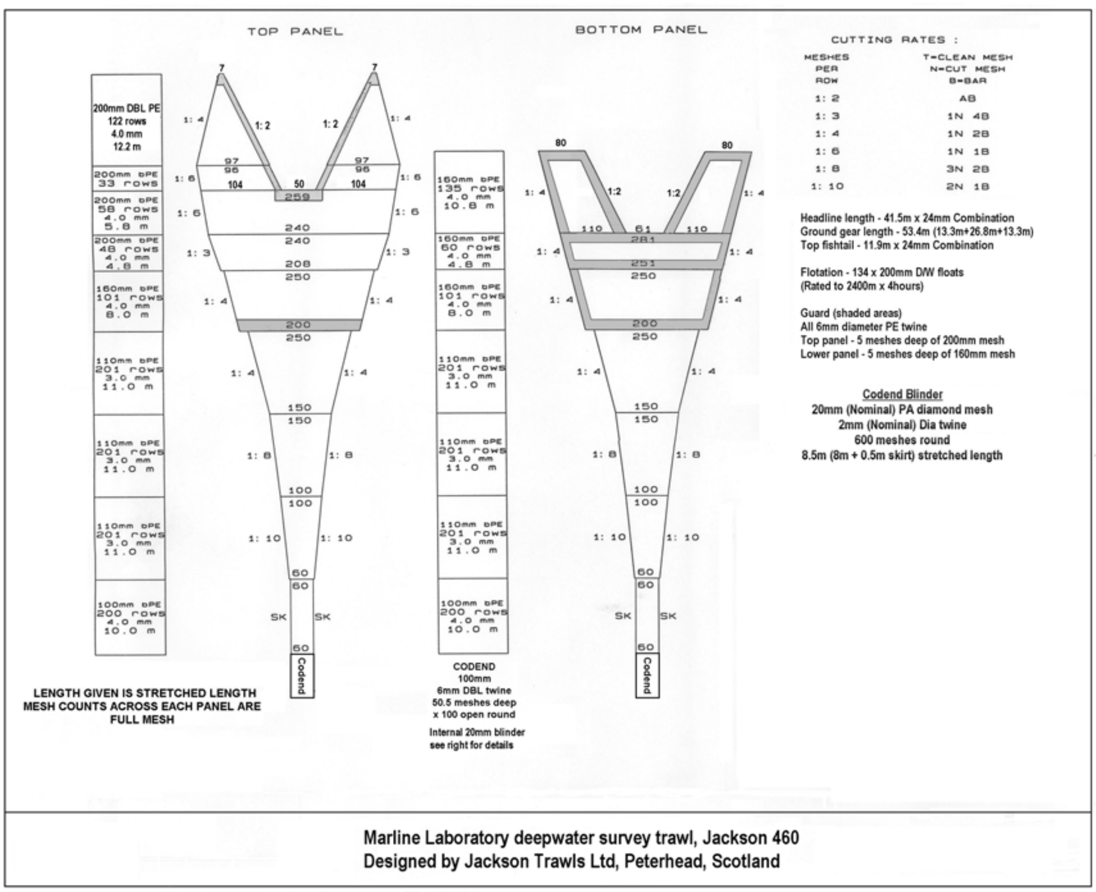

Figure 2.1: Net drawing Marine laboratory deepwater survey trawl (BT184)

2.2 Flotation

From 1998 to 2007 flotation was provided by 50 x 275 mm (11") 'titanium' plastic floats rated to 2000 m with a buoyancy of 6.75 kg. The 275 mm floats were problematic at the deepest fishing depth and unable to withstand the pressures. These were substituted in 2008 by 134 x 200 mm (8 ") floats rated to 2500 m for 4 hours duration. The floats were spaced in strings as shown below in Figure 2.2.

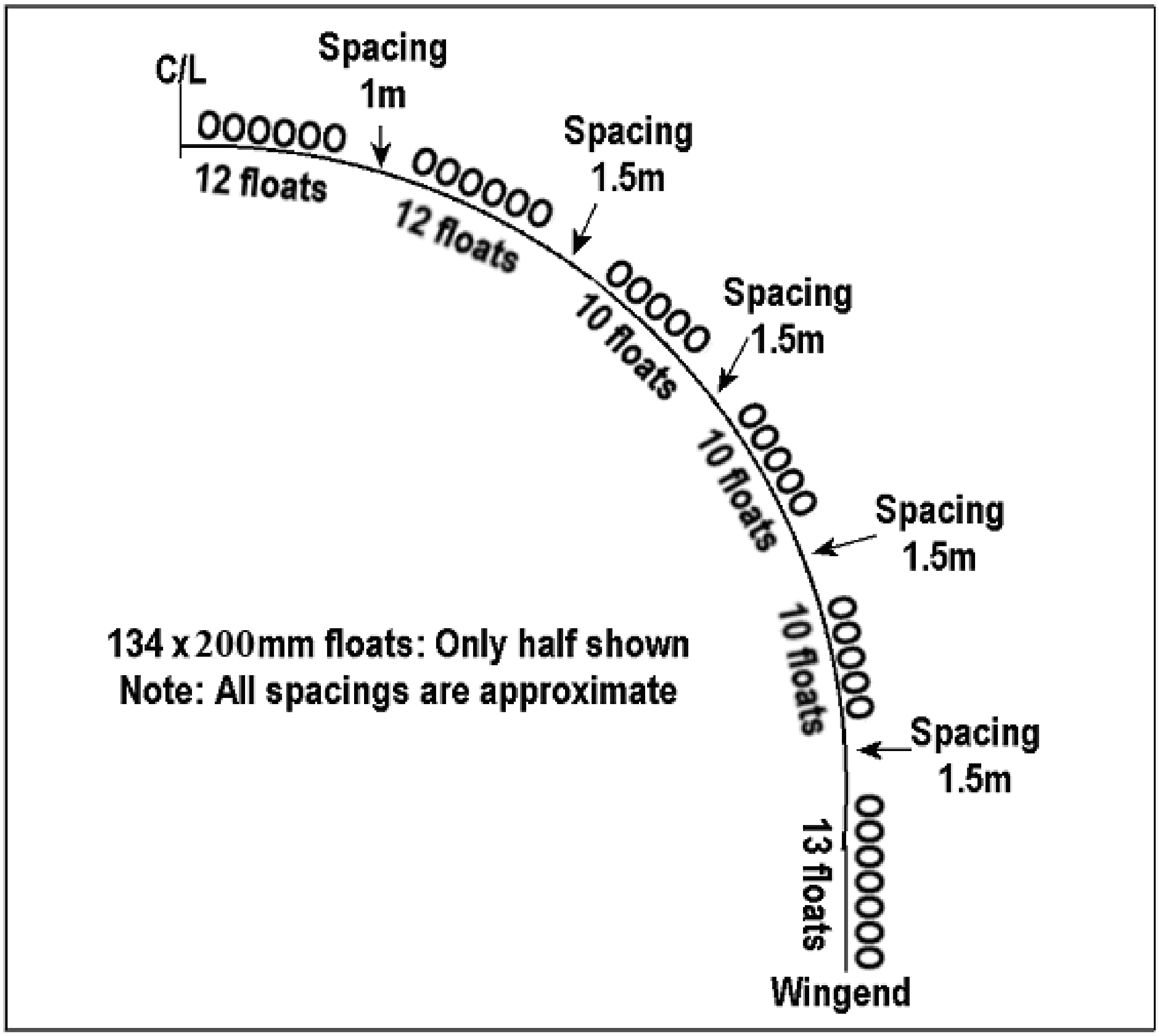

Figure 2.2: Configuration of floats attached to headline of the BT184.

2.3 Otter boards (Trawl Doors)

From 1998 to 2007 a pair of Morgere (St Malo, France) Type 'R' otter boards were used each with a surface area of 4.86 m^2 and weighing 2000kg and fished with a three back-strop configuration. These required to be replaced in 2008 and were substituted with a set of Morgere type 12 Ovalfoil otter boards each with a surface area of 5.82 m^2 and weighing 1700 kg and also with a three backstrop configuration. Although somewhat lighter and of a different design (vented ovalfoil) a series of trials undertaken in May 2007 suggested that this design of door offered better stability over the depth range, net geometry was not significantly altered and furthermore no change in catchability was evident.

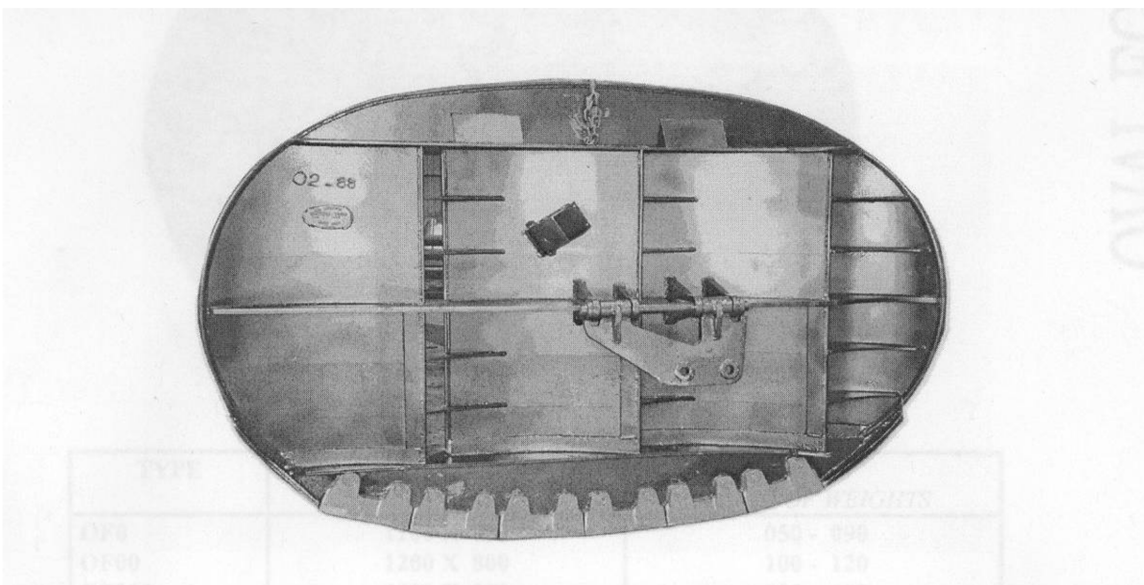

Figure 2.3: The Morgere 'ovalfoil' Trawl doors used with the BT184 net.

2.4 Ground Gear

Two specifications of ground-gear have been used with the deepwater net. A ground gear with 533 mm (21") diameter rock-hopper discs was used from the initiation of the survey in 1996 until 2008 (Figure 2.4). From 2009 a ground gear with 400 mm (16") diameter rock-hopper discs has been used (Figure 2.5).

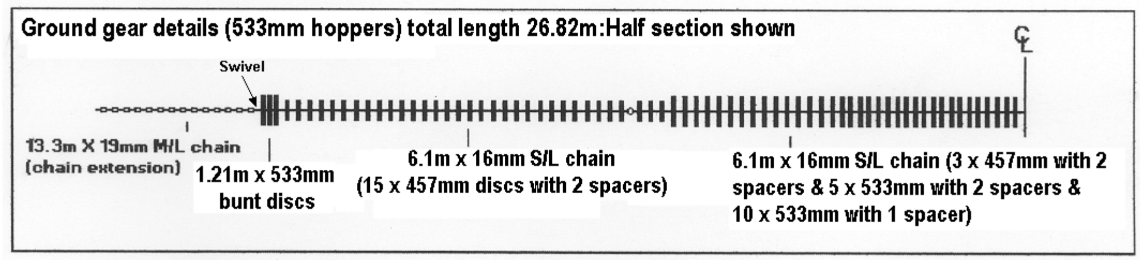

Figure 2.4: The ground-gear used from 1996 to 2008 with 533 mm (21") ground-gear specification

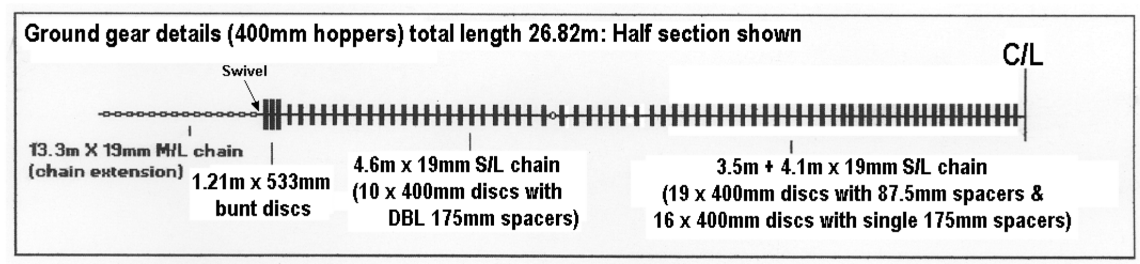

Figure 2.5: The ground-gear used from 2009 with 400 mm (16 ") ground-gear specification

2.5 Sweepline Rig

From 1998 to 2008 the sweep line rig used to fish the deepwater survey trawl consisted of 8.53 m x 26 mm wire back-strop extensions, 100 m x 32 mm wire sweeps, 36.6 m x 16 mm wire upper bridles and 36.6 m x 19 mm mid-link chain lower bridles (Figure 2.6). With the introduction of the new Morgere Oval Foil otter boards and the need to carry out new survey tows in water depths in excess of 1700 m, an 18.3 m section of 22 mm diameter mid-link chain was added to the sweep length. This addition was found to offer better gear stability whilst shooting the gear and when towing at the deeper depths. It should be noted that adding a heavy 22 mm diameter chain sweep to the wire rig is common practice by Scottish skippers when fishing at depths below 500 m.

