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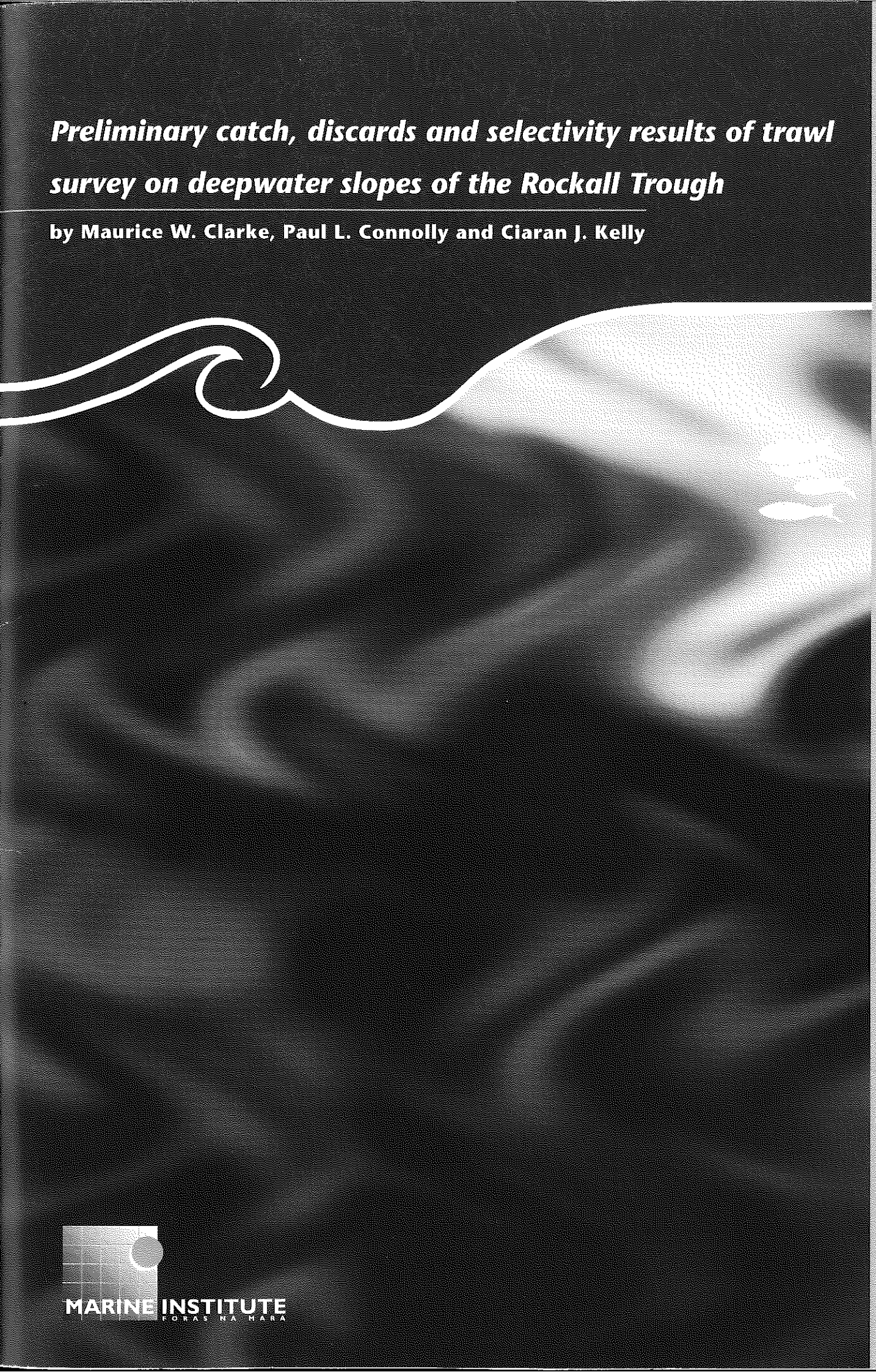

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PRELIMINARY CATCH, DISCARDS AND SELECTIVITY RESULTS OF TRAWL SURVEY ON DEEPWATER SLOPES OF THE ROCKALL TROUGH

by

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SUMMARY

A deepwater trawl survey programme has been operated since 1993 by the Fisheries Research Centre (FRC) in the deep waters of the Rockall Trough and Porcupine Bank. The present survey took place over a period of 10 days in October and November 1997 on the eastern and southern slopes of the Rockall Trough from 54°N to 59°N. Fishing was carried out in five separate areas, in four depth strata: 500–700 m, 700–900 m, 900–1100 m and 1100–1300 m. The primary objective of the survey was to obtain samples of chondrichthyan and teleost fish for the FRC deepwater research programme, for contaminant analysis of fish by the FRC chemistry section and for food technology analysis at the Teagasc National Food Centre. The survey was carried out on a commercial trawler using commercial deepwater demersal otter trawl gear. In total 15 species of chondrichthyan, 41 species of teleost fish and 5 species of cephalopods were taken. Among the most abundant species in the catch were roundnose grenadier, Portuguese dogfish, leafscale gulper shark, and Baird's smoothhead. Over the entire survey discarding was estimated as 50.5% of the total catch. Discard rates expressed as kg discarded per tonne roundnose grenadier landed and as a percentage of the total catch when compared with those of previous years showed no appreciable change. The main species discarded were rabbitfish, birdbeak dogfish, Baird's smoothhead, roundnose grenadier and *Lepidion eques*. Catch per unit effort rates expressed as kg caught per hour fished compared with rates for previous trawl surveys showed marked declines. Length frequency distributions for the main chondrichthyan species showed absence of smaller individuals from the samples and sexual dimorphism with respect to length. Attachment of fine-mesh cod-end liner suggested that the commercial gear selects all length frequencies present and that mesh size may not be an effective management measure in this fishery. This leaflet documents the survey and presents some preliminary results. The data from this survey are currently under analysis at the FRC and results will be published in the scientific literature.

