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The potential impact of commercial fishing activity on the ecology of deepwater chondrichthyans from the west of Scotland

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Since the 1970s the deepwater shelf edge habitat west of the British Isles has been targeted by commercial fishers. The fishery is aimed at teleosts such as ling, black scabbardfish and roundnose grenadier. A smaller component of the catch is, however, composed of Chondrichthyes, i.e. the elasmobranchs (skates & rays) and holocephalans (chimaeras). Until the early 1990s these were discarded, but now they are either actively targeted or retained as by-catch and landed for human consumption. Elasmobranchs are particularly sensitive to high harvesting levels because of slow growth rates, high longevity and low fecundity. A recent combined assessment by ICES of the two most important commercial species, *Centroscymnus coelolepis* and *Centrophorus squamosus* indicated drastic decline to less than 50% original biomass. However, landings data are unreliable and fisheries independent, species-specific data that might be used to quantify the effects of fishing in these areas are sparse because of the technological challenges and expense involved in fishing to these depths. In this study, data from scientific deepwater trawl surveys collected by FRS Marine Laboratory were carried out from 1998-2004 and interrogated. These data were examined for any evidence of a decline in abundance and compared with published data from MAFF surveys in the same region between 1970-1978. Despite the short time series there were indications of declining trends in CPUE for a number of Squaliformes between 1998 and 2004 and the overall catch rates of sharks are dramatically lower than those recorded from pre-exploitation surveys in the 1970s. These results highlight the need to continue fisheries-independent surveys of this vulnerable ecosystem.

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INTRODUCTION

The deep-water continental slope is home to a relatively high diversity of Chondrichthyes. Of these, the deep-living sharks are dominated by the Squaliformes, which comprise both small and large species with cylindrical bodies, small dorsal fins with or without spines. Other orders with deep-water representatives include the Hexanchiformes (frill and cow sharks) and Carchariniformes (e.g. catsharks and false catsharks). Many of these sharks are regularly caught in the deep-water fisheries conducted on the continental slopes of the Northeast Atlantic and there is increasing concern over the impacts on populations (Gordon 2003). Their K-selected life history strategy; slow growth rate, high age of maturity, relatively few offspring and long life span make elasmobranches particularly vulnerable to exploitation (Holden 1973; Stevens et al. 2000).There is therefore a real risk of severe depletion or extinction and loss of biodiversity as well as the unknown impact on the structure and function of eco-systems once these top predators have been removed.

The history of deepwater fisheries in the northeast Atlantic is relatively well documented and dates back to the 1960s, when Soviet and other eastern block countries began exploitation of roundnose grenadier *Coryphaenoides rupestris* in international waters, mainly on the mid-Atlantic Ridge (Atkinson 1995). German trawlers began targeting blue ling (*Molva dypterygia*) in the Rockall Trough in the 1970s, followed by the French fleet in the mid-70s (Gordon 2001). This fishery continues to target blue ling, but, since the early 1990s, a market has developed for other species including the roundnose grenadier and elasmobranchs (Charuau et al. 1995). Other fleets have become involved, including Scotland, Ireland and Spain, but the fishery continues to be dominated by the French. There are also important static gear fleets; a longline fishery prosecuted mainly by Spanish and UK boats targeting hake (*Merluccius merluccius*) with deep-water elasmobranchs mainly as by-catch but sometimes the target species (Iglesias and Paz 1995) and a Spanish and UK gillnet fishery for anglerfish (Hareide et al. 2005).

Management of the stocks is hampered by lack of reliable landings data as well as insufficient biological information on population structures. In 2000, the ICES SGDEEP produced a preliminary assessment of the two most important commercial species, the Portuguese dogfish, *Centroscymnus coelolepis* and leafscale gulper shark, *Centrophorus squamosus*. Separate assessments were not possible due to the practice of using generic categories such as “Siki” to record the landings of both species. The results suggested that in 1998, the combined stock was below 50% of the initial biomass (ICES, 2000). More recent examination of commercial and survey CPUE data suggest that the decline of these species, particularly in *C. coelolepis* has continued (ICES, 2005). However, many other species are also caught and either discarded or only their livers are retained for landing, making identification impossible (Connolly and Kelly 1996). These include longnose velvet dogfish, *Centroscymnus crepidater*, gulper shark, *Centrophorus granulosus*, kitefin shark, *Dalatias licha*, birdbeak dogfish, *Deania calceus*, the lantern shark *Etmopterus princeps* and velvet belly *Etmopterus spinax*. Without species-specific landings data, assessments are currently impossible for these species. However,the Rockall Trough in the northeast Atlantic has a long history of marine exploration and has been described as the cradle of deep-sea (Gage 2001). There have been scientific cruises since the mid-nineteenth century and the fish fauna in the region had been accurately described by the early 20th century (Gordon 2003). Exploratory surveys in the 1970s by the Ministry of Agriculture Food and Fisheries (MAFF) in search of new fishing grounds also provide us with a valuable dataset from before the commercial fishery had begun in earnest (Bridger 1978). Since these first trawling expeditions there have been a number of surveys by U.K., German, Irish and French research vessels. Some of these datasets were collated and analysed to investigate the impacts of fishing on the deepwater community by Basson *et al* (2001). A number of analyses were performed including single-species assessments where feasible and a number of ecological investigations of species composition and size spectra. Whilst the data were found to be very unbalanced there was strong evidence to suggest that the biomass of both exploited and unexploited species had declined from the mid to late eighties, including sharks. Analysis of species diversity of the SAMS semi-balloon trawl surveys also suggested that sharks accounted for a lower proportion of the catch by the end of the time series (Basson et al 2001).