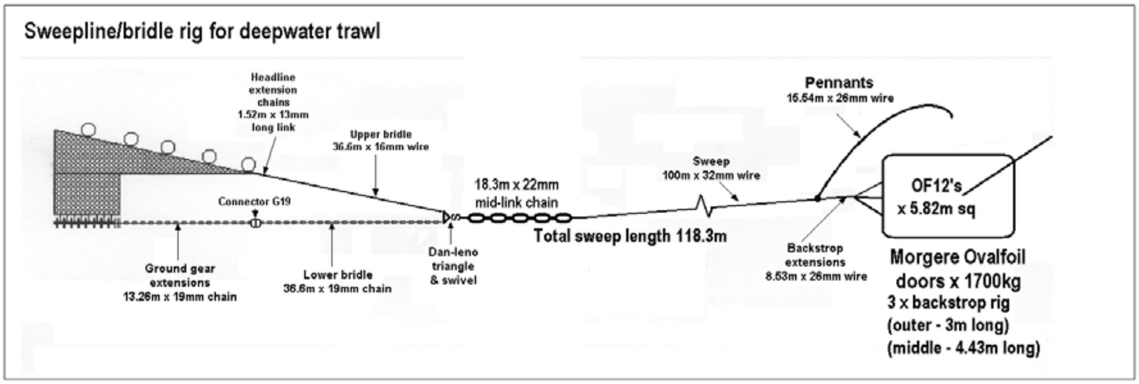

Figure 2.6: Detail of the sweep line rig used from 2008

3. The Fishing Method

All technical information pertaining to each haul should be recorded on the deepwater haul summary sheet (Appendix 2).

3.1 Shooting and Towing Speeds

To ensure the gear arrives on the seabed and maintains gear geometry and symmetry a standard shooting protocol has been adopted with regard speed over the ground (SMG). Whilst paying out the warp, SMG range to between from 5.8 kts to 6.1 kts once paid out and during the gear settling phase SMG is reduced to 1.8kts and 2.2 kts. A soon as the gear touches down, SMG is increased to between 3.2 kts and 3.5 kts. It should be noted that if speed drops below 3.0 kts the otterboards become unstable and start to stall. Standard fishing speed is 3.5 kts measured as trawl speed over the ground. The speed over ground and distance towed should be monitored and recorded. Trawling usually follows the contour of the depth stratum of choice, with a buffer zone of ca. 100 m depth with the intention being to stay to the depth stratum as closely as possible.

3.2 Warp-to-Depth Ratio

The ratio of warp length to depth needed for successful trawling decreases from approximately 2.6 at 500 m to 2.0 at 1800 m. The recommended warp/depth ratio for the BT184 trawl is shown in Figure 3.1 with actual values given in Table 3.1.

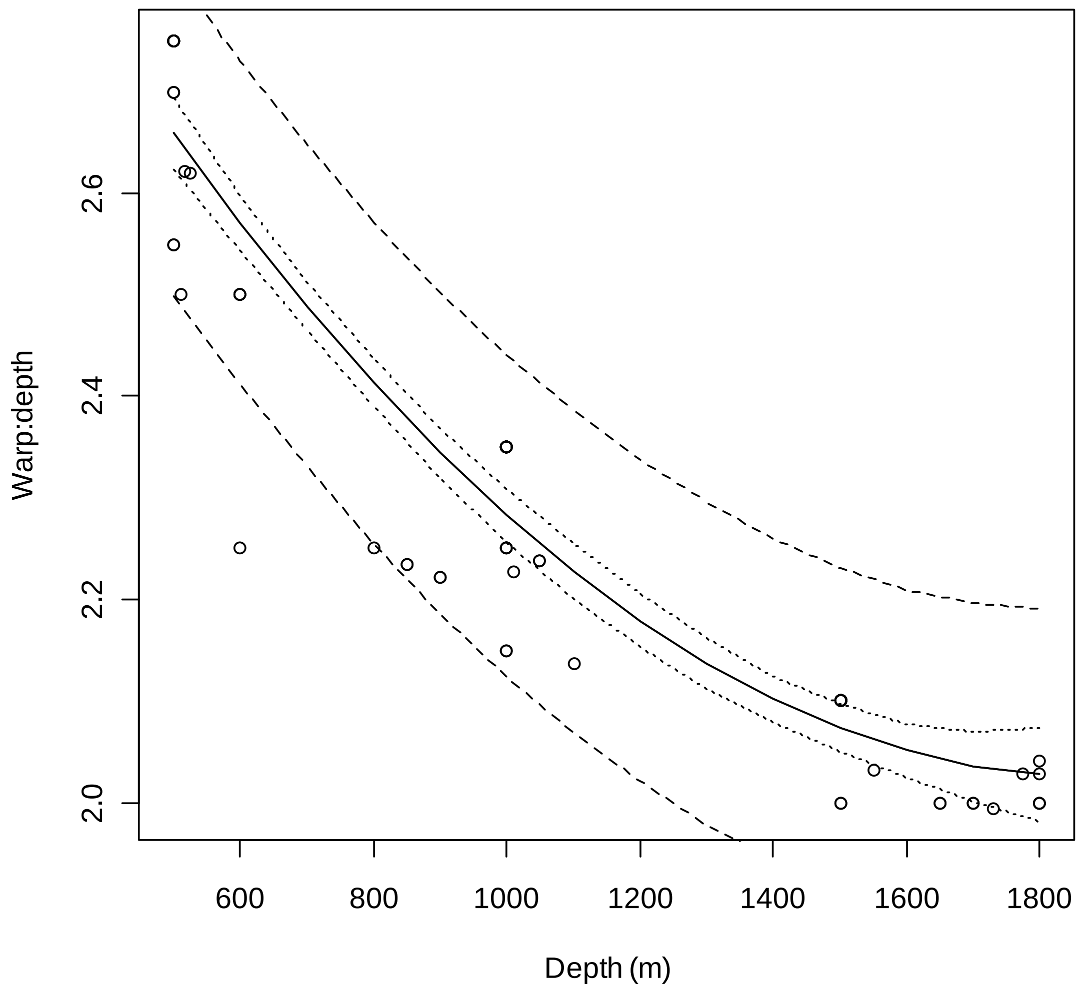

Figure 3.1: Warp to depth ratios across the range of depths on the shelf slope (n = 85 hauls from cruises 0908S, 1108S and 1209S). Actual observations are shown as points and predicted values, range and confidence limits are represented as lines generated from a first order polynomial model. Ideally each haul should fall within the inner confidence limits.

Depth (m)	Warp out (m)
500	1275-1375
1000	2250-2350
1500	3150
1800	3600

Table 3.1: Typical actual length (m) of warp paid out for each depth (m) stratum.

FRV Scotia carries 3800 m of warp on each winch, but at least 100 m of warp must remain on the winch giving a maximum of 3700 m of utilizable warp. At fishing depths greater than 1600 m, a warp-to-depth ration of 2:1 is necessary giving a maximum fishing depth of 1850 m. In practice tows deeper than 1800 m have not always been successful due to the net lifting off the seabed. The maximum depth therefore that trawling can be considered reliable is 1800 m.

3.3 Trawl Duration

The optimal trawl duration adopted by a survey will depend on the objective of the survey and the variation in the abundance of target species and the diversity of the fish assemblage being sampled. For estimation of abundance of common species, short hauls may be adequate, whereas for rarer species longer hauls may be needed. If the survey also aims to monitor species diversity, longer trawl durations have a higher probability of sampling rarer species. There is however a trade-off between the duration of the haul and the number of independent hauls that can be made. With increasing numbers of hauls comes increasing statistical power and precision.

Prior to 2009 the deep-water survey mainly used a trawl duration of 2 hours. Throughout the time-series however a number of 1 hour trawls were made. This provided an opportunity to evaluate 1 hour vs. 2 hours trawls. ICES PGNEACS (ICES 2009) undertook such an analysis for the purposes of standardizing trawl duration between MS-S and the Marine Institute in Ireland. The analysis suggests that overall hauls at one hour duration catch approximately 50% of the fish compared to those recorded for two hours. Therefore there is little to be gained from 2 hour hauls with respect to estimating abundance. With respect to species diversity, 2 hour tows do catch on average more species. However, diversity is related to the total amount of bottom time and given that more 1 hour hauls can be performed per survey than 2 hour hauls, the total time on the sea bed will compensate for the shorter haul durations. Furthermore with the improved catch rate of the net with the 16“ rock-hopper ground gear, it was decided to adopt 1 hour tow durations in 2009 and this will be standard in the future.

Start time is defined as the moment when the vertical net opening and door-spread are stable at a trawl speed of 3.5 kts. A bottom contact sensor (NOAA) that measures tilt is attached in the bosom section of the ground gear which gives a precise time when the ground-gear is actually on the seabed. This information can be used to retrospectively adjust stop and start times. Stop time is defined as the start of pull back.

3.4 Daylight Trawling and Weather Restrictions

Due to the significant diel vertical migrations that are characteristic of deep ocean ecosystems, it is preferable to only conduct trawling operations during daylight hours. In the early years this was not always the case, but in more recent years the vast majority of hauls have been during daylight hours. Trawling is usually not possible at wind speeds greater than 40 kts, although it depends upon sea-state and wind direction and the decision to abandon or resume fishing operations is left to the discretion of the Fishing Master.

3.5 Fishing Positions

All trawl stations from 1996 to 2009 are shown in Figure 1 and a list of station details is given in appendix 1. The majority of stations are on the continental slope where for each ICES statistical rectangle there is normally a trawl station at 500, 1000, 1500 and 1750 m. Core time series stations are found in statistical squares 45E0, 44E0, 43E0, 42E0 and 41E0. Note also the set of trawl stations on Rosemary Bank which have been completed since 2007. Occasionally other areas have been trawled including the Anton Dohrn Seamount (2006-2007), Rockall Bank (2006-2007) and an area in the North around the Ymir and Wyville-Thomson ridges (1996-1997).

3.6 Monitoring Net Geometry using Scanmar Sensors

Scanmar sensors (Figure 3.2) are acoustic transmitters attached to the gear that provide real time data on the distance between the net wings (wing spread), the depth and height of the headline above the seabed, the depth of doors and the distance between the doors (door spread).

Figure 3.2: Scanmar sensors - left; wing spread units, middle; height unit, right; depth unit.

The depth and headline height units are fixed (with quick-release Gibb clips) to the inside of the headline or reinforced meshes that attach the net to the headline. The wing spead units are fixed to the wing tips. The door sensors are housed in special pockets built into the trawl doors. Standard Scanmar sensors are rated to 1200 m. The MS-S deepwater survey has used headline units successfully at 1500 m. However, specially constructed units are required at depths beyond this and to date the MS-S survey has only used door depth and distance units at such depths.

Together the Scanmar sensors provide information on net geometry and allow the net to be monitored in real time, so that one is able to estimate when the net lands on the seabed and at which point it begins to fish. The data also retrospectively allows estimation of the area and volume swept by the gear. It is important to maintain the same net geometry parameters at different depths to ensure the net is sampling in a consistent way. It is important to have good estimates of net parameters also to assess if there is some problem with the net during the tow. Deviations from the normal range of the Scanmar readings are often the first indication that the net is fast on some obstruction on the seabed. Early warning of such events can prevent serious damage of the gear.

3.6.1 Headline Height

Once the net touches down on the seabed and the ship begins to tow, the headline will be pulled taught and should stabilize at a height of between 2.2 and 3.3 m above the seabed (Table 3.2).

Depth	Mean Height (m)	SD	N. Obs	N. Hauls
500 m	2.7	0.6	1531	5
600 m	2.6	0.5	724	2
800 m	2.6	0.3	157	1
900 m	2.6	0.4	344	1
1000 m	2.5	0.3	2196	7
1500 m	2.6	0.4	1845	5
1800 m	-	-	-	-

Table 3.2: Scanmar headline height data from cruise 1209S are shown. N. Obs is the total number of readings from which the mean was derived.

Some variation is to be expected and it can be seen in Figure 3.3 that during the initial minutes after touchdown the headline height is higher and more variable. Over the course of the tow there are moments when the headline height varies which may reflect the net temporarily sticking on the seabed.

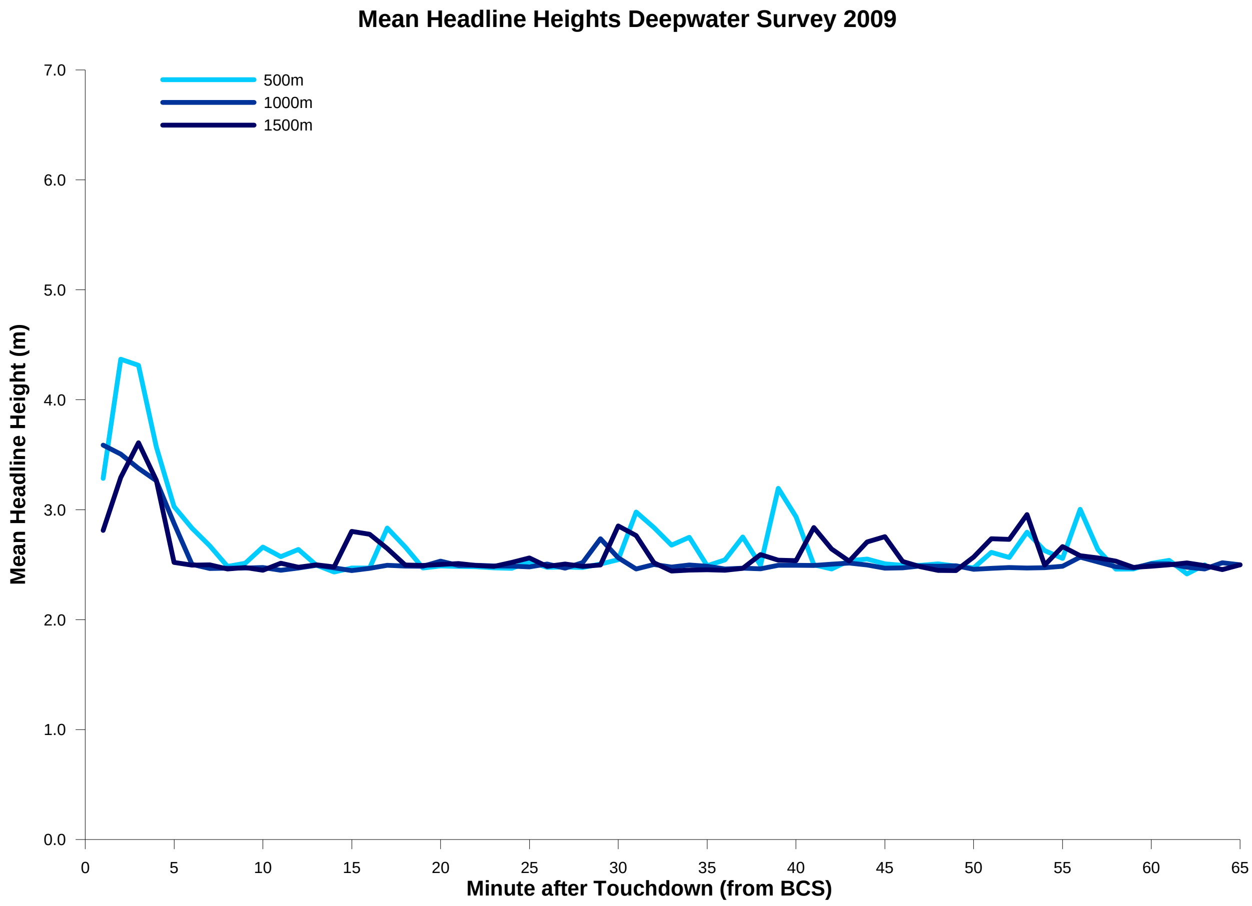

Figure 3.3: Example data for net headline height over the course of a tow (see Table 3.2 for details).