INTRODUCTION

The FRC commenced a deepwater survey programme in 1993, and to date four trawl and two longline surveys have been completed in the deep waters to the west of Ireland and Scotland (Table 2). The purpose of these surveys has been to secure samples of deepwater teleost and chondrichthyan fish for the Marine Institute deepwater fisheries programme. Deepwater fish stocks are currently the subject of considerable fishing effort, and there are no effective management measures in place. The work is focused on providing the basic biological information necessary for future management of the fishery. The differences in species composition, abundances and discarding levels between trawl and longline gears were also investigated. A preliminary investigation of the selectivity of the commercial trawl gear used was conducted during this survey and is discussed in more detail below. A review of the surveys to date and a discussion of the results are contained in Kelly *et al.* (1998). The survey programme also secures samples for contaminant analyses and food tests by the National Food Centre of Teagasc.

This leaflet gives the preliminary results of a deepwater trawl survey conducted off the northwest coast of Ireland and west of Scotland, to obtain information on distributions of chondrichthyan and teleost fish, examine the rate of discarding, and conduct a preliminary investigation of the selectivity of the commercial trawl gear. The target species were roundnose grenadier, the main commercial species in this area, along with deepwater shark, black scabbard and Baird's smoothhead.

PERSONNEL

Maurice Clarke (Chief Scientist)	Marine Institute
Michael Fitzpatrick	Marine Institute
Colm Lordan	Aquaculture Development Centre, U.C.C.

MATERIALS AND METHODS

The vessel used for this survey was the *Mary M*, 34.8 × 9 × 4.5 m steel trawler of 516 GRT and 1,700 hp based at Killybegs, Co. Donegal. The fishing gear consisted of two commercial deep-water trawls with 105 mm mesh cod-end and a ground gear of length 23 m, with bobbins of 40 cm. The headline incorporated 120 × 20 cm deep water floats and the bridles comprised 92 m of singles and 46 m of doubles. One of the trawls had attached a cod-end liner of 25 mm mesh size. Hauls ranged in duration from 135 to 380 minutes. At each station the haul number, latitude, longitude and depth of shoot and haul position, and the length of warp deployed were recorded. The bottom type was monitored by means of an echo sounder and gear configurations using Scanmar® equipment.

Four hours was the preferred towing duration. However, due to local conditions and weather, it was not always possible to adhere to that time period. In the five areas (Fig. 1), trawling was carried out in the following depth strata; 500–700 m, 700–900 m, 900–1100 m and 1100–1300 m. At Stations 14 and 15 and at Stations 17 and 18 the same positions were fished first with the cod-end liner attached and then without it. The position, depth and duration of the hauls completed during the survey are given in Table 2.

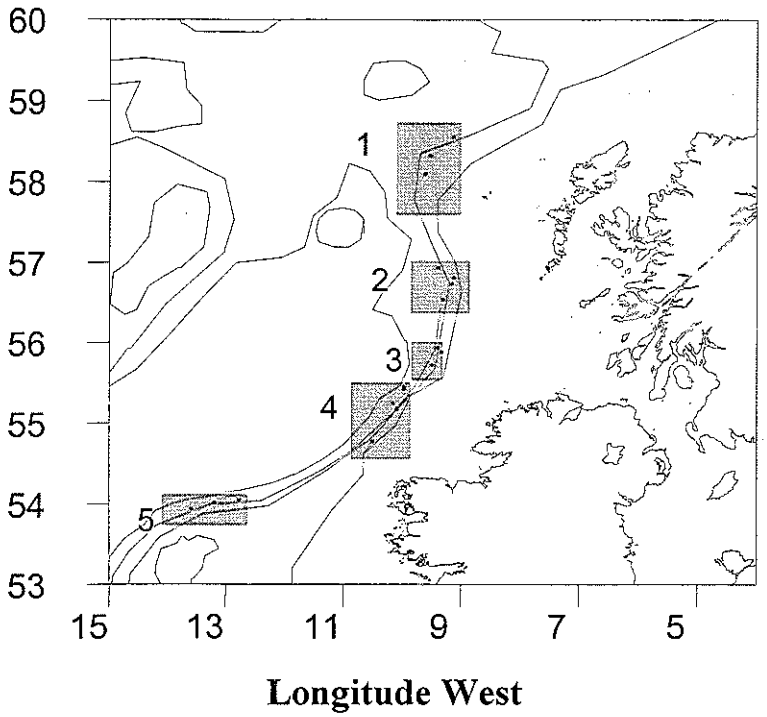

Figure 1. Shoot positions for Trawl Survey of eastern and southern slopes of the Rockall Trough in 1997.

After hauling the gear the catch was discharged onto the stern fish deck. Fish of commercial value were removed from the stern pond for gutting and washing by the crew. Deepwater shark species along with black scabbard and rabbitfish were removed from the catch by the scientific personnel. Fish were identified using several textbooks (Compagno, 1984; Whitehead *et al.*, 1984–1986). Specimens that could not be identified on board were frozen for future laboratory identification at the Marine Institute. A species list for the survey is given in Table 1. Deepwater sharks, black scabbard, rabbitfish and Baird's smoothhead were given priority, in that order, for the purposes of obtaining length, weight, sex, maturity and age information. Otoliths were stored dry, vertebral centra and dorsal fin spines were stored in 70% alcohol and gonads and stomachs were stored in 4% buffered formalin.

Total length was used for all species with the exception of grenadiers and rabbitfish. Pre-anus length was used for the rabbitfish and pre-anal-fin length was used for grenadier species. Both pre-anus and pre-anal-fin length were measured for roundnose grenadier in order to obtain a conversion factor. This was required since, in previous surveys, pre-anus length for this species was the measurement taken.

Discards were placed in baskets, and the number of baskets was recorded in each case. A representative sample of the discard was taken, weighed and separated according to species. Total length, pre-anus length or pre-anal-fin length – where appropriate – were measured, along with total weight per species. Otoliths were taken from five fish from each centimetre length class. Where weights were not taken, length weight regressions (Coull *et al.*, 1989) were used to estimate weight.

Fillets of a wide range of species of fish, along with specimens of crustaceans and cephalopods were frozen for food science analysis by the Teagasc National Food Centre. Specimens were also taken and frozen for the Marine Institute Chemistry Section for contaminant analysis.

