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J. Northw. Atl. Fish. Sci., Vol. 44: 41–60 Publication (Upload) date: 26 Oct 2012

Demersal Fish Fauna of the Continental Slope off Nova Scotia, Canada, Based on Exploratory Bottom Trawl Surveys in 1994–95

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Halliday R. G., L. Van Guelpen and D. E. Themelis. 2012. Demersal fish fauna of the continental slope off Nova Scotia, Canada, based on exploratory bottom trawl surveys in 1994–95. *J. Northw. Atl. Fish. Sci.*, **44**: 41–60. doi:10.2960/J.v44.m681

Abstract

The demersal fish fauna at 900–1800 m depths off Nova Scotia, Canada, is described using data from exploratory bottom trawl surveys conducted in November 1994 and March 1995 by a commercial fishing trawler. Approximately 25 metric tons (39 000 specimens) of demersal fish belonging to at least 82 species were caught, 30% of which had not previously been recorded from the area. However, more than half the catch consisted of the two species *Centroscyllium fabricii* (black dogfish) and *Coryphaenoides rupestris* (roundnose grenadier). Catches were higher in the shallower depth strata fished and cluster analysis showed that depth was the primary factor determining species composition of catches. It is suspected, however, that the vessel fished less effectively at depths greater than about 1500 m, contributing to the reduction in catch quantities at these depths. The importance in catches of large bodied species, particularly Chimaeriformes and sharks, contrasts with results from surveys in adjacent areas. This likely reflects the greater fishing power of the vessel/gear used in present surveys rather than real differences in faunal composition. Catches of mesopelagic species during these surveys, and during an earlier deepwater trawling survey in this area, are also described.

Keywords: *Centroscyllium fabricii; Coryphaenoides rupestris;* distribution; deepsea fish; Scotian Shelf slope

Introduction

In the early 1990s, interest by the Canadian fishing industry in developing fisheries for new species in deep water provided an opportunity for a joint Industry - Government venture to explore the commercial potential of fish resources on the Scotian Shelf slope, south of Nova Scotia. The only previous survey of the demersal fish fauna in this area had been conducted by a research vessel, and sampling was restricted to depths shallower than 1200 m (Markle *et al.*, 1988). The presently reported surveys were conducted by a commercial fishing trawler in November 1994 and in March 1995, at bottom depths of 910–1830 m. This paper reports on the fish catches made during these surveys, examines patterns in species distributions, and compares results with those of Markle *et al.* (1988), and with those from other studies in adjacent geographical areas.

An account of catches of pelagic fish species made during these 1994–95 surveys is provided also. Markle *et al.* (1988) did not include pelagic fish catches in their report, but their records were available to the authors of the present study and are provided here for comparison with 1994–95 catches.

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Methods

The surveys were conducted by the commercial fishing trawler Cape Chidley (length – 43 m; tonnage – 792; horsepower – 2400) on 6–16 November 1994 and 7–16 March 1995 (labelled C19 and C20 respectively). A commercial Engel high-lift bottom trawl was used with 1500 kg polyvalent trawl doors and a 51.8 m footrope equipped with 53 and 61 cm disc rock-hopper foot gear. Netting was of regulation 145 mm mesh but a 30 mm small mesh liner was inserted in the belly extension and codend to retain small specimens and a 20 mm diameter tickler chain was attached ahead of the footrope to enhance capture of bottom dwelling fauna. A headline transducer was deployed on all tows to measure vertical opening of the net. Headline height was typically about 6 m and no marked differences were observed between surveys or among depth zones. No instrumentation was available to measure horizontal net opening but, according to the vessel owners, previous performance data for this net (in shallower waters) indicated that the normal spread from wingtip to wingtip was 24 m and between the trawl doors was 69 m.

Sampling was stratified by area and depth, and fishing locations within strata were chosen randomly. On the first survey (C19), four discrete areas were fished. These were located south of Browns, LaHave, Western and Banquereau banks (Fig. 1, top panel). During the second survey (C20), four larger, contiguous, areas located south of Browns, LaHave, Emerald and Western - Sable Island banks were fished (Fig.1, bottom panel). Each fishing area was divided into five depth strata at 100 fm (183 m) intervals, but for presentation of data, stratum boundaries are defined in metres (rounded to the nearest 10 m). Fishing was conducted on a 24-hour basis, and stations were occupied in the order that minimized transit time.

The vessel's standard fishing procedure was to tow the net at 3.0 knots for one hour, measured from completion of shooting to start of haul back. However, there was insufficient trawl warp to maintain the same scope for deeper as for shallower tows and towing speed had to be reduced to 2.5 knots for the two deepest strata to get the net on bottom. Also, the actual start of trawling was taken as the time that resistance was felt due to bottom contact and it was found that actual time on bottom varied from 51 minutes in the shallowest, to 46 minutes in the deepest, stratum. Thus, distance towed was about 2.5 nautical miles for tows in the three shallowest strata, but the lower towing speed and reduced time on bottom for tows in the deeper strata resulted in the distance towed in the 1460–1650 m stratum being about 0.80, and in the 1650–1830 m stratum being about 0.75, of that in the shallower strata. Thus, abundance estimates for these deep strata were adjusted by x1.25 and x1.33 respectively.

The at-sea scientific protocol was to obtain the weight, number and length frequency (total length to the nearest cm) of each taxon in every catch. Particularly large catches of a taxon were sub-sampled by weight, numbers and length compositions subsequently being adjusted by the ratio of total to sample weight. Species that occurred in high volume were either retained by the vessel for commercial purposes or discarded, with scientific personnel retaining voucher specimens. In addition, a miscellany of taxa that occurred rarely, or that were recognized as presenting identification difficulties, was retained. All kept specimens were identified subsequently by the authors and the at-sea records were edited based on these laboratory results. In the majority of cases, voucher specimens confirmed at-sea species identifications but, in some, the taxonomic situation proved more complex than initially recognized at sea. In the latter circumstance, the authors reassigned taxonomic designations at the species level when the evidence was convincing but to higher taxonomic levels in the other cases. All retained specimens were deposited at the Atlantic Reference Centre (ARC), Huntsman Marine Science Centre (HMSC), St. Andrews, New Brunswick, Canada. Taxonomy follows Eschmeyer and Fricke (2012).

Comparisons of catches between areas, depths and surveys were restricted to those tows that were considered 'problem free'. Problematic tows were defined as those during which severe damage to the net occurred, when tow time was substantially reduced due to hang-ups on bottom obstacles, or when catches contained atypically low numbers of demersal species, indicating that the net was fishing off bottom. Species compositions were compared among stations using Bray-Curtis similarity coefficients following fourth root transformation of abundance data. Samples were partitioned using the CLUSTER routine in PRIMER version six (Clarke and Gorley, 2006). Length frequencies (by 3 cm groups) and mean lengths were calculated for the five species that contributed most to catches (by weight) by combining numbers per tow at length within each depth zone for two areas, Northwest Atlantic Fisheries Organization (NAFO) Divisions 4X (Browns -LaHave sampling areas) and 4W (Emerald-Western-Sable banks sampling areas). Estimates of the area of bottom within each depth/NAFO Division category (DFO: unpublished) were then used to obtain the following depth strata/Division weightings for amalgamation of the data from each survey:

Stratum (m)	4X	4W
910–1 100	0.05	0.09
1 100–1 280	0.06	0.10
1 280–1 460	0.08	0.12
1 460–1 650	0.09	0.14
1 650–1 830	0.12	0.15
	0.40	0.60