3.6.2 Wing-Spread

The wing-spread of the BT184 is expected to be in the range of 22-28 m (Table 3.3 and Figure 3.4).

Depth Category	Mean Wing (m)	SD	N obs	No. Hauls
500 m	25.7	3.1	235	3
600 m	26.8	1.1	342	1
900 m	25.8	1.4	341	1
1000 m	26.7	1.5	1167	5

Table 3.3 Scanmar wing spread data from cruise 1209S.

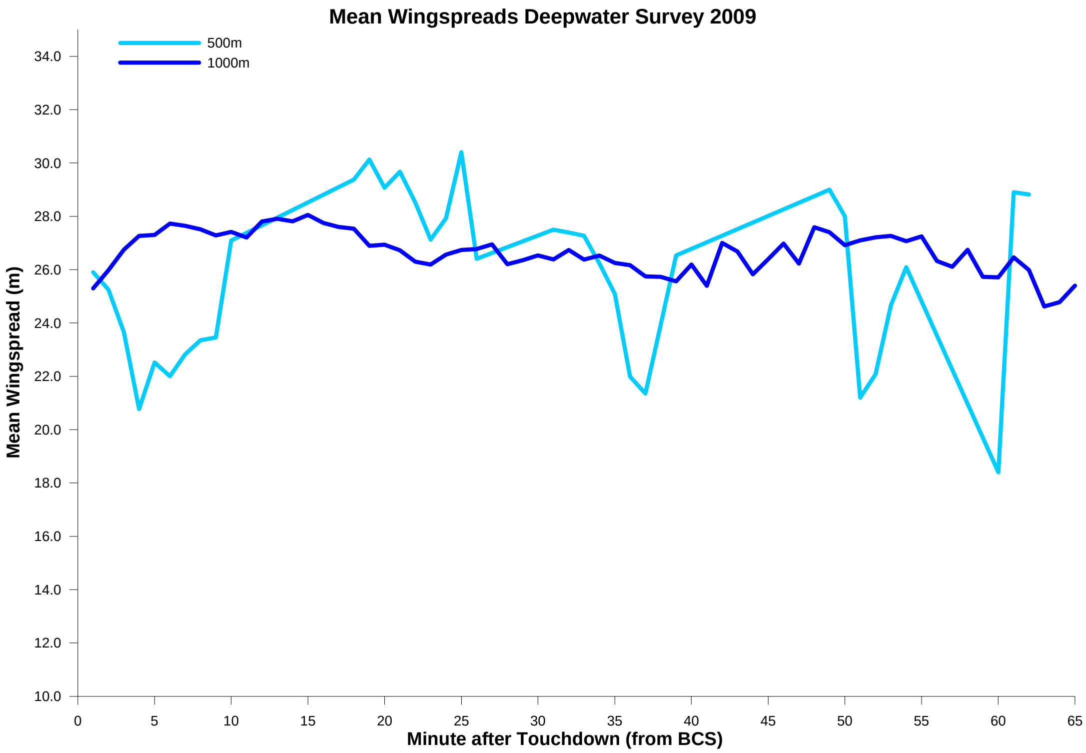

Figure 3.4: Summarised data for net wing spread over the course of a tow (see Table 3.3 for details).

3.6.3 Door-Spread

The door-spread of the BT184 is expected to be in the range of 140-165 m (Table 3.4 and Figure 3.5).

Depth Category	Mean Door (m)	SD	N obs	No. Hauls
500 m	157	15	876	3
600 m	149	10	725	2
800 m	160	28	8	1
900 m	149	9	332	1
1000 m	164	11	1580	6
1500 m	144	26	26	6
1800 m	166	17	10	2

Table 3.2: Scanmar door spread data from cruise 1209S are shown.

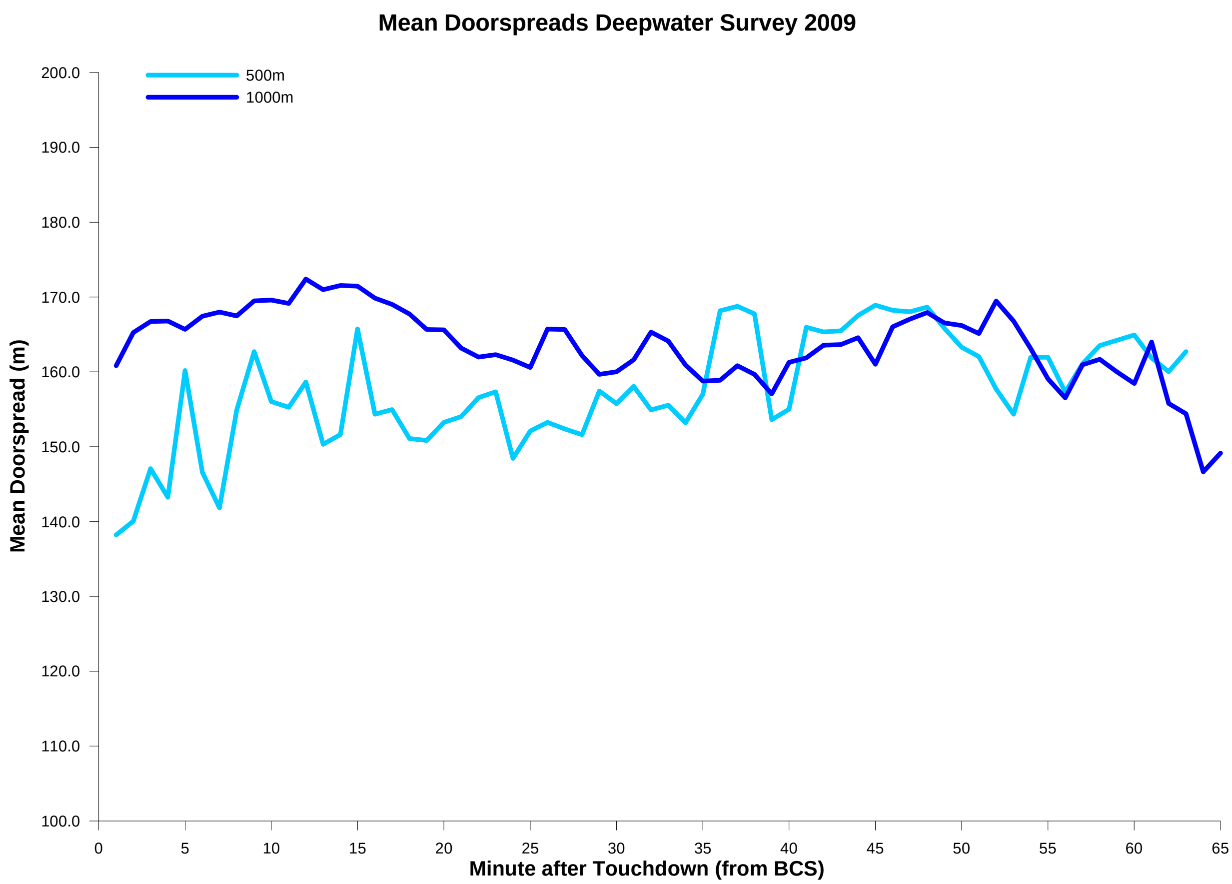

Figure 3.5: Example data for headline height over the course of a tow (see Table 3.4 for details).

4. Assessment of Catch Efficiency and Species Selectivity

Concerns were raised that the rock-hopper diameter was too large and was allowing significant quantities of fish to be lost. To assess this, the amount of fish being lost under the ground gear was quantified by attaching ground gear bags (Figure 4.1).

4.1 Catch Efficiency

These bags catch any fish that dives between the hoppers or is 'run-over' by the net. In 2008 two hauls with ground-gear bags were made at 1000 m depth. It was evident that a significant amount of the fish (52 and 59 % by weight for each of the hauls) was being lost under the ground gear. Furthermore it was apparent that some species were more likely to be captured in the bags and therefore the current ground-gear was causing a selective bias in the catch. Table 4.1 shows the number of individuals of each species captured in the bags versus the main net. Those species likely to be underestimated by the main net (more than 3 individuals, but less than 50 % representation in main net) are highlighted in bold. Altogether these findings suggested that the 21" rock-hoppers were indeed too large and that a smaller diameter rock-hopper ground-gear needed to be considered.

Figure 4.1: The trawl comes aboard with the three ground bags attached under the ground gear (the main cod-end trails behind and is still in the water). Photo FN.

Species	Ground bags	Main net	total	% in main	Species (cont.)	Ground bags	Main net	total	% in main
EPR	1	0	1	0	XCI	52	95	147	64
LAT	1	0	1	0	MAT	2	4	6	66
MOR	2	0	2	0	SYK	18	42	60	70
ORO	1	0	1	0	BAE	1	3	4	75
PLU	2	0	2	0	LSQ	1	3	4	75
TOR	**4**	**0**	**4**	**0**	SBI	1	11	12	91
RAU	**11**	**1**	**12**	**8**	LAU	2	23	25	92
SSG	**141**	**13**	**154**	**8**	BSC	3	43	46	93
GMU	**43**	**4**	**47**	**8**	0MM	0	1	1	100
APU	**5**	**1**	**6**	**16**	AHE	0	1	1	100
FRA	**8**	**2**	**10**	**20**	ARO	0	1	1	100
LEQ	**277**	**97**	**374**	**26**	CHS	0	1	1	100
SMO	**644**	**269**	**913**	**29**	EBA	0	1	1	100
HMI	**7**	**4**	**11**	**36**	GGR	0	2	2	100
HAF	**22**	**13**	**35**	**37**	HOM	0	1	1	100
PAS	**5**	**3**	**8**	**37**	LFA	0	4	4	100
RNG	**992**	**664**	**1656**	**40**	MSE	0	10	10	100
CCR	**58**	**52**	**110**	**47**	OMM	0	1	1	100
MZU	2	2	4	50	PSH	0	1	1	100
NAE	170	196	366	53	SBE	0	2	2	100
GFO	5	6	11	54	TMU	0	1	1	100
BSE	50	69	119	57	VPR	0	1	1	100
BLI	10	14	24	58	WIT	0	1	1	100
SHS	2	3	5	60					

Table 4.1: Species selectivity of deepwater net with 21” rock-hopper ground-gear from 2 hauls at 1000 m undertaken on 0908S. For species codes refer to Appendix 5.

4.2 Comparative Trials of Smaller Gauge Rock-Hoppers

In 2009 it was decided to change from 21” to 16” rock-hoppers. The reason for using16“ hoppers (as opposed to some other gauge) was that this was the gauge of rock-hopper used by the Marine Institute (Ireland) in their deepwater surveys and is also that used by the MS-S monkfish, Rockall and west coast ground fish surveys. Thus by using 16” rock-hoppers the surveys are more comparable. Before doing so, however, a series of bagging trials were undertaken to explicitly assess the consequences of doing so. This would enable the calibration of hauls using the 21” rock-hoppers with those using the 16” hoppers. At 1000 m depth 4 hauls (30 minutes) with the old 21” ground-gear were made followed by 4 hauls (30 minutes duration) with the new 16” ground-gear. Damage to the side bags was caused by boulders in 4 out of the 8 tows, but the central bag remained intact on all hauls. Data from the central bag and the main cod-end of the net were therefore used to estimate the difference in catch using the 2 different ground-gears. The use of the 16“ hoppers clearly had an effect. By weight, on average the amount of fish captured by the central ground bag was 25 % of that in the main cod-end; with the new ground-gear this was reduced to on average 17 %. The results indicate an improved catchability and provide a quantitative basis for comparing data with previous years.

4.2.1 Catch Efficiency

To estimate the overall catch lost, data was used from the 2 hauls in 2008 and 4 in 2009 in which all the bags remained intact. The net rigged with the 21" rock-hopper ground-gear on average was only catching 45 % of the total weight of the catch (Table 4.2). With the 16" ground-gear losses were reduced and the main net was capturing on average 62 % of the total weight of the catch. Such data should be used to correct estimates of absolute biomass.

Ground gear	HAUL No.	MAIN NET	CENTRE BAG	PORT BAG	STBD BAG	TOTAL (kg)
OLD 21 "	S09/366	218 (45%)	66 (14 %)	111 (23 %)	88 (18%)	484
	S09/367	214 (48 %)	78 (17%)	63 (14%)	94 (21%)	448
	S08/242	702 (41%)	380 (22%)	385 (23%)	243 (14%)	1710
	S08/243	426 (48%)	137 (15%)	137 (15%)	191 (21%)	891
overall %		45 %	17 %	19 %	19 %	
NEW 16 "	S09/370	186 (62%)	27 (9%)	65 (22 %)	23 (8%)	301
	S09/373	86 (62 %)	18 (13 %)	21 (16 %)	12 (9%)	138
overall %		62 %	11 %	19 %	8 %	

Table 4.2: Catch by weight (and %) taken in the main net and each of the ground-gear bags from tows in which all bags remained intact.

4.2.2 Species Selectivity

Overall the number of species captured by the main net was higher with the new 16" ground-gear (55 species) compared to the old 21 " (47 species). Accordingly, the number of species captured in the main bag with the new ground gear was lower (25 species) compared with the old ground gear (33 species). In particular the number of species being captured that had a representation in the main net of less than 50 % (marked in bold in Table 4.3) was reduced markedly by using the 16 " rock-hopper gear. Of those previously poorly represented only the mouse shark, *Galeus murinus*, and possibly *Brosme brosme* appears to be strongly selected against by the 16" rock-hopper ground-gear.

