The Meso- and Bathypelagic Fish Assemblage in The Gully: Data Preparation and Species' Distributions

T.J. Kenchington, D. Themelis, S. DeVaney and E.L. Kenchington

Department of Fisheries & Oceans,
Maritimes Region.
Ocean Ecosystem Sciences Division,
Bedford Institute of Oceanography,
PO Box 1006, Dartmouth,
Nova Scotia B2Y 4A2
CANADA

2018

Canadian Technical Report of Fisheries and Aquatic Sciences 3268

Fisheries and Oceans
Canada

Pêches et Océans
Canada

Canada

Canadian Technical Report of Fisheries and Aquatic Sciences

Technical reports contain scientific and technical information that contributes to existing knowledge but which is not normally appropriate for primary literature. Technical reports are directed primarily toward a worldwide audience and have an international distribution. No restriction is placed on subject matter and the series reflects the broad interests and policies of Fisheries and Oceans Canada, namely, fisheries and aquatic sciences.

Technical reports may be cited as full publications. The correct citation appears above the abstract of each report. Each report is abstracted in the data base Aquatic Sciences and Fisheries Abstracts.

Technical reports are produced regionally but are numbered nationally. Requests for individual reports will be filled by the issuing establishment listed on the front cover and title page.

Numbers 1-456 in this series were issued as Technical Reports of the Fisheries Research Board of Canada. Numbers 457-714 were issued as Department of the Environment, Fisheries and Marine Service, Research and Development Directorate Technical Reports. Numbers 715-924 were issued as Department of Fisheries and Environment, Fisheries and Marine Service Technical Reports. The current series name was changed with report number 925.

Rapport technique canadien des sciences halieutiques et aquatiques

Les rapports techniques contiennent des renseignements scientifiques et techniques qui constituent une contribution aux connaissances actuelles, mais qui ne sont pas normalement appropriés pour la publication dans un journal scientifique. Les rapports techniques sont destinés essentiellement à un public international et ils sont distribués à cet échelon. II n'y a aucune restriction quant au sujet; de fait, la série reflète la vaste gamme des intérêts et des politiques de Pêches et Océans Canada, c'est-à-dire les sciences halieutiques et aquatiques.

Les rapports techniques peuvent être cités comme des publications à part entière. Le titre exact figure au-dessus du résumé de chaque rapport. Les rapports techniques sont résumés dans la base de données Résumés des sciences aquatiques et halieutiques.

Les rapports techniques sont produits à l'échelon régional, mais numérotés à l'échelon national. Les demandes de rapports seront satisfaites par l'établissement auteur dont le nom figure sur la couverture et la page du titre.

Les numéros 1 à 456 de cette série ont été publiés à titre de Rapports techniques de l'Office des recherches sur les pêcheries du Canada. Les numéros 457 à 714 sont parus à titre de Rapports techniques de la Direction générale de la recherche et du développement, Service des pêches et de la mer, ministère de l'Environnement. Les numéros 715 à 924 ont été publiés à titre de Rapports techniques du Service des pêches et de la mer, ministère des Pêches et de l'Environnement. Le nom actuel de la série a été établi lors de la parution du numéro 925.

Canadian Technical Report of
Fisheries and Aquatic Sciences 3268

2018

THE MESO- AND BATHYPELAGIC FISH ASSEMBLAGE IN THE GULLY: DATA PREPARATION AND SPECIES' DISTRIBUTIONS

by

T.J. Kenchington, D. Themelis[1], S. DeVaney[2] and E.L. Kenchington

Department of Fisheries & Oceans,
Maritimes Region,
Ocean and Ecosystem Sciences Division,
Bedford Institute of Oceanography,
PO Box 1006, Dartmouth,
Nova Scotia B2Y 4A2 CANADA

---

[1]: Population Ecology Division, Bedford Institute of Oceanography, PO Box 1006, Dartmouth, NS B2Y 4A2 CANADA

[2] Los Angeles Pierce College, Life Science Department, 6201 Winnetka Ave., Woodland Hills, CA 91371, U.S.A.

Cat. No. Fs97-6/3268E-PDF ISBN 978-0-660-27316-7 ISSN 1488-5379

Correct citation for this publication:

Kenchington, T.J., D. Themelis, S. DeVaney and E.L. Kenchington. 2018. The Meso- and Bathypelagic Fish Assemblage in The Gully: Data Preparation and Species' Distributions. Can. Tech. Rep. Fish. Aquat. Sci. 3268: v+153p.

TABLE OF CONTENTS

ABSTRACT

Kenchington, T.J., D. Themelis, S. DeVaney and E.L. Kenchington. 2018. The Meso- and Bathypelagic Fish Assemblage in The Gully: Data Preparation and Species' Distributions. Can. Tech. Rep. Fish. Aquat. Sci. 3268: v+153p.

During 2007–10, a series of midwater trawl surveys was conducted, at meso- and bathypelagic depths, in The Gully, a submarine canyon and Marine Protected Area immediately east of Sable Island, and around the canyon's mouth. One of the major outputs of that program, appearing in the primary literature, is a multivariate statistical analysis of the structure of the fish assemblage. That work is here supported by supplementary information on the preparation of the data matrices for the multivariate analyses and by examination of both the spatio-temporal distribution and the length frequency of each of the 19 species included in the analysis. The examination revealed up-canyon trends in fish abundance (declining in 17 species), in depth distributions and in average lengths (increasing in 10 species – usually because of a rapid up-canyon decline in numbers of small individuals).

RÉSUMÉ

Kenchington, T.J., D. Themelis, S. DeVaney and E.L. Kenchington. 2018. The Meso- and Bathypelagic Fish Assemblage in The Gully: Data Preparation and Species' Distributions. Can. Tech. Rep. Fish. Aquat. Sci. 3268: v+153p.

De 2007 à 2010, une série de relevés au chalut pélagique a été menée à des profondeurs mésopélagiques et bathypélagiques dans le Gully, un canyon sous-marin et une zone de protection marine directement à l'est de l'île de Sable et autour de l'embouchure du canyon. L'un des principaux résultats de ce programme, publié dans la littérature primaire, est l'analyse statistique multivariée de la structure de l'assemblage de poissons. Ce travail est appuyé ici par des renseignements supplémentaires sur la préparation des matrices de données pour les analyses multivariées et par l'examen de la répartition spatiale et temporelle et de la fréquence de longueur pour chacune des 19 espèces incluses dans l'analyse. L'examen a révélé des tendances au haut du canyon en matière d'abondance du poisson (déclin chez 17 espèces), de répartitions par profondeur et de longueurs moyennes (augmentation chez 10 espèces, normalement en raison d'un déclin rapide de la quantité de petits individus au haut du canyon).

1 GENERAL INTRODUCTION

During August / September of each of 2007–09 and in March 2010, midwater trawl surveys, at meso- and bathypelagic depths, were undertaken in The Gully – a very large submarine canyon incised into the margin of the Scotian Shelf immediately east of Nova Scotia's Sable Island, most of which lies within a Marine Protected Area (Figures 1, 2). Sampling followed a fixed-station, depth-stratified, replicated design, reaching 1,750 m depth routinely and occasionally deeper (Kenchington *et al*. 2009, 2014a). Those were the first midwater trawl surveys conducted within any canyon, below its rim depth.

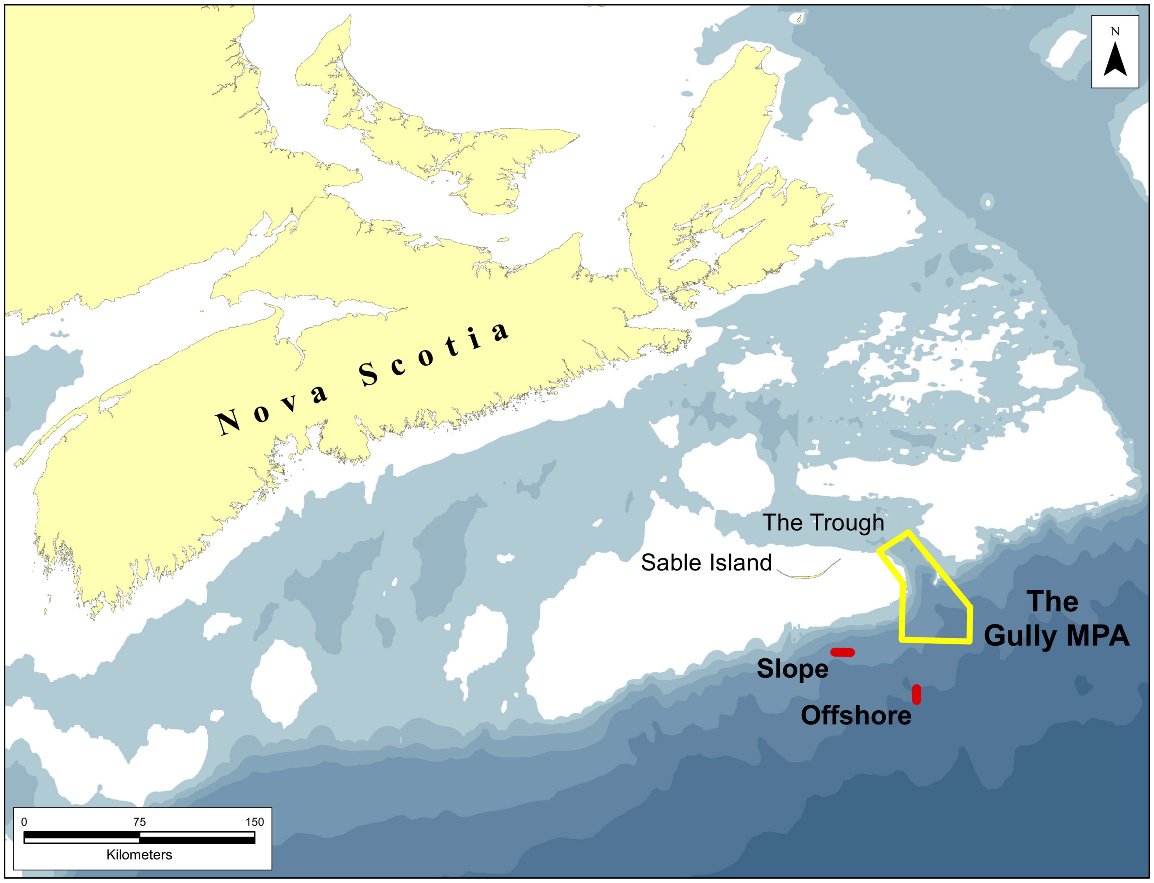


Figure 1 : Location of The Gully and The Trough, showing the Offshore and Slope trawling stations (White areas are shallower than 100 m, while those shaded in the lightest blue are 100 to 200 m deep)

Identification of specimens of rarities is on-going but the surveys took at least 250 species of fish, in addition to crustaceans (MacIsaac *et al*. 2014), cephalopods and others (Kenchington *et al*. 2014b). One major output from the program is an analysis of assemblage structure of the meso- and bathypelagic fish species encountered (Kenchington *et al*. *in prep.*). In support of that study, this Technical Report presents both supplementary information on the preparation of the analyzed data matrices and an examination of each of the species included in the analyses – material too voluminous for primary publication. We consider the spatio-temporal distributions of each species, length frequencies of the specimens caught and prior knowledge available in published literature. Discussion of the implications of that species-specific information for the ecology of The Gully is presented by Kenchington *et al*. (*in prep.*), where it is associated with the results of multivariate statistical analysis of assemblage structure.

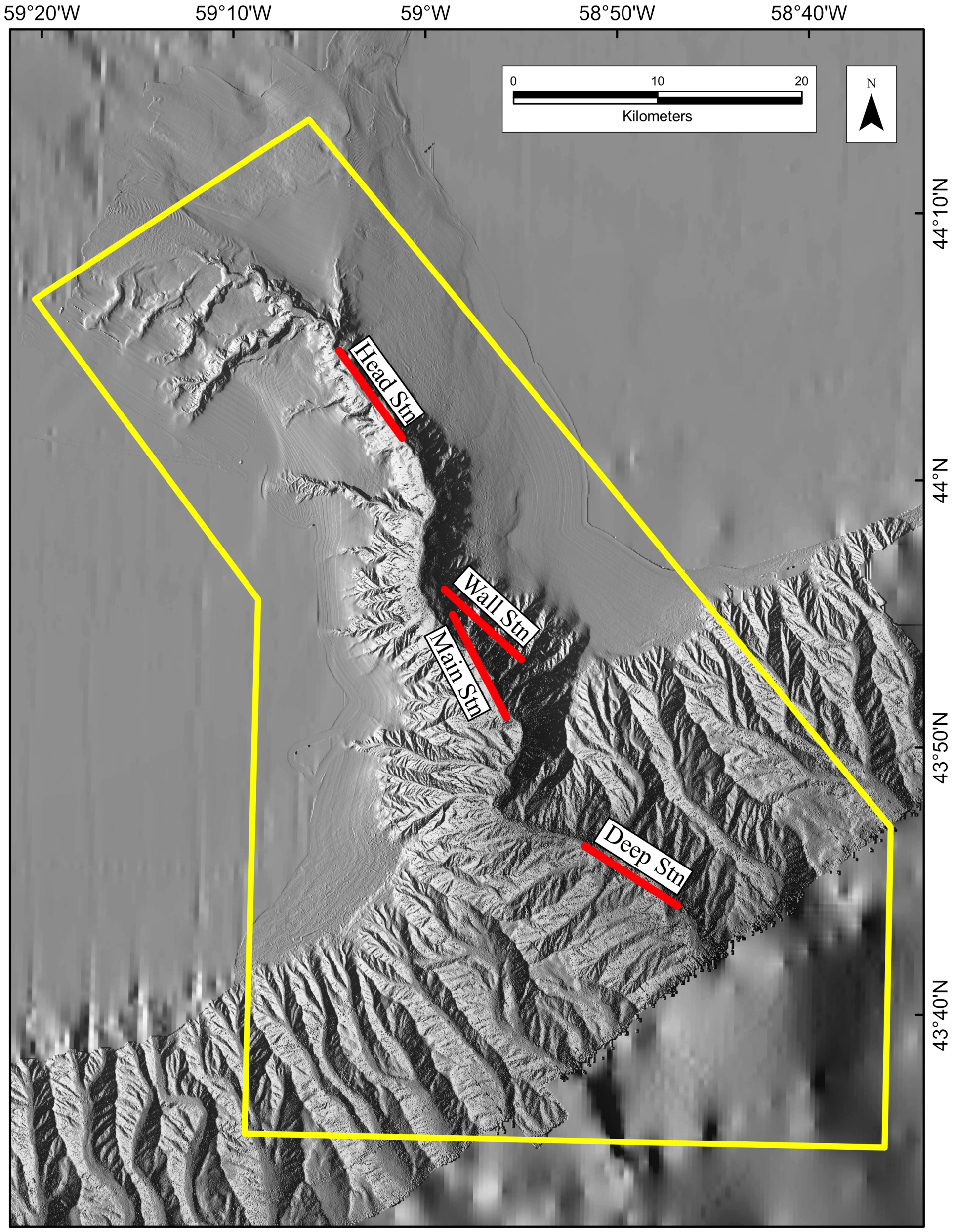


Figure 2 : Bathymetry of The Gully, showing the locations of four trawling stations and the boundary of the MPA

2 SUMMARY OF AT-SEA AND POST-SURVEY METHODS

The field methods of the four surveys have been presented in full by Kenchington *et al*. (2009, 2014a) and only essential points are repeated here. There were three surveys in late summer (August / September in each of 2007–09) and one in early spring (March 2010). The primary gear used, and the only one that contributed catch data used here, was the International Young Gadoid Pelagic Trawl ("IYGPT"), a midwater otter trawl with a mouth area of approximately 60 m^2. From 2008, the trawl was fitted with a rigid "aquarium" codend.

That gear was fished on six fixed stations, four arrayed along The Gully's thalweg (named "Head", "Main", "Deep" and "Offshore" stations, respectively – the last of which was only sampled in 2007 and then incompletely), one over the canyon wall ("Wall Station") and one over the continental slope, away from the canyon's influence ("Slope Station": Figures 1, 2). The Wall Stations was only worked as time permitted. The Slope Station was added to the design in 2009 and sampling there was limited.

The water column was divided into four depth strata (0–250, 250–750, 750–1,250 and 1,250–1,750 m – the latter not fully introduced until the final survey), though seabed depths prevented the deeper strata being fished on some stations. By intent, during each survey, two replicate sets should have been made in each available stratum in each of daylight and night (avoiding periods within one hour of sunrise and sunset), though sets made above 250 m in daylight were not usually replicated, while a third replicate was attempted in each stratum of the Main Station during the 2007 survey. Constraints on available ship time and other factors prevented completion of that design, but a few deeper sets (below the deepest available, defined stratum on the respective station) were made.

Some sets made during the surveys were deemed non-valid because of irregularities in the work at sea (Kenchington *et al*. 2009, 2014a). Some others were subsequently rejected when deficiencies in data recording were discovered. Only the remaining, valid sets (Table 1) were retained for analysis here and by Kenchington *et al*. (*in prep.*).

Table 1 : Number of valid IYGPT sets completed in each cell of the survey design (sets made in each of the 2007, 2008, 2009 and 2010 surveys shown in sequence)

Station:	**Head**		**Wall**		**Main**		**Deep**		**Offshore**		**Slope**	
Nominal Stratum:	**Day**	**Night**	**Day**	**Night**	**Day**	**Night**	**Day**	**Night**	**Day**	**Night**	**Day**	**Night**
0–250 m	1,1,1,1	3,2,2,2	1,0,0,0	2,0,1,0	3,1,1,1	3,2,2,2	1,1,1,0	2,2,1,3	1,0,0,0	1,0,0,0	░	░
250–750 m	3,2,2,2	2,1,1,2	3,0,1,0	2,0,2,0	3,2,**3**,2	3,2,2,2	2,2,0,1	2,3,2,2	1,0,0,0	1,0,0,0	0,0,**2**,1	░
750–1250 m	▓	▓	▓	▓	3,2,1,**2**	3,2,2,2	**2**,2,2,0	2,**3**,2,2	1,0,0,0	1,0,0,0	░	░
1250–1750 m	▓	▓	▓	▓	▓	▓	0,0,0,2	0,1,2,2	░	░	▓	▓
Below Stratum	░	1,0,0,0	▓	▓	1,0,0,0	░	0,0,2,1		░	1,0,0,0	░	░
Max. Depth Fished (m)	░	905	░	░	1503	░	≈2400		░	1647	░	░

Red highlight: One set in each indicated count lacked data on at least one selected species and thus had to be dropped from the data matrices analyzed by Kenchington *et al.* (in prep.). See Section 4 for explanation.
Dark grey shading: bottom depth precluded stratum; Light grey shading: sampling not attempted in cell. Two of the three sets made on the Deep Station below 1,750 m depth spanned the sunset period.

The IYGPT is an open net and each set fished from the surface to its maximum depth and back again. The 0–250 m stratum aside, during each set of the 2007 survey, an attempt was made to drop the net quickly to the top of the assigned stratum, then work a double-oblique (“V”) profile through the full depth of that stratum, taking 60 minutes, before hauling back quickly to the surface. However, the need to maintain a stable spread of the otter boards meant that the rates of descent and ascent above the assigned stratum were little faster than those of the oblique legs within it. Thus, during the latter three surveys, all sets that fished below 250 m followed double-oblique profiles throughout, fishing for 30 minutes above 250 m and 60 minutes in each deeper stratum to the maximum depth of the set. In concept, the average catch of a particular species taken by the replicate sets that reached the deep limit of a particular stratum, on a particular station, during a particular survey and either in daylight or at night, can be subtracted from the catch of that species taken by a set that fished the next-deeper stratum, on the same station, during the same survey and in the same diel phase, to estimate the catch that latter set took from its deepest stratum. In practice, although the catches taken by replicate sets were much more similar than the inter-set variations seen in typical trawl surveys, they were high enough to confound such estimates. Thus, the subtraction process is only used here when exploring the depth distributions of particular species, while formal analyses are confined to the full catch taken by each set, including near-surface as well as deeper captures.

In an attempt to increase the catches taken above 250 m, those sets which went no deeper were towed for 60 minutes. Early in the 2007 survey, they followed a stepped-oblique profile but that was abandoned and replaced with a “W” profile, in which the net was shot away to 250 m depth and hauled back to a depth of 50 m, before being dropped back to 250 m and hauled again. IYGPT nets do not fish with full efficiency when close to the surface, as the warps draw the otter boards together, while the disturbance created by the ship drives fish away from the path of the net. Hence, for those species that were broadly spread in the upper 250 m of the water column the “W” profile should have resulted in the shallow sets catching about twice as much as deeper sets did while passing through the 0–250 m stratum. However, those species concentrated within a few tens of metres of the surface were fished equally (if equally inefficiently) by both the shallow and the deeper sets. That contrast confounds attempts to determine how much of the catch of a set that reached 750 m was taken below 250 m depth.

After each set, the catch was retrieved from the net, the codend was washed down and the rest of the net picked through for specimens caught in the meshes. By design, the fish in the catch were sorted, identified (usually to species), the weight and count of each taxon recorded, and each individual measured (standard length). Specimens that could not be identified at sea were preserved and subsequently examined ashore. There were two exceptions. First, as is commonly seen in such surveys, very large numbers of *Cyclothone* spp. were taken (despite their being too small to be efficiently caught by an IYGPT net), most of them recovered only as broken fragments. Thus, there was no attempt to record them in detail. They were identified only to genus and each catch weighed without counting. Secondly, the dominant myctophid in the catches, *Benthosema glaciale*, was sometimes too abundant for comprehensive length measurements. In that event, a weighed subsample was counted and measured, the total catch from the set being estimated subsequently by expansion.

All data were recorded electronically while at sea. The surveys were followed by an extensive process of specimen identification, plus merging of data from specimen catalogues and data verification, leading to the preparation of a large MicroSoft Access database of trawl catches.

3 SPECIES SELECTION AND DATA PREPARATION

3.1 SPECIES SELECTION

That database includes records of more than 80,000 individual fish (excluding *Cyclothone* spp.) taken by the IYGPT nets, with a combined weight of approximately 365 kg, in addition to invertebrates. No complete count of fish species is available because identification of rarities is on-going. However, at least 250 were caught, some being represented by singletons and most by only a few specimens.

To permit meaningful multivariate analyses, it was necessary to eliminate all such rarities. For the analyses of Kenchington *et al.* (*in prep.*), only species which comprised more than 1% of the total IYGPT fish catch, by either number or weight, and those that comprised more than 2% of the catch from any of the three principal stations (Head, Main or Deep) were retained – the latter criterion adopted so that species important in only one part of the canyon would be included. Nineteen species (Table 2) met at least one of those criteria (14 exceeding 1% by number and 11 by weight, while two others (*Lampanyctus macdonaldi* and *Melanostigma atlanticum*) exceeded 2% by both weight and number at the Head Station). Relaxing the 1% limit to 0.7% would only have added two more species, represented by 271 and 151 individuals, respectively.

3.2 INCOMPLETE IDENTIFICATIONS

The database was searched for alternative taxon codes potentially attached to individuals that could have been used for members of one of the selected species, such as codes for specimens identified only to genus or family (usually because of damage in the net). Only small numbers of specimens were found bearing such species codes:

- Four specimens (three from the same set) were identified at sea only as *Nemichthys* sp. One was subsequently confirmed by DNA barcoding as *N. scolopaceus*, which is the only species of the genus expected in the general region of The Gully (Moore *et al.* 2003a). For the purposes of the analyses, the other three specimens were assumed to be that species also.

- A single specimen was identified to the Nemichthyidae, a family which is represented in the surrounding region by members of three genera (Moore *et al.* 2003a). The specimen was taken on the Head Station in 2008, where no specimens were identified to *N. scolopaceus* that year. Thus, the lone nemichthyid was excluded from the analyses.

Table 2 : Species included in the matrices for analysis

Order	Family	Species
Anguilliformes	Nemichthyidae	*Nemichthys scolopaceus*
	Serrivomeridae	*Serrivomer beani**
Saccopharyngiformes	Eurypharyngidae	*Eurypharynx pelecanoides*
Osmeriformes	Bathylagidae	*Bathylagus euryops*
Stomiiformes	Stomiidae	*Chauliodus sloani*
		Malacosteus niger
		Stomias boa
Aulopiformes	Paralepididae	*Arctozenus risso*
Myctophiformes	Myctophidae	*Benthosema glaciale*
		Ceratoscopelus maderensis
		Hygophum hygomii
		Lampanyctus macdonaldi
		Lobianchia dofleini
		Myctophum punctatum
		Notoscopelus kroyeri
		Notoscopelus resplendens
Stephanoberyciformes	Melamphaidae	*Scopelogadus beanii**
Beryciformes	Anoplogastridae	*Anoplogaster cornuta*
Perciformes	Zoarcidae	*Melanostigma atlanticum*

*: To avoid confusion between *Serrivomer beani* and *Scopelogadus beanii*, their generic names are spelt out throughout the text. In most tables, limited space has required the use of extended abbreviations.

- Some collections of *Bathylagus* sp. taken by the 2007 survey could not be identified to species at sea and were returned to the laboratory. They were there identified, most proving to be *B. euryops*. Of 18 specimens returned from Sets 2007_21 and 2007_29, only 10 could be identified to species, all as *B. euryops*. It is here assumed that the other eight individuals were also that species.

- A further 23 specimens (taken by 6 sets) were identified at sea only to *Bathylagus* sp. but were not retained, probably indicating that they were not considered to be further identifiable. One other specimen was identified at sea only to the Bathylagidae and, although returned to shore, could not be further identified. The catch database contains many records of *B. euryops* but few of other members of the family (29 *Dolicholagus longirostris*, 12 *Melanolagus berycoides* and 10 *Bathylagus greyae*). Given that disparity in numbers, all of the specimens with incomplete identifications were assumed to be *B. euryops* for present purposes.
- A single specimen, identified only to the Stomiiformes, was taken on the Main station by Set 2010_32. It was excluded from the present analysis as there were no grounds for assigning it to any particular species of stomiiform, a considerable variety of which were recorded by the Gully surveys.
- A single specimen identified only to *Chauliodus* sp. was taken by Set 2009_38, which also took 41 specimens identified as *C. sloani*. The lone specimen might have been *C. danae* but no specimen from the Gully surveys was identified to that species, which reaches the limit of its known range south of Banquereau (Moore *et al.* 2003a). The lone specimen was therefore merged into the data on *C. sloani*.
- Eleven specimens, taken by three different sets, are identified in the catch database only to the Paralepididae. One set was made with a large Diamond IX net and so is not considered here. One specimen (taken by Set 2007_24) might have been *Arctozenus risso* but that set also took 12 specimens which were identified to *A. risso*. Thus, the incompletely identified specimen appears to have been deliberately distinguished at sea. Finally, a batch of nine specimens from Set 2007_15 was identified at sea as *Paralepis atlantica*. Some were subsequently subjected to DNA barcoding and expert identification ashore but without conclusive result. They have been coded in the database as Paralepididae but there has been no suggestion that any of them was *A. risso*. Thus, all 11 specimens have been excluded from the present work and that of Kenchington *et al.* (*in prep.*).
- 72 myctophids taken in March 2010 (a maximum of 16 from any one set) were identified only to family or order. None of them were preserved for identification ashore, which likely indicates that all were considered non-identifiable, because of damage. They were all excluded from the data prepared for analysis since there were no grounds for assigning them to any particular myctophid species. (Other myctophids identified only to order or family were taken in 2007 but by sets deemed non-valid and hence excluded from analysis. A single specimen from a valid set, 2007_58, was too damaged for further identification.)

- Three sets of the March 2010 survey took specimens identified as *Hygophum* sp. – nine individuals in all. The great majority of specimens of that genus caught during the summer surveys were identified as *H. hygomii* but *H. benoiti* and *H. reinhardtii* were taken also. *H. hygomii* is very rare in winter to the south of Nova Scotia, even in the Warm Slope Water (Themelis and Halliday 2012: see Section 5.2 for a summary of regional water masses), and is unlikely to be present in The Gully in March. Thus, the nine specimens were excluded from the analyses.
- The database contains records of specimens of *Notoscopelus* identified only to genus that were taken by two sets: Set 2007_33, which was made on the Main Station in 2007 and took 35 such specimens (none of them retained), and Set 2008_07, made on the Deep Station in 2008. In 2007, when The Gully was covered by an exceptional development of the Cold Intermediate Layer, *N. resplendens* was caught almost exclusively on the Offshore Station (then very near the edge of the Warm Slope Water). Only six individuals were taken on the Deep and Main stations, and none further into the canyon. In contrast, there were some hundreds of *N. kroyeri* taken there. Thus, all of the incompletely-identified collection from 2007 was assigned to the latter species. The catch from the affected 2008 set was retained for examination ashore. Three of the five specimens were identified, two as *N. kroyeri*, the other as *N. resplendens*. The two remaining specimens were too damaged for specific identification (which requires a count of gillrakers). For present purposes, those were apportioned one to each species.
- A single specimen was identified only as *Scopelogadus* sp. For present purposes, that specimen was included with the *Scopelogadus beanii*.
- Two very small specimens, newly metamorphosed juveniles, were taken in March 2010 and identified only to the Zoarcidae. While either or both might have been *M. atlanticum*, several species of benthic zoarcids are expected to occur in The Gully. The two early juveniles were therefore excluded from the analyses.

3.3 MISSING DATA

The at-sea data collection could only record positive catches, leaving zero catches indistinguishable in the catch database from potential cases of missing data in which both the weight and the count of a species taken by a particular set went unrecorded. The least-abundant of the 19 species selected for analysis (*Eurypharynx pelecanoides*, *B. euryops*, *M. niger*, *C. maderensis*, *L. macdonaldi*, *Lobianchia dofleini*, *M. punctatum*, *N. kroyeri*, *A. cornuta* and *M. atlanticum*) each had multiple catches of singletons and thus zero catches were expected. Absence of a recorded catch of any of those species was therefore assumed to indicate that no individuals of the species had been taken. *N. scolopaceus*, *A. risso*, *H. hygomii*, *N. resplendens* and *Scopelogadus beanii* were rather more abundant but the same assumption was made, though with less justification – except that no catch of

Scopelogadus beanii was recorded for one 1,250 m set on the Main Station and, likewise, none was recorded for *A. risso* for a set made to the same depth on the Deep Station. Those results were sufficiently improbable that they were assumed to indicate missing data. The data recorded at sea left a strong indication that a third set did take *Scopelogadus beanii* but the quantity caught was not recorded. That too was taken to be a case of missing data.

The four most-abundant species required more complex approaches. For each of them, all sets that fished only to 250 m depth were assumed to have taken zero catch unless a positive one was recorded. In addition:

- *Benthosema glaciale*: One of the two 750 m sets made on the Head Station in 2010 had no recorded catch of this species, while the other took just 3 individuals. Since a zero catch was plausible, that has been accepted as valid. There were no other sets that fished deeper than 250 m which lacked recorded catches of this species. However, the large catches of *B. glaciale* taken by many sets necessitated subsampling, which seems to have confused the data-entry process at sea. It proved possible to reconstruct the catch weights for all but one set, though several lack usable data on counts of individuals. The recorded data for the one set were so confused that it was impossible to reconstruct either the number or weight of the catch and hence that had to be regarded as a case of missing data.
- *Serrivomer beani*: With a single exception, every set made deeper than 250 m had a recorded positive catch. The exception, a 750 m set on the Head Station in 2010, was a replicate (within the survey design) of a set that only took two individuals. Thus, a zero catch was plausible and has been accepted here.
- *Stomias boa*: So few specimens were taken on the Head Station, by any set, that all were assumed to have taken zero catches unless a positive one was recorded.
- *C. sloani*: One 750 m set on each of the Main, Wall and Head stations had no recorded catch of this species. In each case, other similar sets took only single specimens or else catches in single digits. Thus, the sets with no recorded catch were assumed to have taken no *C. sloani*. In contrast, the absence of a recorded catch from a 1,250m set on the Deep Station was implausible and hence was assumed to be a case of missing data.

With those adjustments, the data were deemed suitable for the single-species examinations presented in this Technical Report. However, the multivariate analyses of Kenchington *et al.* (*in prep.*) required consistency in the sets with available data, across all species, and (for clarity of interpretations) also across both numbers and weights caught. Hence, a further step was necessary to eliminate cases of missing data, in either the numbers caught, the weight of that catch or, in a few cases, both.

The five species / set combinations with missing data on both numbers and weight caught were necessarily dropped from further analysis (see Table 1). For each of 24 other species / set combinations, a count of specimens caught was available but not their weights:

Serrivomer beani	22 individuals	1 set
Nemichthyes scolopaceus	26 individuals	3 sets
B. euryops	48 individuals	4 sets
C. sloani	5 individuals	1 set
Malacosteus niger	8 individuals	1 set
A. risso	24 individuals	2 sets
Ceratoscopelus maderensis	23 individuals	3 sets
L. macdonaldi	7 individuals	2 sets
Myctophum punctatum	16 individuals	3 sets
N. kroyeri	4 individuals	2 sets
N. resplendens	6 individuals	1 set
Anoplogaster cornuta	1 individual	1 set

Each of the missing weights was infilled using the multiple of the recorded number of fish caught and the average individual weight of all other specimens of the species in question taken by the sets retained for analysis. In each of three cases, the estimated weight proved to be lower than an at-sea weight recorded for a subset of the catch of the species. In those cases, the average of individual weights was used for the specimens not weighed at sea and the at-sea weight of the others added.

For each of five species / set combinations, a weight of the catch was available but not a corresponding count of specimens:

Serrivomer beani	est 28 individuals	1 set
E. pelecanoides	est 7 individuals	2 sets
S. boa	est 26 individuals	1 sets
N. kroyeri	est 10 individuals	1 sets

The missing counts were generated using the recorded catch weights and the average individual weight for the species, as in cases of missing catch weights, except that the estimated counts were rounded to the nearest integer.

A more serious problem arose with subsampled *B. glaciale*, for which counts of individuals caught were missing for 15 sets. The above approach was applied but it resulted in estimated catches that summed to 8,234 individuals.

Following those adjustments, all catch weights were rounded to the nearest whole gram, except that seven cases that would have rounded down to zero were given their unrounded values (0.25 to 0.45 g). The outcome of those processes was a pair of data matrices, each containing the catches of the 19 selected species in 148 sets, by weight and number respectively. Those matrices, which are presented in an Appendix to this report, compressed records of 72,045 individual fish, with a combined weight of 275.687 kg, comprising the great majority of the program's catches of the 19 selected species (Table 3).