None of the surveys mentioned above have continued to the present day. The first fishing trials carried out by Fisheries Research Services (FRS) in the deep-waters to the west of the Bristish Isles were north-east of the Wyville-Thompson Ridge during September and October of 1996. Since then, there have been a further five surveys (Fig. 1), in 1997 and then biennially from 1998. These are the only known trawl surveys currently being carried out in the region and therefore represent a vital continuation of monitoring the fish populations in the region. The aim of this paper was to present a preliminary analysis of the spatio-temporal patterns of abundance of Chondrichthyes caught in the FRS deep-water survey to date, with particular emphasis is placed on the Squaliformes. A comparison with pre-fishery survey data collected in the same region by MAFF in the 1970s is also made.

MATERIAL AND METHODS

Description of the deepwater trawl survey data

The data used in this analysis was from the last 4 surveys (1998-2004), which are reasonably consistent in terms of survey design and area covered. The dataset consists of 112 stations, over 200 hours of trawling and a total of 205 different fish species recorded between 300-1900m. Tables 1 and 2 summarise the latitudinal and depth coverage of the surveys. It should be noted that in 1998 the survey was more limited in terms of latitude and depth than the three later surveys. A large commercial trawl (Jackson nets) is used, towed along pre-specified depth contours for a period of 1.5-2 hours at a speed of 3-3.5 knots. The catch is sorted to species, weighed and length-frequencies recorded. Only the elasmobranchs and chimaeras are sexed and for selected species additional biological information (e.g. total and gutted weight) is also recorded.

Historical data: UK Ministry of Agriculture Fisheries and Food (MAFF) surveys

Six cruises were carried out by MAFF between 1973-1974 and are summarised in a report by Bridger (1978). The report gives details of the trawls used on the different cruises and the appendices include information on the timing of different cruises, positions, depths and a summary of the catch composition in weight including sharks as a separate category. Four of the cruises were onboard MAFF RV *Cirolana* with another two by chartered commercial trawlers. The area covered ranged from 50 – 60º N and included the slopes of offshore banks such as Rockall, Hatton, Rosemary, Lousy, Bill Bailey etc. During the research vessel surveys, 4 trawls were carried out at each chosen location at 300, 400, 500 and 600 fathoms (549, 732, 914 and 1097m). The net used was a Granton trawl, details given in Table 3. The dimensions of the trawl are smaller than the FRS trawl. No information is given on headline height, but it is likely to have been lower than the FRS Jackson trawl. However, the ground gear used, codend mesh size, tow speed and duration are approximately similar.

Analysis of FRS trawl survey data

From the FRS deep-water survey database catch per unit effort for all elasmobranch and chimaera species was calculated in terms of both numbers and weight caught per hour tow, using length weight relationships that have been built up by FRS staff over a number of years. For each species considered two CPUE values were calculated for each survey; one using all data available, the other excluding data below 1200m. These values were obtained by summing the total catch in numbers or weight and dividing by the total effort (fishing time) in each survey. It was recognized that these values were undoubtedly confounded by patterns of abundance changing with both depth and latitude and the same combinations of depth and latitude not being covered in every survey. In an attempt to separate spatial and temporal variation the count data were modelled using a Generalized Linear Model with a negative binomial distribution. The count data were modelled directly with trawl duration (hours) incorporated as an 'offset' with 'year' and 'latitude' fitted as straightforward linear terms. Depth was incorporated using a natural spline smooth function with 2 degrees of freedom to allow for U-shaped patterns of abundance.

Count = offset + year + smooth (depth, D=2) + Latitude

The year coefficients from these models for each species were used as indicators of increase or decline in the populations over the data time series.

Comparison with 1970s MAFF data

The 1973-1974 MAFF data together with additional data from cruises in 1970 and 1978 were re-analysed by Gordon and Swan (1997). The mean catch rate in terms of number and kg per hour for 8 shark species from all valid hauls in ICES Sub-area VI was presented, excluding stations east of the Wyville-Thompson Ridge. The data were divided into 5 depth bins from 250 - 1250m. These were then compared with FRS CPUE values for the same species at similar depths.

Since the results in Gordon and Swan (1997) are from all hauls in ICES Sub-area VI, including some offshore Banks, a more limited comparison of FRS data was also made with selected data taken from Bridger (1978). Hauls were selected only from the Hebridean Slope between 55 and 58º N in order to overlap with the FRS surveys. Since the Bridger report does not give weights for individual shark species, the comparison was of total CPUE (Kg per hour) for all sharks caught

RESULTS

Chondricthyan species diversity peaked between 1000-1500m (Figure 2), with a total of 18 shark species, 11 skates and rays and 6 chimaera species. Although data for all these were examined, many were so rare that quantitative analysis was not feasible. In this paper we have focused mainly on eight Squaliformes. Figures 3 shows distribution of CPUE (No per hr) in each survey for five of the eight species examined. Numbers were low for the two most important commercial species, *C. squamosus* and *C. coelolepis* compared to the 3 more abundant species; the longnose velvet dogfish, *Centroscymnus crepidater*, the black dogfish *Centroscyllium fabricii* and the shallower-dwelling velvet belly dogfish, *Etmopterus spinax*. Two particularly large catches of *C. crepidater* were recorded in the 1998 survey with 314 and 587 females caught in two separate hauls between 700-800m depth.

The depths fished (400-1900m) cover different parts of the depth distribution of different species. Gordon and Swan (1997) give the centre of maximum abundance for *C. coelolepis* and *C. fabricii* as 1000-1500m for and 1500m for *E. princeps,* compared to 700-1250 for *C. crepidater* and *D. licha*. The trends in CPUE are, therefore confounded by the trend of increasing the depth fished in some of the later surveys. If trawls below 1200m are excluded, the annual CPUE trends in numbers per hour for five of the eight species suggest possible decline in this part of their depth range (Figure 4). Numbers are below 10 h^{-1} for all species in all years except for *C. crepidater* in 1998. The dramatic drop for *C. crepidater* is due to the two large hauls of 1998 and this is in fact one of the more abundant species sampled. Figure 5 shows CPUE expressed as Kgh^{-1} for the same eight species. Using data from 1200m only, declines are evident for *C. crepidater*, *C. coelolepis*, *C. squamosus* and *E. spinax*, but an increasing trend is observed for *E. princeps*. The apparent contradiction with the No. per hr reflects an unusually small average size of catches for this species in 1998.