RESULTS

TRAWL SURVEY LOG

DAY 1; 29 OCTOBER 1997

The *Mary M* departed Killybegs at 07:00 h and proceeded to Area 1.

DAY 2; 30 OCTOBER 1997

Fishing commenced (Station 1) at 08:00 h in 673 m of water. The weather was good (wind force 3–4 south-westerly). A Spanish longliner was working to the east of the survey vessel, at a depth of 500 m. The commercial catch consisted of grenadier (125 kg), with rabbitfish and greater argentine comprising the majority of the discards.

The second tow (Station 2) was begun at a depth of 860 m. The weather continued to be good. The ground was soft with some stones. Some gear damage was sustained. Catch was small, 50 kg roundnose grenadier, which also was the main discard species along with greater argentine and rabbitfish.

The net for Station 3 in area one was shot and hauled at 1150 m and 1167 m, respectively. Wind slackened off to a force 3. The commercial catch amounted to 150 kg with 638 kg of discards.

DAY 3; 31 OCTOBER 1997

Fishing at Station 4 was completed at 09:30 h at a depth of 965 m. The wind had strengthened to 5. Commercial catch (650 kg) consisted of roundnose grenadier, monkfish and blue ling. The main discard species was black scabbard and discards amounted to 348 kg.

Steamed to Area 2 where the first tow (Station 5) was begun at 18:10 h in 1000 m of water and hauled from 1050 m. Again roundnose grenadier dominated the catch with 1.5 boxes of black scabbard also. The greatest depth trawled in this area was 1100 m (Station 6) with a low catch of roundnose grenadier and black scabbard. A French trawler was observed in the area between the two previous stations; no other boats were seen in this area. No tow was completed in the depth range 500–700 m owing to a lack of positions on the boat's plotter.

DAY 4; 1 NOVEMBER 1997

Shot at 06:00 h at a depth of 880 m and hauled from 910 m (Station 7). The small catch was dominated by roundnose grenadier.

Weather good, wind force 3. Began area 3 after a steam of 58 km. The deepest station (No 8) was shot at 1150 m, the ground was level with mud and stones. This was the first tow for which the small mesh cod end liner was attached. The increase in bulk of discards and number of species was obvious, with roundnose grenadier, *Lepidion eques* and Baird's smoothhead accounting for the bulk of the catch.

The next tow, Station 9, was shot at a depth of 950 m. The skipper commented on how few boats were present in an area where there used to be more in previous years. The weather continued to be good.

DAY 5; 2 NOVEMBER 1997

Station 10 was shot at 1150 m. The ground and weather (wind force 2) were ideal and roundnose grenadier, blue ling and monk were the main commercial species in the catch (450 kg) *Lepidion eques*, rabbitfish and roundnose grenadier were the main discards. The entire catch was measured for the first time on this haul.

The ground was very hilly for the shallowest haul (550–680 m) at Station 11, wind force 3–4, and the marketable catch was mainly blue ling, roundnose grenadier and monk but quantities were very low.

Steamed to Area 4. The first station in Area 4 was trawled for 4 h , between 900 m and 950 m. Again the whole catch (450 kg) of grenadier, blue ling and black scabbard was measured. The weather continued to be good. There were 11 baskets of discards (estimated as 319 kg), mainly *L. eques* and roundnose grenadier.

The second tow, again using the fine mesh cod end liner, at 700 m was begun at 2050 h. The ground was muddy with some stones. Discards (estimated as 203 kg) comprised 10 species, predominantly roundnose grenadier, bluemouth rockfish, *Lepidion eques* and forkbeard. Commercial species were characteristic of shallower parts of the continental slope; hake, blue ling and forkbeard along with the roundnose grenadier. The commercial catch was estimated as 200 kg.

DAY 6; 3 NOVEMBER 1997

Comparative fishing was carried out at Station 14 in Area 4 by comparing the results with and without the cod end liner. The time interval between the two shots was 1 hour 50 minutes. Several large stones were trawled up in the first tow and the commercial catch consisted mainly of roundnose grenadier, black scabbard and squaliform sharks. Of the 13 discard species roundnose grenadier, rabbitfish and Murray's longsnout grenadier accounted for the greatest weights. In total the discards amounted to 14 baskets and a sample basket of 27.5 kg was taken. A comparative tow (Station 15) was undertaken at the position of the previous tow without the cod-end liner; the commercial catch was similar, while there were 12 baskets of discards. There were eight species in the discard sample in this case. The weather was calm.

A French trawler was working eastwards of the *Mary M* during the comparative trawling.

The net to which the cod end liner was attached had a headline height of 1.8 fathoms as opposed to 2.3 fathoms for the net without it. Burst headline floats were suspected to be the cause of this difference. The liner was transferred to the other net.

Began steaming to Area 5, northeasterly gales were forecast and it was decided to proceed to the farthest area while conditions remained favourable.

DAY 7; 4 NOVEMBER 1997

Arrived in Area 5 and shot at 02:00 h (Station 16). The gear was towed between 1158 and 1174 m and hauled at 06:00 h. The ground was level and wind was 5–6, northeasterly. The discards, of

which there were nine species, were dominated by roundnose grenadier, Murray's longsnout grenadier, and *Lepidion eques*. Total discards were estimated as 551 kg. The commercial catch consisted of roundnose grenadier, black scabbbard and one box of orange roughy. The net was shot at 1110 m and hauled at 1035 m at Station 17 with the cod-end liner attached. There were 24 baskets of discards, mainly roundnose grenadier and Baird's smoothhead, with the total discarding estimated as 696 kg with nine species present. The wind strengthened to force 7 north north easterly. This tow was repeated without the cod end liner (Station 18) Only five species of discards were recorded; again roundnose grenadier was the principal species along with Baird's smoothhead. Discards amounted to 25 baskets. Commercial species in this area were roundnose grenadier, orange roughy and black scabbard.

Began steaming to Area 4 again since the skipper had no further plots for good tows in shallower water than those conducted already in Area 5. The weather continued to be poor.