	OLD 21" Ground gear				NEW 16" Ground gear			
SPECIES	**CENTRE**	**MAIN**	**TOTAL**	**%**	**CENTRE**	**MAIN**	**TOTAL**	**%**
ANG	1	0	1	0	1	1	2	50
APU	2	0	2	0	0	0	0	0
MAT	2	0	2	0	0	1	1	100
ORO	1	0	1	0	1		1	0
SBI	1	0	1	0	0	9	9	100
SHS	2	0	2	0	0	0	0	0
FRA	**10**	**1**	**11**	**9**	0	0	0	0
GMU	**52**	**6**	**58**	**10**	**16**	**14**	**30**	**47**
SMO	**289**	**60**	**349**	**17**	11	29	40	73
GFO	**3**	**1**	**4**	**25**	0	1	1	100
SSG	**81**	**36**	**117**	**31**	22	99	121	82
HMI	**4**	**2**	**6**	**33**		1	1	100
ALA	**16**	**10**	**26**	**38**	7	17	24	71
CCR	**30**	**19**	**49**	**39**	1	10	11	91
MOR	**3**	**2**	**5**	**40**	0	0	0	0
PAS	**3**	**2**	**5**	**40**	0	6	6	100
RAU	**6**	**4**	**10**	**40**	0	0	0	0
RNG	**586**	**447**	**1033**	**43**	118	379	497	76
CFA	**9**	**8**	**17**	**47**	3	25	28	89
LEQ	**211**	**209**	**420**	**50**	40	251	291	86
EPR	**1**	**1**	**2**	**50**	2	1	3	33
BSE	31	40	71	56	1	59	60	98
HAF	23	31	54	57	4	62	66	94
XCI	18	32	50	64	3	89	92	97
LSQ	1	2	3	67	0	3	3	100
SPO	1	2	3	67	1	3	4	75
TOR	1	2	3	67	**2**	**1**	**3**	**33**
NAE	123	290	413	70	14	176	190	93
MZU	2	5	7	71	0	12	12	100
PLU	1	3	4	75	0	4	4	100
SYK	10	32	42	76	5	53	58	91
BLI	4	22	26	85	4	24	28	86
BSC	4	56	60	93	1	111	112	99
AHE	0	1	1	100	0	4	4	100
BIN	0	1	1	100	0	1	1	100
BLF	0	1	1	100	0	1	1	100
BUL	0	1	1	100	0	0	0	0
BWH	0	1	1	100	0	0	0	0
CNR	0	1	1	100	0	2	2	100
DAR	0	1	1	100	0	0	0	0
HOS	0	1	1	100	0	2	2	100
LAT	0	1	1	100	0	2	2	100
LAU	0	13	13	100	2	27	29	93
LSA	0	3	3	100	0	1	1	100
OMM	0	1	1	100	0	1	1	100

	21 " Ground gear				16 " Ground gear			
SPECIES	**CENTRE**	**MAIN**	**TOTAL**	**%**	**CENTRE**	**MAIN**	**TOTAL**	**%**
POP	0	1	1	100	0	0	0	0
RSE	0	1	1	100	1	2	3	67
SBE	0	2	2	100	1	6	7	86
SBF	0	6	6	100	0	2	2	100
SRO	0	1	1	100	0	1	1	100
WHH	0	1	1	100	0	1	1	100
BAE	NA	NA	NA	NA	0	2	2	100
BOU	NA	NA	NA	NA	0	2	2	100
CHS	NA	NA	NA	NA	0	9	9	100
DOE	NA	NA	NA	NA	0	1	1	100
GAR	NA	NA	NA	NA	1	1	2	50
HAN	NA	NA	NA	NA	0	1	1	100
KSE	NA	NA	NA	NA	0	1	1	100
LBA	NA	NA	NA	NA	0	2	2	100
MEU	NA	NA	NA	NA	0	2	2	100
MNI	NA	NA	NA	NA	0	1	1	100
MSE	NA	NA	NA	NA	0	2	2	100
RUN	NA	NA	NA	NA	0	1	1	100
TMU	NA	NA	NA	NA	0	3	3	100

Table 4.3: Species selectivity of deepwater net with 21" rock-hopper ground-gear (n = 4 hauls) and 16 " rock-hopper ground-gear (n = 4 hauls) at 1000 m undertaken on 1209S. For species code refer to Appendix 4.

5. Processing and Sampling of Catch and Species Identification and Data Records

All the catch is sorted and identified to species level. Each species is sampled in order to quantify the total weight and also the total number of each species present in the haul. For the majority of species this is done by recording the length measurement of each individual fish. This creates a length frequency distribution as well as providing the total abundance for each species. Sex is recorded for all Chondrichthyan species (sharks, rays and *chimaeras*). Data is recorded on standard Marine Laboratory length frequency sheets except for grenadier species (Macrouridae) for which a specific sheet is available (Appendix 3). There are regular instances where either a species, or indeed a number of species, are too numerous for all fish to be measured. In this scenario a subsample will be taken – after sorting to species level - by weight and then raised in order to calculate the total abundance of a species within a haul. In order to ensure a random sample is indeed representative of the catch (and the population), a systematic approach to sub-sampling the catch is important. However, the precise means by which a random sub-sample of the catch is achieved will vary somewhat according to constraints imposed by vessel design, space and layout of the fish processing area. Current practice onboard FRV *Scotia* sees the catch emptied into a hopper from where a total catch weight can be obtained. From here the catch is brought from the hopper (Figure 4.2), down a conveyer and into sorting trays where the catch is sorted into fish baskets (Figure 4.2) which are then weighed and the species weight recorded. It is important to make sure that each time a tray is filled to be sorted that it is completely emptied of fish before the next load of fish is taken in. In the case of numerically dominant species such as the roundnose grenadier that have to be sub-sampled, it is important to make sure that the sub-sample is selected from baskets filled throughout the sorting process. This will prevent any 'settling' effects in the hopper or sorting basins (small fish being left until the end) creating a bias in the sub-sample measured. Data is entered into the computer from the sheets for each species, the total weight, and number at each length class from which a total number is computed.

Figure 4.2: A typical haul from 1700 m as it is dropped into the hopper containing around 1 ton of up to 50 mixed species (left) which are then sorted into baskets for weighing and measuring in Scotia's fish house (right). Photo FN.

5.1 Measures of Deepwater Species

The majority of species encountered during the deepwater surveys are measured to the cm below total length (TL). However, due to the great variety of body shapes of deep-water fish species and the fragility of their tails and fins some species are not measured to total length. Listed below are the species groupings that are not measured using total length, along with details of the length measurement used for each.

Smoothheads and Searsids (Alepocephalidae and Searsidae): Standard Length (SL). Measurement taken from the tip of snout/anterior point of head to the end of the fleshy caudal peduncle.

Grenadiers (Macrouridae): Pre Anal Fin Length (PAFL) Measurement taken from the tip of the snout to the start of the first anal finray/end of the caudal peduncle. Measured to nearest 0.5 cm.

Chimareas/rabbitfish (Chimaeridae): Pre Supra Caudal Fin Length PSCFL - measured from the tip of the snout to the point just before the start of the supra caudal fin.

Long-nosed rabbitfish (Rhinochimaeridae): Second Dorsal Fin Length SDFL. These species contain no supra caudal fin so length measurement is taken from the tip of the snout to the end of the second dorsal fin.

5.2 Species Identification, Recording and Checklist

To date over 200 species have been recorded from the survey, not all of which are exclusively deepwater species. A full check list is provided in Appendix 5. There are a number of codes that indicate that the specimen was only identifiable to genus level for reasons of condition of specimen or taxonomic dispute. In case of difficulties with species identification, specimens will be photographed, tagged and stored (either frozen or in 10 % formalin) for further identification. Photographs should be taken with a scale object or ideally against a ruled board with cruise year and haul number (e.g. S07/152) clearly marked alongside the specimen (Figure 4.3). A series of identification guides for the major groups of fishes is being prepared (F. Burns, working documents, in preparation)

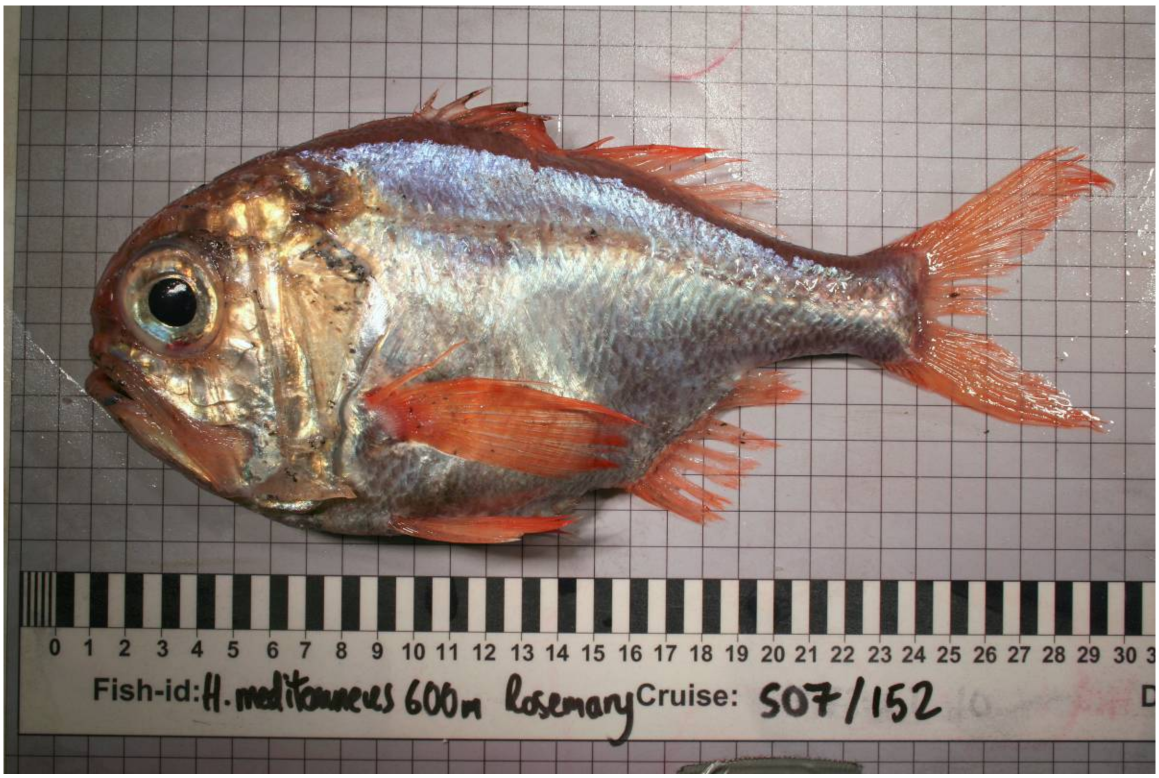

Figure 4.3: Example of standard for photographing fish specimens (photo: FN)

5.3 Invertebrate By-catch

All hard corals, soft corals (gorgonians), black corals and seapens (Figure 4.4) should be sorted and identified when possible. Their presence should be noted on the haul summary sheet and more detailed information recorded on the benthos sheet. A small sample should be retained in pure ethanol for purposes of DNA analysis. Any rare or unidentifiable specimens should be retained frozen for reference and further investigation. The remaining invertebrate by-catch includes deep-water squid and octopus, prawns and crabs, sea-urchins and sea-cucumbers, seastars, sponges and bivalves. This should also be sorted and identified as far as is possible and recorded using the sheet in Appendix 4. If expertise is not available to undertake identification a representative sample should be retained frozen and returned to the laboratory for further investigation.

Figure 4.4: Examples of a sponge (top left), the stoney coldwater coral *Lophelia pertusa* (top right), a gorgonian, *Callogorgia verticallata* (bottom left) and a black coral *Stauropathes arctica*, bottom right. Photos JD/FN.

5.4 Biological Data Collection

There is no standard for collecting additional biological information from the catch. Individual weight-length data has been collected regularly for most species for the purposes of establishing conversion equations. This should be continued opportunistically especially for rarer and large species. In the past, data has also been collected on the maturity stages of various shark species. Otoliths are not routinely collected, but are taken on occasion for specific research projects.

5.5 Physical Environmental Data Collection

The minimum requirement is to record bottom temperature and depth of the sampled area. Usually this will be recorded with a data logger attached to the trawl (most often headline). Such loggers should ideally be calibrated with a CTD profile for quality assurance. A star-oddi high pressure data storage tag has been used on MS-S deepwater surveys since 2005. From 174 hauls there is clear relationship between bottom depth and temperature (Figure 4.5). The relationship is non-linear (best fitted with a third order polynomial function). Most notable is that the rate of decrease markedly slows at depth beyond 1600m.

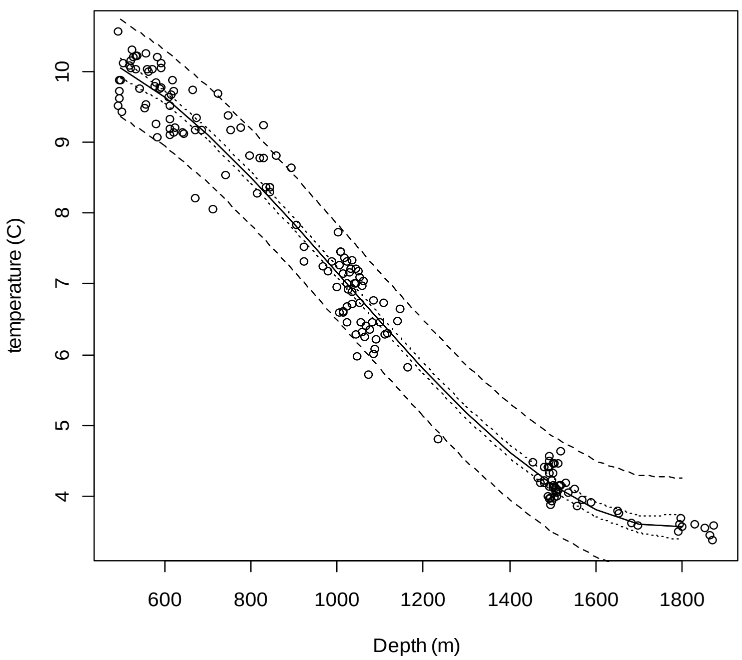

Figure 4.5: Observations of minimum temperature at maximum depth obtained from a data logger attached to the net head-line. Data from 2005-2009 including observations Rockall and the seamounts. Line fitted as a third order polynomial.