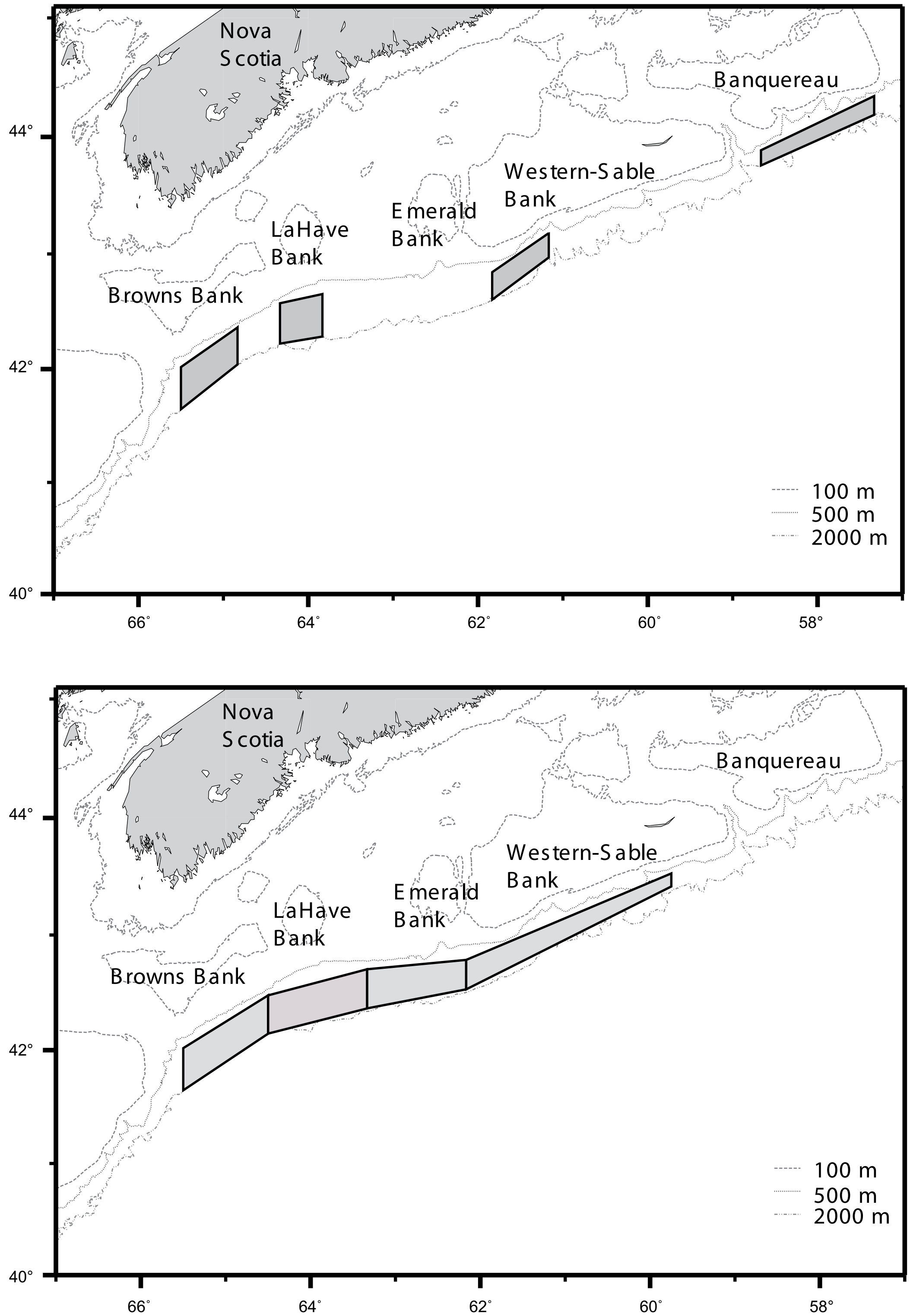

Fig. 1. Areas fished by the Cape Chidley: top panel – C19, November 1994, bottom panel – C20, March 1995.

Distributional records in the primary literature were used to determine which species in the present collections had not previously been reported from the study area. Online sources based on shared, disparate data collections were utilized only when records of interest could be verified through personal communication. The assignment of taxa to demersal or pelagic categories was based on their designations by Moore *et al.* (2003), species listed by them as benthic or benthopelagic in habit being classed here as demersal, and others as pelagic species. Common names, in Tables 1 and 2, follow usage by presently cited authors, particularly Moore *et al.* (2003), but cannot be provided for all species as some do not have accepted common names. Depth categorizations, upper slope (200–750 m), mid slope (750–1500 m) and lower slope (1500–2250 m), follow Haedrich and Merrett (1988). The Northwest Atlantic is equated to the NAFO Statistical Area.

Results

The surveys were largely successful in implementing a stratified-random sampling design with at least two sampling locations being fished in each depth stratum in each fishing area. Fishing areas differed between surveys, however (Fig. 1). On C19, the rate of successful completion of tows in the Banquereau area was low, only six of the 11 tows made there being classifiable as problem free, and thus this area was excluded from the sampling plan for C20. The sampling areas on C20 were contiguous and encompassed the other, discrete, areas used on C19. In these areas, 29 (of 31) tows on C19, and 44 (of 47) tows on C20, were considered problem free. It is the data from these tows that were used in analyses of geographic and bathymetric distributions, and size compositions. However, catches made in the Banquereau area on C19 are described separately and included in the listing of catches overall.

Demersal Species

Taxonomic composition

Approximately 25 metric tons (39 000 specimens) of demersal fish, belonging to at least 82 species, were caught (Tables 1 and 2). Among these, 10 taxa accounted for 90% of the catch by weight and these 10 accounted also for 80% by number. More than half the catch (by weight and number) consisted of *Centroscyllium fabricii* and *Coryphaenoides rupestris*.

For instances in Table 1 where catches are reported at a taxonomic level higher than species, the predominant species can be inferred quite reliably when voucher specimens were available (Table 2), *e.g.* it is likely that most of the fish listed as Rajidae NS in Table 1 were *Amblyraja jenseni*. Inferences about the abundance of the secondary species in a category relative to the primary species would be inappropriate, however. This is because relatively few voucher specimens were kept for abundant species, but most or all specimens of taxa recognized as 'different' were retained. Records reported in Table 1 at the family level that were not supported by voucher specimens (Alepocephalidae, Ipnopidae, Ophidiformes, Gadiformes and Zoarcidae) are mostly of little numerical importance and consist of inadequately documented records. There are, in addition, two special cases:

- *Apristurus* spp.: Markle *et al.* (1988) recognized two forms in their catches but (Moore *et al.*, 2003) listed four species as possibly occurring off New England, all of which might occur also in the present study area. See also Hartel *et al.* (2008).

- *Bathyraja* spp.: while species-level identifications were recorded at sea, there was an association between identifications and surveys (two *B. richardsoni* on C19, two *B. spinicauda* on C20) that raises doubt about their reliability. Thus, the species level identifications were not accepted.

Almost 30% (23) of the species listed in Tables 1 and 2 had not been recorded previously from off Nova Scotia. Thirteen of these new records were of species documented as having ranges that include adjacent areas, primarily to the southwest off New England (Moore *et al.*, 2003), and thus they represent only minor range extensions. The remaining 10 species are ones that previously have not been recorded, or have been recorded only rarely, from the NAFO Statistical Area, *i.e.* north of Cape Hatteras (35°N). Capture information, ARC catalogue numbers, and distributional notes are provided for these in Table 3.

Among the minor range extensions, it is noteworthy that the records of *Rajella bathyphila* are not in conformance with the convention accepted by Moore *et al.* (2003) that this species does not occur southwest of the Grand Banks (and thus that all records to the southwest must be of the closely-related *Rajella bigelowi*). More recently, Sulak *et al.* (2009) ignored this convention by recording *R. bathyphila* from the Mid-Atlantic-Bight. The latter authors are followed here, as the two specimens from off Western Bank had total lengths of 92 and 96 cm, greatly exceeding the maximum length of 50 cm that has been recorded for *R. bigelowi* (Sulak *et al.*, 2009).

Geographic and bathymetric distributions

Variation with depth of the catch rate (no. and wt. per tow) of all demersal species combined showed a similar pattern in both surveys (Fig. 2), with highest values occurring in one of the two shallowest strata and lowest values in one of the two deepest strata. The average time

Table 1. Demersal taxa: total number (No.) and weight (Wt.) caught and depth range of captures (D_{min} and D_{max} - minimum and maximum depths fished during tows in which the taxon was caught). (* - range extension, ** - not or seldom recorded previously from the NW Atlantic (see Table 3), (1) - see Table 2 for supplementary information on species composition, (2) - published by Caruso (2002).)

Order/Family	**Species** (or lowest taxon)	**Common Name**	No.	Wt. (kg)	D_{min} (m)	D_{max} (m)
Chimaeriformes						
Chimaeridae	*Hydrolagus affinis*	Deepwater chimaera	107	354	971	1 820
Rhinochimaeridae	*Harriotta raleighana*	Longnose chimaera	904	1 118	909	1 820
	Rhinochimaera atlantica	Knifenose chimaera	129	354	909	1 750
Carcharhiniformes						
Scyliorhinidae	*Apristurus* spp.	Catsharks	707	1 037	913	1 820
Squaliformes						
Somniosidae	*Centroscymnus coelolepis*	Portuguese shark	262	688	940	1 778
Etmopteridae	*Centroscyllium fabricii*	Black dogfish	10 572	7 816	909	1 809
	Etmopterus princeps	Rough sagre	545	548	918	1 776
Squalidae	*Squalus acanthias*	Spiny dogfish	1	3	1 280	1 428
Rajiformes						
Arhynchobatidae	*Bathyraja* spp.	–	4	62	940	1 820
Rajidae	*Rajella bathyphila**	Deepwater ray	2	16	1 094	1 256
	Rajella bigelowi	Bigelow's ray	37	12	940	1 820
	Rajidae NS (1)		75	74	909	1 803
Notacanthiformes						
Halosauridae	*Aldrovandia* spp. (1)	–	424	18	909	1 803
	*Halosaurus guentheri**	–	1	1	940	1 074
	Halosauropsis macrochir	–	311	110	918	1 820
Notacanthidae	*Lipogenys gillii*	Backfin tapirfish	3	1	1 333	1 748
	Notacanthus chemnitzii	Snubnosed spiny eel	48	32	909	1 809
	Polyacanthonotus rissoanus	Shortspine tapirfish	10	1	940	1 717
Anguillformes						
Synaphobranchidae	*Ilyophis brunneus*	–	15	1	958	1 695
	Simenchelys parasitica	Snubnose eel	350	61	909	1 820
	Synaphobranchus kaupii	Northern cutthroat eel	3 189	497	909	1 820
Nettastomatidae	*Venefica procera*	–	20	4	1 280	1 820
Osmeriformes						
Alepocephalidae	*Alepocephalus agassizii*	Agassiz' smoothhead	4 330	1 908	913	1 820
	Alepocephalus australis	–	2	1	1240	1 655
	Alepocephalus bairdii	Baird's smoothhead	93	241	953	1 794
	Bajacalifornia megalops	Bigeye smoothhead	20	6	940	1 803
	*Bathytroctes microlepis**	Smallscale smoothhead	1	0	1 747	1 794
	Narcetes stomias	Blackhead salmon	28	35	1 531	1 820
	Rouleina attrita	Softskin smoothhead	564	259	953	1 820
	Alepocephalidae NS	–	82	36	909	1 611
Aulopiformes						
Bathysauridae	*Bathysaurus ferox*	–	90	38	913	1 820
Ipnopidae	*Bathypterois dubius***	Spiderfish	5	1	1 483	1 629
	*Bathypterois grallator**	Tripodfish	1	0	1 710	1 803
	*Bathypterois phenax**	Blackfin spiderfish	3	0	940	1 776
	Bathypterois quadrifilis	–	19	0	940	1 664
	*Bathypterois viridensis**	–	3	0	1 313	1 565
	*Bathytyphlops marionae**	–	2	1	1 377	1 459
	Ipnopidae NS	–	6	0	940	1 556
Notosudidae	*Scopelosaurus lepidus*	–	4	1	940	1 547
Ophidiiformes						
Ophidiidae	*Barathrites parri***	–	2	0	1 384	1 533