DAY 8; 5 NOVEMBER 1997

Began shooting again in Area 4 (Station 19) at 08:15 h at a depth of 520 m. The tow duration was 3 h and there was some gear damage; the ground was hard and hilly. The catch amounted to one basket, there being considerable damage to the cod-end. Wind was force 5–6, gusting to 7.

The boat moved east to Station 20, and shot, again on hard ground, at 14:30 h. The weather continued to be variable, winds force 6–7. The cod-end liner was deployed and 12 baskets of discards (estimate 348 kg) were counted, mainly rabbitfish and *Lepidion eques*. The commercial catch consisted of hake, tusk, forkbeard and roundnose grenadier all typical of the depth range fished at this station (650–700 m). However, there was damage to the wing of the net, which would have required several hours of repairs. The second net was used thereafter.

After steaming northeast along the slope Station 21 was shot at 1000 m. Owing to a read failure of the Decca Plotter there were few good tows to chose from. The landings consisted mainly of blue ling, roundnose grenadier and black scabbard, with discards estimated as 319 kg. The cod-end liner was not attached. There were French boats fishing in the area, but in shallower water than the survey vessel. There was further gear damage.

DAY 9; 6 NOVEMBER 1997

The final tow, Station 22 was begun at 03:25 h and hauled at 07:30 h. The gear was severely damaged with the cod-end being badly torn. There was also damage to the wings, no catch.

The survey was terminated at this point. The *Mary M* began the steam home at 08:15 h. The vessel berthed in Killybegs at 15:30 h.

DAY 10; 7 NOVEMBER 1997

Samples catalogued. Equipment and samples loaded onto van and transported to FRC.Freezer returned to Fisheries Laboratory, Killybegs.

CATCH DATA

Catch per unit effort (CPUE) was calculated in kg/h of fishing for each species. CPUE values for some of the most abundant teleost and chondrichthyan fish and their respective depth ranges are given in Table 4. Discarding rates for each species were calculated as kg per tonne of roundnose grenadier landed. This was chosen as the most important commercial species in the area and the

target of the French deepwater fishery. Discard rates per haul, expressed as kg per tonne roundnose grenadier for the more abundant discard species are given in Table 5. Discard rates were also calculated as a percentage of the total catch (kg) and are reported for the more abundant species by haul (Table 6).

Length frequency distributions for the three most abundant shark species are given by sex in Figure 2. Counts per cm length class for each commercial species were raised to the total catch and Figure 3 shows length frequency distributions for three of these species. Figure 4 shows length frequency distributions for three discard species. Figures 3 and 4 are based on counts raised to the total catch for each station. Results of measurements of landings and discards (Figure 5) are based on the comparative tows with and without the cod-end liner at Stations 14/15 and 17/18.

DISCUSSION

Sexual dimorphism with respect to length is apparent from the length frequencies of the squaliform sharks, with females attaining greater total lengths. For Portuguese dogfish the males tended to be smaller than the females, while in the case of birdbeak dogfish both smaller and larger females were found. In the cases of both leafscale gulper shark and birdbeak dogfish no gravid females were obtained. The modal length range for females was less than that for males of leafscale gulper shark, which suggests that females sampled during this survey were mostly immature.

Comparisons of the CPUE rates for various species with those of previous surveys have shown a marked decline by comparison with previous survey data (Connolly and Kelly, 1996; Kelly*et al.*, 1997). Catch rates for leafscale gulper shark showed a decrease each year since 1995. In that year CPUE was 900 kg/h for Area 3, in 1996 the corresponding rate was 66 kg/h while the rate for the

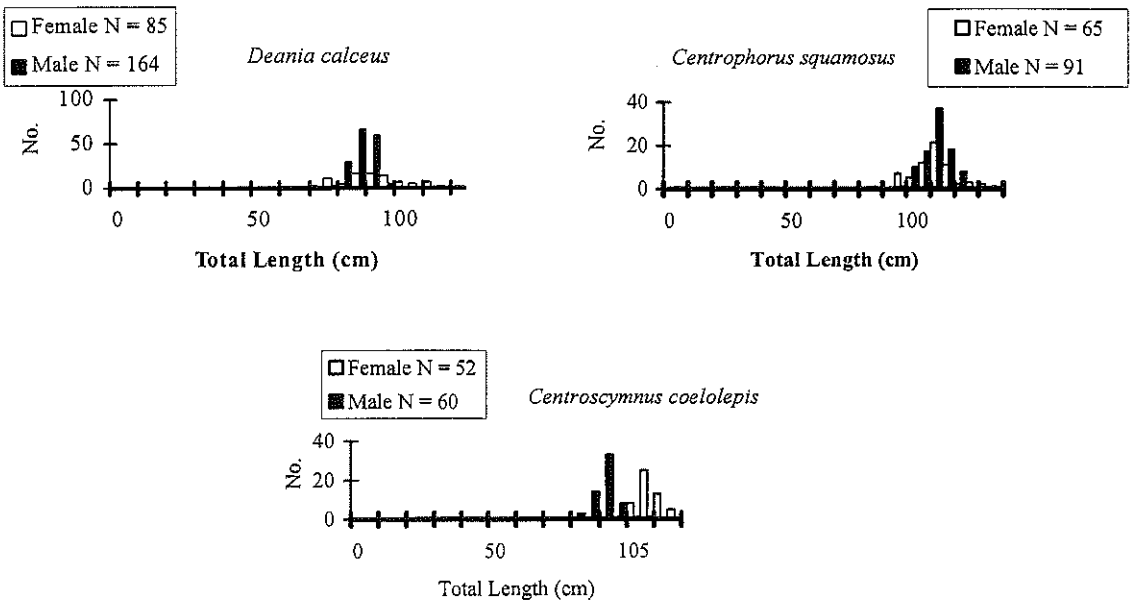

Figure 2. Length frequency for the three most abundant squaliform sharks.