5.6 Data Storage and Management

The number and weights caught and the length frequency data are all stored together with chronological data in the Marine Laboratory Fisheries Management Database (FMD). Cruise data is stored in NTS2/Shared/FMP-Research-Vessel-Sampling/sheetsarchive/deep. Additional research data are stored on the shared drive NTS2/Shared/MF0763_EcoSDEEP/Fish Survey data. Paper copies of all the standard deepwater surveys haul sheets are also retained for reference and are located in room B31 with Finlay Burns. Sheets from gear trials are held in room A110 with Francis Neat.

6. Vulnerable Marine Ecosystems (VMEs) and a Code of Conduct for Surveys in Deepwater Areas

Deepwater ecosystems can contain fragile communities of organisms such as corals and sponges that are vulnerable to damage by trawling and may take many decades to re-grow. In 1992 the European Community adopted Council Directive 92/43/EEC on the Conservation of natural habitats, wild fauna and flora (EC Habitats Directive). This is the means by which the Community meets its obligations as a signatory of the Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention) and applies to the UK. The provisions of the Directive require Member States to introduce a range of measures including the protection of habitats and species listed in the Annexes. These habitats and species are considered to be most in need of conservation at a European level. One of the key provisions is the establishment of a European network of conservation sites (Natura 2000 Network). The EU Habitats Directive extends out to the 200 nm limit of the exclusive economic zone which includes deepwater sites.

Under Annex 1, the definition of 'reef` habitats' includes biogenic reefs or 'concretions' which arise from the sea floor and support communities, such as those formed by *Lophelia pertusa*. *L. pertusa* is listed under CITES I (Convention on International Trade in Endangered Species of Wild Flora and Fauna) and the genus *Lophelia* is listed under CITES II. Its also on the 2004 OSPAR List of Threatened and Declining Species and Habitats which forms part of the OSPAR Convention (1992 Convention for the Protection of the Marine Environment of the North East Atlantic). The non-statutory UK Biodiversity Action Plan recommends that the distribution and status of *L. pertusa* pseudo-colonies and reefs within the 200 mile limit are protected and enhanced. In 2003 an area named the Darwin Mounds was closed under EU jurisdiction for the protection of coldwater corals. In 2007 NEAFC closed a number of areas on Rockall Bank and Hatton Bank to protect coral reefs. In 2009 large areas of mid-Atlantic ridge were closed and there are special areas of conservation recommended by JNCC that include parts of the Rockall Bank, the Wyville-Thomson Ridge and the Anton Dohrn Seamount. Until recently attention has been focused on coldwater coral reefs which tend to be found on hard bottom grounds.

However it is likely that further consideration will be given to species such as sea-pens and sponges that occur on softer, often muddy grounds in the future.

6.1 Towards a Code of Conduct for Deepwater Trawl Surveys

There is clearly a need for appropriate practice when operating trawl surveys in sensitive deepwater areas and therefore a code of conduct may be required. The aim of a code of conduct is to minimize the significant adverse impacts of scientific activities, while maintaining scientific value of the research. Codes of conduct can be developed and applied as a measure in the absence of laws and management plans, but may also be used to enhance the implementation of an existing legal framework or used as self regulatory measures. OSPAR suggests that agreement to its code of conduct should be a prerequisite for the granting of research funds and ship time. In 2008 the ICES Working Group of Deepwater Ecology (ICES 2008 b) reviewed in detail several codes of conduct for research in deepwater areas. It is, however, worth reproducing the code of conduct produced by OSPAR.

6.2 The Code of Conduct for Responsible Marine Research in the Deep Seas and High Seas of the OSPAR Maritime Area

a) Species: avoid, in the course of scientific research, activities that could lead to long lasting changes in regional populations or substantially reduce the number of individuals present.

b) Habitats: avoid, in the course of scientific research, activities which could lead to substantial physical, chemical, biological or geological changes or damage to marine habitats.

c) Threatened and/or declining features: When working in areas of particular ecological vulnerability, including, inter alia, the features listed in the OSPAR “List of Threatened and/or Declining Species and Habitats” utmost care should be taken not to disturb or damage the features as far as possible.

d) Management areas/marine protected areas: When working in areas of particular ecological importance and/or sensitivity, including, *inter alia*, OSPAR marine protected areas, care has to be taken not to disturb or damage the protected features, and that activities are in compliance with regulations for the area. Further, scientists are requested to respect the importance of management areas like marine protected areas and are asked to assist in their implementation through the use of the best scientific knowledge.

e) Notification and research planning: Avoid activities which could disturb the experiments and observations of other scientists. This requires that scientists: a) make themselves familiar with the status of current and planned research in an area; and b) that they ensure that their own research activities and plans are known to the rest of the international research community via appropriate public domain data bases and web sites.

f) Methods: Use the most environmentally friendly and appropriate study methods which are reasonably available.

g) Transport of biota: Ensure that transport of biota between different marine regions, which could lead to changes in the environment or the composition of marine communities, does not occur.

h) Collections: Avoid collections that are not essential to the conduct of the scientific research, and reduce the number of samples to the necessary minimum.

i) Collaboration and cooperation: Ensure the fullest possible use of all biological, chemical and geological samples through collaborations and cooperation within the global community of scientists. Samples which can be archived should be placed in accessible repositories for future use.

j) Data sharing: Practice international sharing of data, samples and results in order to minimize the amount of unnecessary sampling and to further a global understanding of the marine environment.

6.3 Specific Consideration for MS-S Deepwater Trawl Surveys

A range of scenarios concerning Vulnerable Marine Ecosystems (VME) may be encountered when undertaking MS-S trawl surveys in deepwater areas. What follows is a list of these scenarios and the appropriate action that should be taken. It is essential that detailed maps are available in the appropriate projections that contain all relevant data on the extent of closed areas, proposed closed areas and the occurrence of all types of VMEs. Such data is available via the ICES Working Group of Deepwater Ecology.

1) The area has been closed to bottom contact fishing to conserve VMEs. The data quality for the presence of VMEs is good and recent, and VMEs would be predicted in the general area (e.g. appropriate depth, hard seabed profile, steep slopes, seamount, ridge etc). ACTION: Avoid

2) The area has been closed to bottom contact fishing to conserve VMEs, but in recent years surveys have been carried out without evidence of VMEs. Such a situation can arise when an area is closed on basis of historical records of VMEs or simply as a consequence of taking the precautionary approach and closing an area that is of greater size than the records actually indicate. However, it may be deemed necessary to undertake trawl surveys if the purpose of survey is monitor state of the ecosystem following closure. ACTION: special derogations and permissions must be sought and mitigation actions (e.g. pre-survey by TV, past evidence of clean ground, short trawls) should be considered prior to trawling.

3) The area has been proposed to be closed to bottom contact fishing to conserve VMEs. The data quality is good and recent and VMEs would be predicted. The only reason it is not closed is the time the political process takes to do so. ACTION: Avoid
4) Area is proposed to be closed to bottom contact fishing to conserve VMEs. The data quality is variable (e.g. historical data) and VMEs would not necessarily be predicted. ACTION: A careful assessment of the likelihood that VMEs will be present and impacted. Mitigation actions (e.g. pre-survey by TV, short trawl) should be considered prior to trawling.
5) Area is not proposed to be closed. There is some data suggesting the presence of VMEs and the area is predicted to contain VMEs, e.g. a seamount. ACTION: A careful assessment of the likelihood that VMEs will be present and impacted. Mitigation actions (e.g. pre-survey by TV, short trawl) should be considered prior to trawling.
6) Area is not proposed to be closed. There is no data suggesting the presence of VMEs and the area is not predicted to contain VMEs. ACTION: Proceed.

If demersal trawling or work impacting the sea bed is considered essential under any of scenarios 1 through 5, the following should be submitted to the programme director prior to undertaking any trawl deployments:

1) An assessment of the reliability of the data that suggests the presence of VMEs in the area.
2) A list of positions and depths of the hauls / stations within the area
3) An explanation of why the survey is necessary
4) A note of any mitigation actions (e.g. pre-survey by TV) that may be taken and an assessment of the likelihood that VMEs will be impacted.

If, subsequent to the actions described above, any *Lophelia pertusa* or other deep-water corals, gorgonians or sponges are caught in a trawl, the following actions should be taken;

1) The presence of the coral and gorgonians should be noted in the haul record along with additional information such as proportion of live and dead coral and approximate weight caught.
2) This information should be passed onto WGDEC or the relevant MS-S working group member, following completion of the survey.
3) If significant amounts of live coral are caught, the area should be avoided in future MS-S surveys.
4) Small pieces of live coral should be frozen for put into absolute ethanol for identification and genetic studies and passed onto relevant MS-S staff. Photographs are also desirable.
5) If large fragments of live coral are brought aboard, a representative sample should be taken and the rest returned to the sea as quickly as possible.

7. References

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Acknowledgements

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Deepwater gear trials research team of July 2008 FRV *Scotia* cruise 0908S.

Appendix 1

A complete list of trawl stations undertaken in each year from 1998 to 2009. Those marked red are core time series stations. Surveys marked in blue were not undertaken as part of the normal survey.