(Continued)

Table 1. (Continued).

Order/Family	**Species** (or lowest taxon)	**Common Name**	No.	Wt. (kg)	D_{min} (m)	D_{max} (m)
	*Barathrodemus manatinus**	–	1	0	1 313	1 428
	Bassogigas gillii	–	12	16	913	1 820
	Dicrolene introniger	–	295	37	913	1 776
	*Monomitopus agassizii**	–	2	0	971	1 015
Bythitidae	*Cataetyx laticeps***	–	1	1	1 384	1 423
	Ophidiformes NS	–	4	0	634	901
Gadiformes						
Macrouridae	*Cetonurus globiceps***	–	1	0	1 672	1 748
	*Coelorinchus occa?**	Swordsnout grenadier	1	1	1 500	1 618
	Coryphaenoides rupestris	Roundnose grenadier	9 605	7 046	909	1 820
	Coryphaenoides spp. (1)	Grenadiers	738	28	918	1 803
	*Gadomus arcuatus***	–	2	1	913	1 068
	Macrourus berglax	Roughhead grenadier	140	228	909	1 794
	Nezumia bairdii	Marlinspike	3 203	270	909	1 809
	Macrouridae NS (1)	–	77	17	1 130	1 820
Moridae	*Antimora rostrata*	Blue hake	633	383	909	1 820
	*Guttigadus latifrons***	–	1	0	1 682	1 820
	Halargyreus johnsonii	Dainty mora	22	10	1 130	1 820
	Laemonema barbatulum	Smallscale mora	4	0	940	1 522
Lotidae	*Gaidropsarus argentatus*	Silver rockling	1	0	1 362	1 469
	Gaidropsarus ensis	Threebeard rockling	258	119	1 033	1 820
Phycidae	*Phycis chesteri*	Longfin hake	115	29	909	1 778
	Urophycis tenuis	White hake	11	23	913	1 613
	Gadiformes NS	–	32	0	1 077	1 533
Lophiformes						
Chaunacidae	*Chaunacops roseus** (2)	–	1	0	1 653	1 743
Ogcocephalidae	*Dibranchus atlanticus*	Atlantic batfish	1	0	1 324	1 346
Zeiformes						
Oreosomatidae	*Neocyttus helgae**	–	15	9	971	1 820
Scorpaeniformes						
Psychrolutidae	*Cottunculus thomsonii*	Pallid sculpin	194	208	909	1 646
Liparidae	*Paraliparis* spp. (1)	Snailfishes	50	1	909	1 717
Perciformes						
Anarhichadidae	*Anarhichas denticulatus*	Northern wolffish	1	23	1 357	1 428
	Anarhichas minor	Spotted wolffish	2	2	953	1 646
Zoarcidae	*Lycodonus mirabilis*	–	9	0	1 287	1 695
	Lycodes terraenovae	Atlantic eelpout	39	6	918	1 772
	*Pachycara crassiceps***	–	2	1	1 646	1 693
	Zoarcidae NS	–	1	0	1 280	1 428
Pleuronectiformes						
Pleuronectidae	*Glyptocephalus cynoglossus*	Witch flounder	30	6	909	1 629
	Hippoglossus hippoglossus	Atlantic halibut	4	50	918	1 256
	Reinhardtius hippoglossoides	Greenland halibut	575	1 601	909	1 820

of day that fishing occurred did not vary systematically with depth. Thus, time of sampling in relation to diurnal vertical migration patterns does not explain the observed progressive decline in catch rates in the three deepest strata in both surveys. The number of demersal taxa caught per tow did not vary with depth but was about 19 on C19 and 22 on C20. There was a broad similarity in catch rates among areas and between surveys except that, on C20, catch rates in 1100–1280 m and 1280–1460 m strata in the LaHave area were more than double those in other areas. These high catches were composed primarily of *C. rupestris*.

Table 2. Supplementary information on the demersal species contributing to cases where taxa are grouped at genus or family level in Table 1, from laboratory identifications of retained specimens. (No. - number of specimens identified. * - range extension, ** - not or seldom recorded previously from the NW Atlantic (see Table 3).)

Taxon	Species	Common Name	No.
Rajidae NS	*Amblyraja jenseni*	shorttail skate	8
	Rajella fyllae	round skate	1
Aldrovandia spp.	*Aldrovandia affinis*	–	10
	*Aldrovandia gracilis***	–	10
	Aldrovandia oleosa	–	4
	Aldrovandia phalacra	–	83
Coryphaenoides spp.[1] and Macrouridae NS[2]	*Coryphaenoides alateralis***	–	1
	Coryphaenoides armatus	abyssal grenadier	1
	Coryphaenoides carapinus	–	44
	Coryphaenoides guentheri	Günther's grenadier	5
	*Coryphaenoides mediterraneus***	–	4
	*Nezumia longebarbata**	–	1
Liparidae	*Paraliparis copei*	Blacksnout snailfish	19
	Paraliparis garmani	Pouty snailfish	3

[1]Predominantly *C. carapinus*
[2]Predominantly *C. guentheri*

Cluster analyses based on catch numbers (Fig. 3) resulted in dendrograms showing that the depth strata were more important in ordering the stations than sampling area. For C19, three station groups formed, one containing the two tows in the shallowest stratum off Browns Bank, a second composed of the remaining tows in the three shallowest strata plus one at 1460–1650m off Browns Bank, and a third group composed of the remaining tows in the two deepest strata. The two shallow Browns Bank sets differed from the larger 'shallow' group (average dissimilarity = 43%) due primarily to the presence of *Glyptocephalus cynoglossus* and the absence of *Alepocephalus agassizi* and *Etmopterus princeps*. The average dissimilarity between the two large station groups (48%) was due particularly to higher abundance of *C. fabricii* and *C. rupestris* in the 'shallow' strata and *Halosauropsis macrochir* and *A. agassizi* in the deeper strata. For C20, sampling was more intensive and seven groups formed but, nonetheless, there were two main groups, one containing most of the tows in the three shallow strata and another with most of the tows in the two deep strata, analogous to the two main groups in C19. The average dissimilarity between these two groups (49%) was also comparable to that observed in C19, and was due to the same species except that, in C20, *Coryphaenoides* spp. replaced *A. agassizi* in importance in the deep strata. In C20, a secondary deep group formed containing two stations that differed from the main deep group (average dissimilarity = 46%) due to low catches of *Synaphobranchus kaupii* and the absence of *Aldrovandia* spp. and *Simenchelys parasitica*. The three smaller clusters on the left of the dendrogram are composed largely of tows in the shallowest stratum, and differ variously from the main 'shallow' group by the presence of the upper slope species, *G. cynoglossus* and *Phycis chesteri*, and lesser abundance of mid-slope species. Thus, the patterns of species distributions described by the two surveys were in general agreement.

A combined list for the two surveys of the taxa that were among the top 10 numerically within at least one depth stratum (Table 4) illustrates how the predominant species varied with depth. *Centroscyllium fabricii, C. rupestris* and *Nezumia bairdii* dominated catches in the three shallowest strata. *Alepocephalus agassizii* and *S. kaupi* were moderately abundant in all depths but rose to prominence in rankings in the two deepest strata due primarily to the much reduced abundance, at these depths, of the three species that dominated at shallower depths. The species that actually had their highest abundance in the two deepest strata were *H. macrochir, Gaidropsarus ensis*, *Hydrolagus affinis* and *Rouleina attrita*.