Table 4 gives the details of model coefficients for all Chondricthyes analysed, including chimaeras and additional catshark species. Positive values indicate an increasing trend with year, negative values a declining one. The models for all Squaliformes except *D. calceus* indicated a declining trend for year. The highest decline was observed in *C. crepidater* due to the two large 1998 hauls skewing the data. The coefficients for *D. licha* and *C. fabricii* were not included due to the models being unable to explain any of the variation in the very sparse data for these species. The three catshark species included (*Apristurus spp*., *Galeus melastomus, Galeus murinus*) showed either a slight decline or no temporal trend. Of the six chimaeras, three showed a slight positive trend, one no trend and two (*Chimaera monstrosa* and *Rhinochomaera atlantica)* a slight negative trend for year, although all values were very low.

Table 5 gives a comparison of selected species' catch rates (Kg h^{-1}) in different depth bands between MAFF survey data from1970-1978 in ICES Sub-area VI and FRS surveys between 1998-2004. The values for the MAFF surveys were taken from Gordon and Swan (1997). In the 1970s, peak catch rates for *C. squamosus*, *C. coelolepis*, and *D. calceus* and *D. licha* were between 40-100 kg h^{-1}. The peak catch rates for these 4 species in the FRS surveys ranged from 0.6 kg h^{-1} for *D. licha* to 33.43 kg h^{-1} for *C. coelolepis*. These values are between 62-99% lower than the pre-fishery values. In contrast, FRS CPUE values for the other four species were all higher. For *C. crepidater* catches were between 55-97% higher than the MAFF values, with the extremely high catch rate in the 700m depth category was driven by the 2 very large 1998 catches.

Since the original species-specific data from Gordon and Swan (1997) were not available for this analysis and included hauls from offshore banks, a final comparison was made with selected data from Bridger (1978). Only hauls from the Hebridean Shelf between 55-58º N were considered. Since catch data in the report is summarised the results are expressed as the total CPUE (kg h^{-1}) for all shark species. Figure 7a gives total CPUE values for hauls at different latitudes from MAFF surveys between 1973-1974 and FRS surveys between 1998–2004. The total shark catches from FRS surveys are between 10-20% of the catch rates in the 1970s surveys. Figure 7b gives total catch rate of sharks by depth for the 1973-1974 MAFF surveys combined, and the four FRS surveys. Catch rates from FRS surveys at 750m and deeper are 20-30% of the 1970s catch rates.

DISCUSSION

The FRS deep-water survey is a relatively short time series and full coverage of depth and latitude has not been achieved in every year. Therefore the data are unbalanced and it is difficult to draw firm conclusions. However, this initial analysis certainly suggests that, in addition to the commercial species considered by recent ICES Working Groups, some of the other Squaliformes may be declining and catch rates are dramatically lower for certain species and sharks in general when compared to the pre-exploitation cruises in the 1970s.

The analysis of the FRS dataset was hampered by sparse data for many species and problems of confounding due to latitudinal and depth patterns interacting with temporal (year) effects. It was hoped that, by fitting regression models to the data some quantification of the affect of time (year) independent from the conflicting spatial (depth and latitude) effects could be achieved. The length-frequency data exist in the form of discrete counts, which are poorly summarised using standard Gaussian based statistical methods. Therefore Generalized Linear Models, which allow many different distributional assumptions to be made with the data to be modelled, were used. Initially, GLMs from the Poisson family were fitted, but the residual deviances were too high to allow any discrimination between the predictor variables due to non-independence between successive observations and an alternative had to be sought. The solution was to use GLMs from the negative binomial family which can model count data with high variances, often called 'over-dispersed' data (Venables and Ripley, 1994). Not surprisingly, the predictor variables selected (depth, year and latitude) generally explained only a small amount of the variation, but nevertheless did indicate possible declining trends in a number of the squaliform species as well as some catsharks and chimaeras.

Although different vessels and fishing gear were used on the 1970s MAFF surveys, the authors believe that a comparison with the FRS dataset is not totally unjustified. Sharks tend to be strong swimmers and will be affected by the type of fishing gear, towing speed and tow duration. The smaller the trawl and the slower the towing speed, the less effective it will be for catching sharks (Gordon and Duncan 1985). The FRS commercial trawl net is clearly larger than the Granton trawl but ground gear and towing speed were similar. It is likely that the headline height of the FRS net (approx 5m) is higher than the smaller net (probably around 2-3m). The towing time was also slightly longer on some tows. However, all these differences should theoretically result in higher catch rates by the more modern trawl and this was clearly not the case for a number of the species with the notable exception of *C. crepidater*.

Mauchline and Gordon (1983), divided the sharks of the Rockall Trough into 3 trophic groups. The larger species, *C. coelolepis* and *D. calceus* and *D. licha*, along with *C. fabricii* were thought to prey mainly on demersal fish. The second group consisted of *Apristurus* spp. *C. crepidater*, *E. princep*s and *E. spinax* which exploited micronekton in the vicinity of the seabed. The diet of *C. crepidater* was found to be made up of squid and Myctophid fish in particular. A third group, the catsharks *G. melastomus* and *G. murinus* appeared to have a more varied diet, feeding on benthopelagic and epibenthic prey including fish and crustaceans. The catch rates of a number of the sharks included in these last two groups appear to be either higher in the most recent survey, or no different to catch rates from the 1970s surveys. Meanwhile, catch rates of the demersal fish-eating group have declined. The more pelagic foraging behaviour of species such as *C. crepidater* may result in this species being less available to the lower headline Granton trawl compared with the Jackson trawl. Alternatively, the high catch rates may reflect a true increase related to changing availability of the preferred prey of these different feeding groups.