Area code	locality	stats square	old stat.	new stat.	depth	lat shot	long shot	lat haul	long haul	dec lat shot	dec long shot	dec lat haul	dec long haul	1996	1997	1998	2000	2002	2004	2005	2006	2007 (May)	2007 (Sep)	2008 (Jul)	2008 (Sep)	2009 (Sep)
1	Wyville Thomson	48E1/E2		WTR_500	500	59°52.80	-8°10.80	59°46.80	-8°00.00	59.88	-8.18	59.78	-8.00	✓	✓											
1	Wyville Thomson	48E1/E2		WTR_700	700	59°55.80	-8°18.00	59°52.2	-8°10.20	59.93	-8.30	59.85	-8.20	✓	✓											
1	Wyville Thomson	48E1/E2		WTR_1000	1000	59°48.00	-8°04.20	59°54.00	-8°13.80	59.80	-8.07	59.90	-8.23	✓	✓											
1	Northern Rise	47E1		47E1_1500	1500	59°04.79	-8°24.30	59°04.49	-8°28.88	59.08	-8.41	59.07	-8.48											✓	✓	
1	West Lug	47E2		47E2_1000	1000	59°2.37	-7°45.13	59°8.51	-7°39.34	59.04	-7.75	59.14	-7.66		✓		✓				✓	✓				
1	East Lug	47E3		47_E3_850	850	59°22.8	-6°54.00	59°22.2	-7°3.00	59.38	-6.90	59.37	-7.05		✓											
1	North Flannan	46E2	35	46E2_500	500	58°46.33	-7°54.46	58°48.36	-7°52.03	58.77	-7.91	58.81	-7.87				X	✓			✓	✓			✓	
1	North Flannan	46E2	36	46E2_1000	1000	58°52.38	-7°54.94	58°56.48	-7°45.28	58.87	-7.92	58.94	-7.75				✓	✓			✓				✓	✓
1	NW Flannan	46E1	2	46E1_500	500	58°43.52	-8°14.01	58°44.43	-8°0.36	58.73	-8.23	58.74	-8.01			✓	✓	✓	✓	✓	✓			✓	✓	✓
1	NW Flannan	46E1	34	46E1_1000	1000	58°38.91	-8°43.88	58°36.45	-8°54.67	58.65	-8.73	58.61	-8.91				✓	✓		✓	✓			✓	✓	✓
1	NW Flannan	46E1	33	46E1_1500	1500	58°43.17	-8°51.69	58°46.34	-8°41.14	58.72	-8.86	58.77	-8.69				✓			✓	✓			✓	✓	✓
2	N St Kilda	45E0	4	45E0_500	500	58°11.76	-9°33.91	58°17.94	-9°27.05	58.20	-9.57	58.30	-9.45			✓	✓	✓	✓	✓	✓		✓		✓	✓
2	N St Kilda	45E0	5	45E0_1000	1000	58°25.83	-9°38.95	58°32.23	-9°34.80	58.43	-9.65	58.54	-9.58			✓	✓	✓		✓	✓		✓	✓	✓	✓
2	N St Kilda	45E0	6	45E0_1500	1500	58°26.05	-9°29.61	58°29.65	-9°18.19	58.43	-9.49	58.49	-9.30				✓	✓		✓	✓		✓		✓	✓
2	N St Kilda	45E0		45E0_1700	1700	58°29.39	-9°41.10	58°25.98	-9°42.14	58.49	-9.69	58.43	-9.70											✓	✓	✓
2	W St Kilda	44E0	8	44E0_500	500	57°40.64	-9°37.34	57°33.90	-9°34.34	57.68	-9.62	57.57	-9.57		✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓
2	W St Kilda	44E0		44E0_850	850	57°49.00	-9°42.00	57°43.00	-9°42.00	57.82	-9.70	57.72	-9.70		✓					✓		✓	✓			
2	W St Kilda	44E0	9	44E0_1000	1000	57°30.70	-9°39.05	57°37.45	-9°43.06	57.51	-9.65	57.62	-9.72				✓	✓	✓	✓	✓		✓	✓	✓	✓
2	W St Kilda	44E0	10	44E0_1500	1500	57°39.29	-9°52.39	57°46.13	-9°52.98	57.65	-9.87	57.77	-9.88				✓	✓	✓	✓	✓		✓	✓	✓	✓
2	W St Kilda	44E0		44E0_1800	1800	57°37.53	-9°57.69	57°40.44	-9°58.31	57.63	-9.96	57.67	-9.97											✓		
2	S St Kilda	43E0	29	43E0_500	500	57°10.60	-9°21.32	57°3.99	-9°16.60	57.18	-9.36	57.07	-9.28			✓	✓		✓	✓	✓		✓		✓	✓
2	S St Kilda	43E0	48	43E0_800	800	57°9.00	-9°23.00	57°16.00	-9°28.00	57.15	-9.38	57.27	-9.47			✓				✓						✓
2	S St Kilda	43E0	12	43E0_1000	1000	57°21.49	-9°33.70	57°14.86	-9°28.96	57.36	-9.56	57.25	-9.48				✓		✓	✓	✓		✓		✓	✓
2	S St Kilda	43E0	13	43E0_1500	1500	57°16.69	-9°36.84	57°22.41	-9°42.85	57.28	-9.61	57.37	-9.71				✓		✓	✓	✓		✓		✓	✓
3	N Vidal bank	42E0	25	42E0_500	500	56°49.53	-9°4.70	56°43.94	-9°2.13	56.83	-9.08	56.73	-9.04			✓	✓	✓	✓	✓	✓		✓		✓	✓
3	N Vidal bank	42E0	28	42E0_750	750	56°55.00	-9°10.00	56°49.00	-9°6.00	56.92	-9.17	56.82	-9.10		✓	✓	✓	✓								
3	N Vidal bank	42E0	27	42E0_1000	1000	56°43.00	-9°10.66	56°49.58	-9°10.49	56.72	-9.18	56.83	-9.17			✓	✓	✓	✓	✓	✓		✓		✓	✓
3	N Vidal bank	42E0	26	42E0_1500	1500	56°47.80	-9°20.58	56°42.04	-9°26.87	56.80	-9.34	56.70	-9.45				✓	✓	✓	✓	✓		✓		✓	✓
3	N Vidal bank	42E0	47	42E0_1700	1800	56°44.09	-9°47.67	56°49.02	-9°40.79	56.73	-9.79	56.82	-9.68					✓	✓	✓	✓				✓	✓
3	Central Vidal bank	41E0	21	41E0_500	500	56°19.59	-9°9.92	56°13.57	-9°12.71	56.33	-9.17	56.23	-9.21				✓	✓	✓		✓		✓		✓	✓
3	Central Vidal bank	41E0	22	41E0_800	800	56°14.00	-9°16.00	56°8.00	-9°17.00	56.23	-9.27	56.13	-9.28		✓		✓	✓	✓							
3	Central Vidal bank	41E0	23	41E0_1000	1000	56°8.33	-9°23.37	56°15.19	-9°21.13	56.14	-9.39	56.25	-9.35				✓	✓	✓		✓		✓		✓	✓
3	Central Vidal bank	41E0	24	41E0_1500	1500	56°13.81	-9°37.52	56°7.28	-9°37.18	56.23	-9.63	56.12	-9.62				✓	✓	✓		✓		✓		✓	✓
3	Central Vidal bank	41E0		41E0_1800	1800	56°5.22	-9°48.85	56°8.22	-9°51.39	56.09	-9.81	56.137	-9.8565													✓
3	S Vidal bank	40E0	18	40E0_500	500	55°50.09	-9°18.49	55°57.53	-9°16.69	55.83	-9.31	55.96	-9.28				✓	✓	✓		✓					
3	S Vidal bank	40E0	19	40E0_750	750	55°57.73	-9°19.57	55°54.55	-9°21.33	55.96	-9.33	55.91	-9.36				✓	✓	✓		✓					
3	S Vidal bank	40E0	20	40E0_1000	1000	55°58.27	-9°24.83	55°52.79	-9°28.65	55.97	-9.41	55.88	-9.48					✓	✓	✓	✓					
3	S Vidal bank	40E0		40E0_1800	1800	55°56.00	-9°52.00	55°51.00	-9°51.00	55.93	-9.87	55.85	-9.85					✓								
4	North Donegal	39D9	14	39D9_500	500	55°12.21	-10°3.72	55°6.05	-10°6.89	55.20	-10.06	55.10	-10.11				✓	✓	✓		✓		✓		✓	✓
4	North Donegal	39D9		39D9_750	750	55°17.57	-10°3.68	55°23.45	-9°59.84	55.29	-10.06	55.39	-10.00								✓					
4	North Donegal	39D9	15	39D9_1000	1000	55°8.72	-10°9.79	55°15.56	-10°7.70	55.15	-10.16	55.26	-10.13				✓	✓	✓		✓		✓		✓	✓
4	North Donegal	39D9	16	39D9_1500	1500	55°7.00	-10°16.00	55°13.00	-10°17.00	55.12	-10.27	55.22	-10.28				✓	✓	✓							
4	South Donegal	38D9		38D8_1500	1500	54°57.59	-10°29.11	54°53.48	-10°36.79	54.96	-10.49	54.89	-10.61								✓		✓		✓	✓
4	South Donegal	38D9		38D8_1800	1800	55°0.92	-10°29.72	54°58.27	-10°39.83	55.02	-10.50	54.97	-10.66										✓			✓
5	Anton Dohrn	43D9		5_AD_1		57°24.00	-10°52.00	57°19.00	-10°55.00	57.40	-10.87	57.32	-10.92							X						
5	Anton Dohrn	43D8		5_AD_2		57°25.12	-11°13.06	57°22.77	-11°11.75	57.42	-11.22	57.38	-11.20								✓	✓				
5	Anton Dohrn	43D8		5_AD_3		57°21.01	-11°11.69	57°20.76	-11°9.07	57.35	-11.19	57.35	-11.15								✓	✓				
5	Anton Dohrn	43D8		5_AD_4		57°33.68	-11°1.43	57°32.84	-10°58.86	57.56	-11.02	57.55	-10.98								✓	✓				
6	Rockall	42D5		6_ROC_1		56°35.47	-14°1.59	56°32.59	-14°4.85	56.59	-14.03	56.54	-14.08								✓					
6	Rockall	42D6		6_ROC_2		56°42.77	-13°43.26	56°40.04	-13°47.62	56.71	-13.72	56.67	-13.79								✓					
6	Rockall	42D6		6_ROC_3		56°56.91	-13°26.03	56°55.74	-13°28.06	56.95	-13.43	56.93	-13.47									✓				
6	Rockall	42D6		6_ROC_4		56°55.18	-13°28.52	56°53.85	-13°30.14	56.92	-13.48	56.90	-13.50									✓				
7	Rosemary bank	47D9		7_RB_1		59°5.39	-10°0.10	59°6.00	-9°56.89	59.09	-10.00	59.10	-9.95									✓	✓		✓	✓
7	Rosemary bank	47D9		7_RB_2		59°21.75	-10°3.93	59°22.18	-10°7.52	59.36	-10.07	59.37	-10.13									✓	✓		✓	✓
7	Rosemary bank	47D9		7_RB_3		59°26.34	-10°7.11	59°26.02	-10°10.39	59.44	-10.12	59.43	-10.17									✓	✓		✓	✓

Appendix 2

Sheet for recording deepwater haul summary information

Scotia Deepwater Haul Summary Sheet (BT 184 - 16" rockhoppers)	
Cruise Ref: Date:	**Warp out:**
Haul No: S /	**Time Hauled:**
Stat Square:	**Duration:**
Time Shot:	**Lat Hauled:**
Lat Shot:	**Long Hauled:**
Long Shot:	**Wind Force:**
Station Number:	**Wind direction:**
Depth:	**Fishing Master: SIC:**
Comments:	

	MISCELLANEOUS (TL)				MISCELLANEOUS (TL)		
Weight	**Code**	**Species**	**Nos**	**Weight**	**Code**	**Species**	**Nos**
	AAS	*Argyropelecus aculeatus*			**JSC**	*Nesiarchus nasutus*	
	ACO	*Anoplogaster cornuta*			**LAM**	*Lampanyctus spp*	
	AHE	*Argyropelecus hemigymnus*			**LAR**	*Argentina sphyraena*	
	ANG	*Lophius piscatorius*			**LAT**	*Lycodes atlanticus*	
	ARO	*Antimora rostrata*			**LAU**	*Myctophidae*	
	BAE	*Bathylagus euryops*			**LBA**	*Notolepis rissoi*	
	BAN	*Lophius budegassa*			**LCR**	*Lycodes crassiceps*	
	BDE	*Beryx decadactylus*			**LEQ**	*Lepidion eques*	
	BDU	*Bathypterois dubius*			**LFA**	*Lycodonus flagellicauda*	
	BIN	*Benthobella infans*			**LPA**	*Lycodes pallidus*	
	BLF	*Centrolophus niger*			**LSA**	*Lycenchelys sarsi*	
	BOA	*Borostomias antarcticus*			**LYB**	*Lyconus brachiolus*	
	BFE	*Bathysaurus ferox*			**LYU**	*Lycodes unidentified*	
	BSC	*Aphanopus carbo*			**MAT**	*Melanostigma atlanticum*	
	BSE	*Notacanthus bonapartei*			**MNI**	*Malacosteus niger*	
	BSP	*Beryx splendens*			**MOR**	*Mora moro*	
	BUL	*Epigonus telescopus*			**MYC**	*Lampanyctus crocodilus*	
	CAU	*Cataetyx unidentified*			**MZU**	*Melanonus zugmayeri*	
	CBL	*Centrolophus medusaphagus*			**ORO**	*Hoplostethus atlanticus*	
	CEE	*Conger conger*			**PAP**	*Platytroctes apus*	
	CHS	*Chauliodus sloani*			**PAS**	*Cottunculus thomsonii*	
	CLA	*Cataetyx laticeps*			**PBA**	*Paraliparis bathybius*	
	CNR	*Chiasmodon niger*			**PLU**	*Paraliparis unidentified*	
	CSE	*Notacanthus chemnitzii*			**POC**	*Polymetme corythaeola*	
	DAE	*Hystobranchius bathybius*			**RSE**	*Polyacanthonotus risso*	
	DAR	*Diretmus argenteus*			**SBE**	*Serrivomer beani*	
	DFU	*Stomiidae unidentified*			**SBF**	*Stomias boa ferox*	
	DOE	*Nessorhamphus inglofianus*			**SBI**	*Scopelogadus beanii*	
	EEE	*Lycodes esmarkii*			**SEE**	*Nemichthys scolopaceus*	
	FBF	*Neocyttus helgae*			**SGR**	*Spectrunculus grandis*	
	GAR	*Argentina silus*			**SLE**	*Scopelosaurus lopidus*	
	GBA	*Gonostoma bathyphilum*			**SNE**	*Simenchelys parasitica*	
	GOE	*Gonostoma elongatum*			**SPI**	*Entelurus aequoraeus*	
	HAF	*Halargyreus johnsonii*			**SYK**	*Synaphobranchus kaupi*	
	HAM	*Halosauropsis macrochir*			**WHH**	*Myxine ios*	
	HAT	*Argyropelecus olfersi*			**VEE**	*Lycodes vahlii*	
	HAU	*Sternoptychidae*			**VPR**	*Venefica proboscidea*	
	HMA	*Trachurus trachurus*					
	HME	*Hoplostethus mediterraneus*					
	HOS	*Howella sherborni*					
	IBL	*Ilyophis blachei*					
	JCA	*Anarhichas denticulatus*				**total weight (kg)**	

Scotia Deepwater Haul Summary (page 2) Haul No: Stat Sq:

		GADOIDS (TL)				**ELASMOBRANCHS (TL)**	
Weight	**Code**	**Species**	**Nos**	**Weight**	**Code**	**Species**	**Nos**
	BER	*Antonogadus macrophthalmus*			**AAP**	*Apristurus aphyodes*	
	BLI	*Molva dypterygia*			**ALA**	*Apristurus laurussonii*	
	BWH	*Micromesistius poutassou*			**AME**	*Apristurus melanoasper*	
	COD	*Gadus morhua*			**AMI**	*Apristurus manis*	
	GFO	*Phycis blennoides*			**AMN**	*Apristurus microps*	
	HAK	*Merluccius merluccius*			**APU**	*Apristurus unidentified*	
	LIN	*Molva molva*			**ASK**	*Raja hyperborea*	
	NPO	*Trisopterus esmarki*			**BCA**	*Breviraja caerulea*	
	PCO	*Trisopterus minutus*			**BMD**	*Galeus melastomus*	
	RUN	*Rocklings*			**CRA**	*Raja naevus*	
	SAI	*Pollachius virens*			**CCR**	*Centroscymnus crepidater*	
	SPO	*Gadiculus argenteus thori*			**CGR**	*Centrophorus granulosus*	
	SRO	*Onogadus argenteus*			**CFA**	*Centroscyllium fabricii*	
	TBR	*Gaidropsarus vulgaris*			**DCH**	*Scymnorhinus licha*	
	TOR	*Brosme brosme*			**EPR**	*Etmopterus princeps*	
		FLATFISH (TL)			**FCA**	*Pseudotriakis microdon*	
	FME	*Lepidorhombus boscii*			**FRA**	*Raja fyllae*	
	GHA	*Reinhardtius hippoglossoides*			**FSH**	*Chlamydoselachus anguineus*	
	LRD	*Hippoglossoides platessoides*			**GMU**	*Galeus murinus*	
	LSO	*Microstomus kitt*			**KRA**	*Raja krefti*	
	MEG	*Lepidorhombus whiffiagonis*			**LSD**	*Scyliorhinus canicula*	
	WIT	*Glyptocephalus cynoglossus*			**LSQ**	*Centrophorus squamosus*	
		REDFISH (TL)			**LSS**	*Somniosus rostratus*	
	BLM	*Helicolenus dactylopterus*			**PSH**	*Centroscymnus coelolepis*	
	NHA	*Sebastes viviparus*			**RAK**	*Raja kukujevi*	
	RED	*Sebastes marinus marinus*			**RBA**	*Raja bathyphila*	
	SMM	*Sebastes marinus mentella*			**RBI**	*Raja bigelowi*	
		MACROURIDAE (PAFL 0.5 cm)			**RJE**	*Raja jenseni*	
	COC	*Caelorhynchus caelorhynchus*			**SAR**	*Raja circularis*	
	GGR	*Coryphaenoides guentheri*			**SGS**	*Hexanchus griseus*	
	MGR	*Coryphaeonides mediterraneus*			**SHS**	*Deania calceus*	
	MLA	*Malacocephalus laevis*			**SKA**	*Raja batis*	
	NAE	*Nezumia aequalis*			**SKU**	*Raja unidentified*	
	RNG	*Coryphaenoides rupestris*			**SPU**	*Squalus acanthias*	
	RNR	*Trachyrhynchus trachyrhynchus*			**SRA**	*Raja fullonica*	
	GLO	*Gadonus longfilis*			**SRI**	*Scymnodon ringens*	
	RTG	*Nezumia sclerorhynchus*			**TRA**	*Raja clavata*	
	RTU	*unidentified grenadier*			**VBE**	*Etmopterus spinax*	
	SSG	*Caelorhynchus labiatus*					
	TMU	*Trachyrhynchus murrayi*				**Smooth-heads and Searsids (SL)**	
		Chimaeras: Pre Supra Caudal Fin Length			**AAG**	*Alepocephalus agassizi*	
	CHI	*Chimaera monstrosa*			**AAH**	*Alepocephalus australis*	
	COP	*Chimaera opalescence*			**BAM**	*Bajacalifornia megalops*	
	HMI	*Hydrolagus mirabilis*			**HAN**	*Holtbyrnia anomala*	
	HYA	*Hydrolagus affinis*			**HOM**	*Holtbyrnia macrops*	
	HPA	*Hydrolagus pallidus*			**KSE**	*Searsia koefoedi*	
	RAU	*Chimaera unidentified*			**LSM**	*Alepocephalus rostratus*	
		Chimaeras: 2nd Dorsal Fin Length			**MSE**	*Normichthys operosus*	
	RAT	*Rhinochimaera atlantica*			**MSH**	*Rouleina maderensis*	
	HRA	*Hariotta raleighana*			**MUC**	*Conocara murrayi*	
		INVERTEBRATES			**RAA**	*Rouleina attrita*	
	NLO	*Nephrops norvegicus*			**SMO**	*Alepocephalus bairdii*	
	LOL	*Loligo*			**SMU**	*Alepocephalus unidentified*	
	OMM	*Ommastrephidae*			**XCI**	*Xenodermichthys copei*	
		CORALS (presence only)					
		Lophelia				**Other species (note LQ)**	
		Gorgonians					
		Black corals					
		Seapens					