Ranking the top 10 taxa by weight rather than by number replaced four small-bodied taxa (*S. parasitica, Coryphaenoides* spp., *Dicrolene introniger* and *Aldrovandia* spp.) by larger-bodied ones (*Centroscymnus coelolepis*, *Rhinochimaera atlantica*, *Cottunculus thompsonii* and *Macrourus berglax*) (Table 4). This resulted in differences in rankings, particularly in a substantially higher ranking of *Reinhardtius hippoglossoides*, but did not materially change the perceptions based on numbers on how the fauna changed with depth.

Table 3. Demersal species not or seldom recorded previously from the NW Atlantic: number caught (*n*), capture latitude and longitude, depth (min–max tow depth, m), Atlantic Reference Centre (ARC) catalogue number, and notes. (KU – University of Kansas Natural History Museum, MCZ – Museum of Comparative Zoology, Harvard University, Cambridge, MA., USA.)

Aldrovandia gracilis: *n* = 10: 41°55'N, 65°19'W – 42°48'N, 61°26'W, 1313–1776 m. ARC 26788 (*n* = 1), ARC 9713153 (*n* = 1), ARC 9713155 (*n* = 3), ARC 9713157 (*n* = 1), ARC 9813168 (*n* = 1), 9813171 (*n* = 2), ARC 9813173 (*n* = 1). Northern limit previously accepted as Virginia (Sulak, 1990), an unverifiable record from 42°31'N, 63°40'W (Roule and Angel, 1933) being regarded as doubtful. Present records lend credence to that of Roule and Angel (1933).

Bathypterois dubius: *n* = 5: four at 42°08'N 65°08'W, 1483–1629 m, ARC 25403; one at 42°33'N 64°12'W, 1183–1203 m, ARC 9914871. Recorded previously from Grand Bank (ARC 9111413) by Templeman (1966) and from Bear Seamount by Moore *et al.* (2003). Other verified specimens from the vicinity of Bear Seamount are KU 8450, MCZ 165866 (one specimen), and MCZ 167902 (three spec.) (K. Hartel, MCZ, pers. comm.).

Barathrites parri: *n* = 2: one at 42°33'N 63°25'W, 1494–1533 m, ARC 9914912; 1 at 42°39'N 62°25'W, 1384–1423 m, ARC 9914914. Moore *et al.* (2003) report two specimens from off southern New England.

Cataetyx laticeps: *n* = 1: 42°39'N 62°25'W, 1384–1423 m, ARC 27729. Previously reported from off Grand Bank at 42°54'N, 51°18'W (Bänón, 2001) (one specimen), and from the Gulf of Mexico (McEachran and Fechhelm, 1998).

Cetonurus globiceps: *n* = 1: 42°07' 64°57'W, 1672–1748 m, ARC 27641. Previously reported from the Caribbean – Gulf of Mexico (Geistdoerfer, 1986; Geistdoerfer, 1990; McEachran and Fechhelm, 1998).

Gadomus arcuatus: *n* = 2: one at 42°21'N 64°51'W, 913–1053 m, ARC 27758; one at 42°45' 62°40'W, 918–1068 m, ARC 27759. Previously reported from the Caribbean, Gulf of Mexico and northeastern coast of South America (Cohen *et al.*, 1990; Geistdoerfer, 1986; Geistdoerfer, 1990; Goode and Bean, 1896; Iwamoto, 2002; McEachran and Fechhelm, 1998).

Coryphaenoides alateralis: *n* = 1: 42°45'N 62°40'W, 918–1068 m, ARC 27678. Only four specimens have been recorded previously (Moore *et al.,* 2003), from the Gulf of Mexico, Hudson Canyon and Bear Seamount (39°55'N 67°30'W, two specimens).

Coryphaenoides mediterraneus: *n* = 4: one at 42°08'N 64°56'W, 1670–1772 m, ARC 27752; two at 42°51'N 61°24'W, 1653–1743 m, ARC27640; 1 at 42°58'N 61°18'W, 1653–1750 m, ARC27744. Previously recorded from the Gulf of Mexico (Geistdoerfer, 1986; Geistdoerfer, 1990; Iwamoto, 2002; McEachran and Fechhelm, 1998).

Guttigadus latifrons: *n* = 1: 43°50'N 58°20'W, 1682–1820 m, ARC 25404. This is the first record from the NW Atlantic.

Pachycara crassiceps: *n* = 2: one at 42°27'N 63°33'W, 1646–1664 m. ARC 9914939; one at 42°33'N 63°07'W, 1659–1693 m, ARC 9914940. These are the first records from the NW Atlantic.

Some of the taxa in these comparisons consisted of more than one species, distorting the results to some extent. Nothing can be added to clarify the species composition of *Apristurus* spp., but it is clear that the *Aldrovandia* spp. group was largely comprised of *Aldrovandia phalacra* (Table 2). The bi-modal depth distribution of *Coryphaenoides* spp. presents a more complex situation. The abundance of specimens taken in the three deepest strata increased with depth, as did their mean length (12, 14 and 19 cm), and these fish were likely to have been in large part *Coryphaenoides carapinus*. However, of the 123 specimens caught in the shallowest stratum (mean length 25 cm), only one was kept for subsequent laboratory identification and it proved to be *Coryphaenoides alateralis*, a species not previously reported from the area (see Table 3). This is too weak a basis on which to make an inference about the identity of the remaining specimens in this stratum. It is clear, however, that at least two species of *Coryphaenoides*, with different depth distributions, were making important contributions to the present collection.

The six tows made off Banquereau Bank that were classed as problem-free were combined into two depth groups, 1100–1460 m and 1460–1830 m, for data presentation (Table 5). *Alepocephalus bairdii* and *R. attrita* were prominent components of these catches, and *C. rupestris* and *C. fabricii* were less dominant than elsewhere. However, such differences from the more western sampling areas are as likely to be due to the vagaries of sampling in this area as to differences in faunal composition.

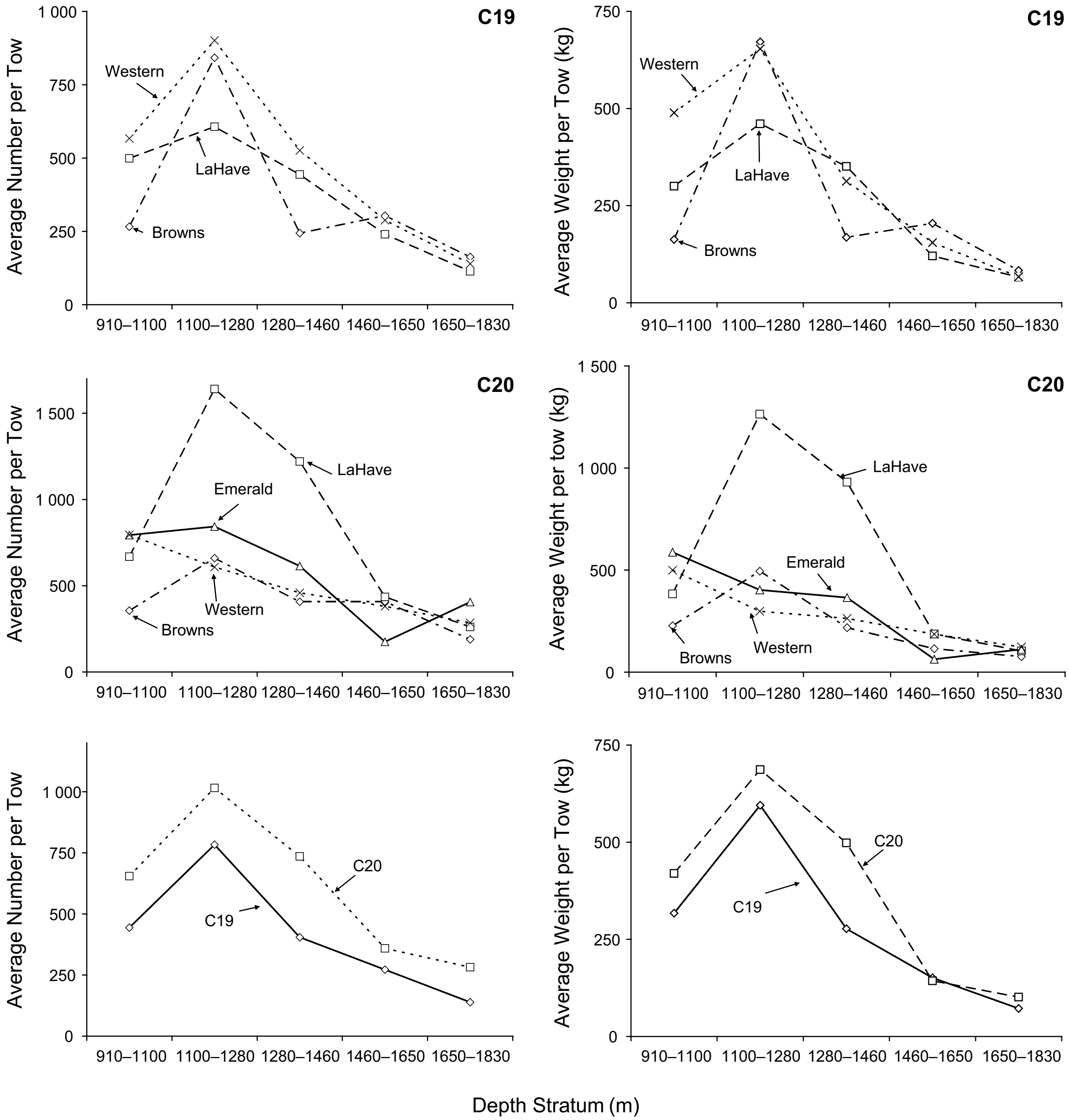

Fig. 2. Average catch rates of demersal species by number and weight for each sampling area by depth stratum for C19 (top panels) and C20 (mid-panels) and by survey overall (bottom panels). (Banquereau Bank data excluded; averages for 1460–1650 m and 1650–1830 m strata adjusted by x1.25 and x1.33 respectively - see text; scales for Y-axes vary.)