Table 3 : Numbers of specimens, of the selected species, taken by the surveys and included in the data matrices for multivariate analysis

Species	**Number caught by valid IYGPT sets**	**Catch included in data matrices**	
		Number	**Weight (kg)**
N. scolopaceus	1695	1517	23.7
Serrivom. beani	2927	2811	45.7
E. pelecanoides	310	304	6.0
B. euryops	1247	1177	11.1
C. sloani	2115	1933	28.6
M. niger	336	311	6.6
S. boa	2574	2277	32.7
A. risso	1950	1827	5.0
B. glaciale	≈51,000	49,125	61.5
C. maderensis	1230	1196	2.7
H. hygomii	2005	1799	3.2
L. macdonaldi	303	276	2.3
L. dofleini	1822	1633	0.8
M. punctatum	1309	1196	3.4
N. kroyeri	1353	1336	1.6
N. resplendens	1738	1516	1.8
Scopelo. beanii	1651	1580	36.1
A. cornuta	58	55	3.7
M. atlanticum	181	176	1.0

4 DISTRIBUTIONS OF SPECIES

4.1 INTRODUCTION

Multivariate analyses of species catch data, such as those presented by Kenchington *et al.* (*in prep.*), can provide insight into assemblage structure beyond what can be developed through species-wise examination of distributions, while they also offer potential for statistical hypothesis testing of observed trends. However, the outputs of such analyses are rarely interpretable in biological terms and cannot readily be compared to existing knowledge in published literature. In the particular case of the Gully midwater surveys, Kenchington *et al.* (*in prep.*) found no significant clusters of species, meaning that each of the 19 had its own distribution pattern. Moreover, the data gathered during those surveys included very large numbers of length measurements, providing information on the sizes of individual fish that is not incorporated in the catch data used in multivariate assemblage analyses.

For all of those reasons, Kenchington *et al.* (*in prep.*) could not rely on multivariate, multispecies analyses alone but also had to draw on examination of each of the 19 species individually. The latter is unavoidably voluminous and is thus presented here, rather than in the primary literature.

The assemblage structure was shaped by oceanographic factors (Kenchington *et al. in prep.*). Key aspects of those were summarized by Kenchington *et al*. (2014b), as a foundation for interpretation of the data from the midwater-trawl surveys. Their account is further abbreviated here, in Section 4.1.1, through the extraction of only those points necessary to an understanding of what follows. Thereafter, the 19 species are considered in sequence. For each, prior knowledge of distribution and ecology is summarized, the distribution of catches across the dimensions of the survey design is presented and interpreted, as are the length frequencies of the fish. With one exception, each species is illustrated with the image of a specimen, all of wchich were prepared from photographs taken at sea during the Gully surveys by program staff.

To aid the reader and reduce repetition, distributional information on each of the selected species and derived from previous survey programs in the western North Atlantic is drawn together in Section 4.1.2 and Table 4. A summary of the distribution of each species in the catches of the Gully surveys is presented in Table 5. Broader ecological implications of the information presented here are considered by Kenchington *et al.* (*in prep.*).

4.1.1 Oceanography of the Gully

This summary follows Kenchington *et al*. (2014b) and the material cited therein.

In most respects other than its size, The Gully (Figure 2) is broadly typical of submarine canyons. Around much of its extent, the steep morphology characteristic of canyons commences at about 400 m depth, the walls plunging from there to the canyon thalweg. However, the surrounding banks give The Gully a rim depth of 200 m or less. Unusually, perhaps uniquely for a large submarine canyon, The Gully's head communicates with a system of continental-shelf valleys, one of which connects it to a large, mid-shelf basin, "The Trough", lying north of Sable Island (Figure 1).

The waters in and over the canyon are both complex and highly variable. North of the shelf break, the uppermost few hundred metres of the water column are composed of the three-layered system of the Scotian Shelf. That includes a Cold Intermediate Layer ("CIL") at about 50 to 100 m depth, with a typical summer core temperature around 5°C. There is warmer (≤10°C), more saline water below, the subsurface temperature maximum usually lying at 150 to 200 m depth. The immediate surface layer is very cold (≈2°C) in winter, when it is continuous with the CIL, but in summer warms, sometimes to nearly 20°C.

A strong, southwest-going shelf-break current, which extends from the surface to depths of at least a few hundred metres, follows the continental margin and carries the shelf waters across the mouth of The Gully. Weaker anticyclonic gyres circle the surrounding banks, flowing northwards to the east of the canyon and southwards to its west. Exchanges of water between those gyres produce a slow southwestward flow over much of the canyon but a northeastward one across its head, each of which takes some days to cross the canyon. The surface waters show no apparent response, in temperature, salinity, nutrients or chlorophyll, to the presence of the deep hole in the seabed beneath them.

The Scotian Shelf waters extend to a shelf / slope boundary which usually lies well south of the shelf break. However, driven by meandering of the Gulf Stream, its location is exceptionally variable, including on temporal scales as short as days. South of that boundary, the surface layer is composed of Warm Slope Water ("WSW": typically >10°C, reaching >20°C at the surface in summer). Although it is a surface water, WSW extends to depths of 300 or 400 m and hence can penetrate beneath the Shelf waters towards the upper continental slope, enhancing the subsurface temperature maximum that underlies the CIL. The main mass of the WSW moves generally eastward, from the flank of Georges Bank to pass the Tail of Grand Bank. However, its northern boundary is a complex of meanders, warm-core rings and filaments. Together, they flow southwestward near the continental slope.

Beneath those layers, hence at depths greater than 200–400 m, there are two alternative water masses: Labrador Sea Water ("LSW") and North Atlantic Central

Water (“NACW”), the former being slightly colder and less saline, at any given depth, than the latter, though LSW is marked more clearly by its higher oxygen concentration. Each water mass is cooler, though not necessarily more saline, at greater depths, reaching about 4°C by 1,000 m. At upper-slope depths, the LSW meets the lower WSW (beneath the Scotian Shelf waters). The two form a “coupled slope water system”, the boundary between them moving very considerably. It can touch the upper slope anywhere from the western flank of Grand Bank to far west of Georges Bank. In recent decades, that boundary seems usually (though not always) to have lain east of The Gully, which thus presumably most often sees WSW in its subsurface temperature maximum.

Below the WSW, LSW alternates with NACW, which passes under the Gulf Stream and forms a subsurface water between the Stream and the continental margin. In contrast to the shallower coupled system, the interplay between the LSW and NACW has yet to draw much attention.

In combination, the LSW and NACW filled most of the volume sampled during the 2007–10 surveys. However, the deepest few trawl sets may have extended into the North East Atlantic Deep Water, which is formed at an overflow of Arctic water across the Faroe–Scotland ridge and reaches the northwest Atlantic through gaps in the Mid-Atlantic Ridge (“MAR’).

In The Gully, north of the shelf break and below about 500 m depth, cross-canyon flows are minimal but there is a net northward flow that has been estimated at a mean rate through the central canyon (here defined, following Kenchington *et al*. (2014b) as the portion between the shelf break and 43°59'N) and below 200 m depth of 35,500 $m^3.s^{-1}$, sufficient to carry a water particle from the canyon mouth to its head in 30 days (Greenan *et al*. 2013, 2014). That movement implies an upwelling in the upper canyon (here defined as north of 43°59'N), with a vertical velocity estimated at 14 m per day, carrying the water over the canyon rim or (at a lesser vertical velocity) into the shelf valleys and thence The Trough. The up-canyon inflow is displaced towards the eastern side of The Gully and there is a southward flow to the west at about 300 to 600 m, especially in summer. There is equivocal evidence for a weak gyre at canyon rim depth in the central canyon.

Resonance within The Gully amplifies the diurnal (and to some extent the semi-diurnal) tidal streams, near the seabed of the thalweg, especially in the upper canyon, in the vicinity of the trawl surveys’ Head Station. Flowing over the complex and irregular seabed, those streams create very high levels of vertical diffusivity in the water column.

In April 2006 and August 2007, CTD surveys of The Gully found that, below 350 m depth, the canyon was filled with water that had the characteristics of LSW. However, at any given depth, there was a near-linear cooling and freshening up the canyon (Greenan *et al*. 2013). In contrast, CTD data from September 2007, gathered during the first trawl survey, found most of the canyon filled with NACW-like water, only that in the upper canyon showing the characteristics of LSW (Kenchington *et al*. 2009; 2014b). That change in water masses during one month was consistent with the estimated rate of inflow. The CTD instrument package taken on the 2008 trawl survey was defective but its data suggested that the canyon may then have contained LSW. During both the 2009 and 2010 surveys, as in 2007, the upper canyon contained apparent LSW and the rest NACW, though there was some interleaving between them (Kenchington *et al*. 2014b).

All four trawl surveys observed acoustic backscatter at 38 kHz, which revealed a distinctive, diffuse non-migratory layer at about 350–750 m depth. (The mechanism responsible remains unknown but has been hypothesized to be resonant backscatter from physonect siphonophores.) During each survey, that layer had a well-defined northern limit that was usually near 44°N but was further south, around 43°53'N, in 2008 (Kenchington *et al*. 2009; 2014b). Whether that backscatter marked the presence of NACW or was excluded from the upper canyon by factors other than the charcteristics of the water in The Gully remains unsure.

Within the high temporal variability of The Gully's oceanography, it would be misleading to identify a "typical" state. However, the 2008 survey encountered conditions within the canyon nearer to the summer "normal" than any of the other surveys. At regional and seasonal scales, 2009 was less anomalous than 2008 but the 2009 survey coincided with the presence of a tongue of WSW (at 23°C) moving across the canyon's thalweg immediately outside its mouth. Below the surface, that WSW penetrated through the canyon mouth and north almost to 43°50'N. It was interleaved with the CIL, generating extreme complexity in vertical profiles. The most anomalous of the three summer survey periods, however, was in 2007. That year, there was exceptional development of the CIL over the Scotian Shelf, resulting in temperature anomalies at some depths over the shelf break in the spring of as much as -6°C. Even at the time of the survey, in September, the CIL over the Gully, remained colder and more extensive that usual, with core temperatures as low as 0°C. Its greater thickness displaced the water that usually forms the subsurface temperature maximum, shifting the observed maximum deeper, where the water was colder (≈8°C). Meanwhile, the greater horizontal extent of the CIL pushed the shelf / slope boundary southwards, to slightly beyond the Offshore trawl station. In 2007, the spring blooms, of both phytoplankton and copepods, were also exceptional. They were long over by the time of the survey but their effects may have lingered higher in the trophic system (Kenchington *et al*. 2009; 2014b).

4.1.2 Western North Atlantic Survey Programs

Several earlier meso- and bathypelagic survey programs have generated information on the distributions of the 19 selected species in various parts of the western North Atlantic. Farthest to the southwest, Gartner *et al.* (2008) made visual observations from a submersible, both near-bottom and in the water column, on the continental slope near Cape Hatteras, which were supplemented by pelagic sampling with a Tucker trawl. Nearby, Ross *et al.* (2015) deployed both an ROV, near the seabed, and a small bottom trawl in Norfolk and Baltimore canyons.

Musick (1973) surveyed the basins in the Gulf of Maine with an Isaacs-Kidd trawl and added data from previous research trawling. Feagans-Bartow and Sutton (2014) made 15 sets with an IYGPT net over small canyons on the continental slope of Georges Bank in 2004, with the maximum depths of the sets being between 435 and 670 m – though the catches of those sets have not been fully published. In much the same location, Uiblein *et al.* (2005) made ten submersible dives into four different canyons, reaching depths of about 900 m. More extensive surveys have been made of Bear Seamount, which lies immediately south of Georges but under WSW, away from the influence of the surface waters on the Bank. Moore *et al.* (2003b) provided an initial report on a cruise to the Seamount in 2000, during which six sets were made with an IYGPT and 14 with bottom trawls, only nine of the latter touching the seabed. Maximum depths of the individual sets varied from 900 to 2,500 m. Moore *et al.* (2004) provided greater detail on a 2002 survey in which the IYGPT was deployed on 20 sets, each of which lasted 60 minutes, and a bottom trawl on four sets. The maximum depths of the IYGPT sets lay between 362 and 1,475 m, while the bottom trawling extended that range to 1,760 m. Previously, Jahn and Backus (1976) had surveyed waters from the Sargasso Sea to the shelf break and from the longitude of Cape Cod eastwards to the Tail of Grand Bank, using Isaacs-Kidd gear, though only summary information on the most abundant species was published.

The largest of the survey programs considered here, and the most directly relevant to The Gully, was conducted by Themelis and Halliday (2012) in waters beyond the shelf break south of Nova Scotia and Newfoundland, extending east as far as the Tail of Grand Bank. Ten cruises between 1984 and 1989 included sampling in alternate calendar months, with a total of 246 “shallow” IYGPT sets (most of them at night, following a standard stepped-oblique profile, with the deepest step at 200 m) and 58 deeper, daylight sets with the same gear, some fishing to 1,000 m depth. Various transects, each of multiple stations, were worked, some of them repeatedly – including one station that was later selected as the Offshore Station of the Gully surveys. In 1994–95, Halliday *et al.* (2012) followed those pelagic surveys with deep bottom trawling on the Scotian Slope, including stations close to the mouth of The Gully, at depths down to 1,820 m. Their bottom trawl took substantial numbers of mesopelagic species as it passed through the water column, while they also provided a summary of pelagic species taken during earlier bottom-trawling on the Scotian Slope in 1984.

Further north, Richard (1987) undertook a small, specialized study, taking 41 samples with an Isaacs-Kidd trawl in two deep bays on the south coast of Newfoundland and southward to the Laurentian and St. Pierre channels. McKelvie (1985) used a commercial-sized midwater trawl to sample on an east–west transect extending from the eastern flank of Grand Bank, making ten sets to maximum depths between 457 and 1,132 m in 1981. McKelvie and Haedrich (1985) combined the data from that survey with multiple older records from waters over the continental slope, extending from off Labrador to Georges Bank, in a study of the most abundant mesopelagic species other than the Myctophidae and *Cyclothone* spp.

In mid-ocean, the pelagic fishes over the MAR have been examined by several recent studies. Sutton *et al.* (2008) reported on a 2004 survey that extended from the Azores to Reykjanes Ridge during which two commercial-sized midwater trawls and a krill trawl (rather smaller than an IYGPT but fitted with multiple codends) were fished at multiple depths, to a maximum of 2,768 m, at each of 18 stations. Sutton *et al.* (2013) followed in 2007 and 2009, using RMT1+8 gear at 14 stations in the vicinity of the Charlie Gibbs Fracture Zone. Only small catches could be taken with that gear but, using the RMT's opening / closing capability, 27 discrete-depth samples were obtained, providing information on depth distributions to supplement the larger catches of the earlier survey. Cook *et al.* (2013) added the results from working the krill trawl, to a maximum depth of 2,769 m, at 12 stations near the Fracture Zone in 2009, though the catches from that work have yet to be published in full. Some of those data, plus more from other sampling on the MAR, have been used in taxon-specific studies by Bartow (2010) and Sweetman *et al.* (2013, 2014).

Finally, Dolgov (2015) has provided extensive information on the mesopelagic fish of the Irminger Sea, based on surveys conducted between 2003 and 2011. His catch records were, however, presented as averages per-fishing hour for each of four surveys and hence not in a form readily comparable to those from other programs.

The catches of five of those prior programs are compared to the numbers taken in The Gully in Table 4. In each case, raw counts of the fish caught are presented, without regard to the number of sets made. Thus, the tabulated numbers are not directly comparable, in an absolute sense, but the relative abundances of the species may be indicative – though only indicative, because of differences in the gears used and (even for those prior surveys that used IYGPT nets) the tow profiles followed.

Table 4 : Numbers of specimens, of the 19 selected species, taken by selected surveys in the northwest and north-central North Atlantic Ocean

Area Surveyed:	**Bear Sea-mount**	**Georges Bank continental slope**	**Oceanic waters south of Nova Scotia and Newfoundland**	**The Gully**	**East of Grand Bank**	**Northern MAR**
Species						
N. scolopaceus	96	1,487	1,115	1,695	3	11
Serrivom. beani	321	212	1,266	2,927	52	1,065
E. pelecanoides	97	?†	157	310	1	96
B. euryops	51	?	408	1,247	210	4,555
C. sloani	413	395	2,792	2,115	101	1,010
M. niger	49	?	109	336	12	237
S. boa	49	710	1,442	2,574	280	349
A. risso	13	206	4,974	1,950	15	67
B. glaciale	77	4,904	59,163	≈51,000	5,643	17,535
C. maderensis	83	?	71,476	1,230	19	102
H. hygomii	391	?	19,913	2,005	0	309
L. macdonaldi	≤22*	?	99	303	16	4,107
L. dofleini	30	?	33,577	1,822	0	423
M. punctatum	0	?	1,823	1,309	11	2,444
N. kroyeri	0	?	521	1,353	0	3,638
N. resplendens	64	?	7,970	1,738	3	0
Scopelo. beanii	117	?	499	1,651	8	2,163
A. cornuta	19	?	33	58	2	26
M. atlanticum	1	?	5	181	0	5
Gear:	IYGPT & bottom trawls	IYGPT	IYGPT	IYGPT	Midwater trawl	Midwater trawls & RMT
Source:	Moore *et al.* (2003b, 2004)	Feagans-Bartow and Sutton (2014)	Themelis and Halliday (2012)	This study	McKelvie (1985)	Sutton *et al.* (2008, 2013)

*: Moore *et al.* (2004) reported 22 *Lampanyctus* sp. It is not known whether any were *L. macdonaldi*.

†: Feagans-Bartow and Sutton (2014) only published their catches of nine dominant fish species. Their catch of other species amounted to <133 individuals.

4.2 METHODS

Examination of the distribution of each species used data from every set for which a record of that species was available, either a recorded finite catch or else a zero catch determined by the approaches set out above. For some species and some sets, either a count or a weight was available, but not both. All available data were used and the alternative (either count or weight) treated as missing data, without the reconstruction used for the multivariate analyses of Kenchington *et al.* (*in prep.*). Thus, the array of sets included in these examinations could differ among species and between the counts and weights for the same species, which led to some apparent anomalies seen in the tables of average catches set out below.

For each of the 19 species, untransformed catch data were tabulated, following all dimensions of the survey design, separately by both weight and number, and the catches of replicate sets averaged. The resulting tables were examined, both in their entirety and when collapsed across those dimensions which showed little or no trend in catches. Primary emphasis was given to arithmetic means of the catches of individual sets but geometric means (calculated from log(X+1) transformed data) and standard deviations were also examined.

For each species, all available length data, including any taken from the catches of non-valid IYGPT sets (though not from the catches of other gears), were assembled for each cell of the survey design and examined for apparent patterns. The data on each species were pooled by collapsing those dimensions of the survey design across which there were no apparent differences in length composition, and the pooled data were prepared as length-frequencies. For sub-sampled catches of *B. glaciale*, the raw numbers-at-length were first expanded by the inverse of the applicable sampling faction. For all others, the raw length data were used directly. A small minority of individuals were damaged and unmeasurable but any resulting bias was ignored.

With four dimensions to the survey design, a fifth when the summer surveys were merged for seasonal comparions, and with separate number, weight and length data on each of 19 species, some hundreds of testable hypotheses could be formulated. If Type I errors were to be kept to an acceptable level, the Bonferroni adjustment would suggest that statistical significance be judged against a criterion of approximately $P<0.0001$. Even with data from some 150 sets available, statistical power would then be very low and the incidence of Type II errors correspondingly high. Rather than presenting *pro forma* hypothesis tests with such inevitably meaningless results, inferences were drawn from direct examination of the available data on each species.

In the tables of mean catches of each species which follow, the sets are classified by their nominal maximum depths. Those which fished below the deepest stratum regularly worked on their station are labelled “Extra” deep, though still-deeper sets may have been made on other stations. In those tables, the numerals “33” and “67”, in decimals, represent three-recurring and six-recurring respectively.

Table 5 : Summary of standard information on each of the analyzed species (see text for details)

Species	**Number caught by valid IYGPT sets**	**Number measured**	**Length range (mm SL) excluding outliers**	**Up-Canyon Trend in Lengths**	**Summer Depth Distribution**	**Up-Canyon Trend in Depths**	**Centre of Horizontal Distribution**	**Occurrence on Head Station**
N. scolopaceus	1695	1488	215–1580	Decline of small fish	Above 750 m, many above 250 m at night	Truncation	Central Canyon	Scarce
Serrivom. beani	2927	2571	150–797	Decline of small fish	Most below 750 m, a few above 250 m at night	Truncation, except large fish elevated	Outside Canyon	Reduced numbers
E. pelecanoides	310	278	90–700	None ?	Most below 750 m, a few above 250 m at night	Elevation	Outside Canyon	Low but higher than 750 m sets elsewhere
B. euryops	1247	1194	21–216	Decline in average size	Below 250 m, some maybe below 1750 m by day, a few above 250 m at night	Truncation, except near-bottom elevation	Deep Station	Reduced numbers
C. sloani	2115	2032	35–315	Decline of small fish	Some above 250 m (mostly at night), many below 750 m	Elevation	Outside Canyon	Scarce
M. niger	336	324	32–296	Decline of small fish and increase in large	Below 250 m (a few above) and most below 750 m	Elevation	Outside Canyon	Reduced numbers but higher than 750 m sets elsewhere

Species	Number caught by valid IYGPT sets	Number measured	Length range (mm SL) excluding outliers	Up-Canyon Trend in Lengths	Summer Depth Distribution	Up-Canyon Trend in Depths	Centre of Horizontal Distribution	Occurrence on Head Station
S. boa	2574	2428	40–335	Decline of small fish and increase in large	Below 250 m (a few above, mostly at night) and usually above 750 m	Elevation	Evenly distributed in numbers, except Head Station	Scarce
A. risso	1950	1924	31–260	Decline of small fish	Above 750 m. Above 250 m at night (some in daylight)	Unaffected	Numbers declined but weights increased up-canyon	Reduced numbers but increased weight
B. glaciale	≈51,000	25,410	12–91	Weak decline of small fish in summer	Most above 250 m at night, 250–750 m in daylight	Unaffected	Evenly distributed except Head Station	Much reduced numbers
C. maderensis	1230	1216	17–78	Decline of small fish	Above 250 m at night. 250–750 m in daylight	Unaffected	Evenly distributed except Head Station	Scarce
H. hygomii	2005	1984	21–60	–	Probably above 750 m	Unaffected	Near WSW	None
L. macdonaldi	303	296	32–160	None ?	Strongly varied along canyon	Elevation	Outside canyon	Higher than 750 m sets elsewhere
L. dofleini	1822	1791	18–48	–	Above 250 m at night. 250–750 m in daylight	Unaffected	Near WSW	None

Species	**Number caught by valid IYGPT sets**	**Number measured**	**Length range (mm SL) excluding outliers**	**Up-Canyon Trend in Lengths**	**Summer Depth Distribution**	**Up-Canyon Trend in Depths**	**Centre of Horizontal Distribution**	**Occurrence on Head Station**
M. punctatum	1309	1295	23–91	Decline of small fish	Below 250 m (a few above, mostly at night) and above 750 m	Unaffected	Central Canyon	Reduced numbers
N. kroyeri	1353	1062	20–132	Decline of small fish to Head Station	Above 250 m at night. Daylight unsure	Unaffected	Central Canyon	Scarce
N. resplendens	1738	1570	20–105	–	Unsure	Unsure	Outside Canyon	None
Scopelo. beanii	1651	1637	25–130	Unsure	Below 250 m (a few above at night). Most below 750 m	Truncated	Outside Canyon	Reduced numbers
A. cornuta	58	56	80–170	Unsure	Below 250 m. Most below 750 m	Unsure?	Unsure?	Scarce
M. atlanticum	181	181	38–170	Unsure	Most 250–750 m	Unaffected	Central and Upper Canyon	Abundant

4.3 SPECIES ACCOUNTS

4.3.1 Nemichthys scolopaceus

Figure 3 : *Nemichthys scolopaceus*, 900 mm SL, taken on the Main Station by Set 2010_14

N. scolopaceus has been seen as circumglobal, though currently available genetic data suggest that the nominal taxon comprises a species complex (Gaither *et al.* 2016). In the western Atlantic, it is known from off Brazil to Greenland (Moore *et al.* 2003a; Møller *et al.* 2010), though it appears to be a more southerly species than some others included in the present analyses. It is also a species of the "oceanic rim" rather than mid-ocean environments (Feagans-Bartow and Sutton 2014). Thus, Gartner *et al.* (2008) observed it frequently in both scattering layers and near-bottom aggregations on the continental slope near Cape Hatteras, Ross *et al.* (2015) found it near the seabed in Baltimore and Norfolk canyons, though not in high densities, while it was very common in IYGPT catches taken over the continental slope of Georges Bank, where Feagans-Bartow and Sutton (2014) found it second only to *B. glaciale* in abundance and first of all species in biomass. Musick (1973) reported four specimens from the deepest basin in the Gulf of Maine, as well as more from outside the mouth of the Northeast Channel. *N. scolopaceus* is one of the most common pelagic species taken when bottom trawling on the Scotian Slope (Halliday *et al.* 2012) and is abundant over oceanic depths south of Nova Scotia (Themelis and Halliday 2012) but is much less so further to the northeast (see Table 4). It has been recorded in the deep channels of the Gulf of St. Lawrence, usually in catches from bottom trawling below 300 m depth, (Bossé 1991; Nozères *et al.* 2010).

Moore *et al.* (2003a) regarded *N. scolopaceus* as meso- and bathypelagic, with a depth range of 457 to 3656 m. It eats almost exclusively decapod and euphausiid crustaceans (Feagans-Bartow and Sutton 2014).

In the Gully surveys, *N. scolopaceus* was taken at every station but was especially a species of the central canyon and immediately outside the canyon mouth (Tables 6A, B). In number terms, it was taken about equally on the Main, Wall and Deep stations. However, individual sizes in the central canyon were higher than on the Deep Station (average standard length, Main Station: 865 mm; Wall Station: 831 mm; Deep Station: 603 mm), such that the average catch in weight terms on the Deep was only half that on the Main Station. The prevalence of the Main Station over the Deep increased from 2007 to 2009 – consistent with more northerly location of the shelf / slope boundary making the latter Station less desirable for this species as the surveys progressed.

Very few *N. scolopaceus* were taken on the Head Station in summer, only 18 individuals in all. However, 63 were caught there in March 2010, suggesting a movement further up the canyon since the previous August. Too few were taken on the Head Station to judge whether there was a difference in length composition from those caught in the central canyon.

On the Main and Deep stations in summer, *N. scolopaceus* was mostly distributed above 750 m depth, with many (perhaps most) above 250 m at night but limited indications of any below 750 m – a markedly shallower distribution than is typically seen for the species. In March 2010, there were many above 250 m, even in daylight, but most taken on the Main Station appeared to have been caught below 750 m. The catches taken on the Head Station in the spring were necessarily above that depth and were near equal (in numbers, though not in weight) to those taken by the 750 m sets on the Main and Deep stations, implying truncation of the depth distribution up-canyon, rather than its further elevation.

The length frequency of *N. scolopaceus* was unimodal (Figure 4). The up-canyon trend in average lengths resulted, in part, from a decline in both absolute and relative abundances of smaller (<600 mm SL) individuals but also from a relative (and, on the Main Station only, an absolute) increase in larger (>700 mm SL) fish. The data are potentially compromised because two sets made on the Wall Station in 2007 generated records of ten individuals of over 1,200 mm SL, the largest 1,580 mm – considerably greater than the maximum usually reported for the species. No specimens were retained and hence the existence of those very large individuals cannot be confirmed.

Table 6A : Arithmetic mean catches of *Nemichthys scolopaceus* in each cell of the survey design: numbers of individuals

Year:		**2007**		**2008**		**2009**		**2010**	
Month:		**Sept**		**Aug/Sept**		**Aug**		**March**	
Diel Phase:		**Day**	**Night**	**Day**	**Night**	**Day**	**Night**	**Day**	**Night**
Station	**Depth (m)**								
Head	**250**	0	0.33	0	0	0	5.5	13	4.5
	750	1	0	0	0	0.5	2	11	9.5
	Extra		0						
Main	**250**	0.67	6.67	3	8	8	13	8	14
	750	6. 67	3.67	12.5	8.5	40.67	18	7	11.5
	1250	6	5.67	16.5	11.5	47	19	35	27.5
	Extra	8							
Wall	**250**	0	2.5				14		
	750	2.33	4			22	28.5		
Deep	**250**	0	9	4	20	8	13		15
	750	11	16	15.5	9.33		16	12	11
	1250	11	10	21	10.33	18.5	12.5		17
	1750				14		10	13	13.5
	Extra					12.5		14	
Slope	**750**					22.5		13	
Offshore	**250**	2	11						
	750	16	7						
	1250	12	3						
	Extra		2						

No valid IYGPT sets were made in the shaded cells.

Table 6B : Arithmetic mean catches of *Nemichthys scolopaceus* in each cell of the survey design: weights caught (g)

Year:		**2007**		**2008**		**2009**		**2010**	
Month:		**Sept**		**Aug/Sept**		**Aug**		**March**	
Diel Phase:		**Day**	**Night**	**Day**	**Night**	**Day**	**Night**	**Day**	**Night**
Station	**Depth (m)**								
Head	**250**	0	6.033	0	0	0	103.5	214	64
	750	8.67	0	0	0	11	38	300.5	287.5
	Extra		0						
Main	**250**	28.67	224		210.45	98	97.5	102	190.5
	750	266.267	172.033	215	244.3	789.33	324.5	93	116.5
	1250	137.33	219.833	272.95	185.05	884	411	555.5	408.5
	Extra	176							
Wall	**250**	0	123				167		
	750	103.33	53.75			507	599.5		
Deep	**250**	0	66.8	26.75	114.4	121	137		95.67
	750	141	195.6	181.7	111.33		197.5	136	33
	1250	137.5	200.5	135.15	93.15	180	127		199.5
	1750				148		121.5	156	115.5
	Extra					151		106	
Slope	**750**					143.5		119	
Offshore	**250**	10	30						
	750	140	59						
	1250	64.5	21						
	Extra		7						

No valid IYGPT sets were made in the shaded cells.

Apart from its shallower depths, the distribution of *N. scolopaceus* in The Gully was in accord with past expectations. A species of the "oceanic rim" (Feagans-Bartow and Sutton 2014), it was one of the few considered here which showed a core distribution in the central canyon.

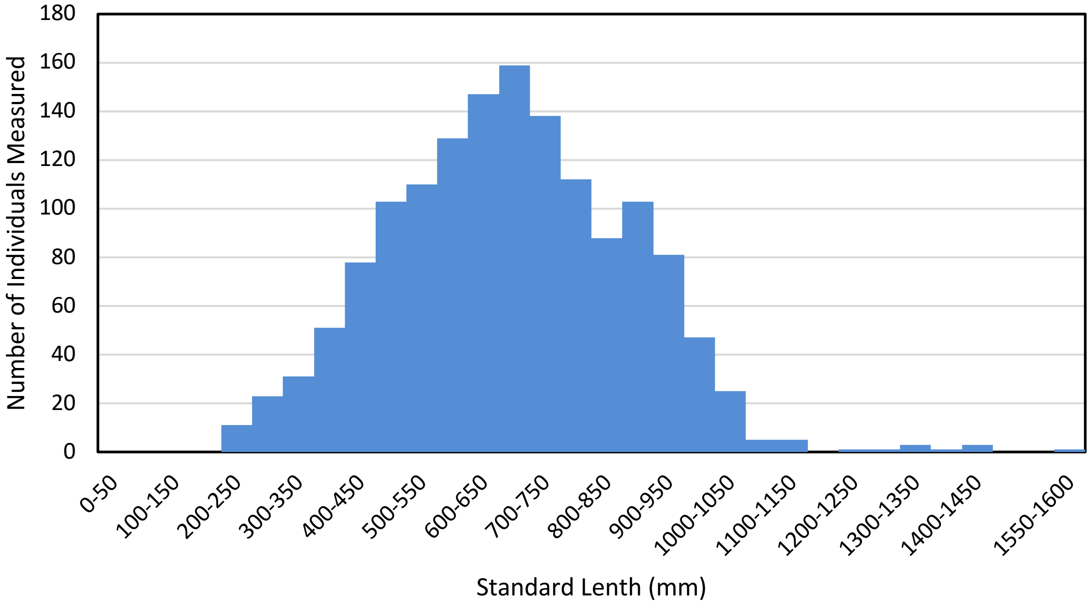


Figure 4 : Length frequency of *Nemichthys scolopaceus*, including all 1,481 measured individuals

4.3.2 Serrivomer beani

Figure 5 : *Serrivomer beani*, taken on the Deep Station by Set 2010_50

Serrivomer beani is a widespread species at temperate and tropical latitudes, though not recognized as circumglobal. In the western Atlantic, it is known from Brazil to Greenland (Moore *et al.* 2003a; Møller *et al.* 2010). Musick (1973) took two in the deepest basin of the Gulf of Maine and Halliday *et al.* (2012) reported 383 from the catches of bottom trawls on the Scotian Slope. It has been taken by bottom trawling, below 300 m depth, in the deep channels in the Gulf of St. Lawrence (Nozères *et al.* (2010). It is among the most abundant of mesopelagic fish species (myctophids and *Cyclothone* spp. excepted) off Newfoundland and on the northern MAR (McKelvie 1985; McKelvie and Haedrich 1985; Sutton *et al.* 2008: see Table 4). Because of its relatively large individual size, *Serrivomer beani* is even more prominent in biomass terms. On the MAR, from the Faraday

Seamount area northwards, it is a major component of fish biomass at 0–750 m depths and an even larger component in the 750—2,300 m depth range (Sutton *et al.* 2008). It is equally prominent in the Irminger Sea (Dolgov 2015).

Serrivomer beani is generally regarded as a species of the lower mesopelagic zone, with a typical depth distribution of 550 to 1,000 m (Moore *et al.* 2003a), though in certain places and seasons, some individuals rise to as shallow as 150 m depth at night (Badcock 1970; van Utrecht and van Utrecht-Cock 1987). Cook *et al.* (2013) found most of them between 200 and 700 m depth at night over the MAR, with some shallower and a few deeper. By day, they were taken from above 700 m to below 1,900 m, their highest densities remaining at 200–700 m.

In the Gully and in biomass terms, *Serrivomer beani* was the principal large predator encountered by the surveys, second only to *B. glaciale* in weight caught (Tables 7A, B). In numbers, catches by both 750 m and deeper sets were highest on the Slope, Offshore and Deep stations, somewhat lower in the central canyon (especially on the Wall Station) and much lower on the Head Station. In weight, however, while the catches were highest on the Slope and Deep (but not Offshore) stations, the amounts taken were little lower in the central canyon and, in summer, not much reduced even on the Head Station, though less was caught there in March 2010.

Those contrasting trends were associated with larger sizes of *Serrivomer beani* up the canyon, the average of standard lengths of individuals taken in 750 m sets on the Offshore Station being 341 mm, on the Deep Station 374 mm, the Main 412 mm, the Wall 428 mm and on the Head Station 451 mm. There was also an increase in average lengths with depth. On the Deep Station, the average of specimens taken by 250 m sets was 311 mm, by 750 m sets 374 mm, by 1,250 m sets 411 mm and by those which reached at least 1,750 m also 411 mm, other stations showing similar trends. The higher average lengths represented a general upward shift in the length frequencies, with fewer smaller individuals, relatively more larger ones and higher modal lengths. In absolute numbers, however, all size-classes declined up-canyon (though the largest held their own between the Deep and Main stations), the trend in average lengths being driven by a swifter decline in numbers of smaller fish.