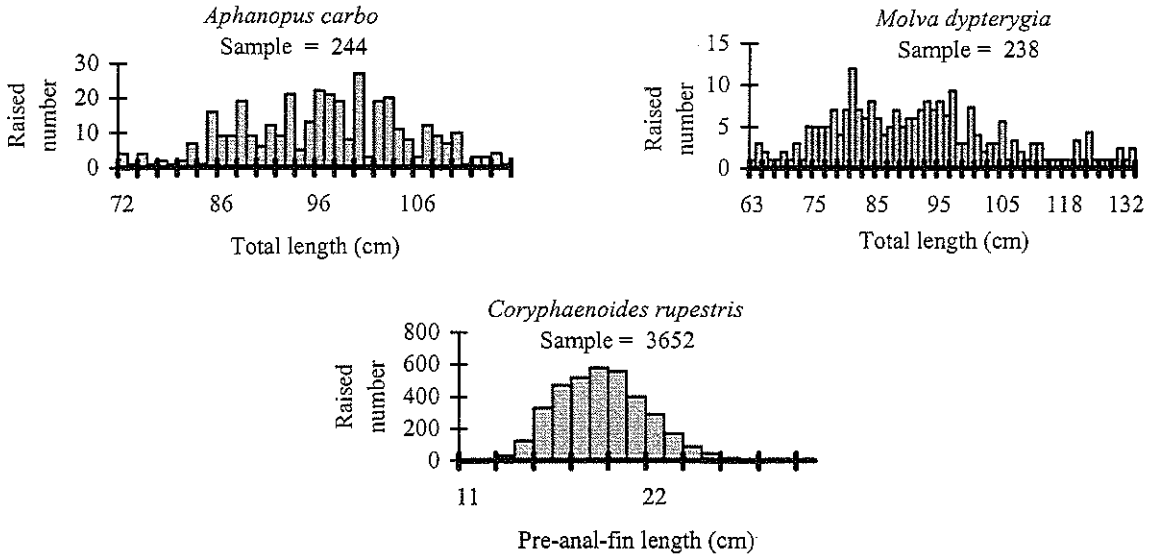

Figure 3. Length frequency for three commercial species based on counts raised to the total catch for each station.

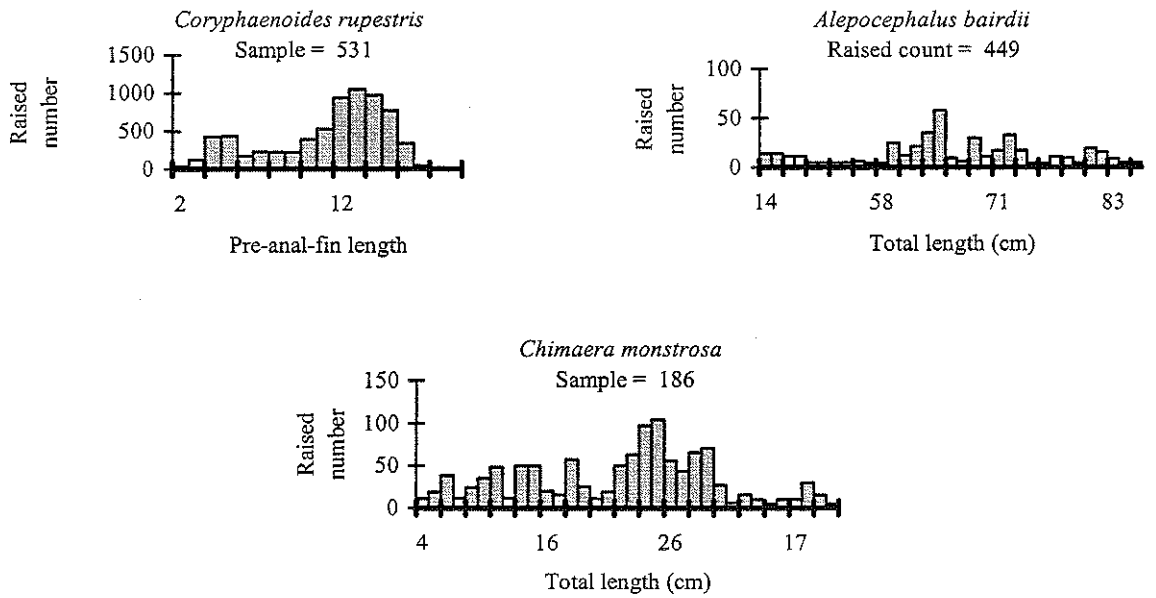

Figure 4. Length frequency for three discarded species based on counts raised to the total catch for each station.

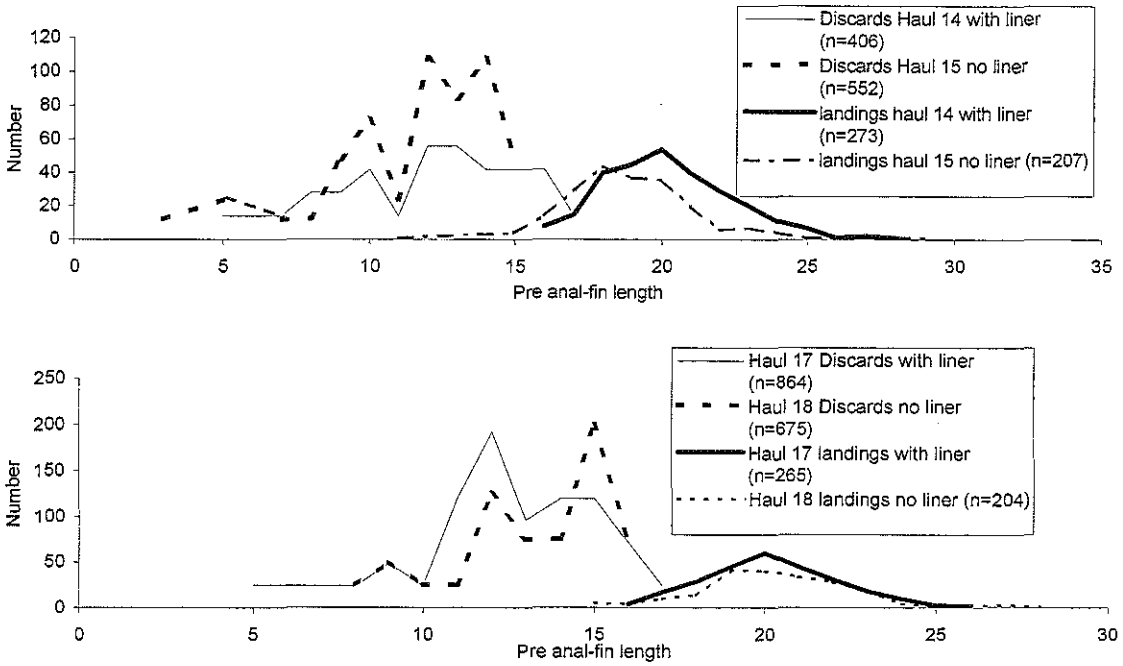

Figure 5. Length frequency of landed and discarded roundnose grenadier from two sets of repeat tows. Mesh of cod-end liner = 25 mm.