Although the MAFF trawl stations were geographically comparable to the FRS survey stations, the 1970s surveys were conducted in January, April, June and July; compared to Aug-Sept-Oct for the FRS surveys. Seasonal migrations are suspected for some deepwater shark species, such as *C. squamosus*, due to the complete absence of gravid females in certain areas (Clarke 2000) and this cannot be ruled out as a contributing factor to the observed differences in catch rate. However, it should be noted that a total catch rate of 290 kgh^{-1} was recorded from 12 hauls at comparable stations onboard the chartered commercial trawler *Swanella* during Sept 1973 (Bridger, 1978), which well within the range of catch rates from the other 1970s cruises.

In summary, this paper represents a preliminary analysis of the short FRS time series and serves to highlight that catch rates of both commercial and some non-commercial elasmobranch species appear to have dropped, in some cases by up to 99% of pre-fishery catch rates and show indications of continuing decline. As proposed by Basson et al (2001), a repeat survey by RV *Cirolana* using a Granton trawl would be a valuable exercise in confirming the extent of decline of these fished communities as well as providing an opportunity to cross-calibrate with more recent fishing surveys. Given the continued pressure on the deepwater fish stocks to the west of Britain and Ireland, continued fishery-independent monitoring is essential.

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Figure Legends

Figure 1 Geographical coverage of FRS deep-water surveys, 1996-2004.

Figure 2 Species diversity of Chondrichthyes and Actinopterygii in FRS deep-water surveys.

Figure 3 Distribution and catch rates (Number per hour) of five Squaliformes from the FRS deep-water surveys, 1998-2004

Figure 4 Annual survey CPUE expressed as numbers per hour for the 8 most abundant Squaliformes, excluding hauls below 1200m.

Figure 5 Annual survey CPUE expressed as kg per hour for the 8 most abundant Squaliformes, excluding hauls below 1200m.

Figure 6 Comparison of catch rates (kg per hour) for 8 species of shark during MAFF and FRS deep-water surveys.

Figure 7 Comparison of total CPUE (kg h^{-1}) for all shark species from MAFF surveys between 1973-1974 and FRS surveys between 1998–2004. (a) by latitude (b) by depth.

Table Legends

Table 1 Coverage by depth for the FRS deep-water surveys between 1998 and 2004.

Table 2 Details of latitudinal coverage for the FRS deep-water surveys between 1998 and 2004.

Table 3 Details of the 2 trawls used during the MAFF and FRS surveys.

Table 4 Model coefficients for 15 species of Chondrichthyes

Table 5 Mean catch rates (kg per hour) for 8 shark species from MAFF and FRS cruises, with overall mean CPUE for 1970s cruises and total CPUE for FRS data.