Few specimens of *Serrivomer beani* were caught above 250 m depth during the summer surveys and most of those were taken at night – the only indication of diel variation apparent in the catches. Many were taken by 750 m sets but a majority of those taken by sets which reached at least 1,250 m were probably caught below 750 m depth. In March 2010, their vertical distribution was wider, with moderate numbers taken above 250 m and large catches in sets which reached at least 1,750 m. There was no indication of the depth distribution being elevated up the canyon.

Table 7A : Arithmetic mean catches of *Serrivomer beani* in each cell of the survey design: numbers of individuals

Year:		**2007**		**2008**		**2009**		**2010**	
Month:		**Sept**		**Aug/Sept**		**Aug**		**March**	
Diel Phase:		**Day**	**Night**	**Day**	**Night**	**Day**	**Night**	**Day**	**Night**
Station	**Depth (m)**								
Head	**250**	0	0	0	0	0	1	4	6.5
	750	5.33	2.5	11	15	7.5	16	1	6
	Extra		7						
Main	**250**	0.67	2	0	0.5	0	1.5	1	0.5
	750	15	14.33	10.5	11.5	10	14	16	14.5
	1250	15	20	13.5	33.5	27	35	37.5	38
	Extra	16							
Wall	**250**	0	1				5		
	750	10.67	8.5			8	10.5		
Deep	**250**	0	1	0	3	0	9		6
	750	20	26	14.5	15.33		32	56	17
	1250	27.5	26.5	32	21.67	69.5	52.5		38
	1750				32		55	96	142.5
	Extra					60.5		28	
Slope	**750**					38		57	
Offshore	**250**	1	0						
	750	38	27						
	1250	58	25						
	Extra		22						

No valid IYGPT sets were made in the shaded cells.

Table 7B : Arithmetic mean catches of *Serrivomer beani* in each cell of the survey design: weights caught (g)

Year:		**2007**		**2008**		**2009**		**2010**	
Month:		**Sept**		**Aug/Sept**		**Aug**		**March**	
Diel Phase:		**Day**	**Night**	**Day**	**Night**	**Day**	**Night**	**Day**	**Night**
Station	**Depth (m)**								
Head	**250**	0	0	0	0	0	18	20	31.5
	750	110.373	38.2	409.85	305	284.5	394	47	62.5
	Extra		258.8						
Main	**250**	2.33	8	0	3.125	0	3.5	11	0.5
	750	230.067	287.067	321	284.3	106.67	264	149	210
	1250	368.33	378.67	271.05	574	1095	735	467.5	651
	Extra	598							
Wall	**250**	0	3.5				59		
	750	157.67	441			165	182.5		
Deep	**250**	0	4	0	35.75	0	43		21.67
	750	311	333.5	189.575	188.267		286	510	119
	1250	698.5	442.8	577	645	1266.5	920		503
	1750				1121		789.5	992.5	1991
	Extra					875.5		376	
Slope	**750**					333		795	
Offshore	**250**	5	0						
	750	165	207.7						
	1250	785	594						
	Extra		500						

No valid IYGPT sets were made in the shaded cells.

The length frequency of *Serrivomer beani* was unimodal (Figure 6). Recorded standard lengths included a single individual at an improbable 935 mm but the others were within the expected range.

In most respects, the catches of *Serrivomer beani* during the Gully surveys were in accord with expectations from prior reports, the exception being the up-canyon trend in average lengths.

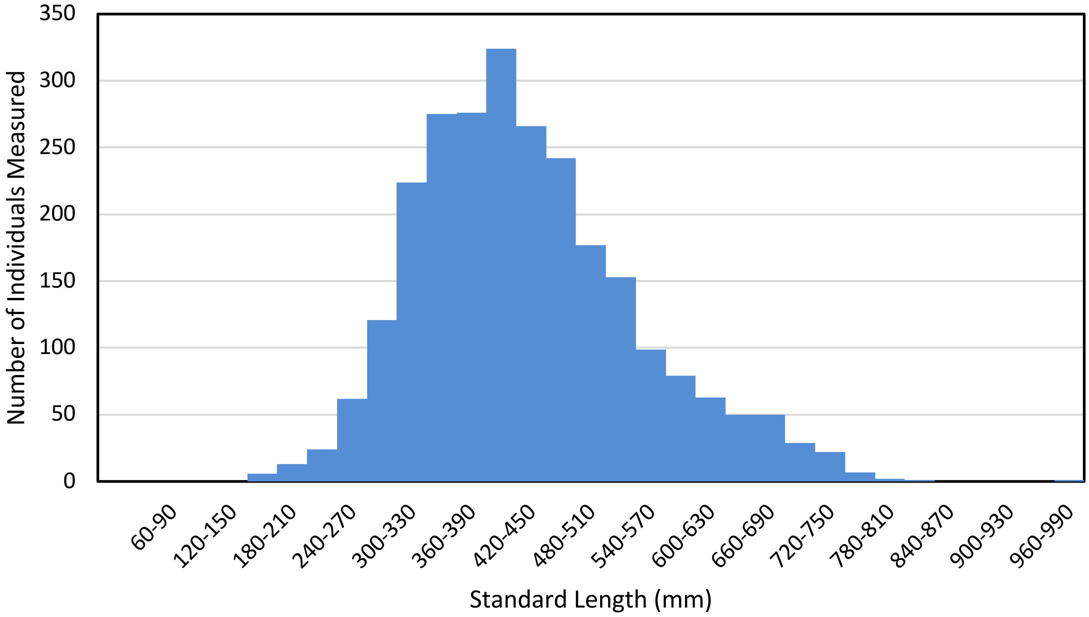


Figure 6 : Length frequency of *Serrivomer beani,* including all 2,565 measured individuals

4.3.3 Eurypharynx pelecanoides

Figure 7 : *Eurypharynx pelecanoides*, 413 mm SL, taken on the Deep Station by Set 2010_50

E. pelecanoides is an oceanic species that is considered to be circumglobal, in tropical and temperate latitudes (Gaither *et al.* 2016; DeVaney 2016), though recent DNA evidence suggests the possible presence of cryptic species within the North Atlantic (Kenchington *et al.* 2017). The nominal species is known in the western Atlantic from Argentina to Greenland (Moore *et al.* 2003a; Møller *et al.* 2010). While nowhere abundant, individuals or small numbers are frequently seen in catches taken at bathypelagic depths (Moore *et al.* 2003a: see Table 4). Some have been taken by bottom trawling on the Scotian Slope (Halliday *et al.* 2012).

The species is known from the lower mesopelagic and bathypelagic zones, likely from 500 to 3,000 m depth (Nielsen *et al.* 1989) but has also been reported from depths of less than 200 m (Moore *et al.* 2003a). *E. pelecanoides* feeds on a wide variety of prey but particularly decapods, fish and squid – perhaps actively hunting with a well-developed lateral-line system and binocular vision, provided by eyes near the tip of its snout, to detect prey items which are then engulfed in its very large mouth (Nielsen *et al.* 1989).

As in survey catches elsewhere, rather few *E. pelecanoides* were taken in The Gully – too few for confident determination of their distribution in space and time (Tables 8A, B). They were rarely taken above 250 m depth and then only at night and (with a single exception) only on the Head and Wall stations. That appearance in the catches of shallow sets was the only evidence of a diel difference in distribution. Most specimens were caught below 750 m and some likely below 1,250 m. There was a marked tendency for deeper-caught fish to be larger, the averages of standard lengths of those caught on the Deep Station increasing from 245 mm if taken by 750 m sets to 312 mm by 1,250 m sets and 405 mm in the catches of sets which reached 1,750 m or deeper. However, that increase was only partly an addition of larger fish. Smaller individuals were scarcer in the catches of deeper sets, despite those fishing through the shallower layers, suggesting a random element in the lengths caught.

Within each depth stratum, average catches were higher on the Slope, Offshore and Deep stations than on the Main Station. 750 m sets on the Head and Wall stations took more than those that fished to the same depth elsewhere, though not enough to match the 1,250 m catches on the deeper stations. Thus, water-column totals were lower where the seabed was shallower but elevation of depth distributions lifted some fish above 750 m. That elevation, combined with the trend for deeper sets to take larger fish on the same station and with the rather low numbers of specimens caught, prevents determination of whether there is also an up-canyon trend in lengths. Unlike some other species considered here, nearly as many small *E. pelecanoides* were taken by 750 m sets on the Head and Wall stations as by similar sets on the Deep, but the count on each station was so low as to be materially altered by random variations.

Table 8A : Arithmetic mean catches of *Eurypharynx pelecanoides* in each cell of the survey design: numbers of individuals

Year:		**2007**		**2008**		**2009**		**2010**	
Month:		**Sept**		**Aug/Sept**		**Aug**		**March**	
Diel Phase:		**Day**	**Night**	**Day**	**Night**	**Day**	**Night**	**Day**	**Night**
Station	**Depth (m)**								
Head	**250**	0	0	0	0	0	1	0	0.5
	750	1.33	0	3	5	5.5	4	1.5	1
	Extra		1						
Main	**250**	0	0	0	0	0	0	0	0
	750	0.33	0.5	0	0	0.33	0.5	0.5	0.5
	1250	4.33	2.5	3.5	0.5	12	4.5	2	4
	Extra	4							
Wall	**250**	0	0.5				1		
	750	1	2			1	1		
Deep	**250**	0	0	0	0	0	0		0.33
	750	0.5	3	0	0		0.5	0	2
	1250	4	6.5	10	4	3.5	4		4
	1750				6		8	6	4.5
	Extra					5.5		13	
Slope	**750**					0		5	
Offshore	**250**	0	0						
	750	0	2						
	1250	12	5						
	Extra		8						

No valid IYGPT sets were made in the shaded cells.

Table 8B : Arithmetic mean catches of *Eurypharynx pelecanoides* in each cell of the survey design: weights caught (g)

Year:		2007		2008		2009		2010	
Month:		Sept		Aug/Sept		Aug		March	
Diel Phase:		Day	Night	Day	Night	Day	Night	Day	Night
Station	Depth (m)								
Head	**250**	0	0	0	0	0	8.5	0	35
	750	3	0	18.025	25.1	45	82	4.5	61.5
	Extra		26						
Main	**250**	0	0	0	0	0	0	0	0
	750	2.6	38.433	0	0	1	9	3.5	2.5
	1250	63.67	47.4	35.975	3.75	162	141	5.5	24.5
	Extra	70							
Wall	**250**	0	0.35				17		
	750	1.4	12.25			6	6.5		
Deep	**250**	0	0	0	0	0	0		1
	750	0.5	47.3	0	0		0.5	0	12.5
	1250	36	73	118.2	48.633	77	56.5		69
	1750				244		309	135	183
	Extra					243.5		436	
Slope	**750**					0		7	
Offshore	**250**	0	0						
	750	0	8.4						
	1250	170	187						
	Extra		485						

No valid IYGPT sets were made in the shaded cells.

In so far as it can be determined, the distribution of *E. pelecanoides* appears to have been broadly consistent with previous reports, except that its depth distribution was elevated up-canyon and over the canyon wall. It penetrated to the Head Station but was more abundant outside the canyon mouth.

The length frequency of *E. pelecanoides* was unimodal (Figure 8).

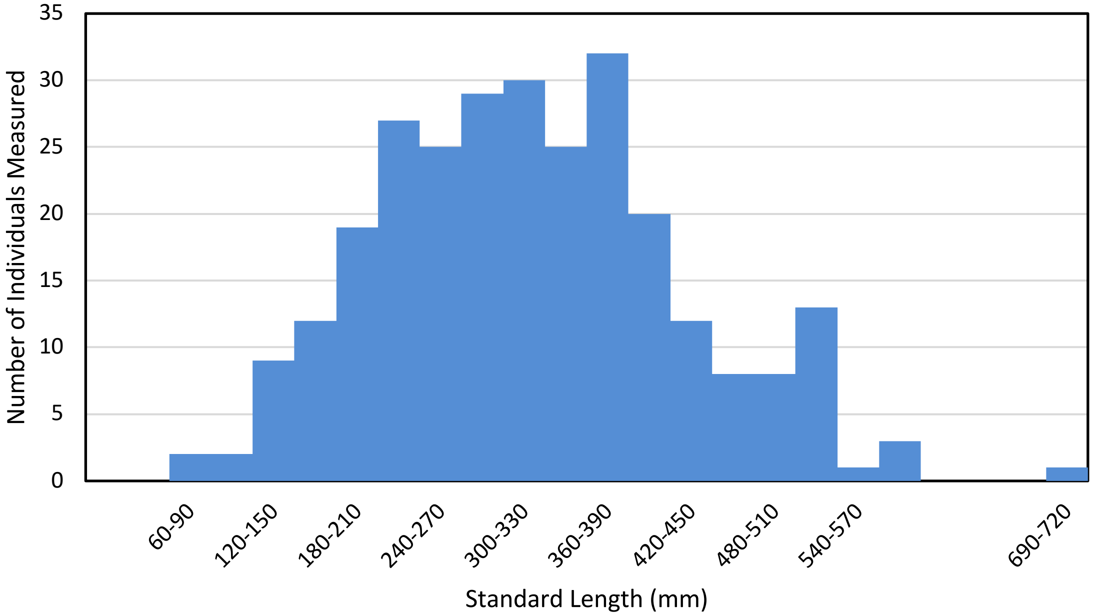


Figure 8 : Length frequency of *Eurypharynx pelecanoides*, including all 278 measured individuals

4.3.4 Bathylagus euryops

Figure 9 : *Bathylagus euryops*, 108 mm SL,
taken on the Deep Station by Set 2008_11
(most of its black epidermis flayed off in net)

Unlike some of the other species examined here, which have circumglobal distributions, the dominant bathylagid of The Gully and the surrounding region, *B. euryops*, is a species of the western North Atlantic, known from Bermuda to Davis Strait and off northwest Greenland (Moore 2003a; Møller *et al.* 2010). It has circumglobal confamilials, including *Bathylagichthys greyae*, *Dolicholagus longirostris* and *Melanolagus bericoides*, each of which was taken in The Gully but in smaller quantities than the regional species.

Within the colder portions of its range, *B. euryops* is among the most abundant of mesopelagic fishes (myctophids and *Cyclothone* spp. excepted: see Table 4). It is the single most abundant such species in the Irminger Sea (Dolgov 2015) and the fourth off Newfoundland (McKelvie and Haedrich 1985). Sutton *et al.* (2008) found it second only to *Cyclothone microdon* in the biomass of trawl-caught fish taken below 750 m depth over the northern MAR, with not-inconsiderable amounts caught above that depth also. It has been taken over the Scotian Slope, though not in large numbers (Halliday *et al.* 2012).

B. euryops is usually found at 500 to 1,500 m depth and only rarely recorded as shallow as 300 m (McKelvie and Haedrich 1985; Opdal *et al.* 2008). However, Sutton *et al.* (2013) reported a specimen as shallow as 280 m on the northern MAR, while Cook *et al.* (2013) found small proportions of the fish both above 200 m and below 1,900 m depth there. Sweetman *et al.* (2013) studied the shallow occurrence of *B. euryops* over the MAR, finding a few above 200 m depth in the vicinities of the Charlie-Gibbs Fracture Zone and the Faraday Seamount, without any diel cycle in that depth distribution. The individuals taken above 200 m depth averaged less than 60 mm standard length, compared to about 155 mm for those taken below 1,500 m, and Sweetman *et al.* (2013) suggested an ontogenetic change in depth distribution, beginning with near-surface larvae.

Over the northern MAR, *B. euryops* eats a wide variety of small crustaceans, particularly copepods, along with small amounts of other zooplankton, including cnidarians – the latter perhaps more important in energy terms than in observable stomach contents (Sweetman *et al.* 2014).

In The Gully, a few *B. euryops* were taken above 250 m depth but only at night and not during 2007, when the CIL was strongly developed (Tables 9A, B). Many were caught between 250 and 750 m but, where bottom depth permitted, others were taken below the latter depth and, on the Deep Station, some perhaps below 1,250 m. Average catches were highest on the Deep Station, declining in each stratum from there to the Main Station, falling further to the Wall and Head stations. Thus, lesser bottom depths not only cut out the portion of the population at greater depth but were also accompanied by reduced numbers in the remaining available water column. There was little sign of the elevation of depth distribution seen in some other species, though the one set made on the Head Station that reached below 750 m depth took 25 individuals – more than all but two of the 1,250 m sets made on other stations. Thus, it seems that some *B. euryops* were forced upwards by the shallowing thalweg but largely avoided swimming above 750 m. Those trends were more marked in weight terms than in numbers, as average sizes declined up the canyon. The average standard length of fish caught by 750 m sets was 84 mm on the Deep Station and 77 mm on both the Main and Head. The few sets made on the Slope Station produced catches similar to those on the Main Station but the catches on the Offshore Station in 2007 were very low – a pattern not seen on the Deep Station in 2009 and hence not closely linked to the proximity of the shelf / slope boundary. Overall, catches rose slightly from 2007 to 2009, remaining at that higher level in March 2010.

Table 9A : Arithmetic mean catches of *Bathylagus euryops* in each cell of the survey design: numbers of individuals

Year:		2007		2008		2009		2010	
Month:		Sept		Aug/Sept		Aug		March	
Diel Phase:		Day	Night	Day	Night	Day	Night	Day	Night
Station	Depth (m)								
Head	250	0	0	0	0	0	0.5	0	0
	750	11.33	2	6.5	14	10.5	8	1	0.5
	Extra		25						
Main	250	0	0	0	1	0	0	0	0
	750	9	5.33	11.5	11	8	10	7.5	10.5
	1250	18	5.33	12	18.5	29	18	8.5	11.5
	Extra	28							
Wall	250	0	0				0		
	750	9.33	3			9	8		
Deep	250	0	0	0	2	0	2		0
	750	13.5	10	6	7.33		11.5	13	7
	1250	12	12	15	6.67	24	21		13
	1750				13		23.5	25.5	22
	Extra					19		22	
Slope	750					8		7	
Offshore	250	0	0						
	750	0	1						
	1250	4	8						
	Extra		9						

No valid IYGPT sets were made in the shaded cells.

For sets that reached at least 1,250 m depth, the average standard length of specimens taken at night was consistently larger that that of individuals taken in daylight in the same stratum, on the same station and by the same survey, the differences varying from 2 to 27 mm. The same pattern was common, but not universal, amongst 750 m sets. The difference in the averages was both an addition of large individuals and some loss of small ones at night (Figure 10), the latter suggesting a reduction in catchability in darkness. With such small fish, active avoidance of the meshes may aid herding towards the codend of the trawl, rather than successful escape. The increase in larger fish appears to be evidence of an upward migration of large *B. euryops* from the bathypelagic zone at dusk, some seemingly rising from below 1,750 m, as the effect was seen in the catches of sets which fished that deep.

Table 9B : Arithmetic mean catches of *Bathylagus euryops* in each cell of the survey design: weights caught (g)

Year:		**2007**		**2008**		**2009**		**2010**	
Month:		**Sept**		**Aug/Sept**		**Aug**		**March**	
Diel Phase:		**Day**	**Night**	**Day**	**Night**	**Day**	**Night**	**Day**	**Night**
Station	**Depth (m)**								
Head	**250**	0	0	0	0	0	15.5	0	0
	750	45.467	8.8	19.175	32.6	119	49	24	4.5
	Extra		163.2						
Main	**250**	0	0	0	9.475	0	0	0	0
	750	27.4	48.67	43.4	46.8	37	48	59.5	127
	1250	123	81.2	58.35	212	237	216	78	133
	Extra	308							
Wall	**250**	0	0				0		
	750	24.133	12.15			50	38		
Deep	**250**	0	0	0	34.325	0	17		0
	750	92.5	63.6	43.05	48.67		98	107	87
	1250	85.5	122.8	162.35	96.2	223	252.5		207.5
	1750				242		344	386.5	311
	Extra					181.5		307	
Slope	**750**					46.5		32	
Offshore	**250**	0	0						
	750	0	12						
	1250	45.5	93						
	Extra		135						

No valid IYGPT sets were made in the shaded cells.

Average lengths increased with depths fished, from the 750 m sets through those that reached 1,250 m and on to the 1,750 m ones, despite the latter fishing through shallower waters. On the Deep Station, those averages were 84, 93 and 102 mm respectively. The fish caught in March 2010 tended to average a little larger than those taken in summer.

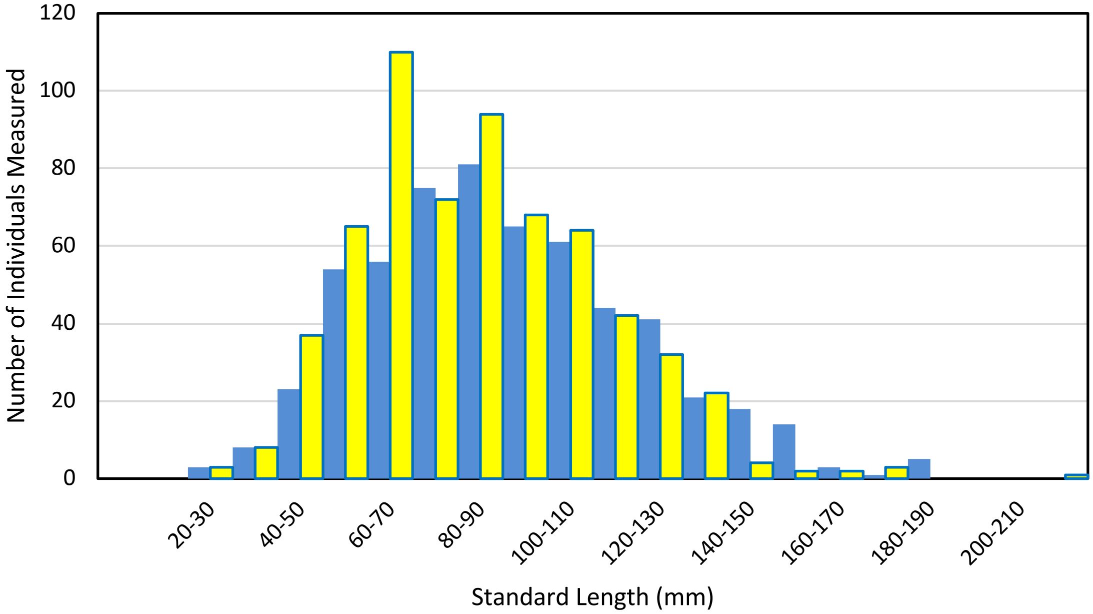


Figure 10 : Length frequencies of *Bathylagus euryops* by diel phase, including all 1,189 measured individuals (Blue: Night catches; Yellow: Daylight catches)

In summary, the distribution of *B. euryops* in and around The Gully was generally consistent with those prior reports, except for some elevation of the depth distribution. Unlike some of the other species included in the present analyses, that elevation was not specific to the upper canyon. Rather, *B. euryops* appeared to maintain the same depths up-canyon, with the rise of the thalweg truncating the depth distribution of the species, except for some squeezing of the fish between the seabed and 750 m depth.

4.3.5 Chauliodus sloani

Figure 11 : *Chauliodus sloani*, 253 mm SL, taken on the Main Station by Set 2010_10

C. sloani is currently seen as circumglobal, though available genetic data suggest that the nominal taxon comprises a species complex (Gaither *et al.* 2016). In the western North Atlantic, it is known from the Caribbean to Greenland (Moore *et al.* 2003a; Møller *et al.* 2010). Gartner *et al.* (2008) observed *C. sloani* off Cape Hatteras, Ross *et al.* (2015) took some by bottom trawl in Norfolk Canyon and Musick (1973) took one in the Gulf of Maine. 233 were taken when bottom trawling on the Scotian Slope (Halliday *et al.* 2012). The species is especially abundant over oceanic depths south of Nova Scotia, where Themelis and Halliday (2012) found it the second most abundant fish (myctophids and *Cyclothone* spp. excepted) in their catches (see Table 4). It was particularly prevalent north of the shelf / slope boundary, though present even in Gulf Stream water. It has been recorded in the deep channels of the Gulf of St. Lawrence (Nozères *et al.* (2010). McKelvie and Haedrich (1985) saw it as one of the four most abundant mesopelagic species (myctophids and *Cyclothone* spp. excepted) off Newfoundland. It was the second such species in Dolgov's (2015) catches in the Irminger Sea.

C. sloani is generally considered to live below 1,000 m depth in daylight and above 800 m at night (Moore *et al.* 2003a). However, Badcock (1970) found them as shallow as 500 m in daylight and in the upper 100 m at night, while McKelvie and Haedrich (1985) noted records of catches from above 500 m in daylight. Over the MAR, Cook *et al.* (2013) and Sutton *et al.* (2013) found this species from above 200 m to below 1,900 m, with highest densities in the 200–700 m and 500–800 m strata of their respective studies.

The length frequencies of *C. sloani* taken during the Gully surveys revealed three modes at lengths around 80, 120–150 and 220–230 mm in summer (the latter two about 160 and 240 mm in March 2010). Modes II and III were prominent in 2007, I and III in 2008, I and II in 2009 but II and III in March 2010 (Figure 12). The modes appear to represent age-classes and indicate rapid growth (from 80 to 220 mm in two years). The changes, between the summer surveys, in the principal modes observed suggest considerable inter-annual variation in year-class strengths (the 2007 'class being weak) but also an incongruity between the dominant year-classes of summer 2009 and those present in spring 2010. Those inter-annual differences in modal presence were accompanied by differences in overall catches. 2008 and 2009 saw higher average catches per set, in both numbers and weight, than either 2007 or March 2010 (Tables 10A, B).

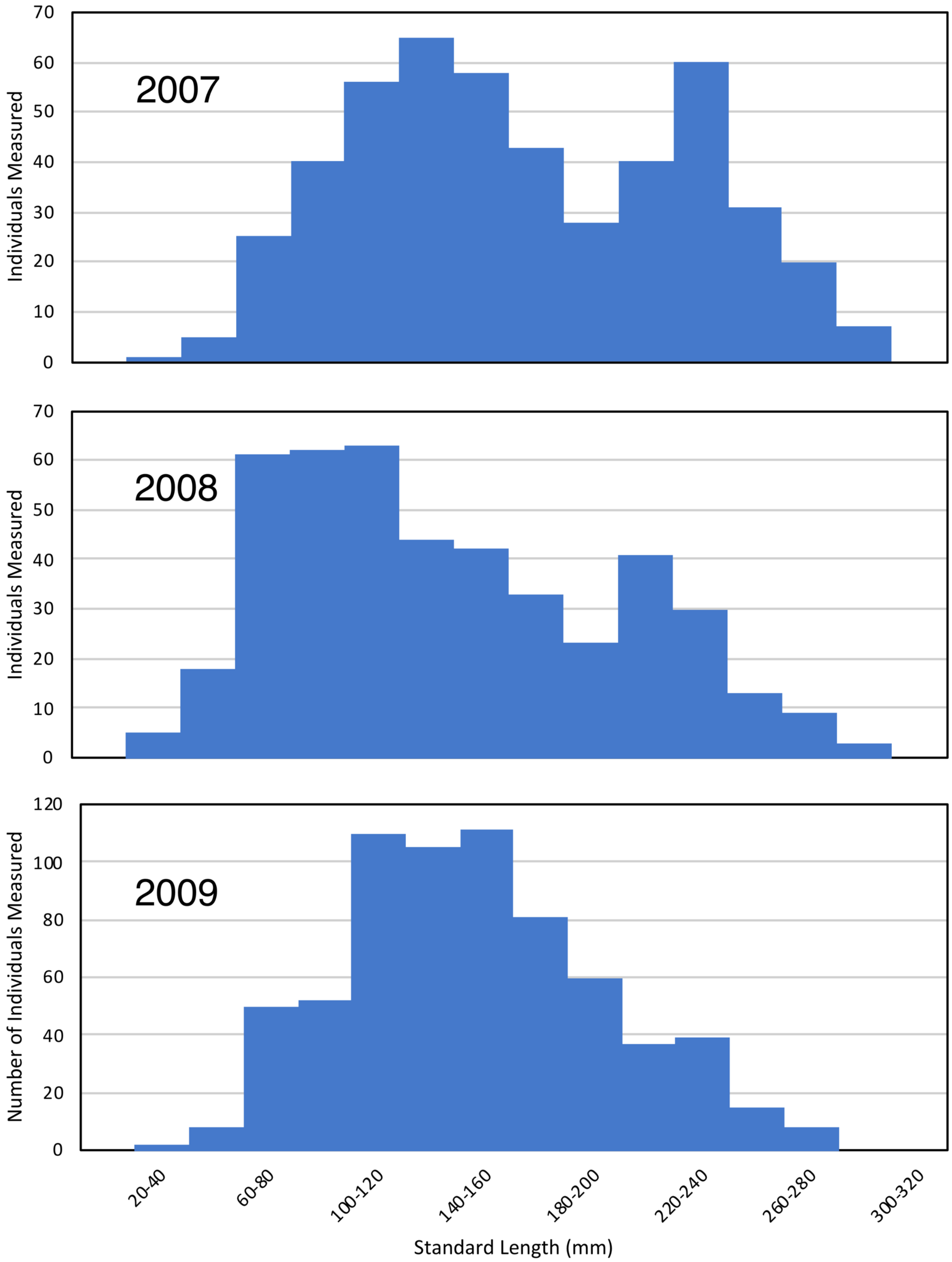
Only single individuals were taken above 250 m depth in daylight, though larger numbers were taken by shallow sets at night. With the sole exception of the Head Station in 2010, sets made to 750 m always took larger catches, often much larger, than the corresponding 250 m ones did, while the 1,250 m sets usually took still-larger catches. Those trends were more exaggerated in weight terms, because of the larger average sizes of individuals caught by the deeper sets. The limited data from depths greater than 1,250 m did not indicate any consistent further increase in catches.

In summer, the average of the lengths of specimens taken at night was generally (though not consistently) larger than that of individuals taken in daylight in the same stratum, on the same station and by the same survey. That pattern was not seen in March 2010. The difference appears in the data as a deficit in numbers of fish of 70–180 mm SL at night during summer (Figure 13), perhaps a consequence of different net-avoidance behaviour – though daylight and night catches were almost exactly equal in weight terms and differed little in numbers. In summer, average lengths also increased with depth fished, from the catches of 250 m sets to those of the 1,750 m ones, despite the latter fishing through shallower waters. On the Deep Station, the averages for sets made to each of the four nominally depth strata were 98, 141, 153 and 160 mm respectively. That pattern too was less clear in March 2010.

Across the array of stations, by far the highest catches, in terms of average numbers caught per set, were taken on the Slope Station, followed by the Offshore and Deep. In weight terms, the Slope and Offshore stations were similar in their 750 m catches and both saw larger amounts than the Deep Station. Whether the latter station, immediately outside the canyon mouth, really sees fewer *C. sloani* than nearby areas is unclear as the very limited sampling on the Slope and Offshore stations leaves their averages vulnerable to random effects. The spatio-temporal differences in catches were tied to variations in the sizes of *C. sloani* caught on the various stations (Figure 14). The Slope Station, fished only in 2009 and 2010, saw mostly Mode II individuals, especially in 2009, though their moderate size mean that the weights caught were less exceptional. The Offshore Station, fished only in 2007, saw both Mode II and Mode III fish in its deeper sets but, above 250 m depth, almost all those taken were in Mode I.

In numbers, the Main Station yielded catches about half those of the Deep, while the Wall and Head stations produced much smaller catches still in number terms, even when comparing only those taken by 750 m sets. The trends were, however, much less marked in weight terms as Mode III fish were relatively more abundant on the Main Station and more so on the Wall and Head, particularly when the comparison was restricted to the catches of the 750 m sets. Mode III fish dominated the catches in that stratum on the Head Station. It was the same trend seen in other species for the abundance of smaller fish to decline, up-canyon, faster than larger ones did, those expressed in the tri-modal structure of the length-frequencies of *C. sloani*.

The disproportionate declines in smaller fish were so pronounced that the average of the standard lengths of fish caught on the Head Station was 176 mm and on the Wall 198 mm – considerably larger than in even the deepest sets made on the Deep Station, even though almost all of the sampling on the Head and Wall was above 750 m. The lengths of fish caught by 1,250 m sets on the Main Station (average 183 mm) were comparable, however.