Appendix 3

Sheets for recording Length frequency of Macrourid species

HAUL NUMBER S /										STAT SQUARE										
MACROURIDAE pre anal fin length 0.5cm																				
Coryphaenoides rupestris RNG							Nezumia aequalis NAE							Trachyrhynchus murrayi TMU						
	OTO	Measured				RT		OTO	Measured				RT		OTO	Measured				RT
1							1							1						
1.5							1.5							1.5						
2							2							2						
2.5							2.5							2.5						
3							3							3						
3.5							3.5							3.5						
4							4							4						
4.5							4.5							4.5						
5							5							5						
5.5							5.5							5.5						
6							6							6						
6.5							6.5							6.5						
7							7							7						
7.5							7.5							7.5						
8							8							8						
8.5							8.5							8.5						
9							9							9						
9.5							9.5							9.5						
10							10							10						
10.5							Total							10.5						
11										1st sample		2nd sample		11						
11.5							Counted							11.5						
12							Range							12						
12.5							Fraction							12.5						
13							Coelorhynchus coelorhynchus COC							13						
13.5								OTO	Measured				RT	13.5						
14							5							14						
14.5							5.5							14.5						
15							6							15						
15.5							6.5							15.5						
16							7							16						
16.5							7.5							16.5						
17							8							17						
17.5							8.5							17.5						
18							9							18						
18.5							9.5							18.5						
19							10							19						
19.5							10.5							19.5						
20							11							20						
20.5							11.5							20.5						
21							12							21						
21.5							12.5							21.5						
22							13							22						
22.5							13.5							22.5						
23							14							23						
23.5							14.5							23.5						
24							15							24						
24.5							15.5							24.5						
25							16							25						
25.5							16.5							25.5						
Total							Total							Total						
			1st sample		2nd sample					1st sample		2nd sample					1st sample		2nd sample	
Counted							Counted							Counted						
Range							Range							Range						
Fraction							Fraction							Fraction						

HAUL NUMBER S /										STAT SQUARE										
MACROURIDAE pre anal fin length 0.5cm																				
Coryphaenoides mediterraneus MGR							**Coelorhynchus labiatus SSG**							**Coryphaenoides guentheri GGR**						
	OTO		**Measured**			**RT**		OTO		**Measured**			**RT**		OTO		**Measured**			**RT**
1							2							2						
1.5							2.5							2.5						
2							3							3						
2.5							3.5							3.5						
3							4							4						
3.5							4.5							4.5						
4							5							5						
4.5							5.5							5.5						
5							6							6						
5.5							6.5							6.5						
6							7							7						
6.5							7.5							7.5						
7							8							8						
7.5							8.5							8.5						
8							9							9						
8.5							9.5							9.5						
9							10							10						
9.5							10.5							10.5						
10							11							11						
10.5							11.5							11.5						
11							12							12						
11.5							12.5							12.5						
12							13							13						
12.5							13.5							13.5						
13							14							14						
13.5							14.5							14.5						
14							15							15						
14.5							15.5							Total						
15							16										1st sample		2nd sample	
15.5							15.5							Counted						
16							16							Range						
16.5							Total							Fraction						
17										1st sample		2nd sample		**Malacocephalus laevis MLA**						
17.5							Counted								OTO		**Measured**			**RT**
18							Range							5						
18.5							Fraction							5.5						
19								**Grenadier ( )**						6						
19.5								OTO		**Measured**			**RT**	6.5						
20														7						
20.5														7.5						
21														8						
21.5														8.5						
22														9						
22.5														9.5						
23														10						
23.5														10.5						
24														11						
24.5														11.5						
25														12						
25.5														12.5						
26														13						
26.5														13.5						
27														14						
Total							Total							Total						
			1st sample		2nd sample					1st sample		2nd sample					1st sample		2nd sample	
Counted							Counted							Counted						
Range							Range							Range						
Fraction							Fraction							Fraction						

Appendix 4

Sheet for recording of deepwater benthos

TRAWL BENTHOS BYCATCH - Marine Scotland deepwater survey * count, estimate or P for present as a fragment **Codend**

Bag

Cruise: 1210S **Haul: S10/** **Date** **-Sep - 2010** **Area:** **Depth** **Station**

Crustacea	No.*	Xtra Inf.	Pres.	Crustacea	No.*	Xtra Inf.	Pres.	Echinodermata	No.*	Xtra Inf.	Pres.	Echinodermata	No.*	Xtra Inf.	Pres.
Lithodes maja				Pasiphaea tarda				Anserapoda placenta				Asteronyx loveni			
Neolithodes grimaldii				Pasiphaea multidentata				Asterias rubens				Gorgonocephalus caputmedusae			
Cancer pagurus				Pasiphaea sivado				Asterina gibbosa				Gorgonocephalus lamarcki			
Cancer bellianus				Parapasiphae sulcatifrons				Astropecten irregularis				Ophiacantha abissicola			
Atelecyclus rotundatus				Aristeus antennatus				Bathybiaster vexillifer				Ophiothrix fragilis			
Chaceon affinis				Aristaeopsis edwardsiansa				Benthopecten simplex				Ophiopleura inermis			
Geryon trispinosus				Acanthephyra pelagica (7-11)				Brisinga endecacnemus				Ophiura albida			
Rochinia carpenteri				Acanthephyra purpurea (4-5)				Brisingella coronata				Ophiura sarsi			
Bathynectes maravigna				Acanthephyra eximia (3-5)				Ceramaster granularis				Ophiura texturata			
Macropipus tuberculatus				Systellaspis braueri				Chondraster grandis				Ophiopholis aculateata			
Inachus				Systellaspis debilis				Diplopteraster multipes				Ophiomusium lymani			
Macropodia tenuirostris				Dichelopandalus bonnieri				Henricia sp				Ophiura sp			
Monodaeus couchii				Pandalus montagui				Hippasterias phrygiana							
Hyas coarctatus				Atlantopandalus propinquus				Hymenaster sp							
Paromola cuvieri				Solonocera sp				Lepasterias mulleri				Cidaris cidaris			
Ebalia tuberosa				Pandalina profunda				Leptoptychaster arcticus				Poriocidaris purpurata			
				Ephyrina benedicti				Luidia cilaris				Echinus esculentus			
				Ephyrina bifida				Luidia sarsi				Echinus acutus			
Anapagurus laevis				Ephyrina figueirai				Paragonaster				Echinus elegans			
Pagurus alatus				Nematocarcinus				Peltaster placenta				Echinus alexandri			
Pagurus carneus				Glyphocrangon longirostris				Persephonaster patagiatus				Echinus affinis			
Pagurus forbsii				Sabinea hystrix				Plinthaster dentatus				Echinus sp			
Pagurus prideaux				Gnathophausia zoea				Plutonaster bifrons							
Pagurus pubescens				Gnathophausia				Pontaster tenuispinus				Phormosoma placenta			
Parapagurus bernhardus				Sergestes arcticus				Porania pulvillus				Calveriosoma hystrix			
Parapagurus pilosimanus				Sergia robusta				Poraniomorpha borealis				Calveriosoma fenestratum			
				Pontophilus norvegicus				Poraniomorpha hispidia				Hygrosoma petersii			
Polycheles granulatus				Pontophilus spinosus				Pseudarchaster gracilis				Sperosoma grimaldii			
Polycheles typhlops				Metacrangon jacqueti				Pseudarchaster pareli				Spatangus raschi			
Stereomastis grimaldii								Psilaster andromeda							
Stereomastis sculpta				Isopod 'blind'				Pteraster sp				Stichopus tremulus			
Nephropsis atlantica				Isopod 'long/dark-bugeye'				Radiaster tizardi				Laetmogone violacia			
Nephrops norvegicus				Isopod 'squat/dark-bugeye'				Solaster endeca				Benthogone rosea			
Calocaris macandreae				Isopod 'yellow-bugeye'				Solaster papposus				Holo sp1 'firm/opaque/off-white			
Munida intermedia				Amphipod 1 'white'				Stichastrella ambigura				Holo sp2 'translucent/jelly'			
Munida rugosa				Amphipod 2 'orange'				Stichastrella rosea				Holo sp3 (Mesothuria)			
Munida sarsi				Amphipod 3 Cyphocaris				Neomorphaster talismani				Holo sp4 (Paelopatides)			
Munida tenuimana								Zoroaster fulgins (robust)				Holo sp5 pink/jelly (Bathyplotes?)			
Munidopsis curvirostra				pycnogonid unid				Zoroaster fulgins (smooth)							
				Colossendeis sp											
Poecilasma kaempferi															
Scalpellum scalpellum															
Scalpellum alatum															
Scalpellum sp3															
Sphyrion lumpi															
Copepod sp															

Cephalopoda	**No.***	**Xtra Inf.**	**Pres.**	**Cnidaria**	**No.***	**Xtra Inf.**	**Pres.**	**Annelida**	**No.***	**Xtra Inf.**	**Pres.**	**Bivalva**	**No.***
Opisthoteuthis massyae				Funiculina quadrangularis				Laetmonice producta				Aequipecten opercularis	
Opisthoteuthis grimaldii				Umbellula aciculifera				Laetmonice filicornis				Anomidae sp	
Stauroteuthis syrtensis				Umbellula huxleyi				Eunoe nodosa				Arctica islandica	
Cirroteuthis mulleri				Pennatula (grandis/aculeatea?)				Harmothoe fraser-thompsoni				Chlamys striata	
Grimpoteuthis wuelkeri				Kophobelemnon (stelliferum?)				Nereis zonata				Circumphalus casina	
Eledone cirrhosa								Eunice norvegica				Modiolus barbatus	
Octopus vulgaris				Callogorgia verticillata				Eunice pennata				Pseudamussium septumradiata	
Benthoctopus normani				Crysogorgia				Aphrodita aculeatea					
Benthoctopus johnsoniana				Paramuricea biscaya				Hyalinoecia tubicola					
Bathypolypus bairdii				Placogorgia graciosa				Serpulid sp					
Bathypolypus ergasticus				Acanthogorgia pico									
Granelodone verrucosa				Acanella arbuscula								Brachiopod sp	
Vampiroteuthis infernalis													
Haliphron atlanticus				Lophelia pertusa				**Porifera**	**No.***	**Xtra Inf.**	**Pres.**		
				Madrepora oculata				Antho dichotoma					
Onychoteuthis sp				Solenosmilia variabilis				Axinella infundibuliformis					
Onychoteuthis banksii								Phakellia ventilabrum					
Todarodes sagittatus				Caryophyllia smithii				Axinella polypoides					
Todaropsis eblanae				Flabellum alabastrum				Tetilla sp (cranium?)					
Illex illecebrosus				Flabellum macandrewi				Suberites pagurorum					
Loligo forbesii				Flabellum angulare				Suberites ficus					
Gonatus sp				Stephanocyathus moseleyanus				Geodia barreti					
Thysanoteuthis rhombus				Stephanocyathus nobilis				Geodia macandrewi					
Histioteuthis bonellii				Desmophyllum cristagalli				Flat/porus					
Histioteuthis atlantica				Vaughnella				Yellow/slimy/on pebble					
Teuthowenia megalops				Parantipathes hirondelle				Furry, white, on pebble					
Vampiroteuthis infernalis				Stauropathes arctica				Furry, yellowish, on pebble					
								Fine spined/silicaceous					
Neorossia caroli				Stylaster erubescens				Mesh sponge					
Rossia macrosoma													
Sepiola atlantica													
Sepietta neglecta													
				Adamsia carciniopadus									
				Epizoanthus paguriphilus									
				Epizoanthus papillosus				**Ascidia**	**No.***	**Xtra Inf.**	**Pres.**		
				Hormathiidae sp1				Collonial					
				Bolocera sp2				Solitary					
Mollusca	**No.***	**Xtra Inf.**	**Pres.**	Tearable/translucent/slimy sp3									
Neptunea despecta				Cerianthus sp4				**Bryzoa**	**No.***	**Xtra Inf.**	**Pres.**		
Beringius sp				Pink/smooth sp5				Reteporella sp					
Aporrhais pespelepani				Actinoscyphia sp6				Cyclostome sp					
Colus sp				Phelliactis sp7				Tubularia (indivisia?)					
Archidoris pseudoargus				Parazoanthus sp (colonial anguicomus?)									
Scaphander lignaris													

Appendix 5

Species check list of Observed Species from Deepwater Survey, 1998 - 2009.