Size compositions

Total length, the measurement used for all species on the Cape Chidley surveys, is not the preferred metric for those species with fragile tails that are easily damaged during capture, *e.g.* Macrouridae and Chimaeriformes, *e.g.* ICES (2008). However, the conclusions made here from comparisons of size compositions between surveys and depth strata are relative, and conclusions are not likely to be affected by whatever bias the use of total length may have introduced.

Area-weighted length frequencies, indicative of the length compositions of the populations available to

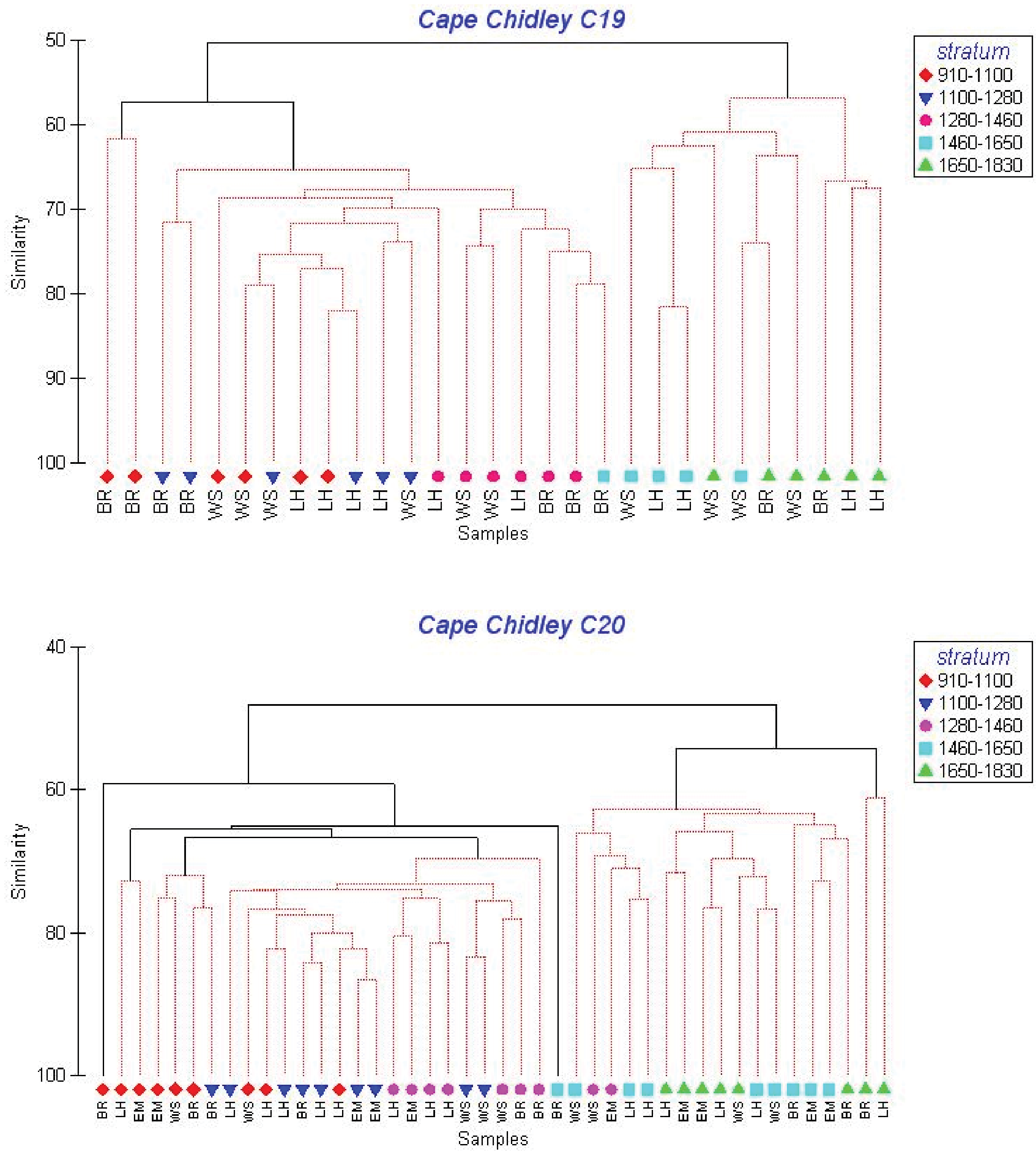

Fig. 3. Hierarchical clustering using fourth-root transformation of catch numbers for all species and stations from Cape Chidley cruises C19 (top panel) and C20 (bottom panel). (Letters indicate banks: BR- Browns; LH-LaHave; EM-Emerald; WS – Western). Symbols indicate depth strata in metres (see key on right).

the gear, were generally similar between surveys for the five species that contributed most, by weight, to catches (Fig. 4). For *R. hippoglossoides* and *Harriotta raleighana*, the relative numbers by length group were almost identical between surveys. In the other three cases, *C. rupestris, C. fabricii* and *A. agassizii*, population estimates from C19 contained fewer small fish than did those from C20. The C19 estimates of large specimens of *C. rupestris* were lower also, and total population number was 60% of that for C20. In the cases of *C. fabricii* and *A. agassizii,* population number estimates from C19 were 85% and 70% respectively, of those from C20.

For these five species, the size of fish caught varied with depth in most cases (Fig. 5). Typically, average lengths were smallest in the shallowest tows, increasing with depth to the 1280–1460 m stratum or to the 1460–1650 m stratum. Catches in the deepest stratum suggested a levelling off in average size but catch numbers in this stratum were so few that any conclusion is speculative. The clearest example of increasing size with depth is provided by *R. hippoglossoides*, average lengths in 910–1100 m being about 60 cm, increasing to about 65 cm in 1100–1280 m and 65–70 cm in 1280–1650 m, and trends for *C. rupestris* and *A. agassizii* were roughly similar in scale. In contrast, the size of *C. fabricii* showed only a slight tendency to increase with depth and *H. raleighana* showed none, average length being lowest at the middle of the depth range sampled.

Pelagic Species

The Cape Chidley bottom trawl surveys caught at least 40 taxa of pelagic fishes, consisting of approximately 1500 specimens weighing almost 60 kg (Table 6). There were cases of catches reported at a taxonomic level higher than species for pelagic taxa also and, for a number of these, voucher specimens were available that give an indication of their species composition (Table 7). However, the data from these voucher specimens are too scant to allow inferences to be made about the relative abundance of these species in catches.

The survey reported on by Markle *et al.* (1988), conducted in 1984 by the government-chartered vessel, Lady Hammond, using a Western IIA bottom otter trawl, similarly caught about 40 taxa of pelagic fishes, consisting of almost 1000 specimens (Table 8). Included in Table 8 are three species of liparid, and the trichiurid *Benthodesmus tenuis*, species that would be considered demersal under present criteria, but presumably were considered pelagic by Markle *et al.* (1988).

There was a strong similarity in the pelagic taxa caught by bottom trawl on the two surveys, about 70% being in common, despite differences in gear design and depths fished, and most of these taxa occurred also in midwater trawl samples from the same area (Themelis and Halliday, 2012), or in waters to the immediate southwest of the sampling area (Moore *et al.*, 2003). Of note, however, is the record of *Platytroctes apus* (Cape Chidley, 42°45'N 61°41'W, 1498–1522 m, ARC 9914821), only two specimens of which have been reported previously from the NW Atlantic, one at about 40°N (Hartel *et al.*, 2008), the other off Greenland ((Møller *et al.*, 2010), and the record of *Benthodesmus tenuis* (Lady Hammond, 42°57'N 61°41'W, 558–585 m, ARC 8600838), which is only the second record north of Cape Hatteras, the first being off Browns Bank (Scott and Scott, 1988).

Discussion

The reason why the number of benthic taxa caught per tow differed between surveys, being about 15% higher on C20 than on C19, is not clear. The surveys were quasi-commercial in character, and close cooperation between ship's crew and scientific personnel was required to meet the needs of both. It is possible that this cooperation improved between surveys, explaining the higher number of taxa per tow observed on C20. It is also possible, however, that minor differences in the trawl nets, the net used on C19 being lost at sea and replaced on C20 with another built to the same specifications, contributed to this, and other, differences in results between surveys.