2007
Individuals Measured
70
60
50
40
30
20
10
0
2008
Individuals Measured
70
60
50
40
30
20
10
0
2009
Number of Individuals Measured
120
100
80
60
40
20
0
20-40
60-80
100-120
140-160
180-200
220-240
260-280
300-320
Standard Length (mm)

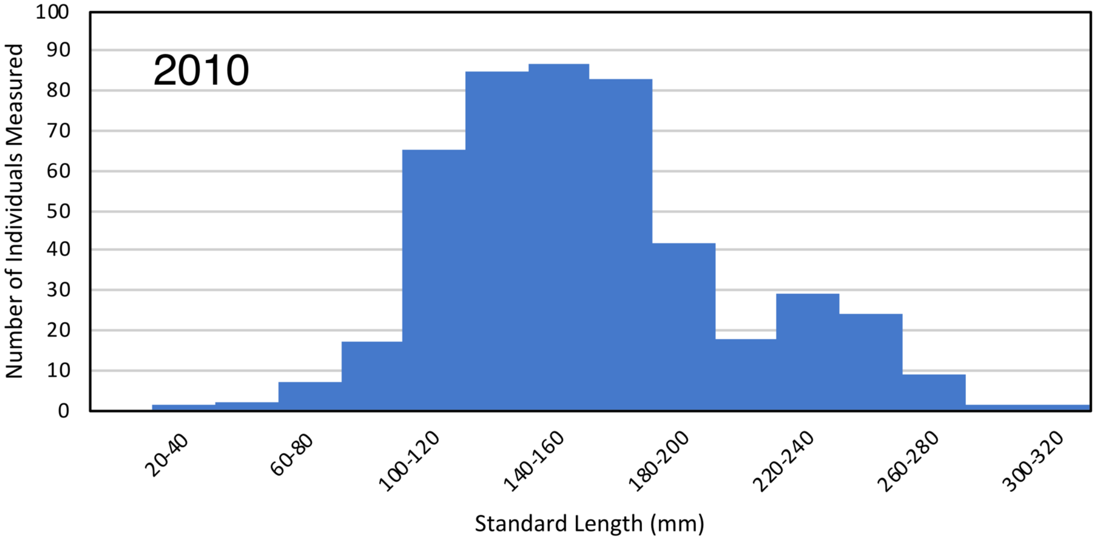


Figure 12 : Length frequencies of *Chauliodus sloani* by survey, including all 2,032 measured individuals (Top left: 2007, Middle left: 2008, Bottom left: 2009, Above: 2010)

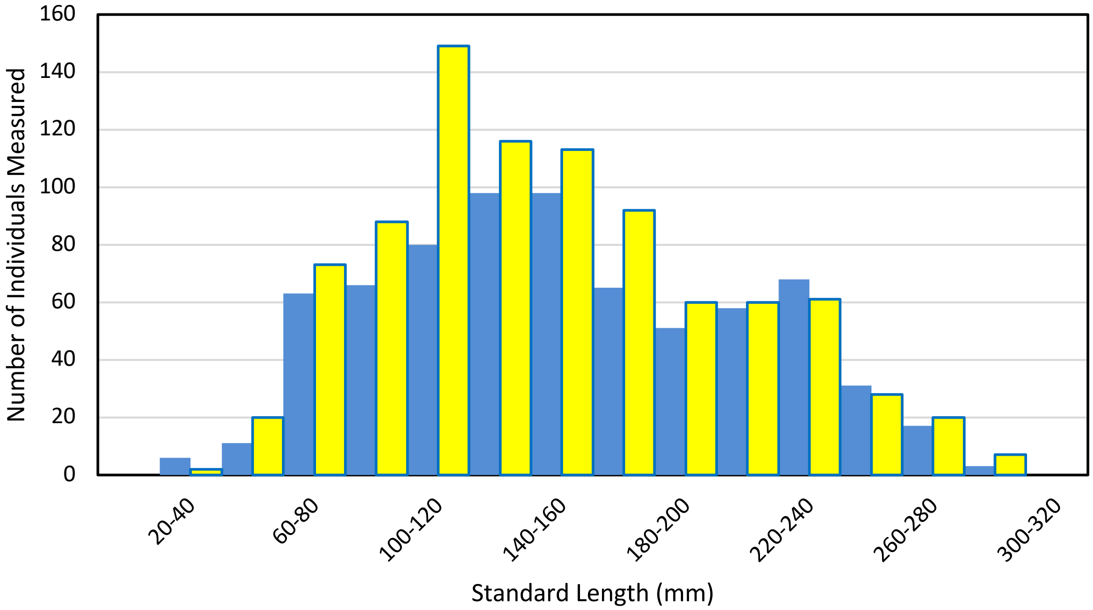


Figure 13 : Length frequencies of *Chauliodus sloani* taken in summer, by diel phase, including 1,604 measured individuals (Blue: Night catches; Yellow: Daylight catches)

Table 10A : Arithmetic mean catches of *Chauliodus sloani* in each cell of the survey design: numbers of individuals

Year:		**2007**		**2008**		**2009**		**2010**	
Month:		**Sept**		**Aug/Sept**		**Aug**		**March**	
Diel Phase:		**Day**	**Night**	**Day**	**Night**	**Day**	**Night**	**Day**	**Night**
Station	**Depth (m)**								
Head	**250**	0	0.33	0	0	0	1.5	1	4
	750	1.67	1.5	3.5	2	1.5	3	0.5	4
	Extra	▨	3	▨	▨	▨	▨	▨	▨
Main	**250**	0.33	0.67	0	1	0	0	0	1.5
	750	3.33	4	1.5	5	17	10.5	7.5	13
	1250	11.67	8.33	23	21	22	21.5	15.5	13
	Extra	11	▨	▨	▨	▨	▨	▨	▨
Wall	**250**	0	0	▨	▨	▨	5	▨	▨
	750	5.67	2.5	▨	▨	6	1	▨	▨
Deep	**250**	0	7.5	1	21.5	0	13	▨	2.33
	750	14	27.5	27	30.33	▨	27	30	16
	1250	23.5	20.5	48	24.5	52	28.5	▨	23
	1750	▨	▨	▨	17	▨	31	38.5	57.5
	Extra	▨	▨	▨	▨	44.5		28	
Slope	**750**	▨	▨	▨	▨	65.5	▨	31	▨
Offshore	**250**	0	7	▨	▨	▨	▨	▨	▨
	750	42	25	▨	▨	▨	▨	▨	▨
	1250	17	25	▨	▨	▨	▨	▨	▨
	Extra	▨	13	▨	▨	▨	▨	▨	▨

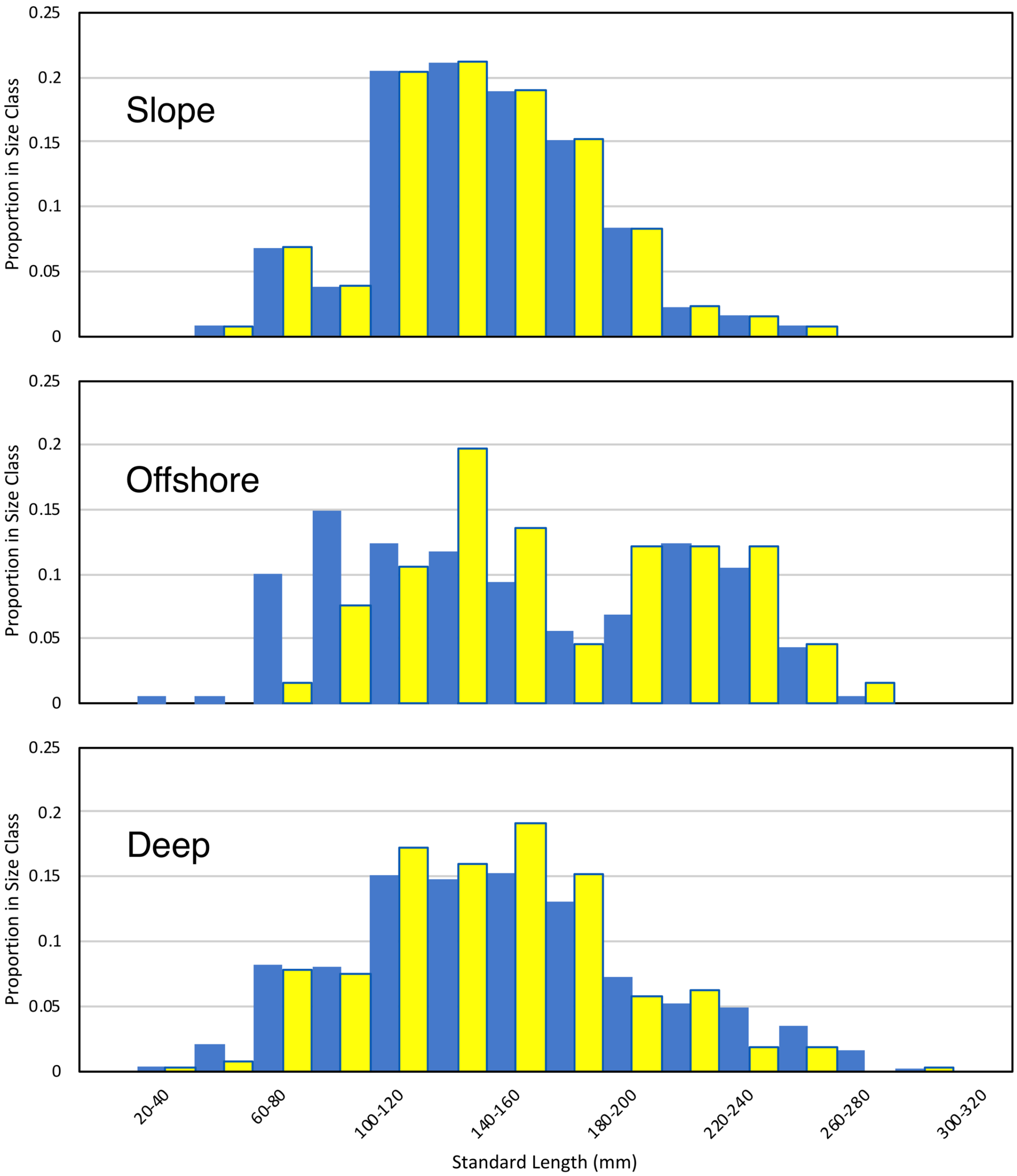
No valid IYGPT sets were made in the shaded cells.

Table 10B : Arithmetic mean catches of *Chauliodus sloani* in each cell of the survey design: weights caught (g)

Year:		2007		2008		2009		2010	
Month:		**Sept**		**Aug/Sept**		**Aug**		**March**	
Diel Phase:		**Day**	**Night**	**Day**	**Night**	**Day**	**Night**	**Day**	**Night**
Station	**Depth (m)**								
Head	**250**	0	1.833	0	0	0	23.5	35	32.5
	750	44.833	78.5	151.75	73.65	30.5	107	6.5	27.5
	Extra		132.9						
Main	**250**	0.467	1	0	5.85	0	0	0	5
	750	48.467	66.6	15.075	90.525	147.33	116.5	131.5	206
	1250	230	238.067	411	382		438.5	336	228.5
	Extra	329							
Wall	**250**	0	0				86		
	750	136.33	82.15			140	22		
Deep	**250**	0	99.5	2.35	37.175	0	60		11.33
	750	111.4	257	249	276.67		240	304	188
	1250	383	564.8	485.5	281.5	537.5	448		363.5
	1750				167.8		584	503.5	859
	Extra					534		359	
Slope	**750**					461		461	
Offshore	**250**	0	25						
	750	580	390						
	1250	400	336						
	Extra		219.2						

No valid IYGPT sets were made in the shaded cells. Blank cell indicates missing data.

In summary, the catches of *C. sloani* taken by the Gully surveys were broadly consistent with past observations, though the species showed some up-canyon elevation of its depth distribution. Despite its association with more waters to the north and east of The Gully, rather than to the southwest, *C. sloani* was a species of the open ocean and much less abundant in the central, and especially the upper, canyon than outside its mouth. That up-canyon decline in numbers was especially marked amongst smaller individuals.


Slope
Offshore
Deep
Proportion in Size Class
0.25
0.2
0.15
0.1
0.05
0
20-40
60-80
100-120
140-160
180-200
220-240
260-280
300-320
Standard Length (mm)

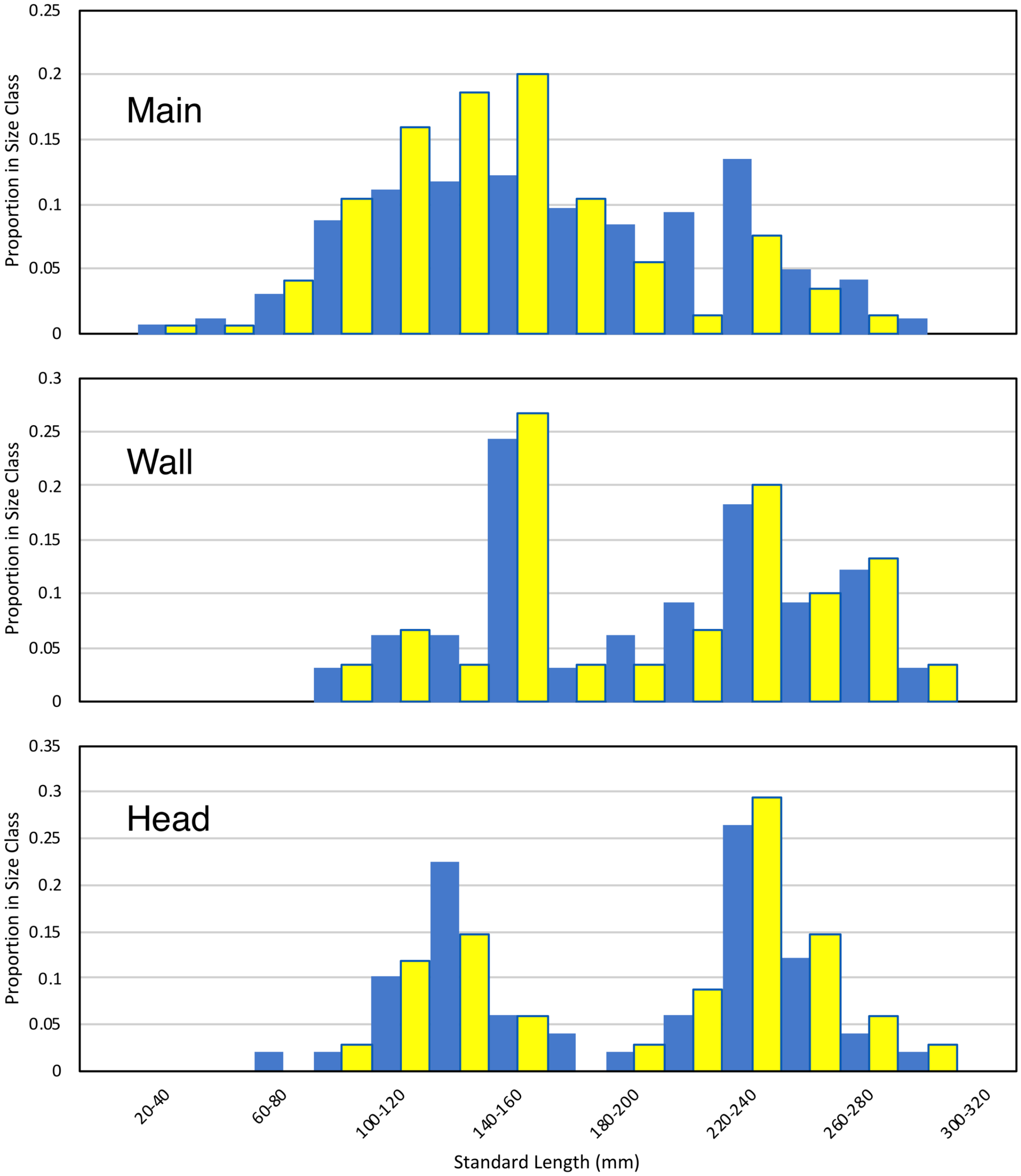


Figure 14 : Length frequencies of *Chauliodus sloani* (shown as proportions of measured individuals) by station
Blue: Data from all 2,032 measured individuals, Yellow: Data from individuals caught in sets made to 750 m depth only (Top left: Slope Station; Middle left: Offshore Station; Bottom left: Deep Station; Top right: Main Station; Middle right: Wall Station; Bottom right: Head Station)

4.3.6 Malacosteus niger

Figure 15 : *Malacosteus niger,* 71 mm SL, taken on the Deep Station by Set 2008_08
(head reflexed, revealing open space between jaws and body)

M. niger is circumglobal at tropical and temperate latitudes (Kenaley 2007), although not listed as such by Gaither *et al.* (2016). In the western North Atlantic, it is known from the Caribbean and is common as far north as Greenland (Moore *et al.* 2003a; Møller *et al.* 2010), though it is individually-larger, and correspondingly less abundant, than most of the other species considered here. It is nevertheless common in waters from south of Nova Scotia to the MAR and the Irminger Sea (Sutton *et al.* 2008; Themelis and Halliday 2012; Dolgov 2015: see Table 4). It was seen in the catches of bottom trawls from the Scotian Slope but only in small numbers (Halliday *et al.* 2012).

Catches taken in closing nets have shown that *M. niger* does not undertake coordinated diel vertical migrations. In one North Atlantic study, almost all were caught below 500 m depth, though a few were taken above 250 m at night (Kenaley 2008). The Malacosteinae, including *M. niger*, are notable for both producing and detecting long-wavelength (red) light, which they apparently use for illuminating prey while remaining undetectable to other deep-living species (Kenaley 2008; Kenaley *et al.* 2014a).

The numbers of *M. niger* caught by the Gully surveys were low but the catch weights were higher (Tables 11A, B). Many of those caught were taken by 750 m sets but the majority found on the Main Station were taken by 1,250 m sets, as was a large fraction of those caught on the Deep Station. Two of the largest catches were taken by sets which reached 1,750 m but, given the overall low numbers caught and hence the greater influence of random variations, the evidence for *M. niger* being taken below 1,250 m remains equivocal. Only six individuals were caught by 250 m sets – all of them in 2008 and most in daylight. While some of those six may have been carried over from previous, deeper sets, it is not probable that all were[3].

---

[3] One set on the Main Station that took three individuals followed another 250 m set which had no recorded catch of *M. niger*.

Table 11A : Arithmetic mean catches of *Malacosteus niger* in each cell of the survey design: numbers of individuals

Year:		**2007**		**2008**		**2009**		**2010**	
Month:		**Sept**		**Aug/Sept**		**Aug**		**March**	
Diel Phase:		**Day**	**Night**	**Day**	**Night**	**Day**	**Night**	**Day**	**Night**
Station	**Depth (m)**								
Head	**250**	0	0	1	0	0	0	0	0
	750	1.33	0.5	2	4	4.5	5	0	0.5
	Extra		4						
Main	**250**	0	0	3	0	0	0	0	0
	750	1	1.67	1.5	1	1	1	1	1.5
	1250	3.67	7.67	5	6.5	7	2.5	8.5	3.5
	Extra	1							
Wall	**250**	0	0				0		
	750	2.33	5			0	2		
Deep	**250**	0	0	0	1	0	0		0
	750	1.5	3	4.5	3.33		0	2	6.5
	1250	4	4	6	3.33	3	0		3.5
	1750				9		2	6.5	5
	Extra					1.5		3	
Slope	**750**					3		3	
Offshore	**250**	0	0						
	750	4	5						
	1250	2	1						
	Extra		1						

No valid IYGPT sets were made in the shaded cells.

In numbers, catches integrated across the water column were highest on the Deep Station and least on the Head, where only one individual was taken in March 2010. However, depth distributions were elevated up the canyon, such that 1,250 m sets on the Main Station caught more than those on the Deep and the 750 m sets on the Wall and Head stations, in summer, caught more than those on the Main. The limited data available from the Slope Station matched the average catch in 750 m sets on the Deep Station. The up-canyon increases at given depths were strengthened in weight terms by matching increases in average lengths: 125 mm on the Deep Station, 134 mm on the Main and 151 mm on the Head – the latter producing five of the seven specimens of greater than 220 mm SL but only one of the 69 smaller than 100 mm.

Table 11B : Arithmetic mean catches of *Malacosteus niger* in each cell of the survey design: weights caught (g)

Year:		**2007**		**2008**		**2009**		**2010**	
Month:		**Sept**		**Aug/Sept**		**Aug**		**March**	
Diel Phase:		**Day**	**Night**	**Day**	**Night**	**Day**	**Night**	**Day**	**Night**
Station	**Depth (m)**								
Head	**250**	0	0	6.55	0	0	0	0	0
	750	117.67	0.6	17.85	109.2	34	206	0	13
	Extra		195						
Main	**250**	0	0	72.65	0	0	0	0	0
	750	16.767	9.167	10.475	8.55	4.733	18	26	9.5
	1250	118.167	195.733	85.875	206	154	35	129	71
	Extra	36							
Wall	**250**	0	0				0		
	750	44	80.45			0	76		
Deep	**250**	0	0	0	9.525	0	0		0
	750	16	48.75	69.775	36.4		0	22	127.5
	1250	113	106.875	43.5	71.15	72.5	0		79.5
	1750				183.6		54	111	107
	Extra					33		43	
Slope	**750**					43		40	
Offshore	**250**	0	0						
	750	55	157						
	1250	33	33.7						
	Extra		6.3						

No valid IYGPT sets were made in the shaded cells.

No inter-annual, seasonal or diel patterns were evident in the length frequencies of *M. niger* and even the expected increase in size with depth was not apparent, perhaps because too few were caught and measured. The overall length frequency (Figure 16) was unimodal.

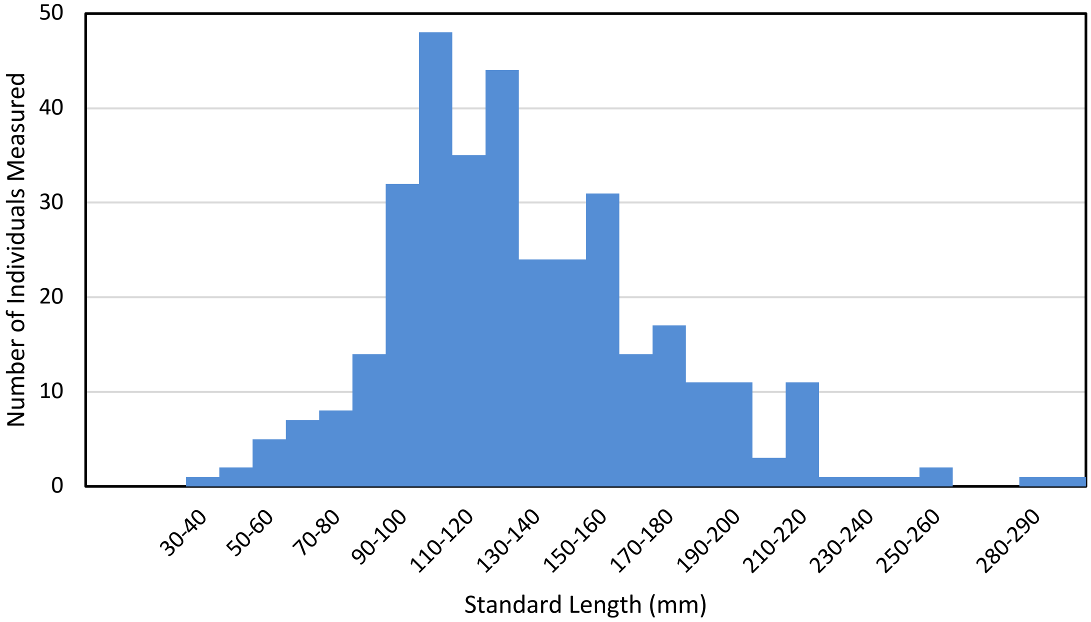


Figure 16 : Length frequency of *Malacosteus niger*, including all 324 measured individuals

Thus, the distribution of *M. niger* observed in The Gully was in accord with prior knowledge of the species, except for the elevation in depths towards the canyon head, which included a daylight presence above 250 m depth, and the up-canyon decline in catches, which was especially pronounced for smaller size-classes.

4.3.7 Stomias boa

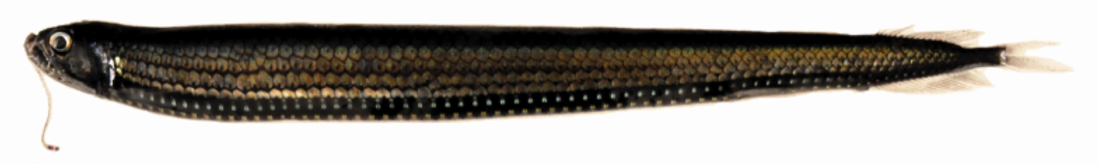


**Figure 17 : *Stomias boa*, 200 mm SL,
taken on the Deep Station by Set 2009_10**

S. boa has an extratropical distribution, being widespread (perhaps circumglobal) in southern temperate latitudes but also occurring in the North Atlantic and Mediterranean (Kukuev 2014). It is currently regarded as comprising two subspecies, the nominate *S. boa boa* occurring in the Southern Hemisphere but also in the northeast Atlantic and the Mediterranean. In contrast, all specimens occurring in the western North Atlantic are considered to be *S. boa ferox*. That subspecies is known from off the Carolinas to Greenland and Iceland (Moore *et al.* 2003a; Møller *et al.* 2010). Within that broad range, it is primarily a species of areas with colder surface waters (see Table 4). Gartner *et al.* (2008) observed small numbers of *S. boa* in near-bottom aggregations off Cape Hatteras, as Ross *et al.* (2015) did in Norfolk and Baltimore canyons. Musick (1973) took ten specimens in the deepest basin of the Gulf of Maine and Nozères *et al.* (2010) reported one from the Gulf of St. Lawrence. 190 were taken when bottom trawling on the Scotian Slope (Halliday *et al.* 2012). It was among the most abundant species in Jahn and Backus' (1976) collections from WSW and was the fifth most abundant fish (myctophids and *Cyclothone* spp. excepted) in Themelis and Halliday's (2012) catches taken south of Nova Scotia, where it was particularly abundant north of the shelf / slope boundary. It was similarly abundant off Newfoundland (McKelvie 1985; McKelvie and Haedrich 1985). Over the MAR, Sutton *et al.* (2008) found it a substantial contributor to the biomass above 750 m depth from Faraday Seamount northwards and it is common in the Irminger Sea (Dolgov 2015).

S. boa is mesopelagic (Moore *et al.* 2003a). In the northeast Atlantic, Roe and Badcock (1984) found most *S. boa boa* between 400 and 600 m in daylight, some remaining at depth through the night while others migrated up at dusk to approximately 100 m depth. Similarly, Sutton *et al.* (2013) suggested depth ranges of 200–800 m in daylight, and a bimodal 0–200 and 500–800 m at night.

In The Gully, *S. boa* was primarily a species of depths between 250 and 750 m. In numbers, the catches in the 1,250 m and deeper sets were somewhat higher than those taken by sets which only reached 750 m, suggesting that some individuals were taken below the latter depth, but that effect was not evident in weight terms (Tables 12A, B). Some fish were taken above 250 m, mostly but not exclusively at night. That increase in numbers taken in the shallow sets during darkness was the only evidence of a diel cycle. The lengths of *S. boa* caught on the Main Station did not greatly differ with depth but on the Deep Station the shallowest sets took notably smaller fish. Thus, the average of the standard lengths of individuals caught by 250 m sets was 154 mm, whereas that of *S. boa* taken by 750 mm sets was 181 mm. There was no further increase in average sizes in the catches of sets that fished to greater depths.

Summer catches, in numbers, were highest in 2009 and lowest in 2008. However, there was marked inter-annual variation in the sizes of *S. boa* caught (Figure 18)[4]. In 2007 and 2008, the length frequencies showed a dominant mode at about 200 mm but in 2009 that was joined by a pronounced mode at about 150 mm. Hence, the inter-annual variation in the catches was evident in weight terms. March 2010 catches were much lower by both measures, while the mode of smaller fish became dominant.

---

[4] The recorded lengths included two improbable records, of 15 and 420 mm respectively. Those are excluded from the summary range given in Table 4.

Table 12A : Arithmetic mean catches of *Stomias boa* in each cell of the survey design: numbers of individuals

Year:		**2007**		**2008**		**2009**		**2010**	
Month:		**Sept**		**Aug/Sept**		**Aug**		**March**	
Diel Phase:		**Day**	**Night**	**Day**	**Night**	**Day**	**Night**	**Day**	**Night**
Station	**Depth (m)**								
Head	**250**	0	1.33	1	0	1	3	0	2.5
	750	3.67	1	5	0	0	0	0	1
	Extra	▨		▨	▨	▨	▨	▨	▨
Main	**250**	2	11	0	9	0	4	0	2.5
	750	32.67	27.67	26	24.5	52.33	27	4.5	5.5
	1250	31	34.67	31.5	29	30	20	2.5	4
	Extra	22	▨	▨	▨	▨	▨	▨	▨
Wall	**250**	0	6	▨	▨	▨	3	▨	▨
	750	28.33	14.5	▨	▨	52	31.5	▨	▨
Deep	**250**	0	9.5	3	7.5	5	16	▨	6.67
	750	19.5	32	27	11.67	▨	45.5	9	10
	1250	23.5	18	24.5	16.33	68	33	▨	7
	1750	▨	▨	▨	19	▨	28	5.5	11.5
	Extra	▨	▨	▨	▨	18		2	
Slope	**750**	▨	▨	▨	▨	39.5	▨	8	▨
Offshore	**250**	6	4	▨	▨	▨	▨	▨	▨
	750	35	18	▨	▨	▨	▨	▨	▨
	1250	25	10	▨	▨	▨	▨	▨	▨
	Extra	▨	8	▨	▨	▨	▨	▨	▨

No valid IYGPT sets were made in the shaded cells. Blank cell indicates missing data.

Table 12B : Arithmetic mean catches of *Stomias boa* in each cell of the survey design: weights caught (g)

Year:		2007		2008		2009		2010	
Month:		Sept		Aug/Sept		Aug		March	
Diel Phase:		Day	Night	Day	Night	Day	Night	Day	Night
Station	Depth (m)								
Head	250	0	35.567	18.65	0	10	58	0	14.5
	750	70.33	10.8	170.8	0	0	0	0	17
	Extra		374						
Main	250	22	137.33	0	113.925	0	36	0	10
	750	730	560	449	416.5	922	369.5	51	46
	1250	535	570	398.5	436	577	363.5	32	34.5
	Extra	279							
Wall	250	0	98.5				21		
	750	592.33	340.5			916	485.5		
Deep	250	0	68.55	53.95	39.25	93	202		31
	750	311.15	333.5	334	195.433		450	40	124
	1250	215.5	143.6	214	233.67	742	334.5		82
	1750				193		363	66.5	100
	Extra					248.5		21	
Slope	750					395.5		71	
Offshore	250	65	36.5						
	750	420	272.8						
	1250	245	155						
	Extra		68.3						

No valid IYGPT sets were made in the shaded cells.

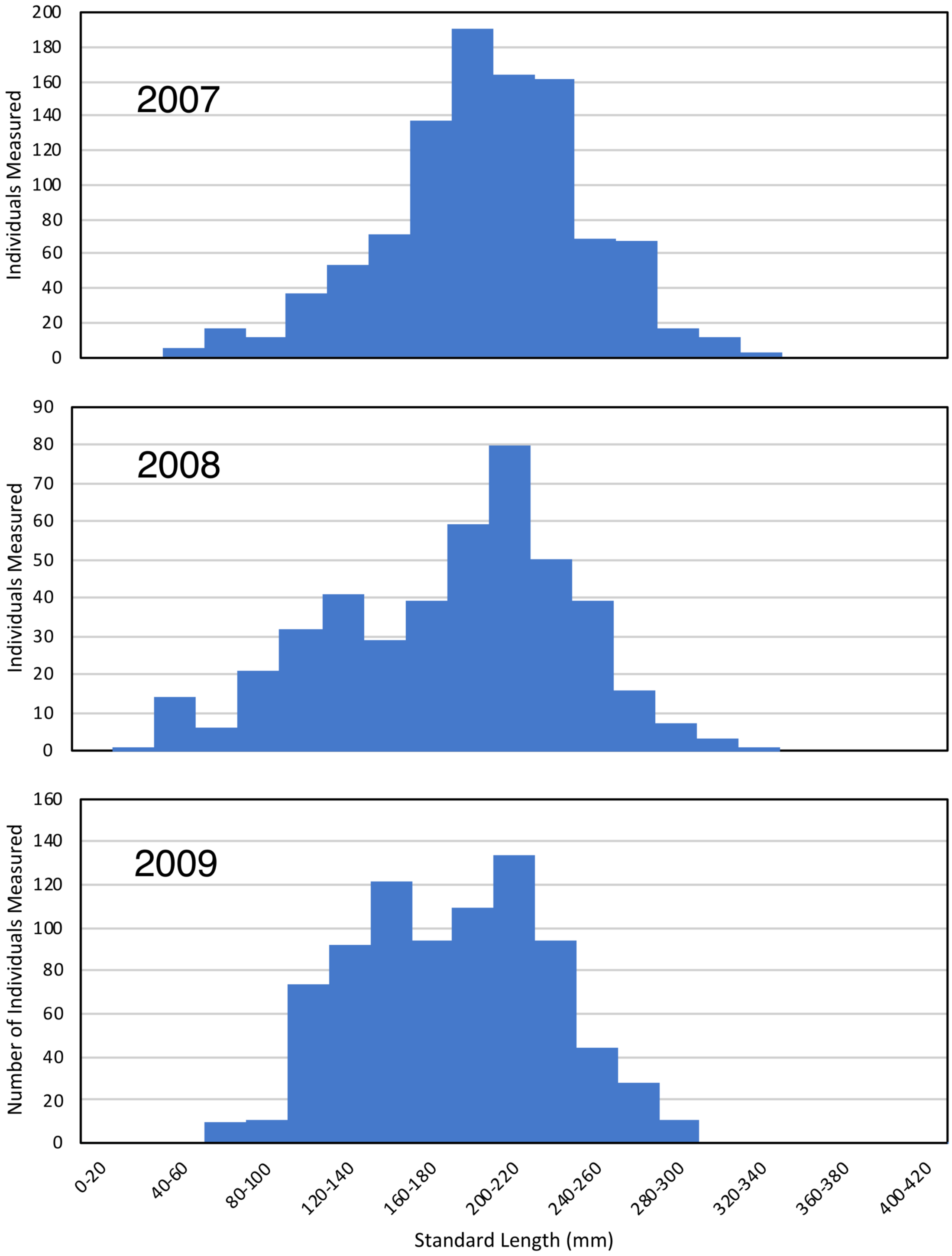
All of the stations other than the Head yielded similar catches, in number terms, when compared across the same strata. However, the sizes of fish taken differed. Sampled only in 2009 and 2010, the Slope Station yielded mostly smaller fish, dominated by the 150 mm mode (Figure 19), for an average standard length of 173 mm. In contrast, the Offshore Station (sampled only in 2007) produced mostly fish of the 200 mm mode, though the average length was similar to that on the Slope, at 179 mm. With catches from all four surveys, the Deep Station had both modes well represented and an average of the standard lengths of the catches of 175 mm. However, the catches taken on the Main Station contained fewer of the

150 mm mode, while the length-frequency of the catches taken there was biased towards larger sizes and the 200 mm mode. The average standard length of specimens taken on the Main Station was 197 mm. The Wall Station showed further diminution of smaller size-classes and the bias towards large fish, resulting in an average standard length of 208 mm.

With relative constancy of numbers caught (per set), the up-canyon decline in smaller *S. boa* was accompanied by a per-set increase, in absolute as well as relative terms, in the catch of larger (>150 mm) individuals. That trend meant that catches in weight terms increased up-canyon, despite the reduced numbers. The average catch of a 750 m set on the Deep Station was 22 individuals and 267 g (and on the Slope Station 29 of 287 g), whereas the Main Station yielded an average of 27 and 489 g taken by such sets and the Wall Station 29 and 543 g.

In marked contrast, catches of *S. boa* by 750 m sets on the Head Station averaged only 1.4 individuals of 32 g. They did tend to be large fish, however, the average standard length of those caught on the Head being 209 mm. The 250 m sets on that Station yielded smaller catches than those made to the same depth further down the canyon but did not show the order-of-magnitude reduction of the 750 m sets, indicating an elevation of the species' depth distribution in the upper canyon.

In summary, the distribution of *S. boa* and its length frequencies varied with all dimensions of the survey design: year, season, station, depth and, mildly, diel phase. That distribution was broadly in accord with prior expectations but added a marked up-canyon decline in small individuals and a corresponding increase in larger ones that extended as far as the Main and Wall stations but a very pronounced fall in catches from there to the Head Station. There was also a slight up-canyon elevation of the depth distribution, plus an apparent withdrawal from the canyon, especially by larger individuals, between August and March.