present survey was 19 kg/h. In 1995 three hauls were completed in this area while four were conducted here in each of the succeeding years. A similar trend was obvious with respect to Portuguese dogfish in Area 2 where the rate dropped from 1050 kg/h to 7 kg/h over these three years. However, only two stations were completed in this area in 1996, with three in each of 1995 and 1997. In the case of roundnose grenadier, the target species of the French fishery in this area, CPUE was down on the 1995 figures for all areas, although the figures for 1996 were higher than those for the present survey in Areas 2 and 3. The CPUE for Area 1 in 1995 was 1172 t, while in 1996 it was 116.2 t and had declined to 69 t in 1997. Rates for Baird's smoothhead have shown a decrease from 1230 kg/h in 1995 at Area 5 to 15 kg/h in 1997. The 1996 rate for this species in this area was 58 kg/h. The catch rate for another commercially important species, black scabbard is down on the 1995 and 1996 figures for Areas 1 and 3, while for Areas 4 and 5 the rate showed no appreciable change between 1996 and 1997. While these CPUE rates are based on very few hauls, they point towards a downward trend in abundance in the areas for which three years' data are now available.

Discarding levels during the survey were broadly comparable with those of the previous deepwater trawl survey (Kelly *et al.*, 1997). When the raised weights for the discards are expressed as a percentage of the total catch the discarding rate is 50.5%. The total reported landings of roundnose grenadier in ICES Areas VI and VII have remained constant since 1991 at between 7000 and 8500 tonnes per annum (Anonymous, 1998). Based on the latter discard value and using the discard rate for birdbeak dogfish in kg per tonne roundnose grenadier landed, the total discarding of birdbeak dogfish in Areas VI and VII may be as high as 1049 tonnes per annum.

Only two comparative trawls were conducted during the survey. If we assume that the cod-end liner used in the experiment selected all size classes, then by comparison the selectivity of the commercial trawl gear may be investigated. Two distinct length modes representing the landings and the discards of roundnose grenadier (Fig. 5) are evident. Length distributions in both cases are similar, suggesting that mesh size regulations may not be an effective management tool (Kelly*et al.*, 1998)

The results of analyses of cephalopods sampled during the survey are reported in Lordan (1997) and Lordan (*in prep.*). Food technology studies are the subject of ongoing work by Teagasc at the National Food Centre (Anonymous, 1995; Gormley *et al.*, 1994) and further results will be published in the scientific literature.

ACKNOWLEDGEMENTS

The skipper and crew of the *Mary M* made this survey a success; their hard work and experience are gratefully appreciated. This survey was funded from the Marine Institute Deep Water Fisheries Programme. Colm Lordan is acknowledged for identification of the cephalopods.

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Table 1. Species identified on the 1997 deep water trawl survey. Classification after Whitehead *et al.* (1984–1986) and Compagno (1984).

CHONDRICHTHYANS	CHONDRICHTHYES
Squaliform sharks	**Squalidae**
Leafscale gulper shark	*Centrophorus squamosus*
Portuguese dogfish	*Centroscymnus coelolepis*
Birdbeak dogfish	*Deania calceus*
Longnose velvet dogfish	*Centroscymnus crepidater*
Velvet belly	*Etmopterus spinax*
Greater lantern shark	*Etmopterus princeps*
Kitefin shark	*Dalatias licha*
Rough Sharks	**Oxynotidae**
Sailfin Rough Shark	*Oxynotus paradoxus*
Catsharks	**Scyliorhinidae**
Blackmouth catshark	*Galeus melastomus*
Iceland catshark	*Apristurus laursonii**
Rays	**Rajidae**
Round Ray	*Raja fyllae*
Norwegian skate	*Raja nidarosiensis*
Sandy ray	*Raja circularis*
Blue ray	*Breviraja caerulea*
Chimaeras	**Chimaridae**
Rabbitfish	*Chimaera monstrosa*

TELEOSTS	TELEOSTOMI
Smoothheads	**Alepocephalidae**
Baird's smoothhead	*Alepocephalus bairdii*
Risso's smoothhead	*Alepocephaus rostratus*
Southern Atlantic smoothhead	*Alepocephalus australis*
Bluntsnout smoothhead	*Xenodermichthyes copei*
Argentines	**Argentinidae**
Greater argentine	*Argentina silus*
Barracudinas	**Paralepidae**
Paralepis sp.	
Arrowtooth eels	**Synaphobranchidae**
Kaup's arrowtooth eel	*Synaphobranchus kaupi*
Loosejaws	**Malacosteidae**
Photostomias guernii	
Spiny eels	**Notocanthidae**
Shortfin spiny eel	*Notocanthus bonapartii*
Smallmouth spiny eel	*Polyacanthonotus rissoanus*
	Melanonidae
	Melanonus zugmayeri
	Caristiidae
	Platyberyx opalescens
Grenadiers	**Macrouridae**
Roundnose grenadier	*Coryphaenoides rupestris*
Murray's longsnout grenadier	*Trachyrynchus murrayi*
Spear-snouted grenadier	*Coelorhynchus occa*
Blackspot grenadier	*Coelorhynchus coeloryhnchus*
Smooth grenadier	*Nezumia aequalis*