The much higher catches of *C. rupestris* in the LaHave area than in other areas on C20 occurred, in large part, in a series of tows added at the end of the sampling program. It is possible that these tows did not conform to the randomized sampling design, biasing results. Nonetheless, when these added tows are disregarded, abundance estimates for this species in the LaHave area, although reduced, remain higher than in other areas. In contrast, C19 estimates of *C. rupestris* in the LaHave area were not higher than elsewhere. However, sampling on C19 was restricted to non-contiguous blocks, which could have introduced bias to abundance estimates from this survey if, for example, areas of high density of *C. rupestris* were excluded from the sampling blocks. An association of *C. rupestris* with canyons, as has been noted by Snelgrove and Haedrich (1985) in data from southeastern Grand Bank and off New England, could underlie such a bias. While there is no evidence for such an association in data from the present study, differences in sampling design nonetheless may have been an important factor causing variability in quantities caught between surveys.

While areas fished differed to some extent between surveys, cluster analysis did not find area to be a factor of importance in determining species composition; rather it was depth that had an over-riding influence. Catch rates were high in the three shallowest strata (910–1460 m) but declined to much lower levels in 1460–1650 m and to minima in 1650–1830 m on both surveys. In the present

Table 4. Demersal species abundance (by number, and weight, per tow) and dominance (ranking) within depth strata. (Banquereau Bank data excluded. **A**: 910–1100 m, **B**: 1100–1280 m, **C**: 1280–1460 m, **D**: 1460–1650 m, **E**: 1650–1830 m. **D** and **E** adjusted by x1.25 and x1.33, respectively. + denotes <0.5/tow.)

	Average/tow					Ranking				
Depth stratum	**A**	**B**	**C**	**D**	**E**	**A**	**B**	**C**	**D**	**E**
Number of tows	15	15	15	14	14	15	15	15	14	14
A. By number										
Centroscyllium fabricii	327	281	98	20	4	1	2	2	5	–
Coryphaenoides rupestris	74	330	201	28	8	2	1	1	3	6
Nezumia bairdii	53	71	68	18	4	3	3	4	6	–
Synaphobranchus kaupii	36	46	68	49	31	4	5	5	2	3
Harriotta raleighana	17	17	15	9	5	5	8	6	–	9
Alepocephalus agassizii	15	55	89	98	56	6	4	3	1	1
Reinhardtius hippoglossoides	13	14	9	1	1	7	9	8	–	–
Apristurus spp.	12	24	7	3	3	8	7	10	–	–
Simenchelys parasitica	9	4	4	5	3	9	–	–	–	–
Coryphaenoides spp.	9	0	2	21	33	10	–	–	4	2
Etmopterus princeps	5	27	4	1	1	–	6	–	–	–
Dicrolene introniger	2	9	5	4	+	–	10	–	–	–
Antimora rostrata	7	6	13	11	7	–	–	7	9	8
Aldrovandia spp.	1	6	8	14	4	–	–	9	7	–
Rouleina attrita	+	+	2	13	8	–	–	–	8	7
Halosauropsis macrochir	+	+	+	9	17	–	–	–	10	4
Gaidropsarus ensis	+	+	1	9	13	–	–	–	–	5
Hydrolagus affinis	+	+	1	1	4	–	–	–	–	10
B. By weight (kg)										
Centroscyllium fabricii	242	206	74	14	3	1	2	2	3	–
Reinhardtius hippoglossoides	30	38	30	6	3	2	3	4	8	–
Coryphaenoides rupestris	25	237	177	26	6	3	1	1	2	6
Harriotta raleighana	22	20	17	10	7	4	7	5	4	3
Apristurus spp.	18	38	9	4	1	5	4	7	10	–
Centroscymnus coelolepis	15	22	7	3	1	6	6	9	–	–
Rhinochimaera atlantica	14	9	1	1	1	7	9	–	–	–
Cottunculus thompsonii	7	4	3	+	0	8	–	–	–	–
Synaphobranchus kaupii	5	7	12	7	4	9	10	6	5	8
Etmopterus princeps	4	28	4	1	+	10	5	–	–	–
Alepocephalus agassizii	3	14	46	38	18	–	8	3	1	1
Antimora rostrata	4	3	7	7	5	–	–	8	6	7
Nezumia bairdii	3	6	7	1	1	–	–	10	–	–
Rouleina attrita	+	+	+	6	3	–	–	–	7	10
Hydrolagus affinis	1	2	6	5	11	–	–	–	9	2
Halosauropsis macrochir	+	+	+	4	6	–	–	–	–	4
Gaidropsarus ensis	+	+	1	4	6	–	–	–	–	5
Macrourus berglax	3	4	2	4	3	–	–	–	–	9

Table 5. Demersal species abundance (by number, and weight, per tow) and dominance (ranking) within depth strata in the Banquereau Bank area. (Deep strata adjusted as in Table 4. + denotes <0.5/tow.)

	Average/tow		Ranking	
Depth Strata	1 100–1 460 m	1 460–1 830 m	1 100–1 460 m	1 460–1 830 m
Number of tows	3	3	3	3
A. By number				
Nezumia bairdii	32	12	1	5
Coryphaenoides rupestris	32	22	2	4
Alepocephalus bairdii	20	+	3	–
Rouleina attrita	16	115	4	1
Synaphobranchus kaupii	15	24	5	3
Centroscyllium fabricii	10	0	6	–
Alepocephalus agassizii	8	98	7	2
Harriotta raleighana	6	5	8	10
Antimora rostrata	5	11	9	6
Reinhardtius hippoglossoides	5	2	10	–
Halosauropsis macrochir	+	9	–	7
Bathysaurus ferox	0	9	–	8
Macrouridae	1	7	–	9
B. By weight (kg)				
Alepocephalus bairdii	64	2	1	–
Coryphaenoides rupestris	18	6	2	8
Reinhardtius hippoglossoides	14	7	3	6
Harriotta raleighana	11	12	4	3
Centroscyllium fabricii	9	0	5	–
Hydrolagus affinis	8	6	6	9
Alepocephalus agassizii	5	141	7	1
Nezumia bairdii	4	2	8	–
Rouleina attrita	4	62	9	2
Antimora rostrata	4	8	10	5
Bathyraja sp.	3	10	–	4
Bathysaurus ferox	0	6	–	7
Narcetes stomias	0	5	–	10

study, it was necessary to apply correction factors to catches to account for a reduction in towing speed, and hence distance towed, when fishing in the two deepest strata, but their adequacy is not known. An inference about the affects of this difference in sampling procedure with depth can be made based on catches of several large-bodied species that are perhaps the most capable of avoiding slow-moving nets. According to Moore *et al.* (2003), the depth distribution of *H. raleighana* extends to 2452 m, that of *C.coelolepis* to 3675 m, and of *E. princep*s to 2213 m, but these species were caught by the Cape Chidley primarily in 910–1460 m. This suggests that, relative to catches in these strata, catches in the two deepest strata may have underestimated abundance of these, and perhaps other, species. Nonetheless, these particular species were not among the most important in determining the dissimilarity between the two main groups and, despite the confounding effect of changes in fishing procedure with depth, present results are consistent with those of other studies which have found a distinction between mid slope and lower slope assemblages. In particular, cluster analysis of fish occurrence data from a video survey at 53°–56°W (Baker