2007
Individuals Measured
200
180
160
140
120
100
80
60
40
20
0
2008
Individuals Measured
90
80
70
60
50
40
30
20
10
0
2009
Number of Individuals Measured
160
140
120
100
80
60
40
20
0
0-20
40-60
80-100
120-140
160-180
200-220
240-260
280-300
320-340
360-380
400-420
Standard Length (mm)

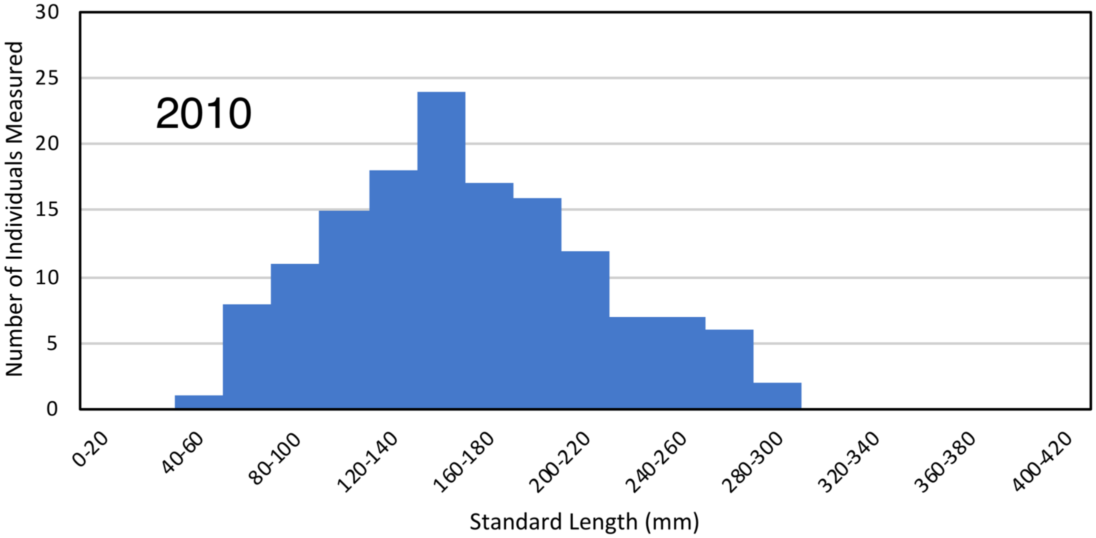
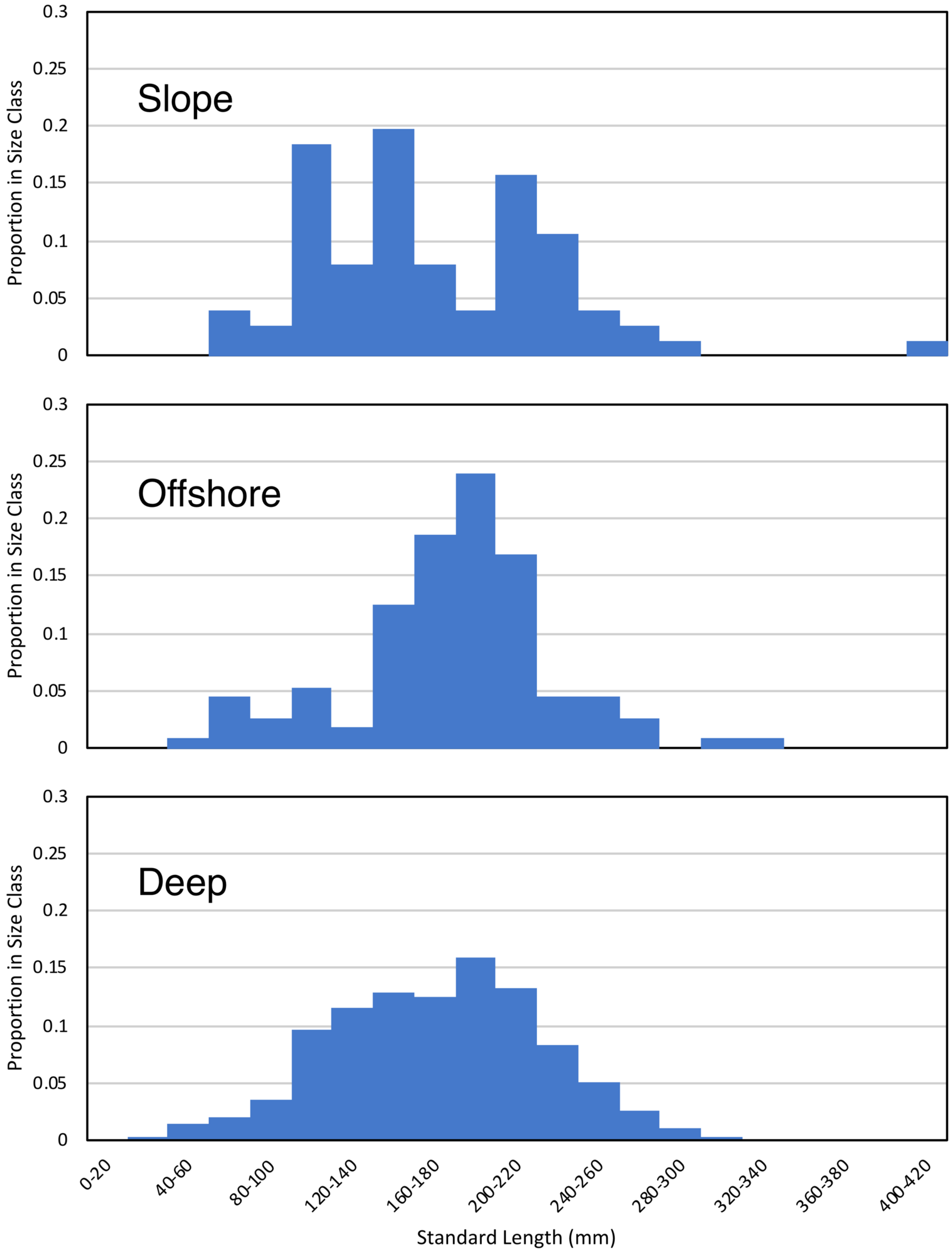


Figure 18 : Length frequencies of *Stomias boa* by survey, including all 2,277 measured individuals (Top left: 2007, Middle left: 2008, Bottom left: 2009, Above: 2010)


Slope
Offshore
Deep
Proportion in Size Class
0.3
0.25
0.2
0.15
0.1
0.05
0
0-20
40-60
80-100
120-140
160-180
200-220
240-260
280-300
320-340
360-380
400-420
Standard Length (mm)

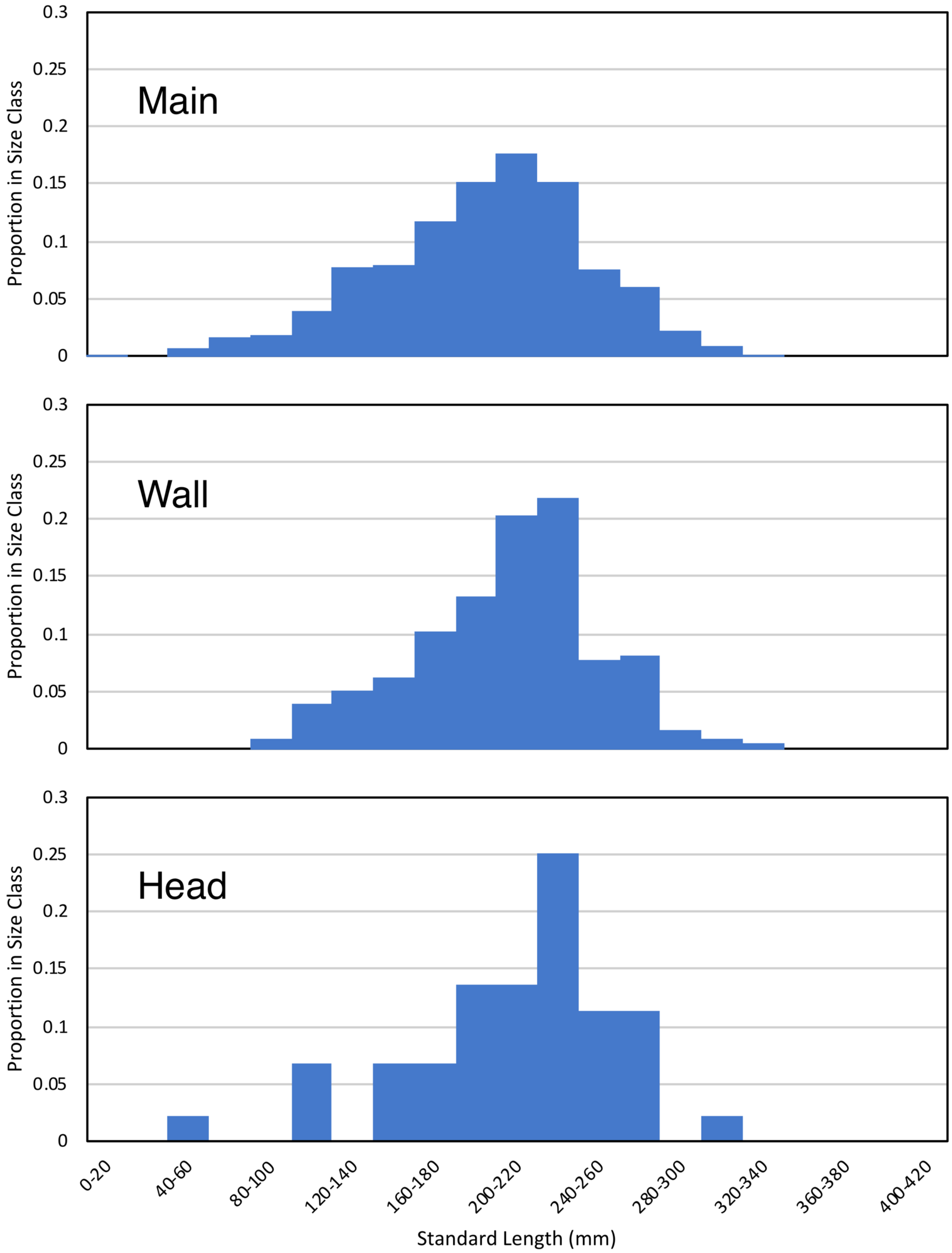


Figure 19 : Length frequencies of *Stomias boa* (shown as proportions of measured individuals) by station, including all 2,277 measured individuals (Top left: Slope Station; Middle left: Offshore Station; Bottom left: Deep Station; Top right: Main Station; Middle right: Wall Station; Bottom right: Head Station)

4.3.8 Arctozenus risso

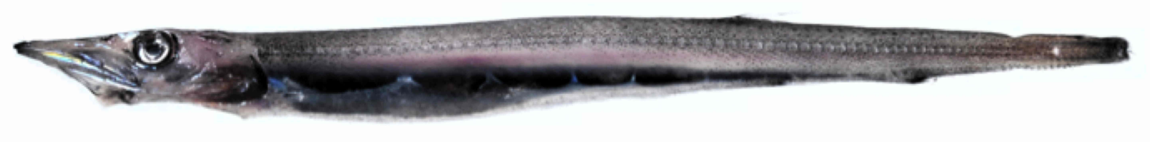


Figure 20 : *Arctozenus risso*, 118 mm SL, taken on the Deep Station by Set 2010_16

A. risso, formerly known as *Notolepis rissoi*, is currently seen as having a circumglobal, antitropical distribution which in the far north sometimes extends beyond Svalbard, into the Arctic Ocean (Dolgov 2013) – further north than any other species included in the present study, except for *B. glaciale*. However, recent genetic data suggest that there may be a specific distinction between the fish in the Atlantic and Pacific basins (Kenchington *et al.* 2017). In the western North Atlantic, *A. risso* is known from off Georgia to Greenland (Moore *et al.* 2003a; Møller *et al.* 2010) but is only highly abundant in the central portion of that range.

A. risso is the most common barracudina off New England (Moore *et al.* 2003a) and the single most abundant mesopelagic fish (myctophids and *Cyclothone* spp. excepted) south of Nova Scotia, where it occurs in Gulf Stream water and the WSW but is most abundant north of the shelf / slope boundary (Themelis and Halliday 2012). It is less dominant but still abundant in the Irminger Sea (Dolgov 2015: see Table 4). Although common over deep ocean, *A. risso* is especially abundant on the continental slope and in deep areas of the shelf. It has been recorded near the seabed in Baltimore and Norfolk canyons (Ross *et al.* 2015), where it was one of only five species common in all habitat types, and over the continental slope near Cape Hatteras, where it was abundant in both a midwater scattering layer and near-bottom aggregations (Gartner *et al.* 2008). The species is abundant on the continental slope of Georges Bank (Feagans-Bartow and Sutton 2014) and in the Gulf of Maine (Musick 1973). Curiously, Halliday *et al.* (2012) did not report it from the catches taken when bottom trawling on the Scotian Slope. 39 specimens of Paralepididae were taken but the only voucher specimen later identified to species proved to be *Magnisudis atlantica*. However, *A. risso* is very common in the deep continental-shelf valleys in the Gulf of St. Lawrence: the Laurentian, Esquiman and Anticosti channels (one of only two species in the present analyses that are taken in more than small numbers there, the other being *M. atlantica*: Nozères *et al.* 2010). It is one of the key species of the fish assemblage in those valleys (Chouinard and Dutil 2011), being taken by a majority of the bottom-trawl survey sets that fish below 300 m depth, as well as some shallower ones (Nozères *et al.* 2010).

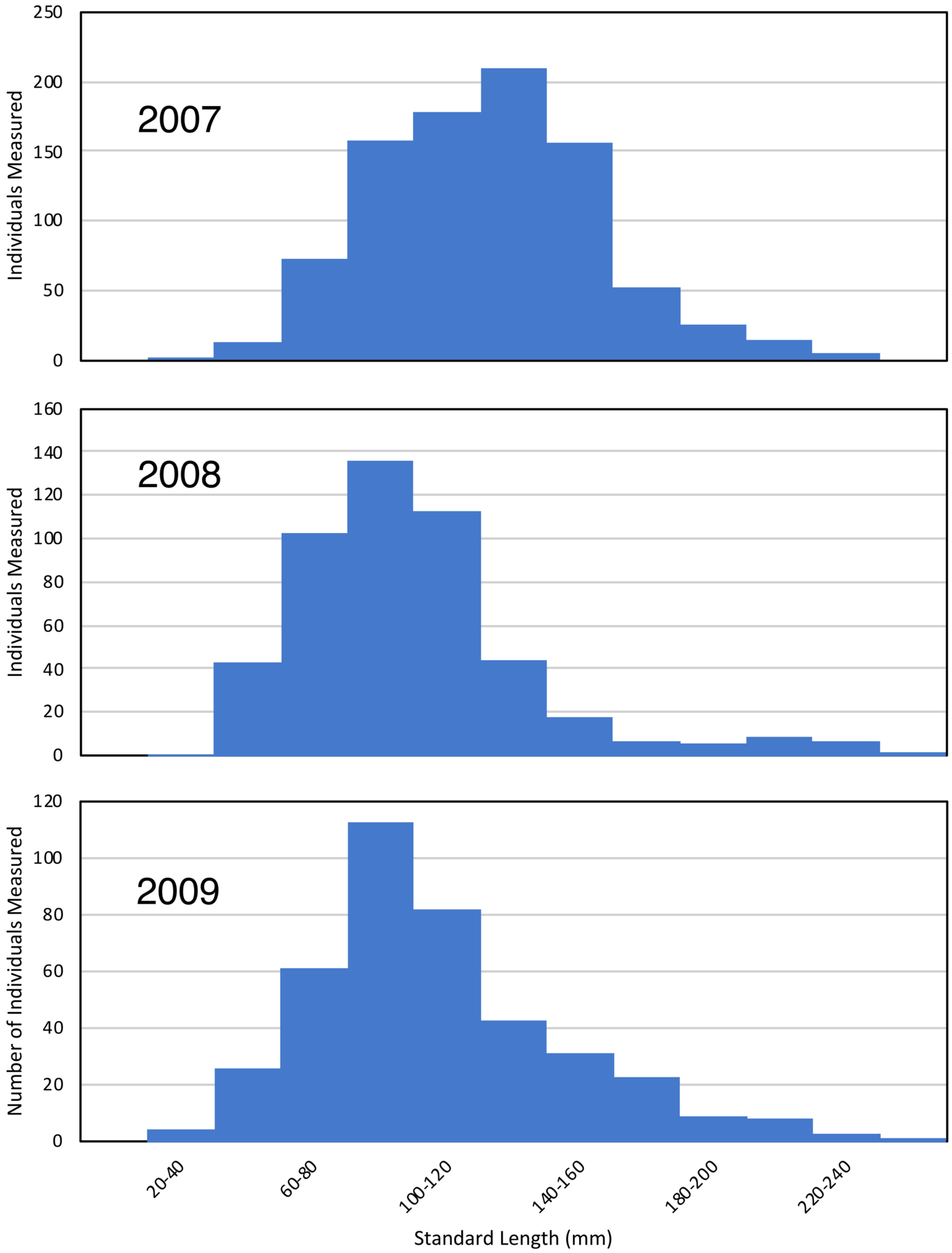
The southern margin of the Laurentian Channel has seen a long series of autumn surveys which, although limited to the fringe of the *A. risso* distribution, has given a unique temporal coverage. Those surveys detected a major increase in catches of *A. risso* and in the area occupied by the species from 1985 through to the mid-1990s, after which the higher levels were maintained into the new century (Benoît *et al.* 2003). A more extensive summer survey series began in 1990 and detected an expansion of the species' range through that decade, followed by a marked contraction into the 2000–05 period (McQuinn *et al.* 2012). Those temporal changes in *A. risso* coincided with variations in water temperatures in the Gulf of St. Lawrence, including a period of extreme cold in the core of the CIL during 1985–97 (though temperatures below 200 m were little affected: Drinkwater and Gilbert 2004), but also with the period of depression of exploited groundfish species, followed by considerable expansion of seal predation, with consequent changes across much of the ecosystem (e.g. Savenkoff *et al.* 2007a,b; Benoît and Swain 2008, Swain and Benoît 2015). The oceanographic characteristics of the deep inflow into the Laurentian Channel are also variable, driven by an exchange of water masses at its mouth between LSW and WSW overlying NACW, with consequences extending to severe hypoxia in the bottom waters of the St. Lawrence Estuary (Gilbert *et al.* 2005). Hence, the causes of the temporal trends in *A. risso* remain obscure.

In contrast to its abundance from Hatteras to the Gulf of St. Lawrence, *A. risso* is comparatively scarce off Newfoundland (McKelvie 1985), over the northern MAR (Sutton *et al.* 2008) and in the Irminger Sea (Dolgov 2015). Moore *et al.* (2003a) considered *A. risso* to be mesopelagic, most living between 200 and 1,000 m depth.

At least three modes were apparent in the length frequencies of *A. risso* taken by the Gully surveys, at around 60, 90 and 130 mm (Figures 21, 22). Mode III dominated in 2007, Mode II in both 2008 and 2009, but Mode I in 2010. The lack of evident progression suggests that the modes may not represent age-classes. The few specimens taken on the Slope Station emphasized Mode II, which was also dominant on the Offshore and Deep stations. In contrast, the Main Station had mainly Mode III fish, while the Wall and Head stations had length frequencies biased towards even larger sizes by a truncation of smaller individuals, analogous to those seen in some of the other species examined here.

The length frequencies differed little with depth, though the largest fish were not taken above 250 m depth (only a single individual of over 200 mm SL was taken by a 250 m set). On the Head and Wall stations, where small fish were scarce at any depth, that distinction drove a notable difference in average individual sizes between the catches of 250 m and 750 m sets (144 to 171 mm SL on the Head Station; 125 to 144 mm SL on the Wall Station), the former lacking large fish because of depth in the water column, the latter lacking small ones because of location.

Interpretation of the quantities of *A. risso* caught during the surveys (Tables 13A, B) is complicated not only by those variations in average individual sizes but also by a higher among-sets variability than was seen in most of the other species, suggestive of local patchiness in *A. risso*.


2007
2008
2009
Individuals Measured
Individuals Measured
Number of Individuals Measured
250
200
150
100
50
0
160
140
120
100
80
60
40
20
0
120
100
80
60
40
20
0
20-40
60-80
100-120
140-160
180-200
220-240
Standard Length (mm)

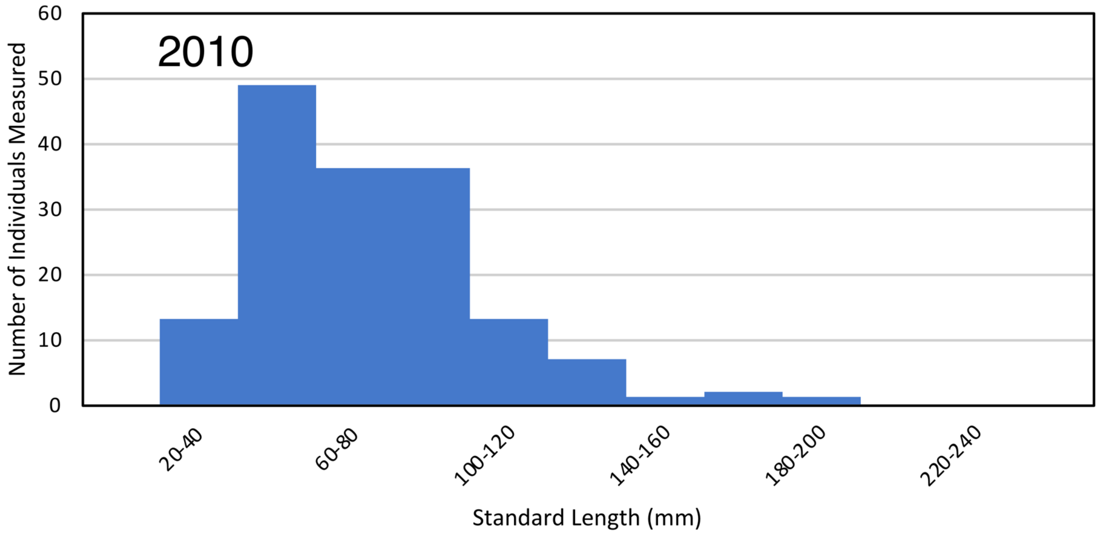
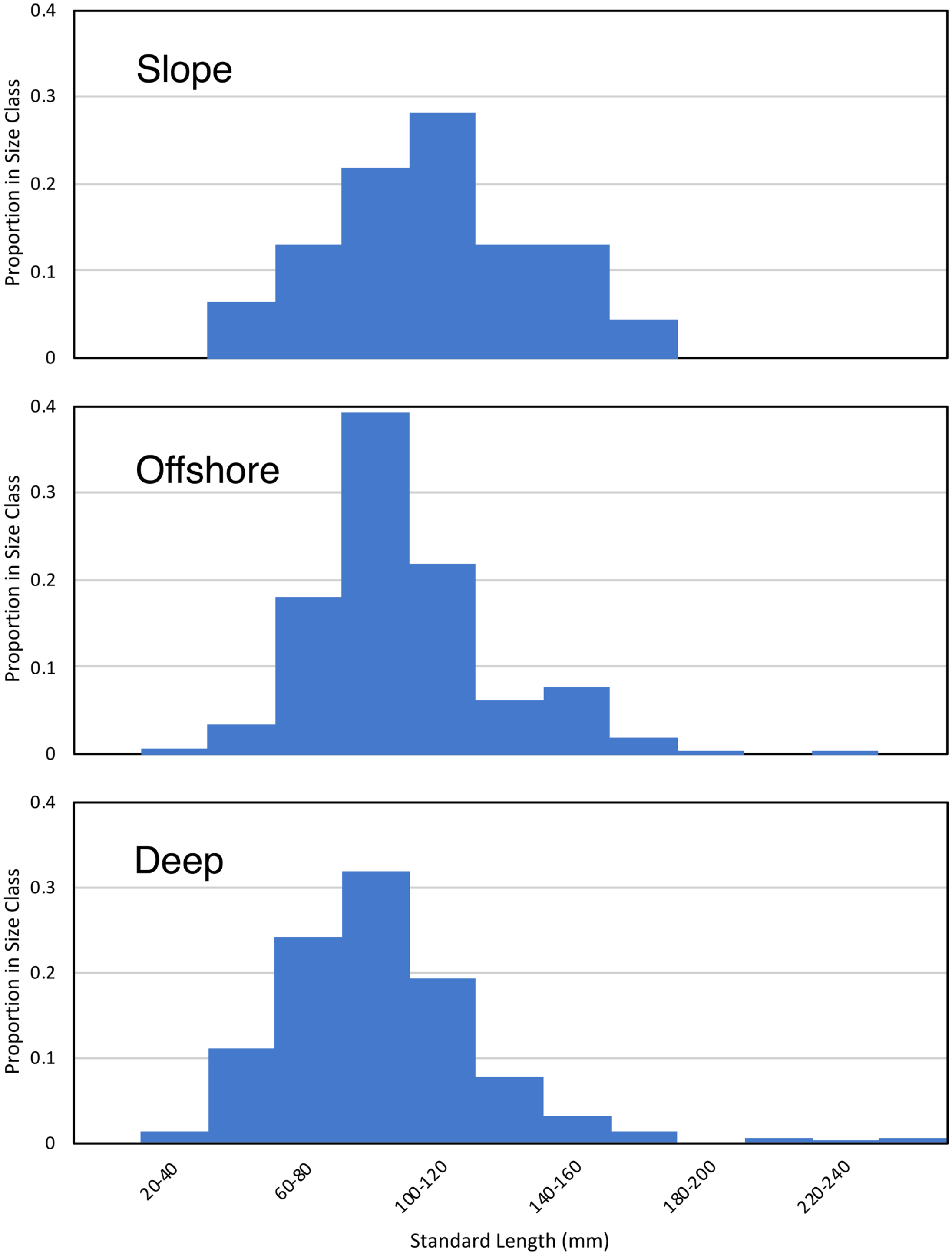


Figure 21 : Length frequencies of *Arctozenus risso* by survey, including all 1,924 measured individuals (Top left: 2007, Middle left: 2008, Bottom left: 2009, Above: 2010)

Almost all, maybe all without exception, *A. risso* were above 750 m depth throughout the diel cycle. Very few were taken above 250 m in daylight during either the 2008 or 2009 surveys but in 2007, when the CIL was strongly developed, and again in March 2010 not inconsiderable numbers were taken in daylight by shallow sets. At night, the numbers, and to a lesser extent the weights, caught by 250 m sets often exceeded those taken in the corresponding 750 m ones, not infrequently more than doubling the latter. Thus, most or perhaps all of the *A. risso* were then above 250 m depth but probably below 50 m, such that they were caught by all four legs of the “W” profiles of the shallow sets.

There was little sign of inter-annual variability in numbers caught during summer but the weights caught declined slowly from year to year. Catches were much lower in March 2010 than during the earlier surveys.

The highest average catches in 750 m sets, in number terms, were made on the Offshore Station, though that was only fished in 2007. From there, numbers declined up the canyon, with the Slope and Deep station yielding similar amounts, the Main rather less, less again on the Wall and fewer still on the Head Station. In contrast, the weights caught were highest on the Head Station, where the few individuals were large. Those declined down-canyon, with the Deep Station yielding less than the Slope, though the catches on the Offshore Station (confined to the relatively rich 2007) nearly equalled those on the Head.


Slope
Offshore
Deep
Proportion in Size Class
0
0.1
0.2
0.3
0.4
20-40
60-80
100-120
140-160
180-200
220-240
Standard Length (mm)

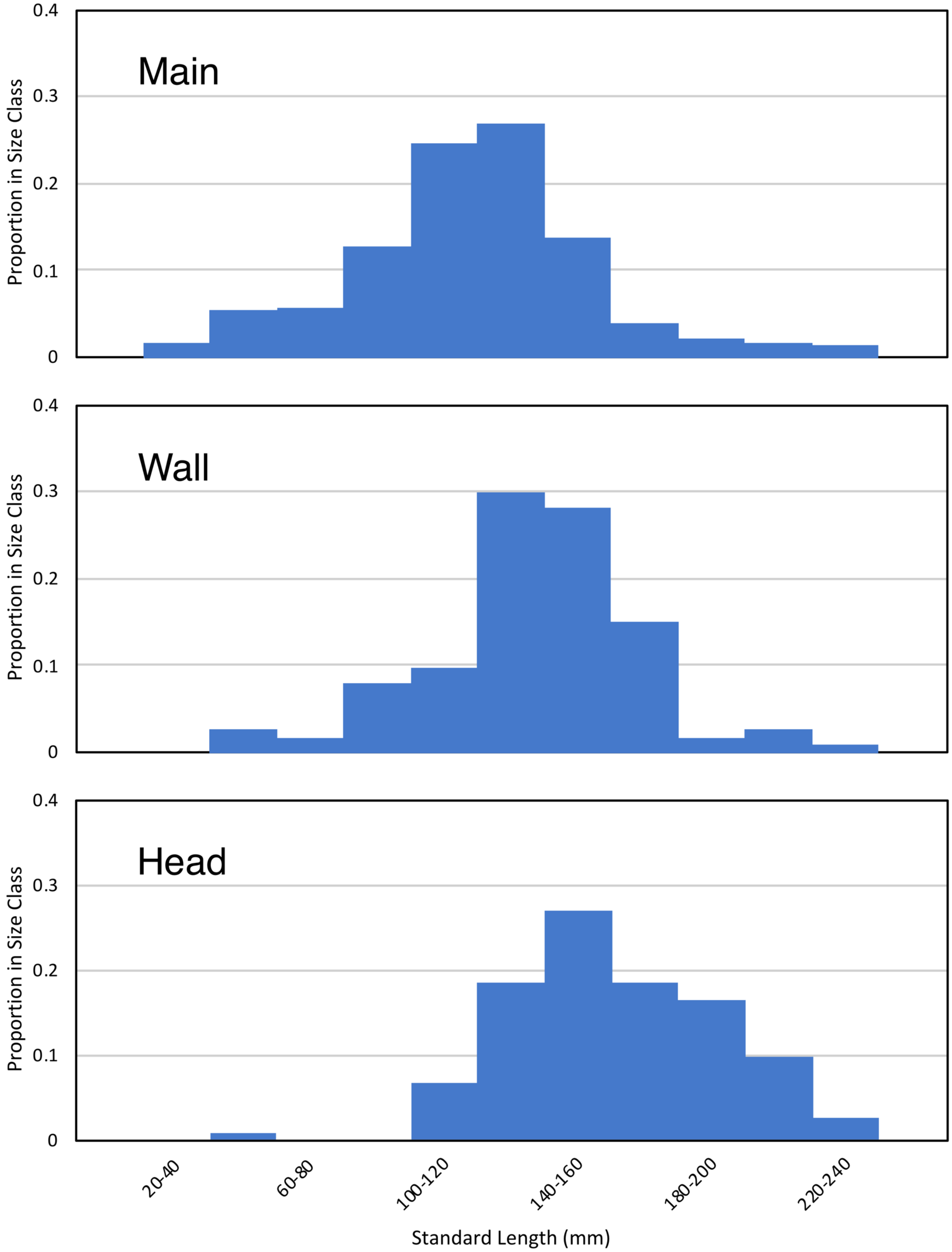


Figure 22 : Length frequencies of *Arctozenus risso* (shown as proportions of measured individuals) by station, including all 1,924 measured individuals (Top left: Slope Station; Middle left: Offshore Station; Bottom left: Deep Station; Top right: Main Station; Middle right: Wall Station; Bottom right: Head Station)

Table 13A : Arithmetic mean catches of *Arctozenus risso* in each cell of the survey design: numbers of individuals

Year:		**2007**		**2008**		**2009**		**2010**	
Month:		**Sept**		**Aug/Sept**		**Aug**		**March**	
Diel Phase:		**Day**	**Night**	**Day**	**Night**	**Day**	**Night**	**Day**	**Night**
Station	**Depth (m)**								
Head	**250**	7	5.33	0	1	0	1	0	0.5
	750	16	10.5	4.5	6	16.5	5	1	0
	Extra		4						
Main	**250**	10.67	43.33	0	15.5	1	12	4	8
	750	23.33	11	16	13	4	15	2.5	2.5
	1250	10.67	8.67	10.5	8	4	6.5	2	3
	Extra	10							
Wall	**250**	2	9				15		
	750	18.67	5			5	4		
Deep	**250**	0	11.5	1	66	0	82		11.67
	750	4	14	15	25.33		11	1	10
	1250	4	5	16.5	24	21	14.5		11.5
	1750				12		14	0	9
	Extra					10		3	
Slope	**750**					23		3	
Offshore	**250**	16	81						
	750	36	17						
	1250	25	31						
	Extra		19						

No valid IYGPT sets were made in the shaded cells.

The Gully catches of *A. risso* were broadly consistent with prior knowledge of the species, though with greater migration above 250 m at dusk than might have been expected. More surprisingly, although *A. risso* was very abundant in the catches from the Gully surveys (the fourth most abundant fish, excluding myctophids and *Cyclothone* spp.), it was proportionately less so than in Themelis and Halliday's (2012) surveys of the deep waters further south, despite it being a species that they primarily took north of the shelf / slope boundary. The prevalence of *A. risso* in the valleys of the Gulf of St. Lawrence was not reflected in The Gully, where numbers caught fell off sharply up-canyon, though an increase in the average individual size led to a reverse trend in weights caught. Those contrasts may result from geographic differences in distribution but they could be, in whole or in part, temporal. Themelis and Halliday's (2012) surveys were conducted during 1984–89, while numbers of *A. risso* were rising in the Gulf of St. Lawrence, whereas the Gully surveys were after the 2000–05 contraction in that area.

Table 13B : Arithmetic mean catches of *Arctozenus risso* in each cell of the survey design: weights caught (g)

Year:		**2007**		**2008**		**2009**		**2010**	
Month:		**Sept**		**Aug/Sept**		**Aug**		**March**	
Diel Phase:		**Day**	**Night**	**Day**	**Night**	**Day**	**Night**	**Day**	**Night**
Station	**Depth (m)**								
Head	**250**	28	17.67	0	14.875	0	7	0	0.5
	750	119.33	67.5	41.675	78.1	139	45	9.5	0
	Extra		16.5						
Main	**250**	33.567	103.33	0	44.4	2	20.5	2	5
	750	100.867	44.133	60.75	23.675	22.33	30	3	3.5
	1250	32	39.767	47.825	13.45	19	17	1	1
	Extra	13							
Wall	**250**	10	31.9				30		
	750	92.867	34.75			47	15.5		
Deep	**250**	0	83.7	0.25	71.325	0	98		9
	750	10	19.45	15.7	51.67		10.5	1	12
	1250	9	13.55	12.575	30.9167	51.5	20		9
	1750				15.5		32.775	0	4
	Extra					24		1	
Slope	**750**					56		9	
Offshore	**250**	25	82						
	750	90	37.2						
	1250	55	47						
	Extra		31.2						

No valid IYGPT sets were made in the shaded cells.

4.3.9 Benthosema glaciale

Figure 23 : *Benthosema glaciale*, 70 mm SL, taken on the Head Station by Set 2008_27

B. glaciale is the dominant myctophid of the North Atlantic subpolar gyre. As such, it has been studied more intensively than any of the other species included in the present analyses. In the west, it is found from Cape Hatteras to the Davis Strait and Greenland (Sameoto 1989; Moore *et al.* 2003a; Møller *et al.* 2010). In the northeast, its range extends to the Barents Sea and even into the Kara Sea (Dolgov 2013), making it the most northerly of the species examined here, along with *A. risso*. A distinct population, formerly considered a separate subspecies, occurs in the Mediterranean and in the Atlantic off North Africa. A recent genetic study found indications of multiple, finer-scale genetic lineages within *B. glaciale*, though their taxonomic implications remain unclear (Kenchington *et al.* 2017).