TELEOSTS	TELEOSTOMI
Morids	**Moridae**
Morid cod	*Mora moro*
	Lepidion eques
	Halargyreus jonsonii
Codfish	**Gadidae**
Greater forkbeard	*Phycis blennoides*
Tusk	*Brosme brosme*
Hake	*Merluccius merluccius*
Blue ling	*Molva dypterygia*
Blue whiting	*Micromistius poutassou*
Three-bearded rockling	*Gaidropsarus vulgaris*
Redfish	**Scorpanidae**
Bluemouth rockfish	*Helicolenus dactylpterus*
Spiny scorpionfish	*Trachyscorpia cristulata echinata*
Beaked redfish	*Sebastes mentella*
Large redfish	*Sebastes marinus*
	Apogonidae
Big eye	*Epigonus telescopus*
Roughies	**Trachthyidae**
Orange Roughy	*Hoplostethus atlanticus*
Scabbards	**Trichuridae**
Black scabbard	*Aphanopus carbo*
Snake macherels	**Gemplydae**
Snake Mackerel	*Nessiarchus nassutus*
Fatheads	**Psychrolutidae**
Pallid sculpin	*Cottunculus thompsonii*
Anglerfish	**Lophidae**
Monkfish	*Lophius piscatorius*
Wolf-fish	**Anarhichidae**
Jelly Wolf-fish	*Anarhichas denticulatus*
Flatfish	**Pleuronectidae**
Witch	*Glyptocephalus cynoglossus*
Flatfish	**Scopthalmidae**
Megrim	*Lepidorhombus whiffagonis*
Four-spot megrim	*Lepidorhombus boscii*

CEPHALOPODS	CEPHALOPODA
Sea bat	*Opisthoteuthis grimaldii,*
Northern flying squid	*Todarodes sagittatus,*
Umbrella squid	*Histioteuthis bonnellii,*
	Bethoctopus ergasticus,
	Benthoctopus piscatorium
	Benthoctopus sp.
	Teuthowenia megalopws

Table 2. List of previous deepwater surveys carried out by the FRC.

Survey code	Boat	Gear	No. hauls	Date	Depth range (m)
MMIR130493	*Mary M*	Otter Trawl	48	04/93	201–915
MMIR010993	*Mary M*	Otter Trawl	47	09/93	196–1168
MIR011195	*Mary M*	Otter Trawl	26	11/95	740–1400
SSIR271195	*Sea Sparkle*	Longline	22	11–12/95	542–1332
MMIR160996	*Mary M*	Otter Trawl	26	09/96	560–1102
SKIR020897	*Skarheim*	Longline	32	08/97	292–2925

Table 3. Station positions for deepwater trawl survey by M.F.V. *Mary M* 29 October to 8 November 1997. An asterisk (*) indicates comparative hauls, in which the same positions were fished with and without cod-end liner.

Haul	Area	Fishing duration	Depth (m)		Position shot				Position hauled			
		(min)	Shot	Haul	Lat °N			Long °W	Lat °N			Long °8W
1	1	240	673	646.1	58	6	0	9 37 0	58	18	1	9 30 24
2	1	235	860	823	58	19	91	9 93 2	58	28	87	9 13 35
3	1	245	1150	1167	58	33	51	9 8 55	58	27	77	9 29 5
4	1	245	930	965	57	53	92		57	41	91	9 43 62
5	2	255	1000	1050	56	44	0	9 9 23	56	32	37	9 17 17
6	2	260	1100	1111	56	32	10	9 18 95	56	44	22	9 10 28
7	2	230	880	910	56	48	93	9 7 67	56	37	33	9 13 33
8	3	270	1115	1100	56	56	27	9 23 34	55	43	48	9 30 38
9	3	135	950	925	56	46	88	9 29 27	55	57	77	9 21 37
10	3	285	1150	1150	55	56	92	9 23 90	55	43	61	9 30 54
11	3	125	550	680	55	53	21	9 20 18	55	45	41	9 24 75
12	4	250	950	900	55	25	37	9 58 82	55	13	42	
13	4	225	700	700	55	11	28	10 6 9	55	24	61	9 58 13
14*	4	275	1100	1100	55	26	82	9 57 99	55	14	19	10 9 66
15*	4	230	1100	1100	55	15	17	10 9 49	55	26	70	9 59 36
16	5	240	1174	1158	54	3	69	12 46 51	54	2	74	13 8 75
17*	5	230	1110	1035	54	1	46	13 11 53	53	56	90	13 34 76
18*	5	380	1100	1100	53	56	79	13 35 76	54	1	28	13 14 96
19	4	190	520	565	54	46	95	10 30 48	54	55		10 19 30
20	4	185	650	700	55	10	16	10 5 96	55	20	79	10 0 43
21	4	277	1000	989	55	27	37	9 58 10	55	12	5	10 9 8
22	4	288	890	910	55	12	71	10 7 63	55	24	96	10 0 4

Table 4. Catch per unit effort kg per hour of fishing and depth for seven species caught during survey.

Area	Min. depth	Max. depth	Species	CPUE kg/h
1	930	930	*Alepocephalus bairdi*	42.72
	823	930	*Aphanopus carbo*	5.56
	640	823	*Argentina silus*	11.60
	823	1150	*Centrophorus squamosus*	10.67
	930	1150	*Centroscymnus coelolepis*	19.91
	640	1150	*Coryphaenoides rupestris*	56.69
	930	1150	*Deania calceus*	2.64
	1150	1150	*Etmopterus princeps*	2.24
2	1000	1100	*Alepocephalus bairdi*	35.93
	1000	1000	*Aphanopus carbo*	33.67
	880	1100	*Centrophorus squamosus*	24.32
	880	1100	*Centroscymnus coelolepis*	23.58
	880	1100	*Coryphaenoides rupestris*	83.98
	1000	1100	*Deania calceus*	2.85
	1000	1000	*Etmopterus princeps*	2.92
3	1100	1100	*Alepocephalus bairdi*	4.52
	925	1100	*Aphanopus carbo*	13.89
	550	550	*Argentina silus*	87.00
	925	1150	*Centrophorus squamosus*	19.98
	925	1150	*Centroscymnus coelolepis*	12.01
	550	1150	*Coryphaenoides rupestris*	132.82
	550	1150	*Deania calceus*	5.70
	925	1150	*Etmopterus princeps*	0.91
4	900	1100	*Alepocephalus bairdi*	16.04
	700	1100	*Aphanopus carbo*	15.10
	650	900	*Argentina silus*	4.29
	650	1100	*Centrophorus squamosus*	30.33
	1100	1100	*Centroscymnus coelolepis*	15.76
	650	1100	*Coryphaenoides rupestris*	82.43
	650	1100	*Deania calceus*	3.88
5	1035	1100	*Alepocephalus bairdi*	22.99
	1035	1158	*Aphanopus carbo*	25.33
	1035	1158	*Centrophorus squamosus*	4.98
	1035	1158	*Centroscymnus coelolepis*	25.51
	1035	1158	*Coryphaenoides rupestris*	169.24
	1035	1158	*Deania calceus*	36.29