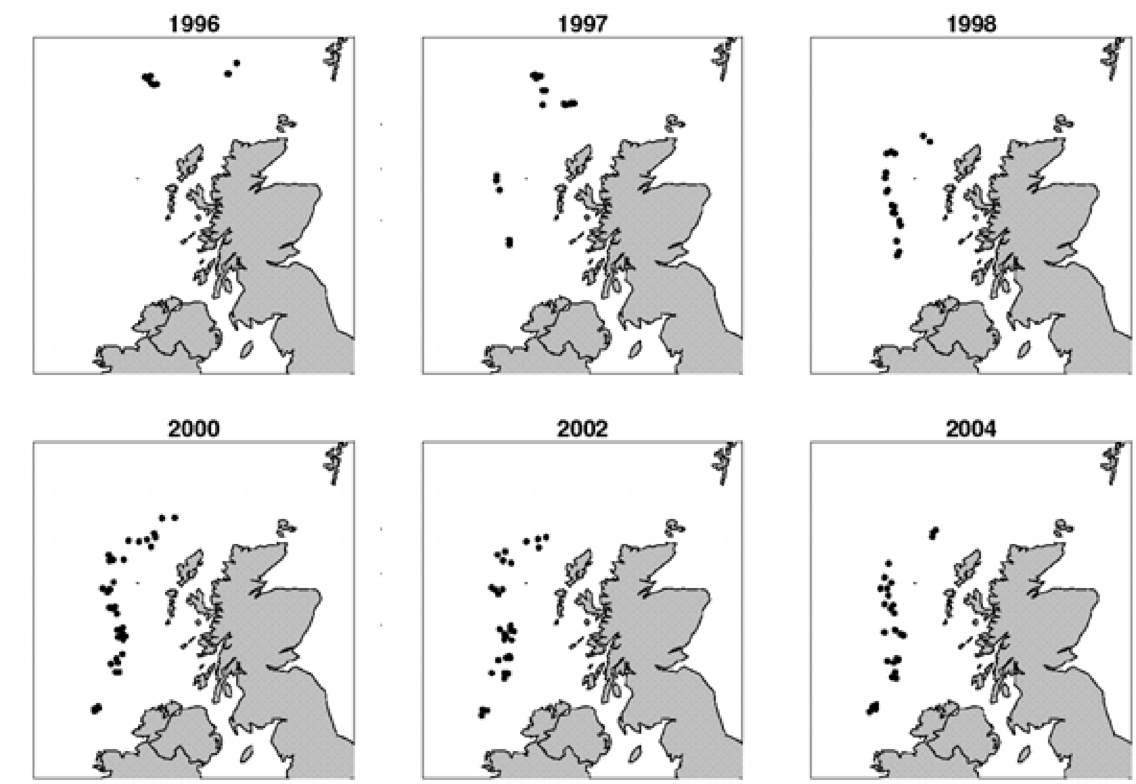

Figure 1

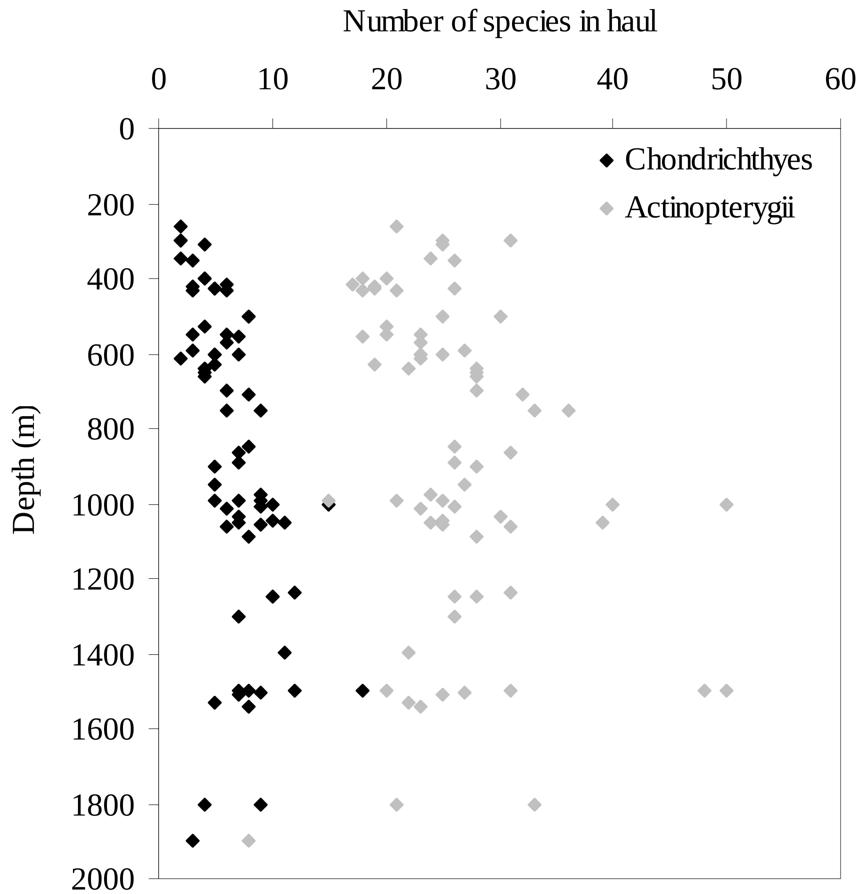
Number of species in haul
0
10
20
30
40
50
60
Depth (m)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
Chondrichthyes
Actinopterygii

Figure 2

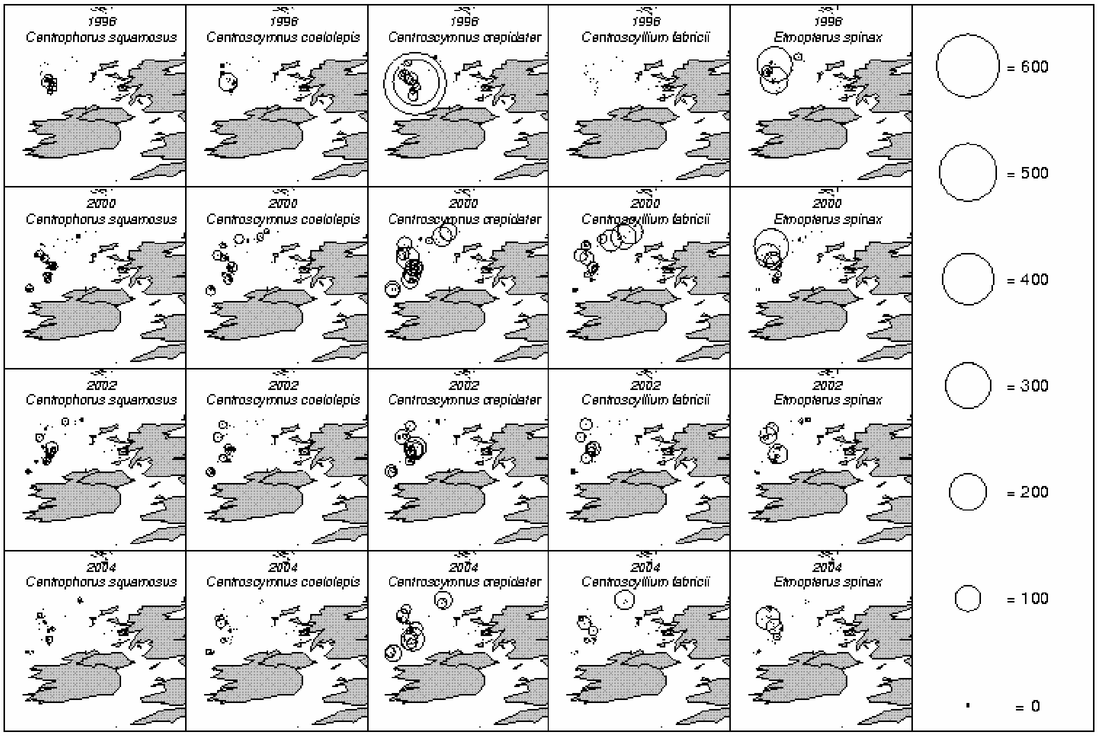
1996
Centrophorus squamosus
1996
Centroscymnus coelolepis
1996
Centroscymnus crepidater
1996
Centroscyllium fabricii
1996
Etmopterus spinax
2000
Centrophorus squamosus
2000
Centroscymnus coelolepis
2000
Centroscymnus crepidater
2000
Centroscyllium fabricii
2000
Etmopterus spinax
2002
Centrophorus squamosus
2002
Centroscymnus coelolepis
2002
Centroscymnus crepidater
2002
Centroscyllium fabricii
2002
Etmopterus spinax
2004
Centrophorus squamosus
2004
Centroscymnus coelolepis
2004
Centroscymnus crepidater
2004
Centroscyllium fabricii
2004
Etmopterus spinax
= 600
= 500
= 400
= 300
= 200
= 100
= 0