As a species of the subpolar gyre, in the northwest Atlantic *B. glaciale* is especially abundant north of the WSW (see Table 4), though Jahn and Backus (1976) also found it the second most abundant in their catches from WSW. It has been seen in a deep scattering layer off Cape Hatteras (Gartner *et al.* 2008). It was the single most abundant fish in IYGPT catches over the continental slope of Georges Bank, exceeding all other species combined in number, though only ranked third by weight (Feagans-Bartow and Sutton 2014). Musick (1973) reported hundreds from the Gulf of Maine. *B. glaciale* dominates the deep-pelagic assemblage south of Nova Scotia, being first in abundance (*Cyclothone* spp. excepted) north of the shelf / slope boundary and third in the WSW (Themelis and Halliday 2012). It was also the principal myctophid in bottom-trawl catches taken on the Scotian Slope, though the available data on those were compromised by incomplete identifications (Halliday *et al.* 2012). In Bay d'Espoir, on the south coast of Newfoundland, it was second only to *M. atlanticum* in midwater catches (Richard 1987). Further to the east, McKelvie (1985) took far more *B. glaciale* than all other mesopelagic fish species combined. The species is no less dominant, in numbers, over the northern MAR (Sutton *et al.* 2008, 2013) and in the Irminger Sea (Dolgov 2015), though it was only the third most abundant myctophid in one study on Flemish Cap (Bañòn Díaz *et al.* 2001).

Along the edge of the Scotian Shelf, between April and July, *B. glaciale* are concentrated between 350 and 450 m depth in daylight, though some can be found from 25 to 950 m. At night, almost all rise to above 200 m, while they concentrate around 30 m depth (Sameoto 1988) – in the presence of a research ship but perhaps shallower without that intrusion. In October, however, a large proportion of the population remain at depth throughout the diel cycle (Sameoto 1988). In the northeast Atlantic, Roe and Badcock (1984) found a shallower daylight depth distribution, with most of the fish between 200 and 300 m but the same upward migration at dusk to depths of less than 100 m, some reaching the sea surface.

Off Nova Scotia, *B. glaciale* spawns in winter or early spring, the highest proportion of ripe ovaries being found during December to February. Larvae have been taken along the edge of the continental shelf (and as far to the southwest as Cape Hatteras) in April to June. Metamorphosis occurs at about 12 mm. By August, the young-of-the-year have a modal length around 18 mm, growing to 25 mm by December and 37 mm by the following August, at Age 1 (Halliday 1970; Halliday *et al.* 2015). Halliday (1970) found the modal length of Age 2 *B. glaciale* to be 44.5 mm in summer and the very few Age 4 individuals in his aged sample to be between 50 and 60 mm. García-Seoane *et al.* (2015) found a similar growth rate on Flemish Cap, the average individual passing 50 mm at about Age 3. Yet, *B. glaciale* length frequencies there show a mode at 50–60 mm in June / July (García-Seoane *et al.* 2015) – a latter mode which thus appears to represent an accumulation of year-classes from Age 3 upwards. A small proportion of the fish may be able to survive for several years. On Flemish Cap, counts of as many as seven otolith annuli (suspected of representing annual marks) have been reported (García-Seoane *et al.* 2015).

B. glaciale seems to produce very small numbers of comparatively large (though not necessarily old) individuals, exceeding 80 mm and outside the norm for the species. The maximum standard length yet reported, from a Norwegian specimen, was 98.5 mm after fixation, estimated to correspond to 103 mm when fresh (Gjösæter 1973a; Halliday *et al*. 2015).

Female *B. glaciale* off Nova Scotia reach 50% maturity at about 40 mm standard length, while 50% of males develop their luminous caudal glands, indicative of sexual maturity, by the time they reach 28 mm (Halliday *et al.* 2015). The two sexes appear to have similar growth rates (García-Seoane *et al.* 2015).

Various studies of the diet of *B. glaciale* have been undertaken. Off Nova Scotia, the recognizable stomach contents (which may exclude some key prey types) are dominated by calanoid copepods, notably the small *Metridia* spp. and the deep-migrating *Pleuromamma* spp., while much of the rest is small euphausiids (especially *Thysanoessa* spp.). The remainder includes hyperiid amphipods (*Themisto* spp.) and other small crustaceans (Halliday *et al.* 2015). Their diets east of Newfoundland, over the MAR, in the northeast Atlantic and in Norwegian fjords are all broadly similar (Gjösæter 1973b; Roe and Badcock 1984; García-Seoane *et al.* 2013; Pepin 2013; Hudson *et al.* 2014). Sameoto (1988) found their feeding opportunistic, in that various prey were represented in their stomachs in proportion to abundances at the depths where the *B. glaciale* were taken. In contrast, Roe and Badcock (1984) found evidence of elective feeding in the northeast Atlantic. In both studies, *B. glaciale* were found to have fed mostly at night, near the surface, but also at depth by day.

In The Gully, *B. glaciale* dominated the mesopelagic ichthyofauna in both biomass and (*Cyclothone* spp. aside) numbers (Tables 14A, B). This one species constituted two-thirds of the non-*Cyclothone* fish caught and nearly a quarter of the fish biomass.

The very high number of individuals measured allows closer examination of the lengths of *B. glaciale* than is possible for the other species considered here. The length frequencies were shaped by the presence of three modes, centred on 20–25, 35–45 and 50–60 mm in summer but in March 2010 six months of growth had changed the lengths of the first two to 25–35 and 40–45 mm, respectively, while the largest mode remained unchanged (Figure 24). By comparison with the ageing studies of Halliday (1970), García-Seoane *et al.* (2015) and Halliday *et al.* (2015), the first summer mode corresponds to Age 0 fish, which are one year old at 25–35 mm in March. Likewise, the summer mode at 35–45 mm represents Age 1 fish, which grown to 40–45 mm by the following spring, by then Age 2. As on Flemish Cap (García-Seoane *et al.* 2015), the largest mode appears to represent an accumulation of Age 3 and older individuals.

The minimum length of a *B. glaciale* recorded during the Gully surveys was 12 mm, equal to the length at metamorphosis (Halliday 1970). The largest specimen from The Gully, at 91 mm SL, was exceptional for its species but well below the reported maximum (see Gjösæter 1973a).

In summer, the relative frequencies of the three modes varied inter-annually. The 40–45 mm mode was always predominant and, in 2009, it so dominated the catch by every set, other than those made on the Head Station, that the other modes were rarely apparent, though fish of the relevant lengths were present. In 2007 and 2008, however, that principal mode was less dominant, though it was apparent in the data from almost every set. Since the sets that took exceptionally high catches tended to be those with a greater emphasis on that 40–45 mm mode, it was even more prominent after expansion for subsampling than in the length measurements themselves.

The 50–60 mm mode was weaker than that at 35–45 mm and often less well defined. It was nevertheless seen in the catches of most sets in 2007, though more intermittent in 2008 and usually masked by the prevalence of the smaller mode in 2009. That steady decline in its prominence was consistent with there having been better recruitment of the 2004 year-class than of subsequent ones. Conversely, young-of-the-year were relatively more prominent in 2008, which would have contributed to increased numbers in the 40–45 mm mode in 2009, reducing the relative proportion of larger individuals.

Table 14A : Arithmetic mean catches of *Benthosema glaciale* in each cell of the survey design: numbers of individuals

Year:		**2007**		**2008**		**2009**		**2010**	
Month:		**Sept**		**Aug/Sept**		**Aug**		**March**	
Diel Phase:		**Day**	**Night**	**Day**	**Night**	**Day**	**Night**	**Day**	**Night**
Station	**Depth (m)**								
Head	**250**	0	35	0	8	1	7.5	15	16
	750	119	109.5	40	21	37	79	1.5	4
	Extra	▨	342	▨	▨	▨	▨	▨	▨
Main	**250**	21.33	729.5	53	760	23	613	1	595.5
	750	471	651.67	228.5	847	690	502	215.5	310
	1250	515	351	241.5	210	347	661	145	218
	Extra	700	▨	▨	▨	▨	▨	▨	▨
Wall	**250**	1	127.5	▨	▨	▨	639	▨	▨
	750	375.67	286.5	▨	▨		445.5	▨	▨
Deep	**250**	0	260.5	10	384.5	31	678	▨	293.67
	750	362.5	548.5	185.5	393.67	▨	350	249	356
	1250	252.5	603.5	238	529.67	437.5	683	▨	295
	1750	▨	▨	▨	231	▨	706.5	271	764
	Extra	▨	▨	▨	▨	462		192	
Slope	**750**	▨	▨	▨	▨	339	▨	94	▨
Offshore	**250**	2	438	▨	▨	▨	▨	▨	▨
	750			▨	▨	▨	▨	▨	▨
	1250	267	955	▨	▨	▨	▨	▨	▨
	Extra	▨	347	▨	▨	▨	▨	▨	▨

No valid IYGPT sets were made in the shaded cells. Blank cells indicate missing data

Table 14B : Arithmetic mean catches of *Benthosema glaciale* in each cell of the survey design: weights caught (g)

Year:		2007		2008		2009		2010	
Month:		Sept		Aug/Sept		Aug		March	
Diel Phase:		Day	Night	Day	Night	Day	Night	Day	Night
Station	Depth (m)								
Head	**250**	0	29.733	0	5.7	1	14.5	5	11
	750	189.33	109.1	72.725	42.3	112	166	2	9.5
	Extra		430.1						
Main	**250**	29	715.567	31.3	889.5	20	721.5	1	396.5
	750	872.33	829.067	379	967	483.67	654.5	164.5	236
	1250	1091	605.733	364.35	560	653	1020.5	118	187.5
	Extra	1172							
Wall	**250**	0.6	97				544		
	750	533	318.5			343	477.5		
Deep	**250**	0	235.3	24.3	436	33	637		195
	750	531	515.8	361	525		392.5	292	313.5
	1250	431.5	649.8	478.5	672.6	692.5	936		235.5
	1750				399		978.5	261.5	747.5
	Extra					736.5		256	
Slope	**750**					539		119	
Offshore	**250**	1	399						
	750	705	976.7						
	1250	706	865						
	Extra		731						

No valid IYGPT sets were made in the shaded cells.

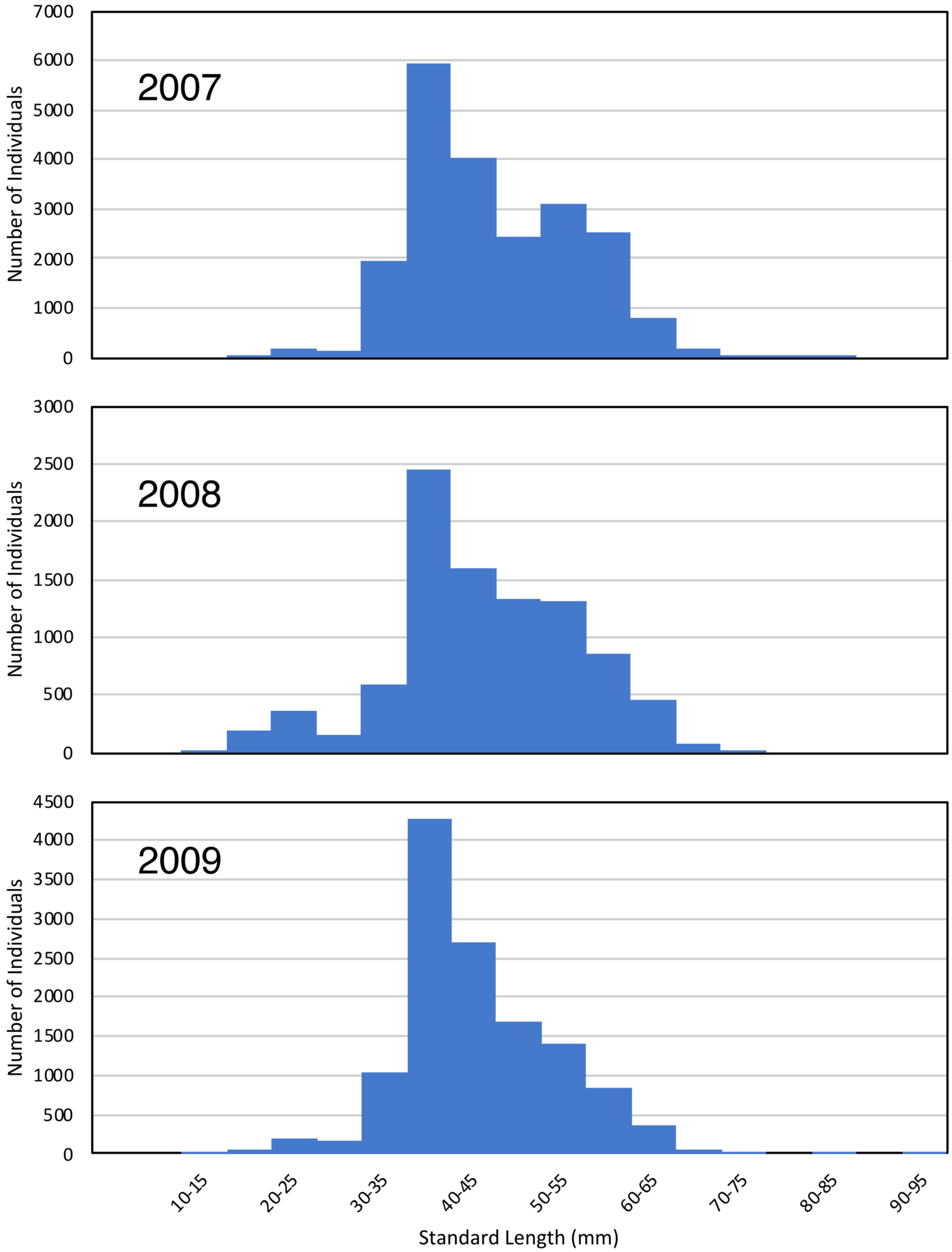
In marked contrast, the 20–25 mm mode, representing young-of-the-year was weak in summer. Halliday *et al.* (2015) found that such small *B. glaciale* had low vulnerability to IYGPT nets in daylight but they took many at night. That pattern was not apparent in the catches of the present program. Rather, in each of the first two summer surveys, the number of 20–25 mm fish caught was more than an order-of-magnitude less than the number of 35–45 mm individuals the following year, while the 2009 catch was an even smaller proportion of the numbers of the same fish taken the following March. Thus, it appears that only a few of the young-of-the-year are in the vicinity of The Gully during August / September and that they move into that area over the following months. In 2007, this 20–25 mm mode was absent from the Main Station and almost so on the Wall, though just discernable in the catches from the Head Station. In 2008, it was seen on the Deep and Main stations but was represented by only a single individual on the Head Station. In 2009, it was only weakly detectable but was present on every station.

The relative proportions of the three modes varied with season, the year-old fish (25–35 mm mode) dominating in spring. The two modes of larger individuals were present but in much reduced numbers, in both relative and absolute terms.

There was little difference in those proportions between the stations in summer (other than ones attributable to inter-annual change for the stations not sampled every year), except for the Head Station, where the length frequencies were biased towards larger fish (Figure 25). That pattern did not persist in March 2010, when the 25–35 mm mode was equally prevalent on the Deep, Main and Head stations. The proportions of the three modes also showed little dependence on the maximum depth reached by each set – as expected for a species with a comparatively shallow depth distribution.

In summer, the 50–60 mm mode was markedly more prominent in the catches of daylight sets than in those taken at night (Figures 26, 27). Halliday *et al.* (2015) found a similar deficit in numbers of larger individuals of *B. glaciale* in their standard night sets (which followed a stepped-oblique profile, with a maximum depth of 200 m). It is possible that the fish have more effective net-avoidance behaviour at night but more probable that the reduced catches at night result from the depth distribution of the large individuals – either remaining below 250 m or else migrating upward at dusk to depths so close to the surface as to be invulnerable to trawls.

There was certainly a particular nocturnal scarcity of large, trawl-vulnerable individuals taken above 250 m depth (Figure 28), consistent with some larger *B. glaciale* remaining at 250–750 m depths throughout the diel cycle – which has been previously suggested for this species (e.g. Sameoto 1988; Kaartvedt *et al.* 2009; Dypvik *et al.* 2012a,b). However, the sets which fished those depths still showed the diel variation in the proportion of 50–60 mm mode individuals (Figure 27). Thus, it seems that some larger *B. glaciale* successfully avoid the IYGPT at night, whether by being too near the sea surface or by active evasion remains unclear.


2007
2008
2009
Number of Individuals
0
1000
2000
3000
4000
5000
6000
7000
0
500
1000
1500
2000
2500
3000
0
500
1000
1500
2000
2500
3000
3500
4000
4500
10-15
20-25
30-35
40-45
50-55
60-65
70-75
80-85
90-95
Standard Length (mm)

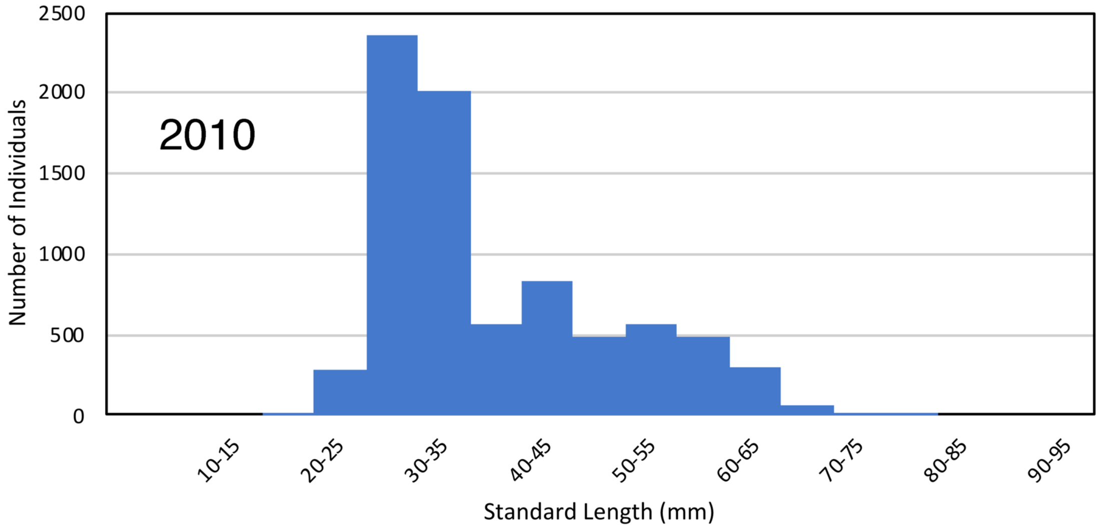
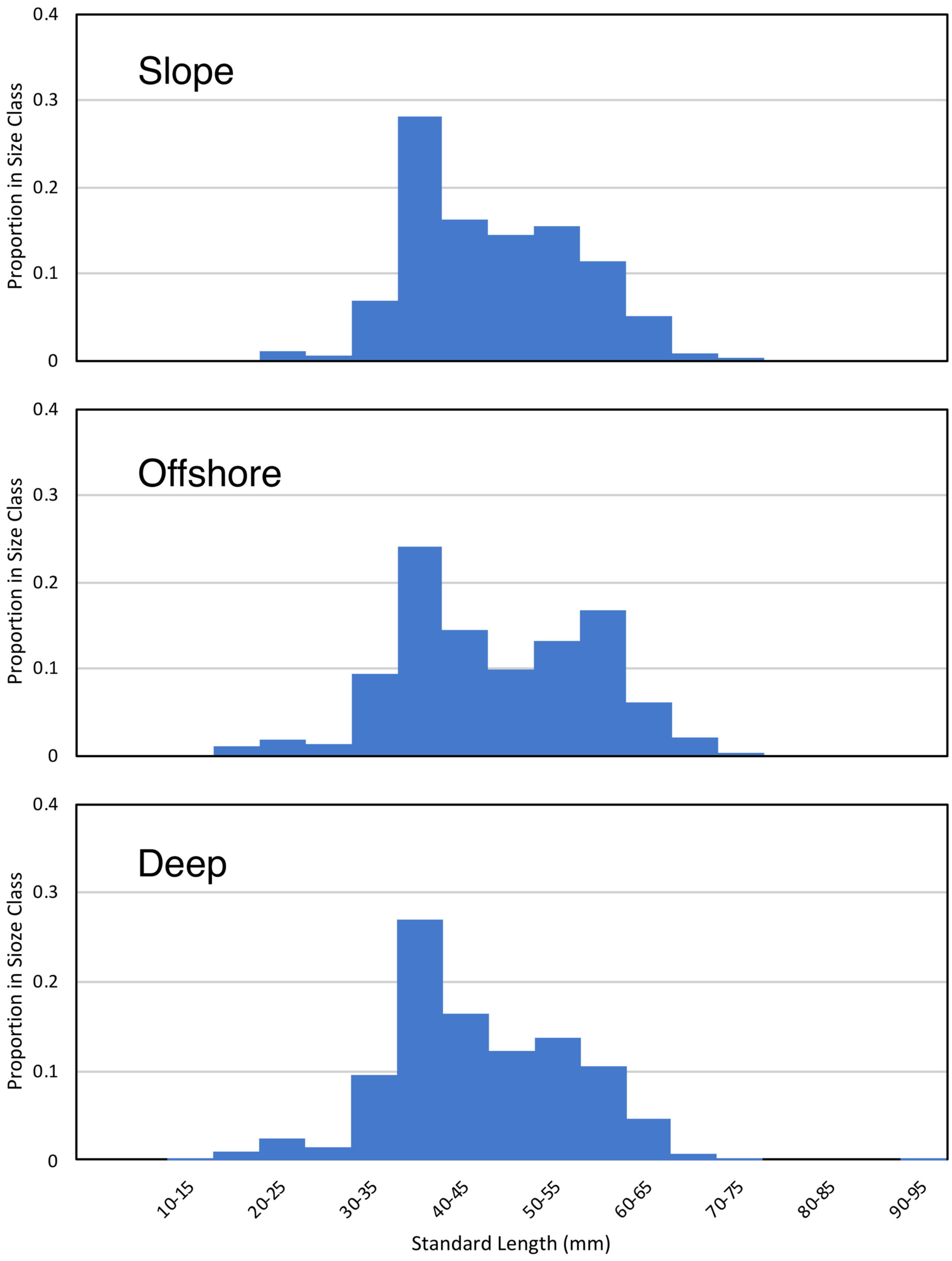


Figure 24 : Length frequencies of *Benthosema glaciale* by survey, including 51,404 individual lengths, after expansion for subsampling of the 25,410 measurements recorded (Top left: 2007; Middle left: 2008; Bottom left: 2009; Above: March 2010)

Since few *B. glaciale* were taken above 250 m in daylight, the nocturnal deficit in 50–60 mm fish was confounded with a lack of them in the catches of shallow sets in summer. Conversely, there was no such depth-related difference in length frequencies in March 2010. In summer, echosounders showed the migratory deep scattering layer (assumed to represent primarily the biomass-dominant *B. glaciale*) passing through the CIL at dusk, without noticeable change in its rate of ascent. During the spring survey, however, the scattering layer was observed to halt its upward migration beneath the CIL (Kenchington *et al.* 2014b), where all of the migrants would be vulnerable to midwater trawls.

There was a further, finer-scale, component to the variation in the relative proportions of the three length modes, however, as they differed between replicate sets within the same cell of the survey design. The data appear consistent with a model in which the fish tended to aggregate with conspecifics of similar size (most aggregations matching one or another mode), while the IYGPT chanced to encounter a mix of aggregations characterized by various individual sizes. In effect, the length measurements from each set were not of approximately 200 randomly-selected individuals but of representatives of perhaps a dozen aggregations, those low degrees of freedom leading to instabilities in the length frequencies.


Slope
Offshore
Deep
Proportion in Size Class
Proportion in Size Class
Proportion in Sioze Class
0.4
0.3
0.2
0.1
0
10-15
20-25
30-35
40-45
50-55
60-65
70-75
80-85
90-95
Standard Length (mm)

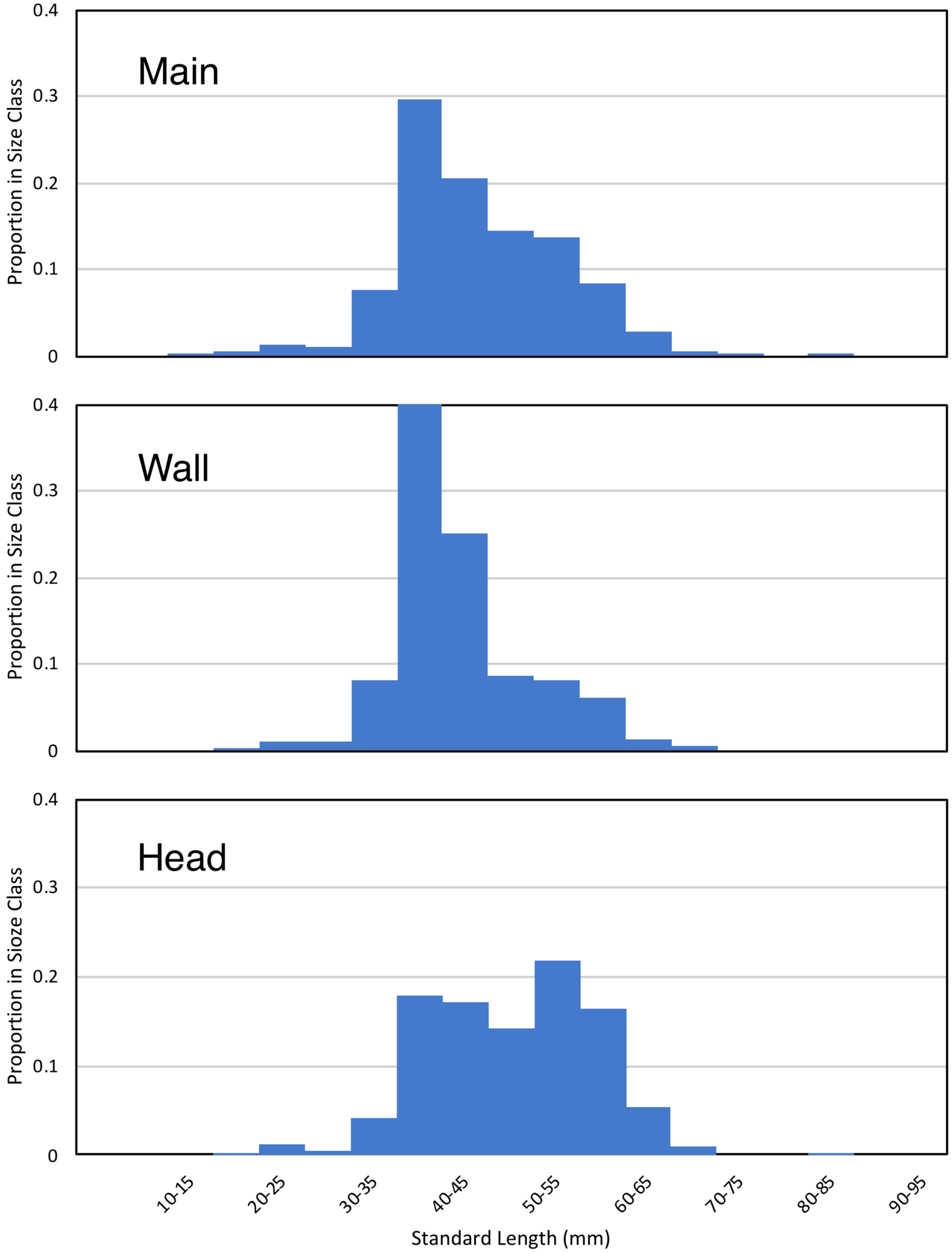


Figure 25 : Length frequencies of *Benthosema glaciale* taken in summer (after expansion for subsampling and shown as proportions) by station (Top left: Slope Station; Middle left: Offshore Station; Bottom left: Deep Station; Top right: Main Station; Middle right: Wall Station; Bottom right: Head Station)

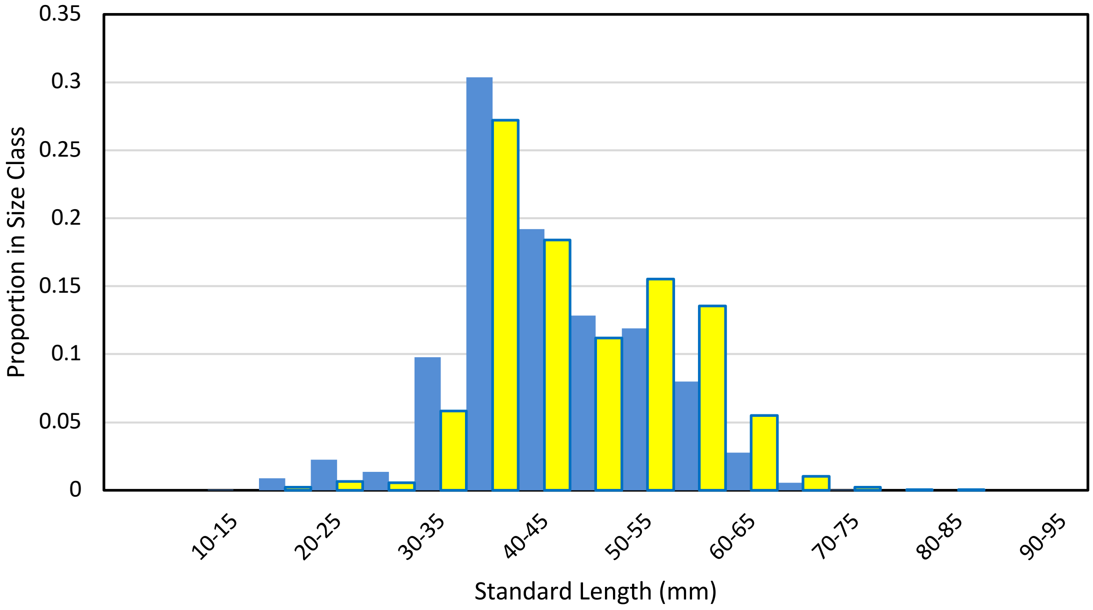


Figure 26 : Length frequencies of *Benthosema glaciale* taken in summer, including data from all sets (after expansion for subsampling and shown as proportions), by diel phase (Blue: Night; Yellow: Daylight)

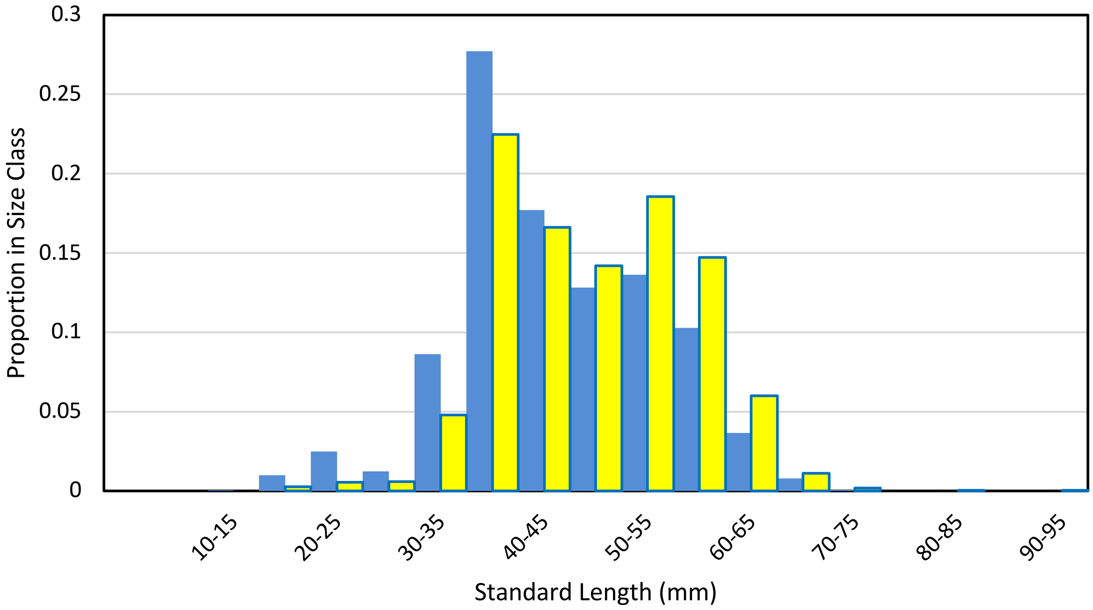
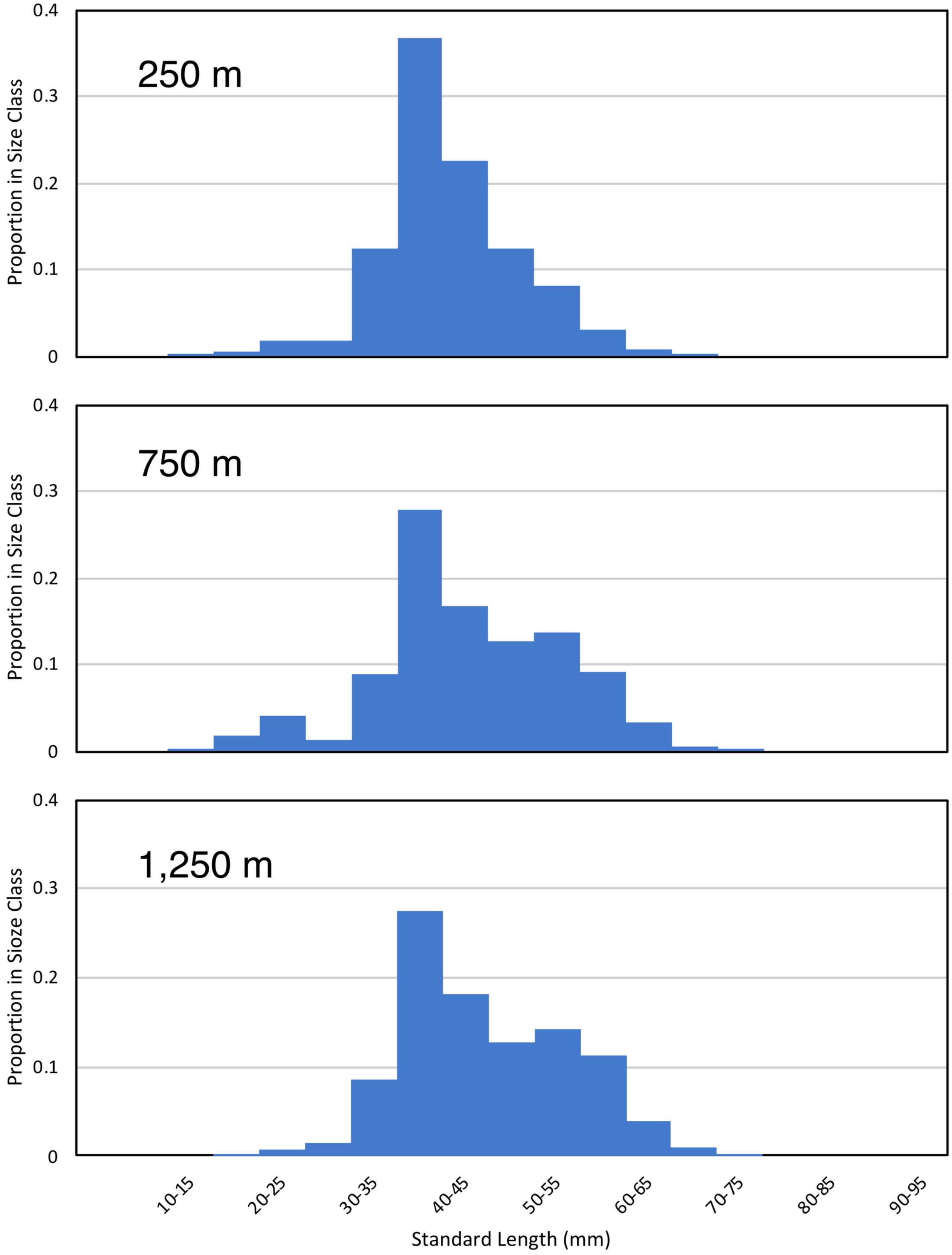


Figure 27 : Length frequencies of *Benthosema glaciale* taken in summer, including data only from sets which fished deeper than 250 m (after expansion for subsampling and shown as proportions), by diel phase (Blue: Night; Yellow: Daylight)

Those complex spatio-temporal variations in the size composition of the *B. glaciale* taken by the surveys complicate interpretation of the magnitude of the catches (Tables 14A, B), which usually reflected only the dominant size mode. Hence, the diel cycle in catches of larger fish was lost amongst the more numerous, smaller individuals, leaving very little diel variation in either numbers or weights caught. Vertical migration was, however, very evident, with the catches of 250 m sets at night being comparable to those of deeper sets, whereas the shallow daylight sets caught few *B. glaciale* (the single largest catch in the latter group was 52 individuals, weighing 73 g – half being between 40 and 50 mm standard length). With the open IYGPT it is not possible to be certain but there was little indication that many, if any, *B. glaciale* were taken below 750 m. On most stations, all of them may have been above 250 m at night but, on the Head Station, most remained below that depth throughout the diel cycle in the summer. In March 2010, in contrast, the few *B. glaciale* present on that Station appeared to remain above 250 m depth throughout the cycle.