Table 5. Discard rates expressed as per kg per tonne roundnose grenadier (*Coryphaenoides rupestris*).

Area	Species name	Discard weight sampled (kg)	Total discard weight (kg)	Total landed catch *C. rup* (kg)	Discard rate kg/tonne target spp.
1	*Alepocephalus bairdi*	26.92	174.44	789.04	221.08
	Argentina silus	19.86	92.66	789.04	117.43
	Chimaera monstrosa	118.63	339.51	789.04	430.28
	Coryphaenoides rupestris	29.53	133.14	789.04	168.74
	Deania calceus	21.58	21.58	789.04	27.35
	Etmopterus spinax	0.58	0.58	789.04	0.74
	Lepidion eques	2.06	9.31	789.04	11.80
2	*Alepocephalus bairdi*	66.76	309.65	833.92	371.32
	Centroscymnus crepidater	123.45	123.45	833.92	148.04
	Chimaera monstrosa	10.22	51.15	833.92	61.34
	Coryphaenoides rupestris	38.28	185.31	833.92	222.22
	Deania calceus	24.50	24.50	833.92	29.38
	Lepidion eques	1.42	6.39	833.92	7.66
3	*Alepocephalus bairdi*	1.68	20.33	1256.90	16.17
	Argentina silus	20.14	181.26	1256.90	144.21
	Chimaera monstrosa	10.10	116.28	1256.90	92.51
	Coryphaenoides rupestris	42.90	665.51	1256.90	529.48
	Deania calceus	57.44	57.44	1256.90	45.70
	Galeus melastomus	12.00	12.00	1256.90	9.55
	Lepidion eques	8.38	119.62	1256.90	95.17
4	*Alepocephalus bairdi*	19.26	213.94	1200.00	178.28
	Chimaera monstrosa	81.38	515.36	1200.00	429.47
	Coryphaenoides rupestris	44.02	535.28	1200.00	446.07
	Deania calceus	79.82	79.82	1200.00	66.52
	Galeus melastomus	2.04	2.04	1200.00	1.70
	Lepidion eques	27.34	316.10	1200.00	263.42
	Phycis blennoides	1.78	13.96	1200.00	11.63
5	*Centroscymnus crepidater*	109.50	109.50	900.00	121.67
	Coryphaenoides rupestris	60.50	1339.36	900.00	1488.18
	Deania calceus	431.28	431.28	900.00	479.20
	Halargyreus johnsoni	0.52	10.68	900.00	11.87
	Lepidion eques	4.06	99.18	900.00	110.20
	Raja fyllae	0.14	2.66	900.00	2.96
	Trachyrhyncus murrayi	1.78	38.50	900.00	42.78

Table 6. Discard rates expresssed as percentage of the total catch.

Area	Species	Discard weight sampled (kg)	Total discard weight (kg)	Total catch (kg)	Discard rate % total catch
1	*Alepocephalus bairdi*	26.92	174.44	2270.32	8
	Argentina silus	19.86	92.66	2270.32	4
	Centroscymnus crepidater	50.38	50.38	2270.32	2
	Chimaera monstrosa	118.63	339.51	2270.32	15
	Coryphaenoides rupestris	29.53	133.14	2270.32	6
	Deania calceus	21.58	21.58	2270.32	1
					0
2	*Alepocephalus bairdi*	66.76	309.65	2421.69	13
	Centroscymnus crepidater	123.45	123.45	2421.69	5
	Coryphaenoides rupestris	38.28	185.31	2421.69	8
	Deania calceus	24.50	24.50	2421.69	1
	Etmopterus princeps	12.42	12.42	2421.69	1
	Lepidion eques	1.42	6.39	2421.69	0
					0
3	*Alepocephalus bairdi*	1.68	20.33	3856.23	1
	Argentina silus	20.14	181.26	3856.23	5
	Chimaera monstrosa	10.10	116.28	3856.23	3
	Deania calceus	57.44	57.44	3856.23	1
	Epigonus telescopus	0.86	16.34	3856.23	0
	Lepidion eques	8.38	119.62	3856.23	3
					0
4	*Alepocephalus bairdi*	19.26	213.94	4674.64	5
	Centroscymnus crepidater	49.62	49.62	4674.64	1
	Chimaera monstrosa	81.38	515.36	4674.64	11
	Coryphaenoides rupestris	44.02	535.28	4674.64	11
	Deania calceus	79.82	79.82	4674.64	2
	Lepidion eques	27.34	316.10	4674.64	7
	Mora moro	0.10	0.70	4674.64	0
	Notacanthus bonapartei	0.02	0.22	4674.64	0
	Trachyrhyncus murrayi	5.08	68.36	4674.64	1
					0
5	*Centroscymnus crepidater*	109.50	109.50	4689.80	2
	Coryphaenoides rupestris	60.50	1339.36	4689.80	29
	Deania calceus	431.28	431.28	4689.80	9
	Halargyreus johnsoni	0.52	10.68	4689.80	0
	Lepidion eques	4.06	99.18	4689.80	2
	Raja fyllae	0.14	2.66	4689.80	0
	Trachyrhyncus murrayi	1.78	38.50	4689.80	1

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