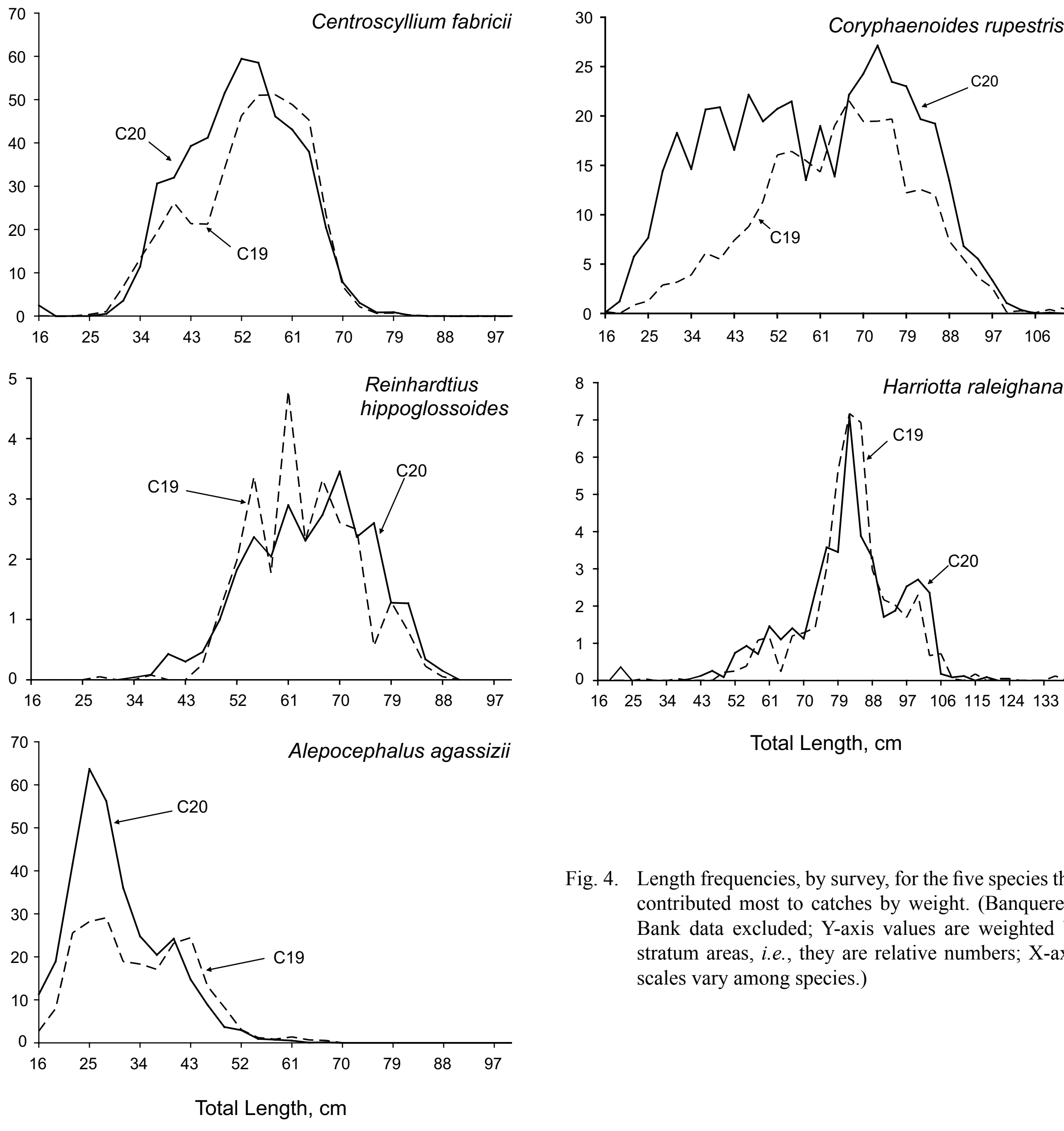

Fig. 4. Length frequencies, by survey, for the five species that contributed most to catches by weight. (Banquereau Bank data excluded; Y-axis values are weighted by stratum areas, *i.e.*, they are relative numbers; X-axis scales vary among species.)

et al., 2012), immediately to the east of the present surveys, defined a boundary between species assemblages at about 1300m, and these authors cite other such cases.

The bottom trawl survey off Nova Scotia by the Lady Hammond (Markle *et al.*, 1988) extended from LaHave Bank to St. Pierre Bank (56°W) and thus overlapped strongly, geographically, with the Cape Chidley surveys. Depths surveyed by the Lady Hammond extended from 400 m to 1200 m and thus catches contained many upper slope species that were not available to Cape Chidley surveys. However, in those depth strata that overlapped (strata 3+4: 800–1200 m of Markle *et al.* (1988), their Table 5, versus 910–1280 m, present data), the species predominating in catches were similar. However, in these overlapping strata, the Cape Chidley caught more than five times the number, and ten times the weight, per tow of the Lady Hammond (all taxa combined), and caught almost twice as many species per tow. The Western IIa net used by Markle *et al.* (1988) was smaller than the Engel trawl used by the Cape Chidley (headline height 4.6 m, wingspread 10.7 m (Carrothers, 1988) versus 6.0 m and

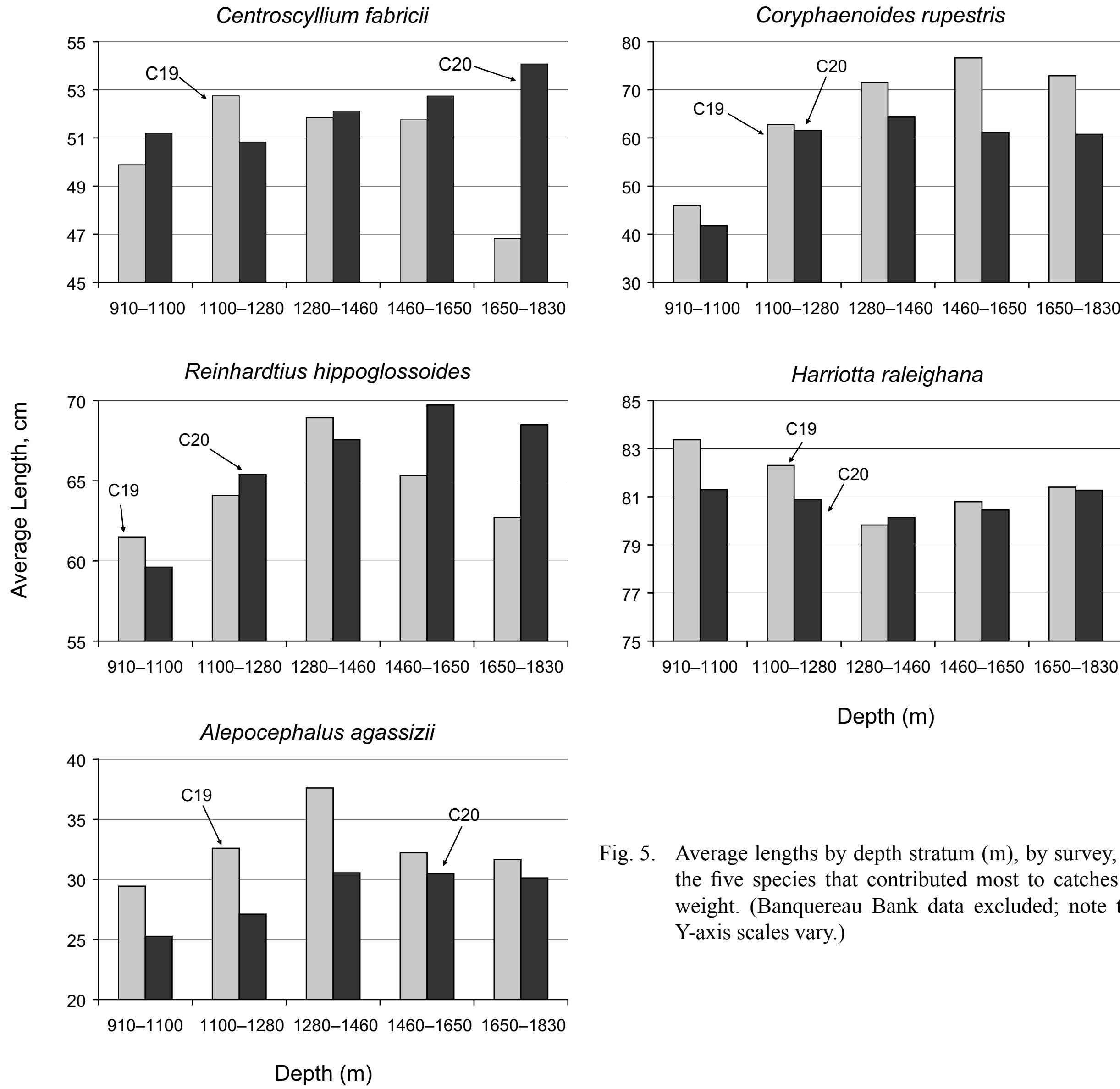

Fig. 5. Average lengths by depth stratum (m), by survey, for the five species that contributed most to catches by weight. (Banquereau Bank data excluded; note that Y-axis scales vary.)

24 m, respectively) and nominal tow time was half as long. These factors likely account for much of the difference in catches. Also, however, the Lady Hammond was fishing at the limit of its capability at these depths, a factor that likely reduced further its fishing power relative to the Cape Chidley.

The video survey of Baker *et al.* (2012) of the fish fauna in canyons off SW Newfoundland in 350–2250 m provided a list of species observed that was very similar to the lists of species caught by the Lady Hammond and Cape Chidley at comparable sampling depths. There were differences in the relative importance of these species between trawl and video surveys which could reflect differences in gear selection or sampling design, *e.g.* restriction of video sampling to canyons.

Markle *et al.* (1988) found the slope fauna off Nova Scotia to have many similarities with the temperate fauna of the Mid-Atlantic Bight, *i.e.* the area from south of Georges Bank to Cape Hatteras, as characterized by Sulak (1982). Other descriptions of that fauna are given by Markle and Musick (1974) and Haedrich *et al.* (1975). Markle *et al.* (1988) did, however, note substantial differences between the Scotian Slope fauna and that off southeastern Grand Bank (Snelgrove and Haedrich, 1985) in terms of dominant species, diversity and depth distributions. Pinhorn and Halliday (1997) subsequently proposed, based on research vessel trawl surveys conducted in 1949–91, that The Tail of Grand Bank (about 51°W) was a boundary of importance to the distribution of slope fish species, 'northern' species occurring at reduced densities (and/or at greater depth) to the west and 'southern' species

Table 6. Pelagic taxa, Cape Chidley exploratory fishing 1994–95: number caught (No.) and number of occurrences (Occur.) by taxon. ((1) – see Table 7 for supplementary information on species composition.)