Overall, catches were broadly similar across the Main, Deep and Offshore stations, somewhat lower on the Wall Station than the adjacent Main, but very much lower on the Head Station. Catches were also broadly similar across the three summer surveys. March 2010 saw catches that were perhaps a little lower than in summer on the Deep Station, substantially so on the Main Station and very low on the Head Station. The Slope Station was only fished in August 2009 and March 2010, with a total of only three sets made there. During each survey, they took about half as many *B. glaciale* as equivalent sets on the Main Station but there were relatively more large individuals, such that the per-set weight caught in 2009 was similar to that on the Main and Deep stations. Whether those observations were of anything more than transient variations of the fish present at the time of the few sets remains unknown.

The up-canyon loss of smaller individuals, seen in several other species, was not strongly evident in the data on *B. glaciale* but was present in summer. It can be seen in the length frequencies (Figure 25) but was most marked in the numbers of individuals with standard lengths of ≤30 mm caught. Excluding daylight 250 m sets (which took few *B. glaciale* but represented a higher proportion of all sets on shallower stations), the per-set average for the summer surveys was 20 small fish on the Deep Station, 13 on the Main, 11 on the Wall but only 1.5 on the Head Station. In 2009, the Head Station catches contained only two measured individuals (2.14 after expansion for sampling) of ≤30 mm and even the 35–40 mm mode, so dominant elsewhere, was thinly represented, such that the 50–60 mm mode predominated. In marked contrast, in March 2010 the 25–30 mm size-class comprised the same 30% of the catches on the Head Station that it did of the much larger ones taken on the Deep and Main stations.


0.4
0.3
0.2
0.1
0
Proportion in Size Class
250 m
750 m
Proportion in Sioze Class
1,250 m
10-15
20-25
30-35
40-45
50-55
60-65
70-75
80-85
90-95
Standard Length (mm)

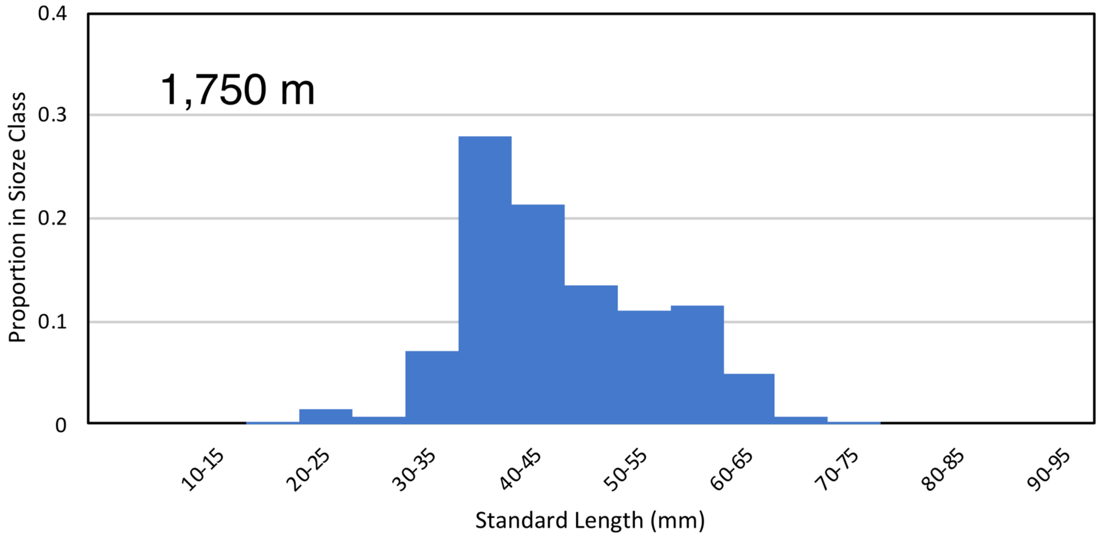


Figure 28 : Length frequencies of *Benthosema glaciale* taken at night in summer (after expansion for subsampling and shown as proportions), by nominal depth of set (Top left: 250 m sets; Middle left: 750 m sets; Bottom left: 1,250 m sets; Above: 1,750 m sets)

In summary, the catches of *B. glaciale* in The Gully were generally consistent with prior knowledge of the species. As expected for waters north of the shelf / slope boundary, it dominated the pelagic ichthyofauna in both biomass and (*Cyclothone* spp. aside) numbers, while its length frequencies accorded with the results of previous ageing studies. Unlike several other species taken in the present surveys, *B. glaciale* was no less abundant in the central canyon than outside its mouth but its numbers were much reduced on the Head Station. It showed the upward shift in individual sizes up-canyon, through a disproportionate depletion of small fish, seen in several other species but only weakly, other than on the Head Station.

A quantitative comparison with the catches of Themelis and Halliday's (2012) surveys is possible. North of the shelf / slope boundary, those took an average of 302 individuals per standard night set with an IYGPT in September 1987 and 219 in August 1989 (Halliday *et al.* 2015), for an average of 260.5. The present survey program began with an attempt to replicate Themelis and Halliday's (2012) stepped-oblique tow profile on the Offshore Station (itself selected as one that had been worked during the earlier surveys). In the event, only two such sets were made, both in September 2007. They took 337 and 196 *B. glaciale* respectively (average 266.5), while the 250 m set made at night on that Station, following the protocols of the Gully surveys, took 438. Thus, where similar densities of fish might be expected, the catches were broadly comparable across the two programs.

4.3.10 Ceratoscopelus maderensis

Figure 29 : *Ceratoscopelus maderensis*, 58 mm SL, taken on the Deep Station by Set 2008_07

The genus *Ceratoscopelus* contains a circumglobal species complex, commonly designated *C. warmingii-townsendi,* plus a distinct regional species, *C. maderensis*, which is found in the North Atlantic and Mediterranean. Both occurred in The Gully but only *C. maderensis* was abundant enough to be included in the present analyses. In the western North Atlantic, it is known from the Sargasso Sea to, very rarely, Greenland (Moore *et al.* 2003a; Møller *et al.* 2010).

It is exceptionally abundant in WSW off New England and Nova Scotia, where it forms very dense schools that show a distinctive pattern of acoustic backscatter (Backus *et al.* 1968) and has been the second or third most abundant myctophid taken by various surveys (Jahn and Backus 1976; Backus and Craddock 1982; Kukuev 2002). It has been observed close to the seabed in Baltimore and Norfolk canyons (Ross *et al.* 2015) and in both near-bottom aggregations (mostly 400 to 1,000 m depth) and midwater scattering layers on the continental slope near Cape Hatteras (Gartner *et al.* 2008). In the Gulf of Maine, it is second only to *B. glaciale* among myctophids (Musick 1973). South of Nova Scotia, Themelis and Halliday (2012) found *C. maderensis* to be the most abundant of all fishes (*Cyclothone* spp. excepted) in their catches, dominant in WSW and second only to *B. glaciale* north of the shelf / slope boundary, with densities four times higher in WSW than further north in summer but 17 times in winter (Themelis and Halliday 2012; Halliday *et al.* 2015). It was similarly important in the catches taken by bottom trawling on the Scotian Slope (Halliday *et al.* 2012). *C. maderensis* has been reported from the shelf valleys in the Gulf of St. Lawrence (e.g. Winger *et al.* 2017) but the lack of mesopelagic surveys there precludes quantification. The species was the second most abundant myctophid in one study on Flemish Cap (Bañón Díaz *et al.* 2001) but is much less abundant further to the northeast and apparently absent from the Irminger Sea (Dolgov 2015: see Table 4).

C. maderensis follows a typical myctophid diel vertical migration, spending daylight at depths of hundreds of metres but being above 200 m at night (Moore *et al.* 2003a). In the WSW south of Nova Scotia, it appears to have an annual life cycle, larvae and post-metamorphosis individuals being taken in August, with modal lengths increasing from then until reaching about 50 mm in June. The fish taken north of the shelf / slope boundary, which may be expatriates rather than a selfsustaining population, appear to survive longer, reaching 60 mm during their second winter and spring. Spawning occurs from April to October, over the continental slope, predominantly from Georges Bank westwards (Halliday *et al.* 2015). Larger individuals, up to mean lengths of 65 mm for females, have been taken in near-bottom aggregations off Hatteras (Gartner *et al.* 2008), where the dominant water mass is WSW.

Off Nova Scotia, *C. maderensis* eats mostly calanoid copepods but also amphipods, euphausiids and chaetognaths (Halliday *et al.* 2015).

In The Gully, night catches of *C. maderensis* averaged nearly an order-of-magnitude greater than those taken in daylight (Tables 15A, B) – probably a difference in catchability resulting from an ability to pass through the meshes of the trawl, when given visual cues. (An IYGPT has 100 mm stretched mesh at its mouth, tapering to 13 mm in the codend: Kenchington *et al.* 2014a.)

Single individuals were taken by two of the 250 m daylight sets but the fish were otherwise deeper during the day. At night, all or substantially all, *C. maderensis* appear to have been above 250 m depth. While the open net does not permit a conclusive answer, there was no evidence that the fish were ever below 750 m.

Per-set average catches were approximately equal, in number terms, on the Offshore, Deep, Main and Wall stations but were nearly an order-of-magnitude lower on the Head Station (where *C. maderensis* was entirely absent from the catches in 2009, while only a single individual was taken in March 2010). Since the Slope Station was only fished in daylight, catches there were low. Since smaller fish were scarce further up the canyon, catches in weight were highest on the Main and Wall stations, somewhat lower on the Deep and much lower on the Offshore Station.

There was considerable inter-annual variation in summer catches of *C. maderensis*, with the highest in 2007 (especially on the Main Station) and the lowest the following year. Catches were very low in March 2010.

Average standard lengths of the individuals caught did not differ consistently between night and daylight, nor with depth. There was a strongly dominant mode at 60 mm, while a much weaker mode was seen in most years and most stations at 25 to 30 mm, except on the Offshore Station in 2007, when it lay at 30–35 mm (Figures 30, 31). That smaller mode was well developed on the Deep Station in 2008. It was much weaker on the Main Station and was absent entirely on the Wall and Head stations, where no individuals of less than 45 mm SL were taken.

Table 15A : Arithmetic mean catches of *Ceratoscopelus maderensis* in each cell of the survey design: numbers of individuals

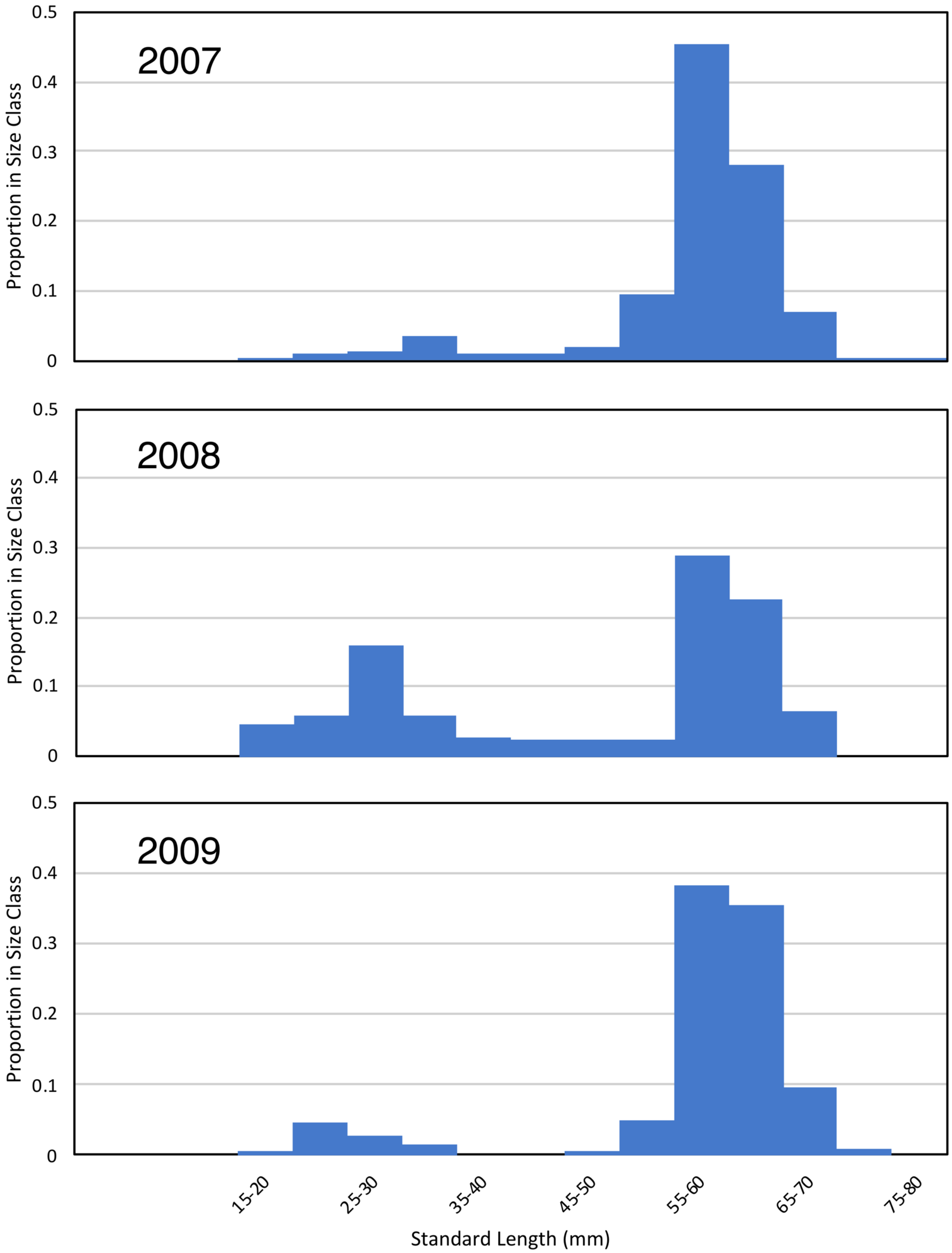
Year:		2007		2008		2009		2010	
Month:		Sept		Aug/Sept		Aug		March	
Diel Phase:		Day	Night	Day	Night	Day	Night	Day	Night
Station	Depth (m)								
Head	250	0	1.67	0	0	0	0	0	0.5
	750	0.67	8.5	0	6	0	0	0	0
	Extra		3						
Main	250	0	49	1	10	0	30.5	0	1
	750	5.67	48	2	13	1	12	0.5	0.5
	1250	0.33	9.67	2.5	14	1	9	1	0.5
	Extra	1							
Wall	250	1	32.5				9		
	750	1.67	12			3	19		
Deep	250	0	28.5	0	15	0	73		3
	750	1.5	24.5	2	14		9.5	0	0.5
	1250	0	16	6.5	12.67	0.5	11		0.5
	1750				4		9.5	1	1.5
	Extra					10.5		0	
Slope	750					1		3	
Offshore	250	0	5						
	750	1	30						
	1250	2	3						
	Extra		2						

No valid IYGPT sets were made in the shaded cells.

Table 15B : Arithmetic mean catches of *Ceratoscopelus maderensis* in each cell of the survey design: weights caught (g)

Year:		**2007**		**2008**		**2009**		**2010**	
Month:		**Sept**		**Aug/Sept**		**Aug**		**March**	
Diel Phase:		**Day**	**Night**	**Day**	**Night**	**Day**	**Night**	**Day**	**Night**
Station	**Depth (m)**								
Head	**250**	0	2.8567	0	0	0	0	0	1
	750	1.6	23.25	0	15.6	0	0	0	0
	Extra		8.5						
Main	**250**	0	115.967	0.5	24.395	0	80	0	2.5
	750	14.4	119.067	5.3	25.8	2.67	36.5	0.5	0.5
	1250	1.33	23.233	3.025	28.625	2	20.5	4	1.5
	Extra	3							
Wall	**250**	2	83.5				22		
	750	5.5	22.325			9	45.5		
Deep	**250**	0	70.75	0	31.675	0	177		6.67
	750	3	56.8	4.65	18.267		21.5	0	1.85
	1250	0	41.15	6.875	14	1	23		1
	1750				9.9		19.5	3	3.5
	Extra					13		0	
Slope	**750**					2		9	
Offshore	**250**	0	5						
	750	1	17						
	1250	0.4	1						
	Extra		2.8						

No valid IYGPT sets were made in the shaded cells. Blank cells indicate missing data for this species.


2007
2008
2009
Proportion in Size Class
0.5
0.4
0.3
0.2
0.1
0
15-20
25-30
35-40
45-50
55-60
65-70
75-80
Standard Length (mm)

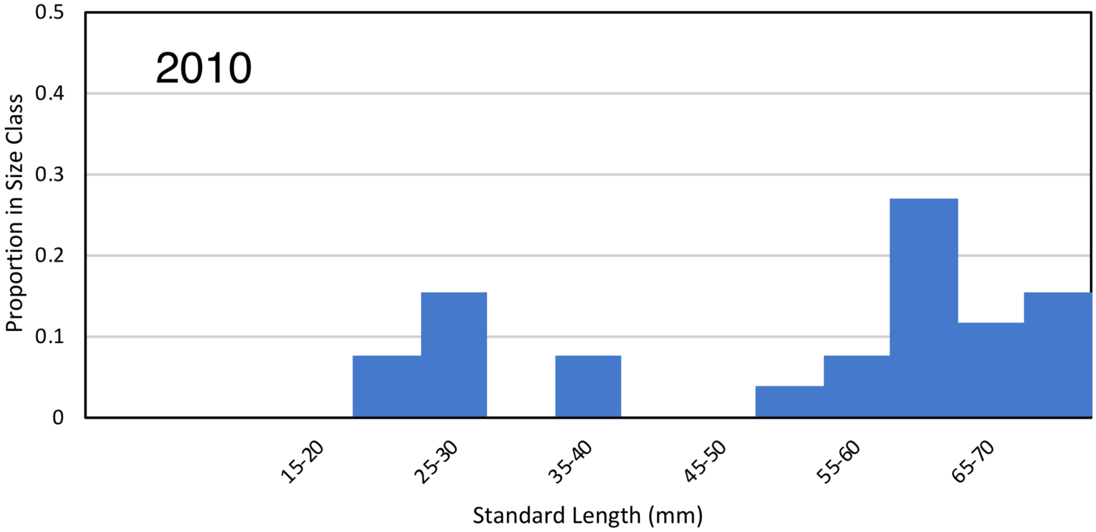
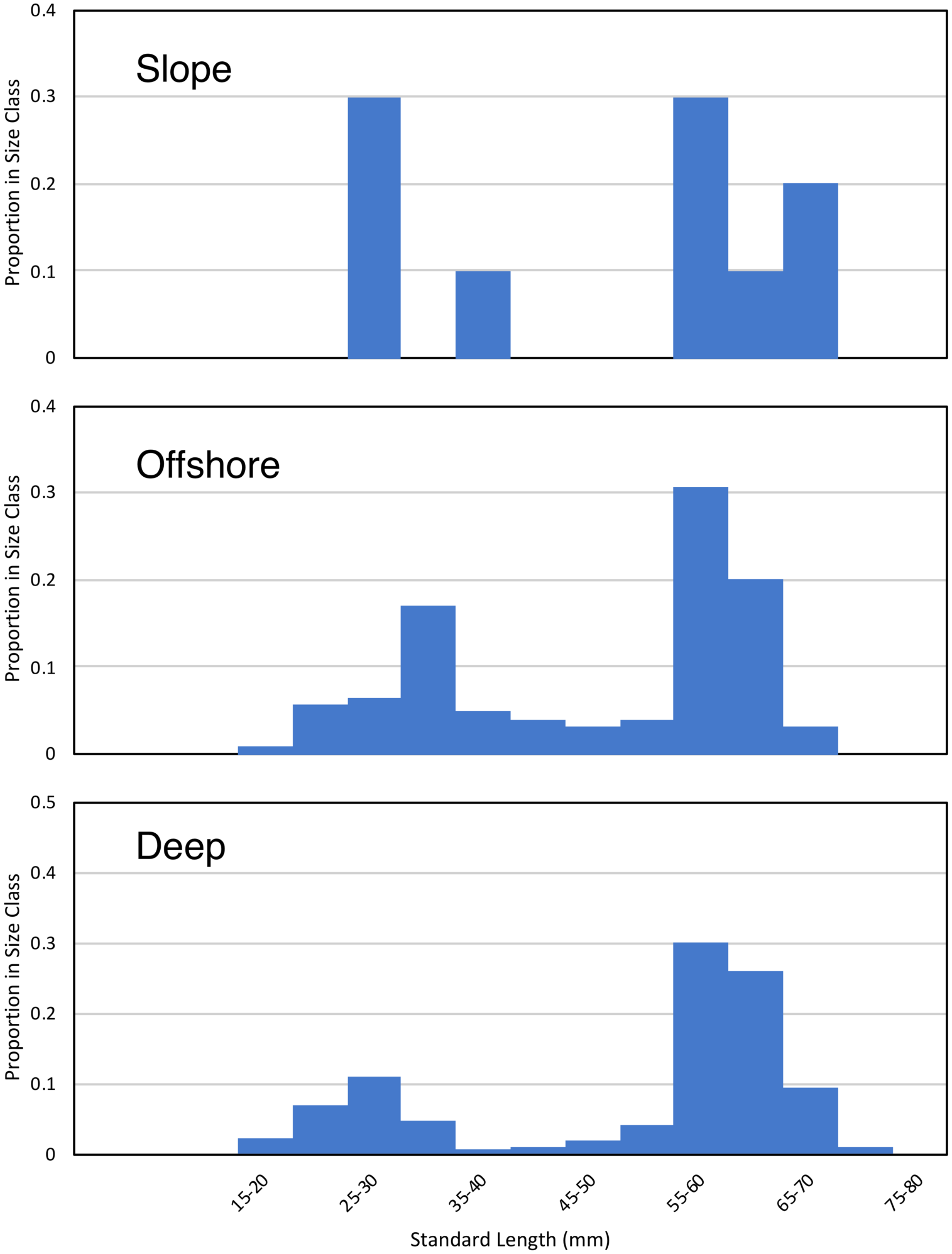


Figure 30 : Length frequencies of *Ceratoscopelus maderensis* (shown as proportions of measured individuals) by survey, including all 1,216 measured individuals (Top left: 2007; Middle left: 2008; Bottom left: 2009; Above: 2010)

Thus, catches in The Gully were generally consistent with prior expectations, given that most of the fishing was well to the north of the shelf / slope boundary. As with *B. glaciale*, night catches were similar at every station where they were taken, except for the Head Station, where they were much lower. Average sizes increased up-canyon and were especially high on the Head and Wall stations, such that the highest catches in weight terms were taken in the central canyon. As seen in several other species, that increase in the average came through an up-canyon decline in numbers of small fish.


Slope
Offshore
Deep
Proportion in Size Class
0
0.1
0.2
0.3
0.4
0.5
15-20
25-30
35-40
45-50
55-60
65-70
75-80
Standard Length (mm)

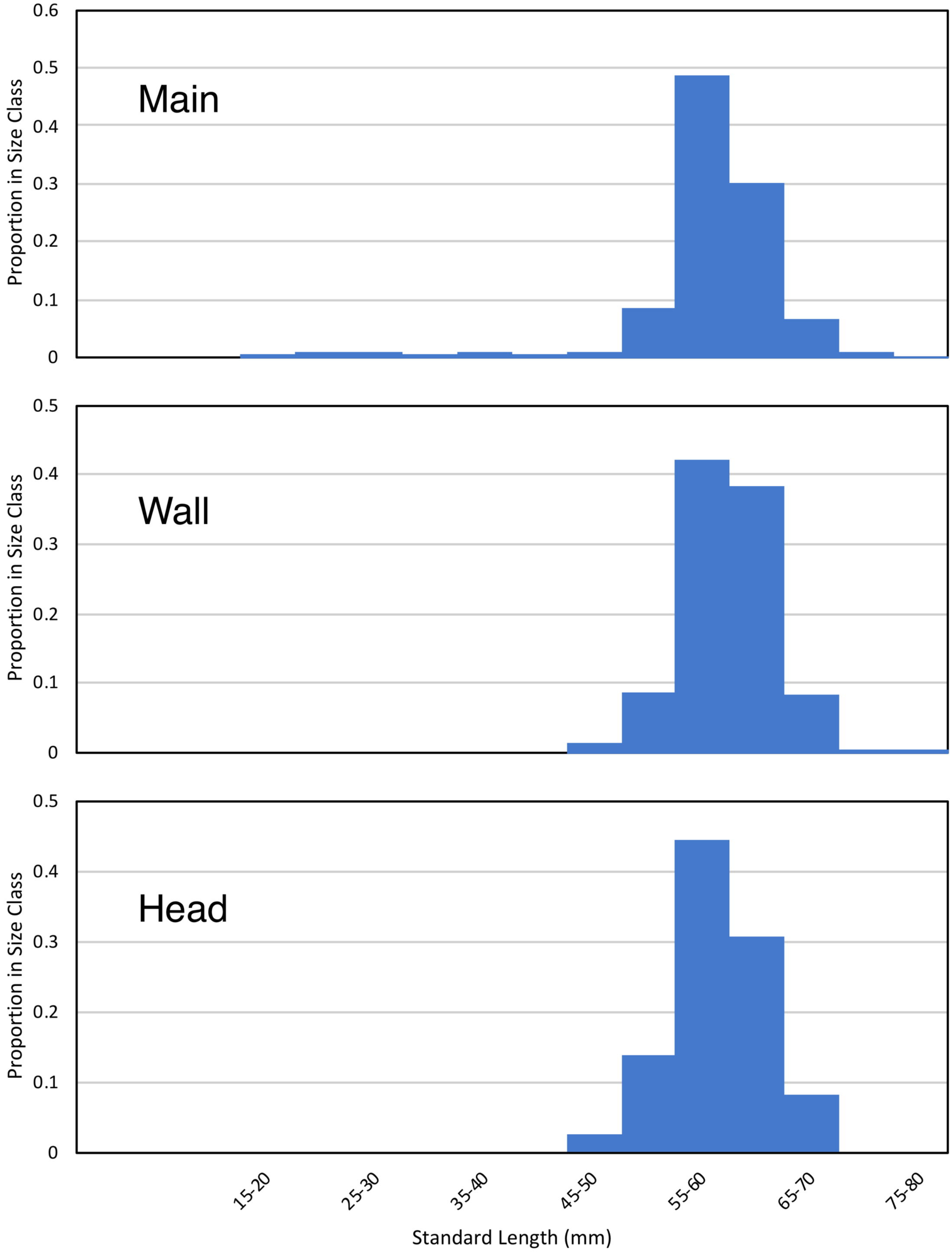


Figure 31 : Length frequencies of *Ceratoscopelus maderensis* (shown as proportions of measured individuals) by station, including all 1,216 measured individuals (Top left: Slope Station; Middle left: Offshore Station; Bottom left: Deep Station; Top right: Main Station; Middle right: Wall Station; Bottom right: Head Station)

4.3.11 Hygophum hygomii

Figure 32 : *Hygophum hygomii*, 48 mm SL, taken on the Deep Station by Set 2008_01

H. hygomii is currently thought to be circumglobal in tropical latitudes (Gaither *et al.* 2016), though recent genetic evidence suggests that the Mediterranean population may be distinct (Kenchington *et al.* 2017). In the western North Atlantic, it occurs from Mexico to Flemish Cap (Moore *et al.* 2003a) and is among the more abundant species in WSW off New England (Jahn and Backus 1976). A few have been recorded in the Gulf of Maine (Musick 1973). South of Nova Scotia, Themelis and Halliday (2012) found it the single most abundant species in their Gulf Stream catches but less prominent in the WSW and even less so north of the shelf / slope boundary. In WSW, it was a summer species, seen in June and August but very rare from October to April (see Table 4). It has a typical myctophid depth distribution, being found at about 500 to 650 m in daylight and in the upper 100 m at night (Badcock 1970).

Along the MAR, *H. hygomii* gains most of its nutriment from euphausiids but, in numbers of prey items, its stomach contents are dominated by ostracods and copepods, including both the common *Calanus finmarchicus* and the deep-migrating *Pleuromamma* spp. (Hudson *et al.* 2014). Over Great Meteor Seamount, in contast, *H. hygomii* eats mostly hyperiid amphipods but also copepods, euphausiids and pteropods (Pusch *et al.* 2004).

Like *C. maderensis*, in the Gully surveys *H. hygomii* showed a strong diel variation in catchability, night catches averaging nearly an order-of-magnitude larger than those taken in daylight (Tables 16A, B). Unlike *C. maderensis*s, however, as a warm-water species, *H. hygomii* had a very restricted distribution in the Gully area.

In 2007, it was confined to the Offshore Station – the only one that year which lay near the shelf / slope boundary between the intensely developed CIL and the WSW. Fish were caught by all of the sets made on that Station, including a daylight set above 250 m. Much the largest catch was taken by a 1,250 m set but the depth at which the IYGPT encountered aggregations of the fish remains unknown.

Table 16A : Arithmetic mean catches of *Hygophum hygomii* in each cell of the survey design: numbers of individuals

Year:		2007		2008		2009		2010	
Month:		**Sept**		**Aug/Sept**		**Aug**		**March**	
Diel Phase:		**Day**	**Night**	**Day**	**Night**	**Day**	**Night**	**Day**	**Night**
Station	**Depth (m)**								
Head	**250**	0	0	0	0	0	0	0	0
	750	0	0	0	0	0	0	0	0
	Extra		0						
Main	**250**	0	0	0	0.5	0	1	0	0
	750	0	0	2.5	4.5	0	0.5	0	0
	1250	0	0	4	26.5	0	0.5	0	0
	Extra	0							
Wall	**250**	0	0				1		
	750	0	0			0	0		
Deep	**250**	0	0	0	53	7	187		0
	750	0	0	12.5	57.33		120.5	0	0
	1250	0	0	4	32.67	31.5	104		0
	1750				72		24.5	0	0
	Extra					51.5		0	
Slope	**750**					26.5		0	
Offshore	**250**	9	30						
	750	17	51						
	1250	3	200						
	Extra		67						

No valid IYGPT sets were made in the shaded cells.

In 2008 and 2009, *H. hygomii* was taken on the Deep Station, above 750 m depth, with many (perhaps all) being above 250 m at night. Catches were greater in 2009, when the shelf / slope boundary lay across the station. The two daylight sets on the Slope Station in 2009 yielded a similar catch to that taken on the Deep Station in daylight. There were much smaller (and perhaps deeper) catches on the Main Station in 2008, while only five individuals were taken in the central canyon in 2009 (one on the Wall Station, the others on Main). No *H. hygomii* were taken on the Head Station on any survey and none identified to the species were taken at any station in March 2010 – though it should be noted that nine specimens identified as *Hygophum* sp. were caught (all of them on the Deep Station) but excluded from analysis (see Section 3.2).

H. hygomii showed no apparent pattern in the average lengths of the individuals caught across either years, stations, depths or the diel cycle. The length frequencies presented a single, strong mode of large fish throughout (Figure 33).

Table 16B : Arithmetic mean catches of *Hygophum hygomii* in each cell of the survey design: weights caught (g)

Year:		**2007**		**2008**		**2009**		**2010**	
Month:		**Sept**		**Aug/Sept**		**Aug**		**March**	
Diel Phase:		**Day**	**Night**	**Day**	**Night**	**Day**	**Night**	**Day**	**Night**
Station	**Depth (m)**								
Head	**250**	0	0	0	0	0	0	0	0
	750	0	0	0	0	0	0	0	0
	Extra		0						
Main	**250**	0	0	0	0.55	0	1.5	0	0
	750	0	0	4.35	7.15	0	1	0	0
	1250	0	0	4.85	44.35	0	0.5	0	0
	Extra	0							
Wall	**250**	0	0				1		
	750	0	0			0	0		
Deep	**250**	0	0	0	84.175	11	280		0
	750	0	0	19.075	86.433		186	0	0
	1250	0	0	8.575	53.133	54.5	163		0
	1750				102.3		45.5	0	0
	Extra					93		0	
Slope	**750**					42		0	
Offshore	**250**	1	49						
	750	24	84.6						
	1250	3.6	635						
	Extra		103						

No valid IYGPT sets were made in the shaded cells. Blank cells indicate missing data for this species.