Figure 3

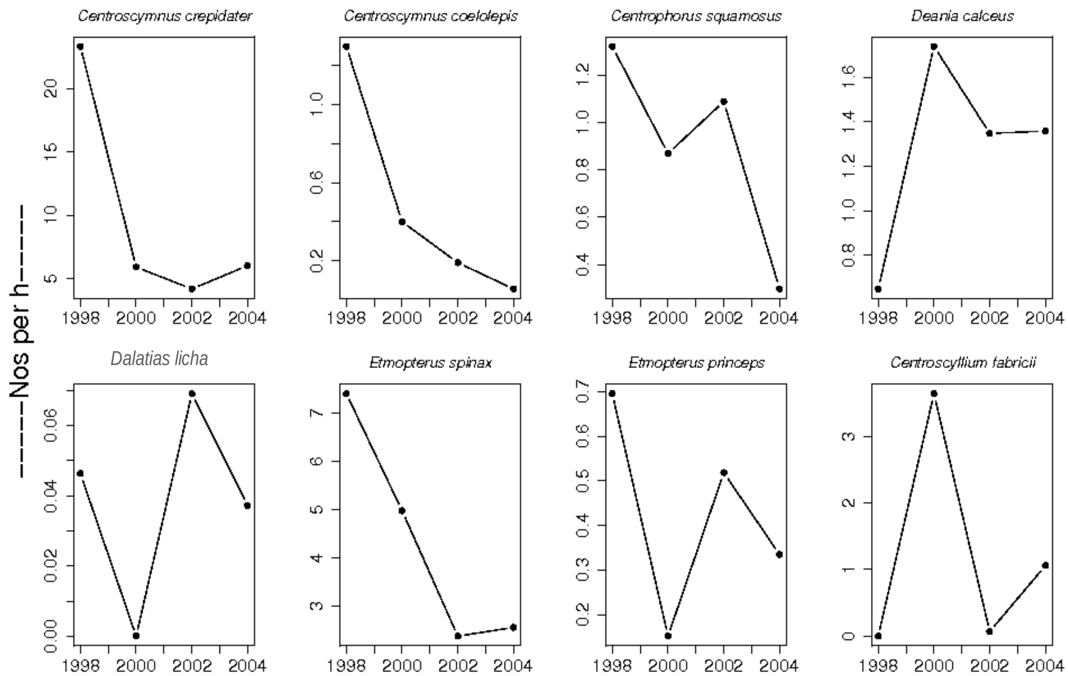

Figure 4

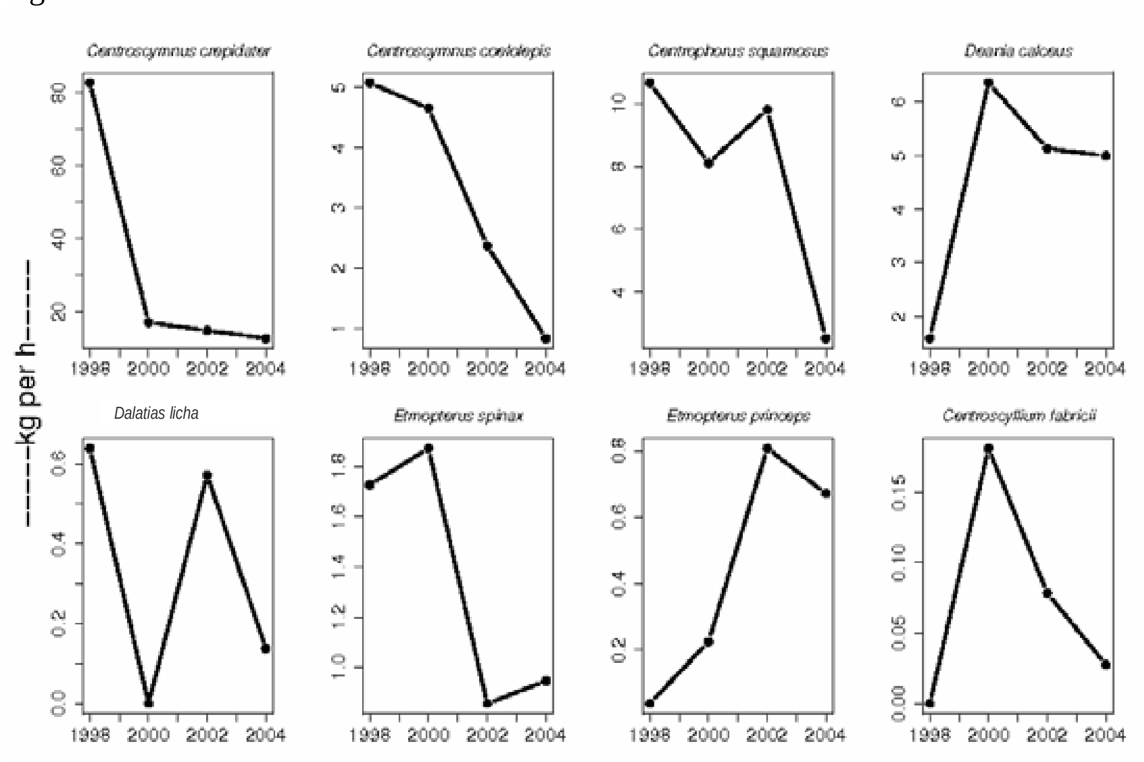

Figure 5

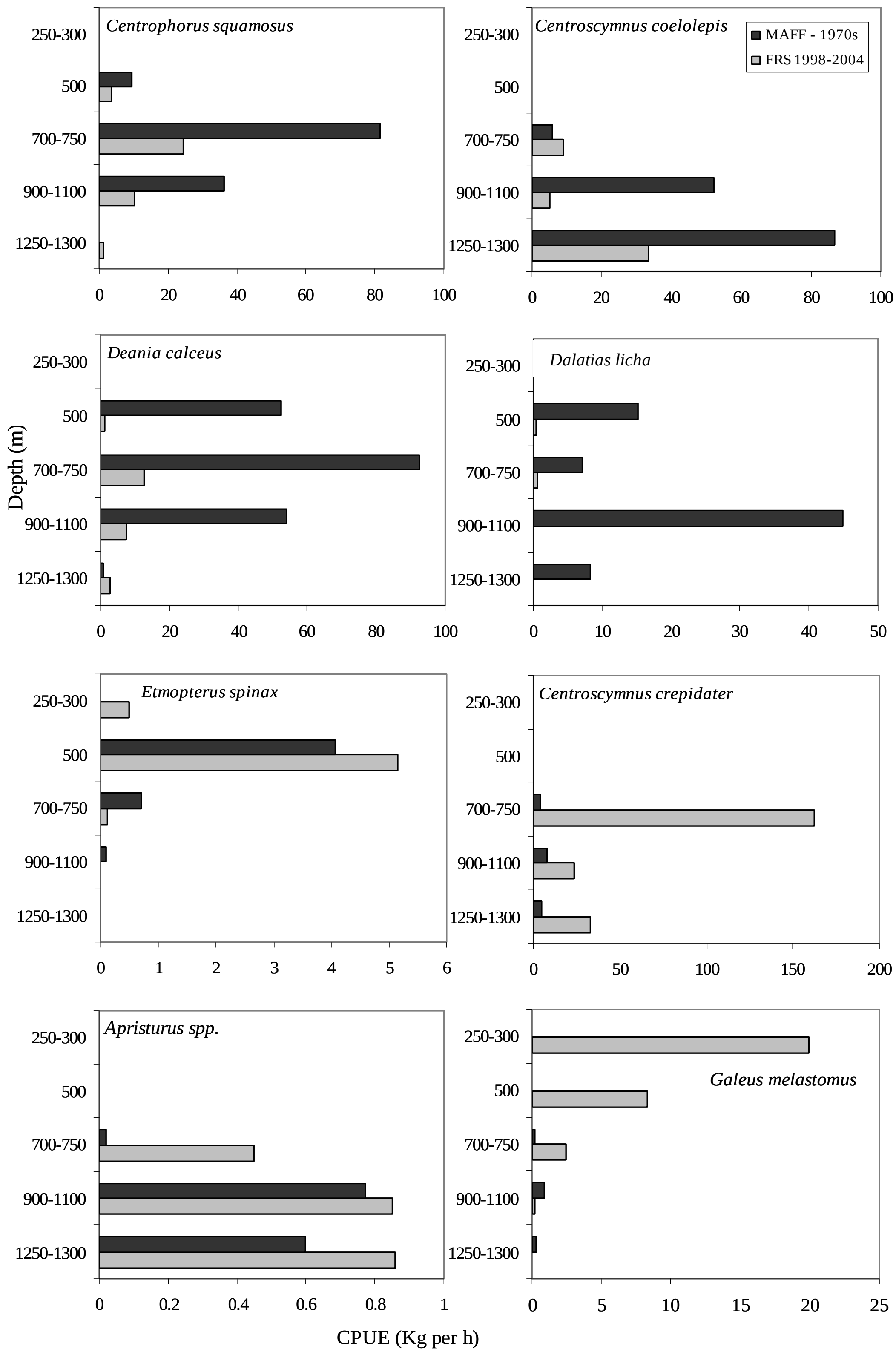
Centrophorus squamosus
Centroscymnus coelolepis
MAFF - 1970s
FRS 1998-2004
Deania calceus
Dalatias licha
Etmopterus spinax
Centroscymnus crepidater
Apristurus spp.
Galeus melastomus
250-300