Species Code	Scientific Name	Common Name
AAF	*Aldrovandia affinis*	Aldrovandia affinis
AAG	*Alepocephalus agassizi*	Agassiz's smooth-head
AAP	*Apristurus aphyodes*	Pale Catshark
AAS	*Argyropelecus aculeatus*	Argyropelecus aculeatus
AAU	*Alepocephalus australis*	Southern Atlantic smooth-head
ABR	*Alepisaurus brevirostris*	Shortnose lancetfish
ACO	*Anoplogaster cornuta*	Fangtooth
AHE	*Argyropelecus hemigymnus*	Argyropelecus hemigymnus
ALA	*Apristurus laurussonii*	Iceland Catshark
ALD	*Aldrovandia phalacra*	Aldrovandia phalacra
ALP	*Alepocephalus productus*	Smalleye smooth-head
AMA	*Apristurus madaerensis*	Madeira catshark
AME	*Apristurus melanoasper*	Apristurus melanoasper
AMI	*Apristurus microps*	Smalleye Catshark
AMN	*Apristurus manis*	Ghost catshark
ANG	*Lophius piscatorius*	Angler (Monk fish)
APU	*Apristurus sp*	Apristurus unidentified
ARG	*Argyropelecus gigas*	Greater Silver Hatchetfish
ARO	*Antimora rostrata*	Antimora
BAE	*Bathylagus euryops*	Bathylagus euryops
BAM	*Bajacalifornia megalops*	Big-eyed smoothhead
BAN	*Lophius budegassa*	Black-bellied Angler
BCA	*Neoraja caerulea*	Blue ray
BCU	*Barbantus curvifrons*	Palebelly Searsid
BDE	*Beryx decadactylus*	Beryx decadactylus
BDU	*Bathypterois dubius*	Spiderfish
BER	*Gaidropsarus macrophthalmus*	Big-eyed Rockling
BFE	*Bathysaurus ferox*	Bathysaurus ferox
BFI	*Capros aper*	Boar Fish
BGL	*Benthosema glaciale*	Benthosema glaciale
BIN	*Benthalbella infans*	Zugmayer's pearleye
BLF	*Centrolophus niger*	Blackfish
BLI	*Molva dypterygia*	Blue Ling
BLM	*Helicolenus dactylopterus*	Blue-mouth
BMD	*Galeus melastomus*	Black Mouthed Dogfish
BMI	*Bathytroctes microlepis*	Smallscale Smoothhead
BNI	*Bathylaco nigricans*	Black Warrior
BOA	*Borostomias antarcticus*	Borostomias antarcticus
BOU	*Borostomias unidentified*	Snaggletooths unidentified
BSC	*Aphanopus carbo*	Black Scabbardfish
BSE	*Notacanthus bonapartei*	Bonaparte's Spiny Eel
BUL	*Epigonus telescopus*	Bullseye

BWH	*Micromesistius poutassou*	Blue Whiting
CAU	*Cataeyx sp*	Cataetyx unidentified
CBL	*Schedophilus medusophagus*	Cornish Blackfish
CCR	*Centroscymnus crepidater*	Longnose velvet dogfish
CDA	*Limanda limanda*	Common Dab
CEE	*Conger conger*	Conger Eel
CFA	*Centroscyllium fabricii*	Black dogfish
CGR	*Centrophorus granulosus*	Gulper shark
CHI	*Chimaera monstrosa*	Rabbit Ratfish
CHO	*Ceratias holboelli*	Ceratias holboelli
CHS	*Chauliodus sloani*	Sloan's Viperfish
CLA	*Cataetyx laticeps*	Cataetyx laticeps
CNR	*Chiasmodon niger*	Chiasmodon niger
COC	*Caelorinchus caelorinchus*	Hollowsnout Rat tail
COD	*Gadus morhua*	Cod
COP	*Chimaera opalescens*	Deepwater Rabbitfish
CPI	*Chaunax Pictus*	Pink Frogmouth
CPL	*Chirostomias pliopterus*	Chirostomias pliopterus
CRA	*Leucoraja naevus*	Cuckoo Ray
CSE	*Notacanthus chemnitzii*	Chemnitz's Spiny Eel
DAE	*Histiobranchus bathybius*	Deepwater arrowtooth eel
DAR	*Diretmus argenteus*	Diretmus argenteus
DCH	*Scymnorhinus (Dalatias) licha*	Darkie Charlie
DEA	*Trachipterus arcticus*	Dealfish
DFU	*Stomiidae*	Dragonfish unidentified
DOE	*Nessorhamphus inglofianus*	Duckbill oceanic eel
DPR	*Deania profundorum*	Arrowhead Dogfish
DRA	*Callionymus lyra*	Dragonet
EBA	*Evermmanella balbo*	Balbos Sabretooth
EPR	*Etmopterus princeps*	Greater lantern shark
EPU	*Zoarcidae*	Eelpout (unidentified)
FBF	*Neocyttus helgae*	False Boarfish
FCA	*Pseudotriakis microdon*	False Catshark
FME	*Lepidorhombus boscii*	Four-spot Megrim
FRA	*Rajella fyllae*	Fylla's Ray
FRO	*Benthodesmus simonyi*	Frostfish
GAR	*Argentina silus*	Greater Argentine
GBA	*Gonostoma bathyphilum*	Gonostoma bathyphilum
GFO	*Phycis blennoides*	Greater Forkbeard
GGR	*Coryphaenoides guentheri*	Gunther's grenadier
GGU	*Eutrigla gurnardus*	Grey Gurnard
GHA	*Reinhardtius hippoglossoides*	Greenland Halibut
GLO	*Gadomus longifilis*	Gadomus longifilis
GMU	*Galeus murinus*	Mouse catshark
GOE	*Gonostoma elongatum*	Gonostoma elongatum
HAD	*Melanogrammus aeglefinus*	Haddock
HAF	*Halargyreus johnsonii*	Halargyreus johnsonii
HAK	*Merluccius merluccius*	Hake

HAL	*Hippoglossus hippoglossus*	Halibut
HAM	*Halosauropsis macrocir*	Halosauropsis macrochir
HAN	*Holtbyrnia anomala*	Bighead searsid
HAT	*Argyropelecus olfersi*	Hatchetfish
HAU	*Sternoptychidae*	Hatchet fish unidentified
HER	*Clupea harengus*	Herring
HMA	*Trachurus trachurus*	Horse Mackerel (Scad)
HME	*Hoplostethus mediterraneus*	Silver roughy
HMI	*Hydrolagus mirabilis*	Large-eyed Rabbitfish
HOM	*Holtbyrnia macrops*	Bigeye searsid
HOS	*Howella sherborni*	Howella sherborni
HPA	*Hydrolagus pallidus*	Hydrolagus pallidus
HRA	*Hariotta raleighana*	Bentnose rabitfish
HYA	*Hydrolagus affinis*	Smalleye rabbitfish
IBL	*Ilyophis blachei*	Ilyophis blachei
IGR	*Hymenocepahalus italicus*	Italien Grenadier
JCA	*Anarhichas denticulatus*	Jelly Cat
JSC	*Nesiarchus nasutus*	Johnson's Scabbardfish
KRA	*Raja kreffti*	Krefft's ray
KSE	*Searsia koefoedi*	Koefoed's searsid
LAM	*Lampanyctus spp*	Lampanyctus spp
LAR	*Argentina sphyraena*	Lesser Argentine
LAT	*Lycodes atlanticus*	Lycodes atlanticus
LAU	*Myctophidae (Lantern fishes)*	Lantern fishes (unidentified)
LBA	*Notolepis rissoi Kroyeri*	Lesser Barracudina
LCR	*Pachycara crassiceps*	Pachycara crassiceps
LEQ	*Lepidion eques*	Lepidion eques
LFA	*Lycodonus flagellicauda*	Lycodonus flagellicauda
LFU	*Gonostomatidae*	Lightfish unidentified
LIN	*Molva molva*	Ling
LLA	*Laemonema latifrons*	Laemonema latifrons
LNS	*Dipturus oxyrinchus*	Long Nosed Skate
LOC	*Eledone cirrhosa*	Lesser Octopus
LPA	*Lycodes pallidus*	Lycodes pallidus
LRD	*Hippoglossoides platessoides*	Long Rough Dab
LSA	*Lycenchelys sarsii*	Lycenchelys sarsii
LSD	*Scyliorhinus canicula*	Lesser Spotted Dogfish
LSH	*Conocara macroptera*	Longfin somooth-head
LSM	*Alepocephalus rostratus*	Lesser Smoothhead
LSO	*Microstomus kitt*	Lemon Sole
LSP	*Lampadena speculigera*	Lampadena speculigera
LSQ	*Centrophorus squamosus*	Leafscale Gulper Shark
LSS	*Somniosus rostratus*	Lesser sleeper shark
LYB	*Lyconus brachycolus*	Lyconus brachycolus
LYU	*Lycodes sp*	Lycodes unidentified
MAC	*Scomber scombrus*	Mackerel
MAT	*Melanostigma atlanticum*	Melanostigma atlanticum
MAU	*Maulisia mauli*	Maulisia mauli

MBE	*Macrourus berglax*	Rough Rat tail
MEG	*Lepidorhombus whiffiagonis*	Megrim
MEM	*Melamphaes microps*	Melamphaes microps
MEU	*Melanostomiidea*	Scaleless d'fish unident.
MGR	*Chalinura mediterranea*	Mediterranean grenadier
MLA	*Malacocephalus laevis*	Softhead Rat tail
MLU	*Melamphaidae sp*	Melamphaidae unidentified
MNI	*Malacosteus niger*	Malacosteus niger
MOR	*Mora moro*	Mora
MSE	*Normichthys operosus*	multipore searsid
MSH	*Rouleina maderensis*	Madeiran smooth-head
MSU	*Melamphaes suborbitalis*	Melamphaes suborbitalis
MUC	*Conocara murrayi*	Conocara murrayi
MYC	*Lampanyctus crocodilus*	Lampanyctus crocodilus
MZU	*Melanonus zugmayeri*	Melanonus zugmayeri
NAE	*Nezumia aequalis*	Smooth Rat tail
NEU	*Neoscopelidae (family)*	Neoscopelidae (family)
NGA	*Nansenia groenlandica*	Greenland Argentine
NHA	*Sebastes viviparus*	Norway Haddock
NLO	*Nephrops norvegicus*	Norway Lobster
NOB	*Nansensia oblita*	Forgotten Argentine
NOE	*Notoscopelus elongatus*	Notoscopelus elongatus
NPO	*Trisopterus esmarki*	Norway Pout
OMM	*Ommastrephidae*	Short Finned Squid
OPS	*Opisthoproctus soleatus*	Opisthoproctus soleatus
ORO	*Hoplostethus atlanticus*	Orange Roughy
PAA	*Paralepis atlantica*	Paralepis atlantica
PAP	*Platytroctes apus*	Legless searsid
PAS	*Cottunculus thomsonii*	Pallid sculpin
PAU	*Pandalus sp*	Pandalus sp.
PBA	*Paraliparis bathybius*	Paraliparis bathybius
PCA	*Poromitra capito*	Poromitra capito
PCO	*Trisopterus minutus*	Poor Cod
PEA	*Maurolicus muelleri*	Pearlsides
PEE	*Eurypharynx pelecanoides*	Pelican eel
PEF	*Echiodon drummondi*	Pearlfish
PHU	*Photichthyidae*	Photichthyidae sp.
PLA	*Pleuronectes platessa*	Plaice
PLU	*Paraliparis (unidentified)*	Paraliparis (unidentified)
PMI	*Pachystomias microdon*	Pachystomias microdon
POB	*Pachycara obesa*	Pachycara obesa
POC	*Polymetme corythaeola*	Polymetme corythaeola
POP	*Platyberyx opalescens*	Platyberyx opalescens
PSH	*Centroscymnus coelolepis*	Portuguese Shark
RAA	*Rouleina attrita*	Softskin smooth-head
RAK	*Raja kukujevi*	Raja kukujevi
RAR	*Rajella ravidula*	Smoothback Skate
RAT	*Rhinochimaera atlantica*	Straightnose rabbitfish

RAU	*Chimaera unidentified*	Chimaera unidentified
RBA	*Raja bathyphila*	Deepwater Ray
RBE	*Brama brama*	Ray's Bream
RBI	*Rajella bigelowi*	Bigelow's ray
RBU	*Bathyraja spp*	Bathyraja (unidentified)
RED	*Sebastes marinus marinus*	Redfish (marinus)
RIB	*Regalecus glesne*	Ribbonfish
RJE	*Amblyraja jensenii*	Shorttail Skate
RLO	*Rondeletia loricata*	Redmouth Whalefish
RNG	*Coryphaenoides rupestris*	Round Nosed Grenadier
RRA	*Bathyraja richardsoni*	Richardson's ray
RSE	*Polyacanthonotus rissoanus*	Risso's Spiny Eel
RTG	*Nezumia sclerorhynchus*	Nezumia sclerorhynchus
RTU	*Macrouridae (Rat tails)*	Rat tails (unidentified)
RUN	*Phycinae*	Rocklings (unidentified)
SAI	*Pollachius virens*	Saithe
SAR	*Leucoraja circularis*	Sandy Ray
SBD	*Serrivomer brevidentatus*	Black Sawtoothed Eel
SBE	*Serrivomer beani*	Bean's sawtoothed eel
SBF	*Stomias boa ferox*	Stomias boa ferox
SBI	*Scopelogadus beanii*	Scopelogadus beanii
SDR	*Callionymus maculatus*	Spotted Dragonet
SEE	*Nemichthys scolopaceus*	Snipe Eel
SGR	*Spectrunculus grandis*	Spectrunculus grandis
SGS	*Hexanchus griseus*	Six Gilled Shark
SHS	*Deania calceus*	Shovelnosed Shark
SKA	*Dipturus batis*	Skate
SKU	*Rajidae (Skates & Rays)*	Skates (unidentified)
SLE	*Scopelosaurus lepidus*	Scopelosaurus lepidus
SMM	*Sebastes marinus mentella*	Redfish (mentella)
SMO	*Alepocephalus bairdii*	Smoothhead
SNE	*Simenchelys parasitica*	Snubnosed eel
SPI	*Entelurus aequoreus*	Snake Pipefish
SPO	*Gadiculus argenteus thori*	Silvery Pout
SPU	*Squalus acanthias*	Spurdog
SPY	*Raja montagui*	Spotted Ray
SQU	*Squids*	Squids (unidentified)
SRA	*Leucoraja fullonica*	Shagreen Ray
SRI	*Scymnodon ringens*	Knifetooth dogfish
SRO	*Gaidropsarus argentatus*	Silvery Rockling
SSG	*Caelorinchus labiatus*	Spear-snouted grenadier
SSI	*Sagamichthys schnakenbecki*	Schnakenbeck's searsid
SYK	*Synaphobranchus kaupi*	Cut-throat Eel
TBR	*Gaidropsarus vulgaris*	Three-bearded Rockling
TCR	*Trachyscorpia cristulata*	Spiny scorpionfish
TMU	*Trachyrhynchus murrayi*	Murray's Rat tail
TOR	*Brosme brosme*	Torsk
TRA	*Raja clavata*	Thornback Ray

TRM	*Trigonolampa miriceps*	Trigonolampa miriceps
VBE	*Etmopterus spinax*	Velvet Belly
VPR	*Venifica proboscidea*	Whipsnout sorcerer
WHH	*Myxine ios*	White Headed Hagfish
WHI	*Merlangius merlangus*	Whiting
WIT	*Glyptocephalus cynoglossus*	Witch
XCI	*Xenodermichthys copei*	Bluntsnout smoothead

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