Order/Family	**Species** (or lowest taxon)	No.	Occur.
Anguilliformes			
Derichthyidae	*Derichthys serpentinus*	1	1
Nemichthyidae	*Nemichthys scolopaceus*	117	50
Serrivomeridae	*Serrivomer beanii*	294	77
Saccopharyngiformes			
Eurypharyngidae	*Eurypharynx pelecanoides*	17	12
Osmeriformes			
Bathylagidae	*Bathylagus euryops*	65	29
Platytroctidae	*Holtbyrnia anomala*	1	1
	Maulisia microlepis	4	4
	Platytroctes apus	1	1
Stomiiformes			
Gonostomatidae	*Sigmops bathyphilus*	9	8
	Sigmops elongatum	15	14
Sternoptychidae	*Argyropelecus aculeatus*	10	9
	Argyropelecus gigas	2	2
Stomiidae	*Borostomias antarcticus*	6	5
	Chauliodus sloani	101	48
	Stomias boa ferox	67	38
	Melanostomias bartonbeani	3	3
	Malacosteus niger	8	7
	Stomiiformes NS	6	4
Aulopiformes			
Paralepididae	Paralepididae NS (1)	13	13
Anotopteridae	*Anotopterus pharao*	3	3
Alepisauridae	*Alepisaurus ferox*	6	6
	Alepisaurus brevirostris	3	3
Myctophiformes			
Myctophidae	Myctophidae NS (1)	546	68
Lophiiformes			
Melanocetidae	*Melanocetus* spp. (1)	5	5
Himantolophidae	*Himantolophus albinares*	2	2
Ceratiidae	*Cryptopsaras couesii*	4	3
Gigantactinidae	*Gigantactis vanhoeffeni*	3	3
Beloniformes			
Scomberesocidae	*Scomberesox saurus*	1	1
Stephanoberyciformes			
Melamphaidae	Melamphaidae NS (1)	91	43
Cetomimiformes			
Rondeletiidae	*Rondeletia loricata*	3	4
Cetomimidae	*Cetostoma regani*	1	1

(Continued)

Table 6. (Continued).

Order/Family	**Species** (or lowest taxon)	No.	Occur.
Beryciformes			
Anoplogastridae	*Anoplogaster cornuta*	18	16
Perciformes			
Howellidae	*Howella brodiei*	28	14
Caristiidae	*Caristius* sp.	1	1
Chiasmodontidae	*Chiasmodon* sp.	25	21
	Pseudoscopelus sp.	3	3
Zoarcidae	*Melanostigma atlanticum*	2	1

occurring in lesser abundance to the east. This was attributed to the influence of the cold Labrador Current, which bathes northeastern slopes with water less than 4°C to depths of at least 1000 m but turns offshore at about this location. However, their data for southern Grand Bank and west was restricted very largely to upper slope depths.

Direct comparisons of faunal composition and species abundances obtained from present data with those from previous surveys at similar depths are confounded by differences in survey design and by the large differences in gear size and vessel fishing power. The differences in vessels and gears used are particularly pertinent to comparisons with those surveys in the Mid Atlantic Bight that used shrimp trawls (Markle and Musick, 1974; Haedrich *et al.*, 1975; Haedrich *et al.*, 1980; Sulak, 1982). These trawls were substantially smaller (headline height of about 2.0 m) than that used in present surveys and they were towed at half the speed (1.5 knots). Testimony to a difference in fishing capability is provided by the Cape Chidley captures of large mobile species, which would have the greatest capability for avoidance of small slow-moving nets. While Chimaeriformes and sharks comprise a third of numbers and almost half the weight caught on Cape Chidley surveys, these taxa were of minor to no importance in Mid-Atlantic Bight survey catches, and this must surely be an effect of sampling.

In areas to the north and east of the present study area (NAFO Subareas 2–3), the existence of substantial populations of *C. rupestris* (Atkinson, 1995), *R. hippoglossoides* (Bowering and Brodie, 1995) and *M. berglax* (Murua *et al.*, 2005) has been well established. Present data show that a substantial population of *C. rupestris* occurs also on the Scotian Slope and that it is a dominant member of the upper – mid slope fauna in that area. Pinhorn (1976) cites an observation of spawning and post-spawning fish "off Nova Scotia", and sexually maturing fish have been observed in the area by one of the present authors (DET). The size at sexual maturation of this species in more northern areas is 40–50 cm (Atkinson, 1995). Thus, the occurrence in present catches of substantial numbers of *C. rupestris* in the length range 15–40 cm supports a view that the species resides within the surveyed area throughout its life cycle. *Reinhardtius hippoglossoides* was of moderate abundance in Scotian Shelf slope catches, but nonetheless ranked fourth by weight as all catches were of large fish (>40 cm). This suggests that they were progeny of a more northern spawning population, perhaps that in the Gulf of St. Lawrence (Bowering, 1983). The contribution of *M. berglax* to present catches was minor. Thus, the data for *M. berglax* and *R. hippoglossoides* are consistent with The Tail of Grand Bank being of some biogeographic importance, but there is no clear support for this in the case

Table 7. Pelagic taxa, Cape Chidley exploratory fishing 1994–1995: supplementary information on the species contributing to cases where taxa are grouped at genus or family level, from laboratory identifications of retained specimens (except Myctophidae includes at-sea identifications also). (No. – the number of specimens identified.)

Taxon	**Species**	No.
Paralepididae NS	*Magnisudis atlantica*	1
Myctophidae NS	*Benthosema glaciale*	140
	Ceratoscopelus maderensis	3
	Lampadena speculigera	3
	Lampanyctus macdonaldi	24
Melanocetus spp.	*Melanocetus johnsonii*	1
	Melanocetus murrayi	2
Melamphaidae NS	*Poromitra crassiceps*	4
	Scopelogadus beanii	6
	Scopelogadus mizolepis	1

Table 8. Pelagic taxa, Lady Hammond bottom trawling 1984: number caught (No.) and number of occurrences (Occur.) by taxon.

Order/Family	Species (or lowest taxon)	No.	Occur.
Anguilliformes			
Derichthyidae	*Nessorhamphus ingolfianus*	5	5
Nemichthyidae	*Nemichthys scolopaceus*	90	27
Serrivomeridae	*Serrivomer beanii*	89	22
Saccopharyngiformes			
Eurypharyngidae	*Eurypharynx pelecanoides*	3	3
Osmeriformes			
Bathylagidae	*Bathylagus euryops*	17	4
	Bathylagus sp.	59	15
	Melanolagus bericoides	1	1
Stomiiformes			
Gonostomatidae	*Cyclothone* sp.	3	2
	Gonostoma elongatum	47	16
Sternoptychidae	*Argyropelecus aculeatus*	7	6
	Polyipnus clarus	9	3
	Sternoptyx diaphana	4	4
Stomiidae	*Chauliodus sloani*	143	27
	Stomias boa ferox	123	25
	Melanostomias bartonbeani	1	1
	Malacosteus niger	9	7
	Photostomias guernei	2	2
	Stomiiformes NS	2	2
Aulopiformes			
Paralepididae	Paralepididae NS	26	12
Myctophiformes			
Myctophidae	*Benthosema glaciale*	89	16
	Ceratoscopelus maderensis	59	10
	Lampanyctus sp.	15	7
	Lampadena sp.	3	3
	Myctophum punctatum	23	4
	Notoscopelus sp.	14	3
	Myctophidae NS	8	2
Gadiformes			
Moridae	Moridae NS	1	1
Melanonidae	*Melanonus zugmayeri*	3	3
Lophiformes			
Gigantactinidae	*Gigantactis vanhoeffeni*	1	1
Beloniformes			
Scomberesocidae	*Scomberesox saurus*	1	1
Stephanoberyciformes			
Melamphaidae	*Melamphaes suborbitalis*	1	1
	Poromitra sp.	6	5
	Scopelogadus sp.	104	8
Cetomimiformes			
Rondeletiidae	*Rondeletia loricata*	1	1
Beryciformes			
Anoplogasteridae	*Anoplogaster cornuta*	2	2
Scorpaeniformes			
Liparidae	*Paraliparis calidus*	1	1

(Continued)

Table 8. (Continued).

Order/Family	**Species** (or lowest taxon)	No.	Occur.
	Paraliparis copei	2	2
	Paraliparis garmani	3	2
Perciformes			
Howellidae	*Howella brodiei*	5	5
Caristiidae	*Caristius* sp.	1	1
Chiasmodontidae	*Chiasmodon* sp.	4	3
Zoarcidae	*Melanostigma atlanticum*	8	3
Trichiuridae	*Benthodesmus tenuis*	1	1

of *C. rupestris*. Kulka (2006) identified the Laurentian Channel, immediately adjacent to the Scotian Shelf slope, as the pupping area for *C. fabricii*, and the high catches in present surveys are consistent with the survey area being the centre of the species distribution.

Acknowledgements

This project was jointly funded by National Sea Products Limited (now High Liner Foods Limited), Lunenburg, Nova Scotia, and by the Canadian Department of Fisheries and Oceans (DFO) through Contribution Agreement No. FP280-4-5353/VB4-07/A94-SF353 of the Atlantic Fisheries Adjustment Programme (DFO scientific authority - R. G. Halliday). At-sea data collection was conducted by HMSC under contract to National Sea Products Limited. The authors are particularly grateful to G. Pohle, HMSC, who managed the field sampling programme, to C. Chambers (then of HMSC), who supervised data collection during the March 1995 survey, and to our collaborators at National Sea Products. We thank D. Kulka, Northwest Atlantic Fisheries Centre, St. John's, Newfoundland and G. Pohle for reviews of an earlier draft.

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