500
700-750
900-1100
1250-1300
Depth (m)
CPUE (Kg per h)

Figure 6

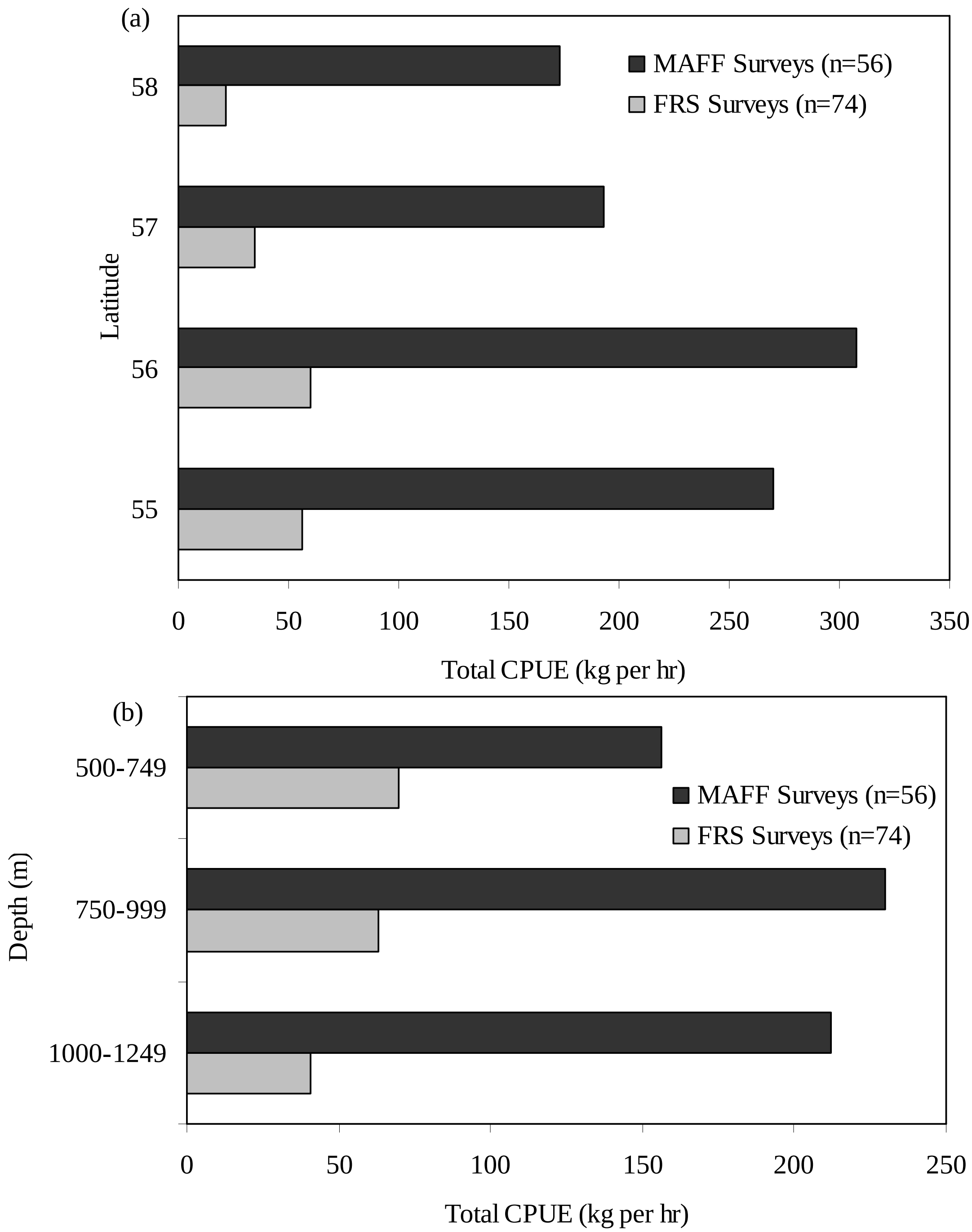
(a)
MAFF Surveys (n=56)
FRS Surveys (n=74)
Latitude
58
57
56
55
0
50
100
150
200
250
300
350
Total CPUE (kg per hr)
(b)
MAFF Surveys (n=56)
FRS Surveys (n=74)
Depth (m)
500-749
750-999
1000-1249
0
50
100
150
200
250
Total CPUE (kg per hr)

Figure 7

Table 1 Coverage by depth for the FRS deep-water surveys between 1998 and 2004.

	Depth Category (m)					Total
Year	300-499	500-749	750-999	1000-1250	1250+	
1998	2	7	10	1		20
2000	6	8	5	8	7	34
2002	5	7	4	8	8	32
2004	4	8	3	5	6	26
Total	17	30	22	22	21	112

Table 2 Details of latitudinal coverage for the FRS deep-water surveys between 1998 and 2004.

	Latitude					Total
Year	55	56	57	58	59	
1998		7	8	5		20
2000	6	10	8	9	1	34
2002	8	12	4	8		32
2004	7	8	8	3		26
Total	21	37	28	25	1	112

Table 3 Details of the 2 trawls used during the MAFF and FRS surveys.

	Granton Trawl (MAFF)	***Jackson Trawl (FRS)***
Headline length	23m	41.5m
Groundrope length	35m	53.4m
Headline height	Unkown (~2-3m)	~5m
Codend mesh size	110mm + unspecified blinder	100mm codend+20mm blinder
Tow duration	90-100min	90-120min
Towing speed	2.8-3.3 knots	3-3.5 knots
Depth range	250-1250m	400-1900m

Table 4 Model coefficients for 15 species of Chondricthyes

Species	0ffset	**year**	depth1	depth2	latitude	r2
Centroscymnus crepidater	17880.09	**-8.75**	42.63	-46.66	-6.36	0.2
Centrophorus squamosus	2917.43	**-1.41**	12.5	-14.2	-1.63	20
Centroscymnus coelolepis	2213.05	**-1.05**	32.38	20.55	-1.93	26.6
Etmopterus princeps	789.68	**-0.31**	10.8	10.2	-3.07	16.2
Etmopterus spinax	304.64	**-0.19**	-5.2	-1.4	1.23	11.6
Deania calceus	-169.2	**0.15**	9.8	-13.5	-2.22	23.9
Apristurus laurussonii	91.11	**-0.04**	1.74	0.13	-0.27	20.7
Galeus melastomus	206.52	**0**	-33.01	-2.3	-3.21	31.7
Galeus murinus	-5.52	**0**	0.34	-0.16	-0.06	17.5
Chimaera monstrosa	748.78	**-0.19**	-36.65	-1.75	-6.18	43.4
Rhinochimaera atlantica	101.38	**-0.05**	1.55	1.75	-0.06	19
Hydrolagus pallidus	-3.94	**0**	0.11	0.56	-0.02	21.7
Hariotta raleighana	-162.56	**0.08**	3.45	5.16	0.11	47.6
Hydrolagus affinis	-266.71	**0.14**	1.9	1.94	-0.08	12.5
Hydrolagus mirabilis	-414.82	**0.23**	4.35	-4.91	-0.86	22.6

Table 5 Mean catch rates (kg per hour) for 8 shark species from MAFF and FRS cruises, with overall mean CPUE for 1970s cruises and total CPUE for FRS data.

MAFF Survey, ICES Sub-Area VI Catch Rate – kg per h					
Species	500m	750m	1000m	1250m	**Overall mean**
Centrophorus squamosus	9.61	**81.52**	36.25	0	**31.85**
Centroscymnus coelolepis	0.58	5.97	51.97	**86.93**	**36.36**
Centroscymnus crepidater	0.37	4.11	**8.03**	4.79	**4.3**
Dalatias licha	15.23	7.13	**44.96**	8.26	**18.90**
Deania calceus	52.46	**92.37**	54.11	0.9	**49.96**
Etmopterus spinax	**4.07**	0.7	0.09	0	**1.22**
Apristurus spp.	0	0.02	**0.77**	0.6	**0.35**
Galeus melastomus	**0.84**	0.19	0.02	0	**0.26**
FRS Surveys, 1998-2004, Hebridean Slope – kg per h					
Species	500m	700m	900-1100m	1300m	**Total**
Centrophorus squamosus	3.56	**24.32**	10.32	1.12	**7.68**
Centroscymnus coelolepis	0	9.08	5.03	**33.43**	**2.77**
Centroscymnus crepidater	0.84	**162.50**	23.64	33.20	**22**
Dalatias licha	0.35	**0.64**	0	0	**0.12**
Deania calceus	1.03	**12.79**	7.31	2.59	**5.75**
Etmopterus spinax	**5.15**	0.12	0.02	0.00	**0.99**
Apristurus spp.	0	0.45	0.85	**0.86**	**0.36**
Galeus melastomus	**8.29**	2.40	0.18	0	**3.63**