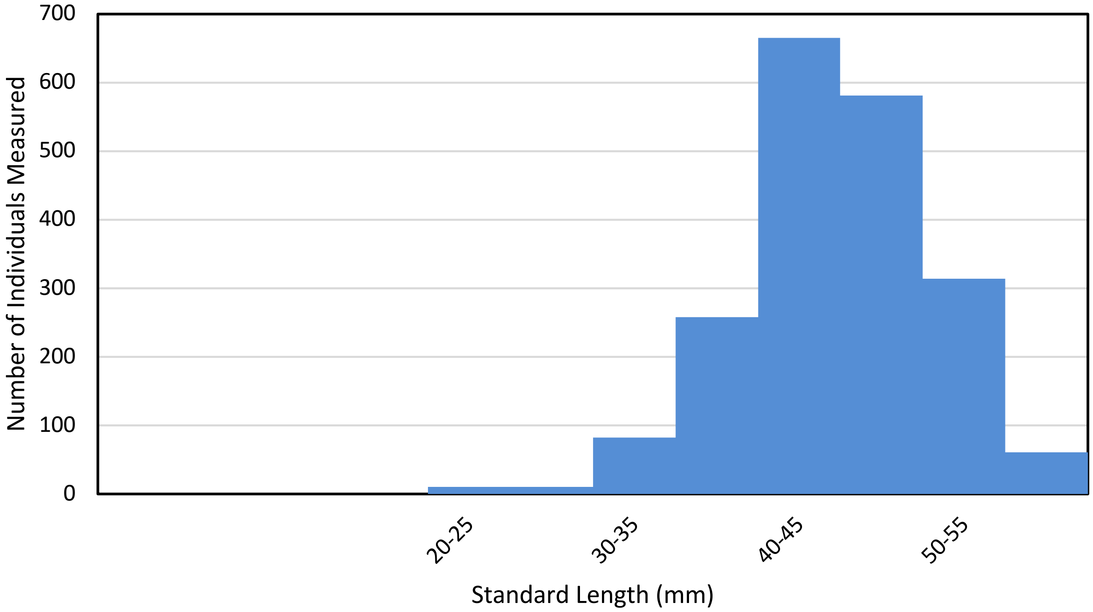


Figure 33 : Length frequency of *Hygophum hygomii*, including all 1,984 measured individuals

4.3.12 Lampanyctus macdonaldi[5]

L. macdonaldi is circumglobal in the Southern Hemisphere and is also found in the North Atlantic, in the west from off Delaware to Greenland (Moore *et al.* 2003a; Møller *et al.* 2010). It is a relatively large and deeper-living myctophid, with a range extending into the bathypelagic zone. Adults generally remain below 850 m depth through the diel cycle. Younger individuals do migrate up for the night but remain below 60 m, while they are below 550 m in daylight (Moore *et al.* 2003a).

Because of its deeper distribution, *L. macdonaldi* is scarce in the catches of survey programs that emphasize mesopelagic sampling (see Table 4). In contrast, Sutton *et al.* (2008), whose trawling over the northern MAR reached to 3,600 m depth, found this species to be the second most abundant myctophid in their collections, with a biomass considerably higher than all of the other members of the family combined. It was routinely taken below 1,500 m depth (Sutton *et al.* 2008). In the Irminger Sea, Dolgov (2015) routinely sampled down to 950 m depth and found *L. macdonaldi* to be one of the more abundant myctophids in his catches. While the data were compromised by incomplete identifications of myctophids, *L. macdonaldi* was one of the more abundant pelagic species in the catches from deep bottom trawling on the Scotian Slope (Halliday *et al.* 2012).

---

[5] The few photographs of *L. macdonaldi* made during the Gully surveys were all of damaged specimens and do not merit reproduction here.

In The Gully, *L. macdonaldi* showed such extreme elevation of its depth distribution that this essentially bathypelagic species was taken in a daylight 250 m set on the Head Station (Tables 17A, B). That elevation shaped its distribution across the survey design.

Table 17A : Arithmetic mean catches of *Lampanyctus macdonaldi* in each cell of the survey design: numbers of individuals

Year:		**2007**		**2008**		**2009**		**2010**	
Month:		**Sept**		**Aug/Sept**		**Aug**		**March**	
Diel Phase:		**Day**	**Night**	**Day**	**Night**	**Day**	**Night**	**Day**	**Night**
Station	**Depth (m)**								
Head	**250**	0	0	0	0	1	0	0	0
	750	10	7.5	3	4	7.5	4	0	0
	Extra		18						
Main	**250**	0	0	0	0	0	0	0	0.5
	750	0	1.67	0.5	0	0.33	0	0	1.5
	1250	2.67	1.33	9	3.5	2	1.5	0	0
	Extra	11							
Wall	**250**	0	0				1		
	750	0.67	0.5			0	0		
Deep	**250**	0	0	0	0.5	0	0		0
	750	0.5	4.5	2	1		0.5	0	0
	1250	2	2	1.5	7.33	1	1.5		0.5
	1750				16		9.5	0	11.5
	Extra					5.5		0	
Slope	**750**					0.5		2	
Offshore	**250**	0	0						
	750	0	0						
	1250	0	0						
	Extra		4						

No valid IYGPT sets were made in the shaded cells.

Table 17B : Arithmetic mean catches of *Lampanyctus macdonaldi* in each cell of the survey design: weights caught (g)

Year:		2007		2008		2009		2010	
Month:		**Sept**		**Aug/Sept**		**Aug**		**March**	
Diel Phase:		**Day**	**Night**	**Day**	**Night**	**Day**	**Night**	**Day**	**Night**
Station	**Depth (m)**								
Head	**250**	0	0	0	0	13	0	0	0
	750	93.33	38.7	19.35	20.85	57.5	32	0	0
	Extra		142.6						
Main	**250**	0	0	0	0	0	0	0	7.5
	750	0	15.233	8.425	0	6.67	0	0	4
	1250	22.5	16.533	66.15	41.05	40	16.5	0	0
	Extra	110							
Wall	**250**	0	0				35		
	750	2	0.47			0	0		
Deep	**250**	0	0	0	6.6	0	0		0
	750	2.75	41.5	38.6	6		3.5	0	0
	1250	17.5	0	32.275	66.167	16	9.5		9.5
	1750				124		69	0	68.5
	Extra					29.5		0	
Slope	**750**					0		24	
Offshore	**250**	0	0						
	750	0	0						
	1250	0	0						
	Extra		37						

No valid IYGPT sets were made in the shaded cells.

On the Offshore Station, *L. macdonaldi* was only taken by the deepest set, which fished to 1,694 m. On the Slope and Deep stations, it was taken by 750 m sets (and a single individual by a 250 m set) but the 1,750 m sets on the Deep Station took considerably more than those which did not go below 1,250 m depth. (There was no further apparent increase in catches by those sets which went below 1,750 m.) Summed across the water column, catches on the Main Station averaged less than a third of those on the Deep Station but 1,250 m sets took more on the Main than on the Deep. The highest Main Station catch, by a small margin, was by the one set which fished below 1,250 m. 750 m sets on the Head Station yielded larger catches than 1,250 m sets on the Main Station, the former having much the largest average for sets in their nominal stratum, while the greatest catch of any set in the surveys (18 individuals, 143 g) was taken by the one set on the Head Station set which fished below 750 m. Thus, *L. macdonaldi* was less abundant in the central canyon than outside but became concentrated in the upper canyon, its depth distribution apparently forced upwards by the up-canyon shallowing of the thalweg.

There was little evidence of inter-annual variability in the summer catches but there was a major seasonal change. In March 2010, no *L. macdonaldi* were taken on the Head Station and 23 of the 29 individuals taken were caught by a 1,750 m set on the Deep Station, suggestive of a retreat to deep water for the winter.

The numbers of *L. macdonaldi* caught were rather low, such that only 295 were measured. With so few, no patterns in length frequencies were discernable. Overall, there was a unimodal frequency (Figure 34). The only two stations which yielded substantial catches, the Deep and Head, produced closely similar length frequencies.

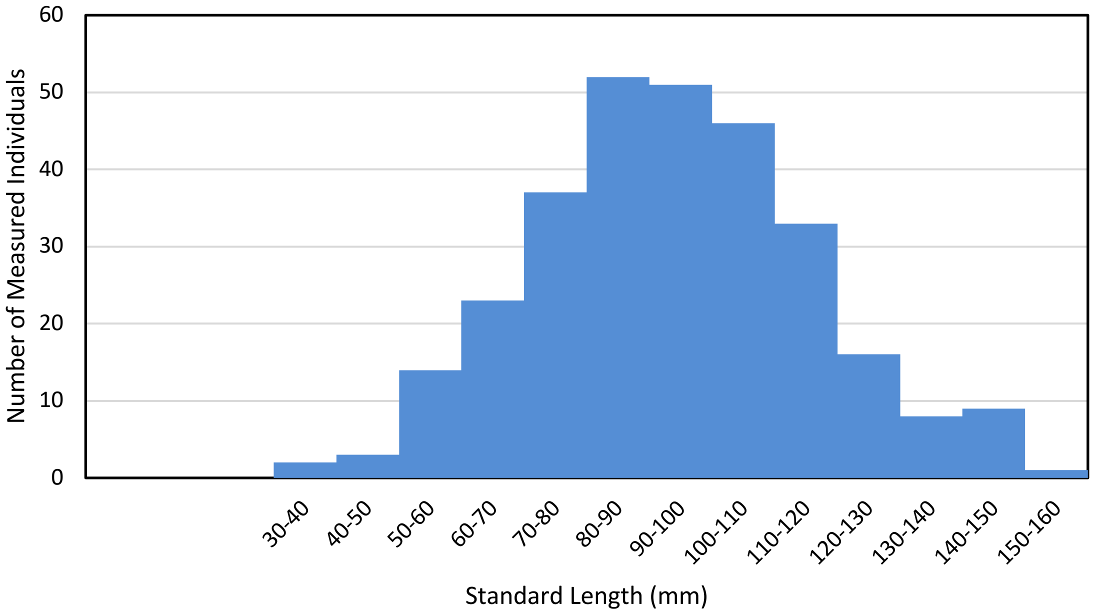


Figure 34 : Length frequency of *Lampanyctus macdonaldi*, including all 295 measured individuals

4.3.13 Lobianchia dofleini

Figure 35 : *Lobianchia dofleini*, 38 mm SL, taken on the Deep Station by Set 2008_52

L. dofleini is circumglobal in tropical latitudes (Gaither *et al.* 2016). Like *H. hygomii*, it is a warm-water species and the western North Atlantic occurs from the Sargasso Sea to Flemish Cap (Moore *et al.* 2003a). Many specimens have been taken in the Gulf of Maine (Musick 1973) and it was the most abundant species in Jahn and Backus' (1976) catches from WSW off New England. South of Nova Scotia, Themelis and Halliday (2012) found it to be the third most abundant myctophid in their catches (se Table 4). It ranked second in abundance in Gulf Stream water and was the principal fish species in WSW in the summer, though almost absent from that water mass in February and April and was less abundant north of the shelf / slope boundary (Themelis and Halliday 2012). It is much less abundant northeast of the Tail of Grand Bank. It is another species with a typical myctophid depth distribution, most being at 400 to 500 m in daylight but about 100 m at night (Badcock 1970).

Over Great Meteor Seamount, small *L. dofleini* (<35 mm) eat mostly ostracods and copepods, with lesser amounts of euphausiids, pteropods and others. Most of the copepods are the deep-migrating *Pleuromamma* spp. (Pusch *et al.* 2004), suggesting much feeding at depth rather than near the surface at night. Whether that is indicative of the species' diet in waters off Nova Scotia is unclear.

In the Gully surveys, *L. dofleini* was only taken in substantial quantities on the Offshore Station in 2007 and the Deep Station in 2009 (Tables 18A, B) – which is to say very close to, or actually spanning, the shelf / slope boundary. On each of those stations and during the relevant survey, the largest catches were taken above 250 m depth at night (perhaps enhanced by the "double counting" of 50–250m depths by the "W" tow profiles), with no indication that any were deeper then. Almost all *L. dofleini* were below 250 m in daylight, when catchability may have been lower. Whether any were deeper than 750 m is unclear from the available data.

Table 18A : Arithmetic mean catches of *Lobianchia dofleini* in each cell of the survey design: numbers of individuals

Year:		**2007**		**2008**		**2009**		**2010**	
Month:		**Sept**		**Aug/Sept**		**Aug**		**March**	
Diel Phase:		**Day**	**Night**	**Day**	**Night**	**Day**	**Night**	**Day**	**Night**
Station	**Depth (m)**								
Head	**250**	0	0	0	0	0	0	0	0
	750	0	0	0	0	0	0	0	0
	Extra		0						
Main	**250**	2	0	0	1	0	1	0	0
	750	0	0	0	0.5	0.67	4	0	0
	1250	0	0	0	2	0	3	0	0
	Extra	0							
Wall	**250**	0	0				4		
	750	0	0			0	1		
Deep	**250**	1	0	0	8	0	157		0
	750	0	0	2.5	11.33		95.5	0	0
	1250	0	0	14.5	8.67	51	144		0
	1750				12		87	0	0
	Extra					124.5		0	
Slope	**750**					19		1	
Offshore	**250**	2	215						
	750	17	34						
	1250	5	9						
	Extra		17						

No valid IYGPT sets were made in the shaded cells.

Only one individual, taken on the Deep Station, was found in 2007 away from the Offshore Station. Catches on the Deep Station in 2008 were about an order-of-magnitude smaller than they were in 2009, when the shelf / slope boundary lay across that station. 38 individuals were taken on the Slope Station, for a lower per-set average than on the Deep that year but, with so few data, that may have arisen from randon variations. In both 2008 and 2009, small numbers reached the central canyon, where they were caught on both the Main and Wall stations. None was found on the Head Station. The sole individual taken in March 2010 that was recorded as *L. dofleini* was caught on the Slope Station. It was anomalously large for this species, at 58 mm, and may have been a case of a misrecorded species code or a misidentified *L. gemellari*.

Throughout the summer surveys, the modal length was 25–30 mm, though there was some inter-annual variation in the relative proportions of smaller and larger individuals (Figure 36). Too few were taken anywhere but on the Offshore and Deep stations for spatial variations in length frequencies to be determined. There were no apparent diel or depth-related differences in sizes.

Table 18B : Arithmetic mean catches of *Lobianchia dofleini* in each cell of the survey design: weights caught (g)

Year:		**2007**		**2008**		**2009**		**2010**	
Month:		**Sept**		**Aug/Sept**		**Aug**		**March**	
Diel Phase:		**Day**	**Night**	**Day**	**Night**	**Day**	**Night**	**Day**	**Night**
Station	**Depth (m)**								
Head	**250**	0	0	0	0	0	0	0	0
	750	0	0	0	0	0	0	0	0
	Extra		0						
Main	**250**	0.267	0	0	0.4	0	1.5	0	0
	750	0	0	0	0.15	0.67	2	0	0
	1250	0	0	0	0.525	0	2.5	0	0
	Extra	0							
Wall	**250**	0	0				1		
	750	0	0			0	0.5		
Deep	**250**	1	0	0	3.45	0	80		0
	750	0	0	1.4	4.4167		48	0	0
	1250	0	0	8.85	4.67	25	63		0
	1750				5.9		37.5	0	0
	Extra					50		0	
Slope	**750**					9.5		2	
Offshore	**250**	1	125						
	750	7	19						
	1250	2.7	7.2						
	Extra		11						

No valid IYGPT sets were made in the shaded cells.

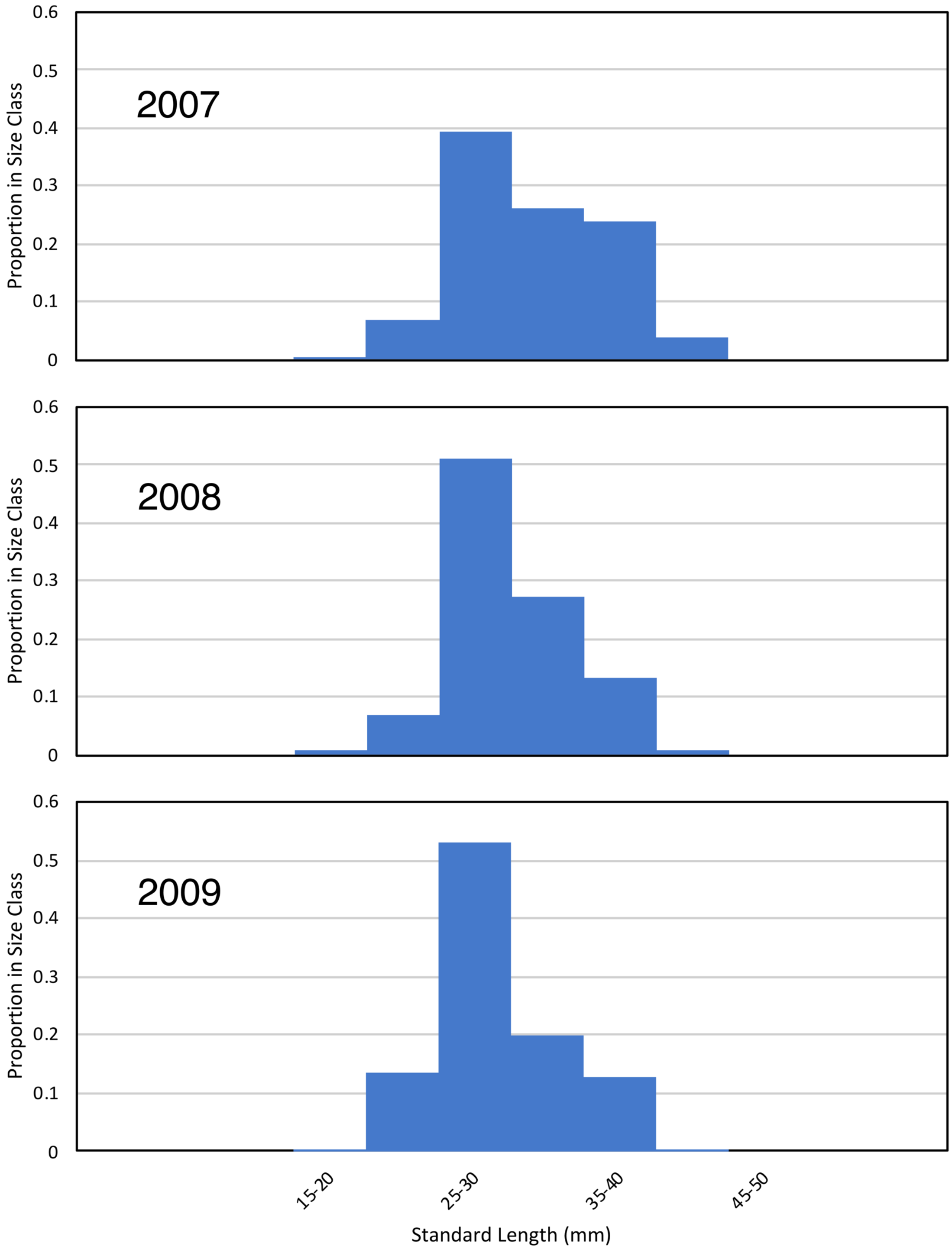


Figure 36 : Length frequencies of *Lobianchia dofleini* caught in summer (shown as proportions of measured individuals) by year, including data from all 1,791 measured individuals (Top: 2007 survey; Middle: 2008 survey; Bottom: 2009 survey)

4.3.14 Myctophum punctatum

Figure 37 : *Myctophum punctatum* taken on the Deep Station by Set 2008_01

M. punctatum is a cold-water North Atlantic species, found in the west from Bermuda to Greenland (Moore *et al.* 2003a; Møller *et al.* 2010) and in the northeast has once been recorded from the Kara Sea (Dolgov 2013). It is known from the Gulf of Maine (Musick 1973), the Scotian Slope (Halliday *et al.* 2012) and the Laurentian Channel (Zurbrigg and Scott 1972). Themelis and Halliday (2012) found this species to be the third most abundant myctophid between the shelf / slope boundary and the shelf break, south of Nova Scotia, but much less common in the WSW (see Table 4). It is the most abundant myctophid on Flemish Cap (Bañón Díaz *et al.* 2001). *M. punctatum* is also prominent in the fish assemblage above 750 m depth over the northern MAR (Sutton *et al.* 2008). In the Irminger Sea, it is second only to *B. glaciale*, occurring primarily above 500 m depth (Dolgov 2015).

This species has the pronounced diel vertical migration typical of myctophids, spending daylight periods in the mesopelagic zone but reaching surface waters at night (Moore *et al.* 2003a). Indeed, it is commonly encountered at the surface itself (Halliday and Scott 1969).

In The Gully, there was strong inter-annual variation in the summer catches of *M. punctatum*, with catches in 2007 about double those of 2009 and nearly an order-of-magnitude greater than those of 2008 (Tables 19A, B). Only two individuals were taken in 2010, both together in a 1,250 m set on the Deep Station.

The per-set numbers caught at night were approximately double those taken in daylight, probably because of visual evasion of the IYGPTs. Most were caught between 250 and 750 m depth. There was no indication that any were taken deeper but some were shallower, especially but not only at night (and notably by one shallow night set on the Wall Station).

In 2007, catches in numbers were highest on the Main Station and smaller on the Deep Station. The Wall and Head stations yielded still smaller catches in numbers though not in weight. Few *M. punctatum* were caught on the Offshore Station. Much the same was true in 2009, except that the highest catches were seen on the Wall Station. The few caught on the Slope Station were similar in number to those on the Deep, though less in weight. The small numbers taken in 2008 also conformed to the same pattern, as far as could be judged from the limited available data.

Table 19A : Arithmetic mean catches of *Myctophum punctatum* in each cell of the survey design: numbers of individuals

Year:		**2007**		**2008**		**2009**		**2010**	
Month:		**Sept**		**Aug/Sept**		**Aug**		**March**	
Diel Phase:		**Day**	**Night**	**Day**	**Night**	**Day**	**Night**	**Day**	**Night**
Station	**Depth (m)**								
Head	**250**	6	3.33	0	0.5	7	1.5	0	0
	750	9.33	16	3	2	2	3	0	0
	Extra		24						
Main	**250**	9.33	21.33	0	1	6	16	0	0
	750	17.33	44.33	2.5	2	19.33	15	0	0
	1250	10	18.33	5.5	9	15	5.5	0	0
	Extra	8							
Wall	**250**	7	13				54		
	750	19	7.5			27	47		
Deep	**250**	1	23	0	3	0	5		0
	750	5.5	20.5	0.5	2		7.5	0	0
	1250	4	27.5	0.5	3.67	3.5	3		1
	1750				4		1	0	0
	Extra					0		0	
Slope	**750**					3.5		0	
Offshore	**250**	0	0						
	750	4	1						
	1250	0	2						
	Extra		3						

No valid IYGPT sets were made in the shaded cells.

Table 19B : Arithmetic mean catches of *Myctophum punctatum* in each cell of the survey design: weights caught (g)

Year:		**2007**		**2008**		**2009**		**2010**	
Month:		**Sept**		**Aug/Sept**		**Aug**		**March**	
Diel Phase:		**Day**	**Night**	**Day**	**Night**	**Day**	**Night**	**Day**	**Night**
Station	**Depth (m)**								
Head	**250**	33	6.85	0	2.775	43	10.5	0	0
	750	44.6	71.8	18.6	13.9	14	24	0	0
	Extra		125						
Main	**250**	22.833	51.433	0	0.875	32	51	0	0
	750	58.267	96.3	5.325	10.525	55.67	24	0	0
	1250	51.5	79.67	26.075	12.8	60	9	0	0
	Extra	23							
Wall	**250**	41.9	36.7				81		
	750	91	28.9			82	77.5		
Deep	**250**	2	47.7	0	1.8	0	8		0
	750	17.5	34.8	0.15	0.85		9	0	0
	1250	10	50.1	0.2	1.8833	9	1.5		1.5
	1750				1		0.5	0	0
	Extra					0		0	
Slope	**750**					2		0	
Offshore	**250**	0	0						
	750	1	4						
	1250	0	1.6						
	Extra		1.2						

No valid IYGPT sets were made in the shaded cells.

Although not fully evident in the pooled data (Figure 38), there were three discrete length modes at 30-35, 35–55 and 70–80 mm. Mode I accounted for most of the fish taken on the Offshore Station in 2007, on the Deep and Main stations in 2008 (the modal size-class on the latter pushed upwards to 35–40 mm) and on the Slope and Deep stations in 2009. Mode II was prominent on the Deep Station and further up the canyon in 2007 and on the Main and Wall stations in 2009. Mode III was present on all stations in 2007 but especially in the central and upper canyon. In 2008, it was found on the Main Station and included all of the few fish taken on the Head Station. It was present on the Deep Station and all of those further up the canyon in 2009 but primarily on the Main Station and the Head, where it comprised almost all of the fish present. The average lengths of the fish caught did not appear to vary in any systematic way with the depth reached by the sets nor with diel phase. The dominance of Mode III on the Head Station reflected the same lack of small individuals there that was seen in several other species. Only three of ≥50mm were taken on that Station.

Thus, the distribution of *M. punctatum* resembled that of the other cold-water myctophid, *B. glaciale*, with an emphasis on the central canyon but far fewer fish, especially small fish, on the Head Station. However, unlike *B. glaciale*, many *M. punctatum* appear to remain below 250 m depth in daylight and the species seems to withdraw to greater depths for the winter.

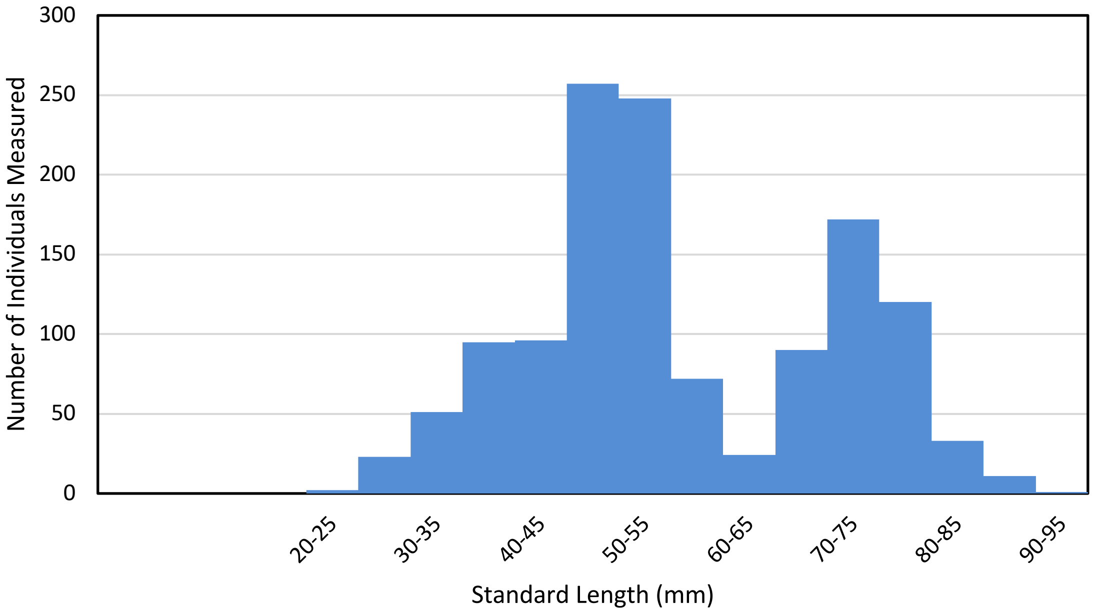


Figure 38 : Length frequency of *Myctophum punctatum*, including all 1,295 measured individuals

4.3.15 Notoscopelus kroyeri

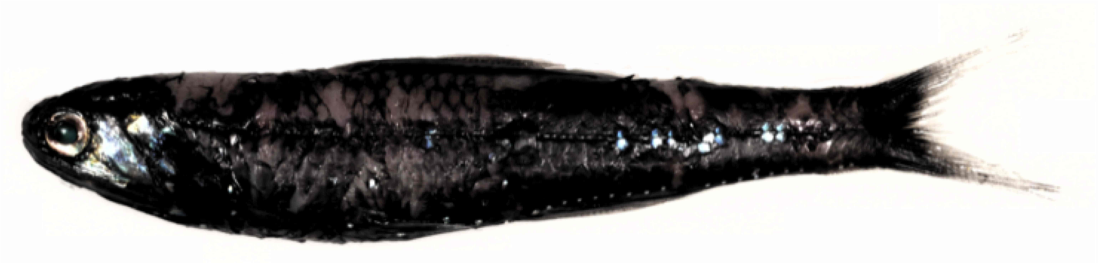


Figure 39 : *Notoscopelus kroyeri*, 119 mm SL, taken on the Head Station by Set 2008_23

Notoscopelus was the only genus represented by two species amongst the 19 selected. The first of the two, *N. kroyeri*, is sometimes considered a subspecies, *N. elongatus kroyerii*. It is a fish of the North Atlantic, known in the west from off southern New England to Greenland (Moore *et al.* 2003a; Møller *et al.* 2010). *N. elongatus* (alternatively: the nominate subspecies *N. elongatus elongatus*) is primarily a Mediterranean form, though recent genetic data suggests that relationships within the group may be more complex than that simple, binary division suggests (Kenchington *et al.* 2017).

N. kroyeri is scarce near the southern limit of its range (see Table 4) but has been found in the Gulf of Maine (Musick 1973) and the Gulf of St. Lawrence (Scallon-Chouinard *et al.* 2007). Most of those caught over oceanic depths south of Nova Scotia were taken north of the shelf / slope boundary (Themelis and Halliday 2012). *N. kroyeri* is considerably more abundant further to the northeast, where it has been taken on Flemish Cap (Bañón Díaz *et al.* 2001) and is one of the most abundant myctophids over the northern MAR (Sutton *et al.* 2008) and in the Irminger Sea (Dolgov 2015).

Ages of up to 6 y have been suggested for *N. kroyeri* in the northeast Atlantic (Gjøsaeter 1981) and on Flemish Cap (Mazhirina and Filin 1987). In the latter area, spawning occurs from January to April (Mazhirina and Filin 1987). Their diet includes euphausiids, copepods, amphipods and decapods, plus chaetognaths, fish, squid and others (Gjøsaeter 1981; Filin 1995).

Because of the presence of two abundant congeners in the catches of the Gully surveys, the records of *Notoscopelus* are more subject to complications from incomplete identifications of damaged individuals than applied to the other selected species. Those had to be resolved in the data prepared for the multivariate analyses of Kenchington *et al.* (*in prep.*), as detailed above below, and the same species-assignments were used here, except that the length data were only used if they came from specimens which could be confidently assigned to one species or the other.

Thus defined, the catches of *N. kroyeri* were about an order-of-magnitude higher at night than in daylight, in number terms (Tables 20A, B). However, that difference was seen in fish smaller than 70 mm standard length, whereas those of 80–120 mm (the largest taken in summer) either showed no diel difference or perhaps a reverse trend (catches of such big fish being too few for certainty: Figure 40). Presumably, visually-cued escapes of the smaller fish in daylight were made by passing through the meshes of the IYGPT, rather than by evading its mouth – the former route apparently unavailable to larger individuals. With that size distinction, the diel disparity in catches was less pronounced in weight terms.

Table 20A : Arithmetic mean catches of *Notoscopelus kroyeri* in each cell of the survey design: numbers of individuals

Year:		**2007**		**2008**		**2009**		**2010**	
Month:		**Sept**		**Aug/Sept**		**Aug**		**March**	
Diel Phase:		**Day**	**Night**	**Day**	**Night**	**Day**	**Night**	**Day**	**Night**
Station	**Depth (m)**								
Head	**250**	2	0.33		0	0	0	1	0
	750	2	0	1.5	0	0	3	0	0
	Extra		0						
Main	**250**	0	87.33	1	16.5	12	19.5	0	0
	750	0	35.67	4	13.5	4.33	10.5	0	0
	1250	1.33	16	4.5	8.5	1	7.5	0.5	0.5
	Extra	4							
Wall	**250**	0	7.5				69		
	750	2.33	7.5			4	26.5		
Deep	**250**	0	51.5	0	21.5	0	67		0
	750	0.5	31	0.5	2.33		0	0	0
	1250	2.5	33	1	6.33	4.5	27		0
	1750				15		13	0	0
	Extra					3		1	
Slope	**750**					0		0	
Offshore	**250**	0	11						
	750	0	0						
	1250	0	0						
	Extra		0						

No valid IYGPT sets were made in the shaded cells.

Table 20B : Arithmetic mean catches of *Notoscopelus kroyeri* in each cell of the survey design: weights caught (g)

Year:		**2007**		**2008**		**2009**		**2010**	
Month:		**Sept**		**Aug/Sept**		**Aug**		**March**	
Diel Phase:		**Day**	**Night**	**Day**	**Night**	**Day**	**Night**	**Day**	**Night**
Station	**Depth (m)**								
Head	**250**	25	4.1	11.75	0	0	0	24	0
	750	16.65	0	25.95	0	0	59	0	0
	Extra		0						
Main	**250**	0	80.567	0.25	10.85	13	17	0	0
	750	0	60.67	23.15	8.825	4.33	10.5	0	0
	1250	2	13.2	10.4	5.71	12	6.5	4.5	12.5
	Extra	5							
Wall	**250**	0	8.3				60		
	750	18.67	8.75			2	21.5		
Deep	**250**	0	54.3	0	15.95	0	48.3		0
	750	4	34.1	0.35	1.167		0	0	0
	1250	7.5	33.2	0.725	2.7	3	14		0
	1750				23.65		6.5	0	0
	Extra					3		5	
Slope	**750**					0		0	
Offshore	**250**	0	7.8						
	750	0	0						
	1250	0	0						
	Extra		0						

No valid IYGPT sets were made in the shaded cells.

The limited daylight catches were mostly taken by deeper sets, often those which fished to 1,250 m or deeper, but catches were too small and variable to determine whether the fish were actually caught below 750 m or simply chanced to be taken by such sets. Few individuals were taken in 250 m sets in daylight and those only on the Head and Main stations. In contrast, night catches were almost consistently largest in 250 m sets, implying that many fish were between 50 and 250 m depth, where they were double-sampled by the "W"-profile sets.

Summer catches were largest in 2007, when *N. kroyeri* was taken on every station, though the average catches were highest on the Main Station and somewhat less on the Deep. The Wall and Offshore stations showed an order-of-magnitude less than the Main, while night catches on the Head Station were two orders-of-magnitude less than those on the Main in numbers and one in weights – the few individuals caught there all being 89 mm standard length or longer. 2008 saw the lowest average catches of the summer surveys. They were about equal on the Deep and Main stations but much scarcer on the Head (where none at all were taken at night, though three individuals chanced to be taken in daylight). In 2009, there were good night catches on the Deep and Wall stations but less on the Main and few at the Head. No *N. kroyeri* were taken on the Slope Station, which was only fished in daylight and then only to 750 m depth.

There was some inter-annual variation in average size (consistent with either the progressively earlier calendar dates of the three summer surveys, interacting with rapid summer growth, or else with possible inter-annual variation in growth rate – the unusually high primary production on the Scotian Shelf in 2007 perhaps driving faster growth and hence larger fish caught that September: Figure 41). However, there was no discernable pattern in the lengths of individuals by either the maximum depth achieved by the set or the station on which the catch was taken – aside from the absence of small fish on the Head Station. The few specimens caught on the latter station averaged 100 mm SL in 2007, with a minimum length of 89 mm, but in 2008 and 2009 the few taken were all longer than 107 mm SL.

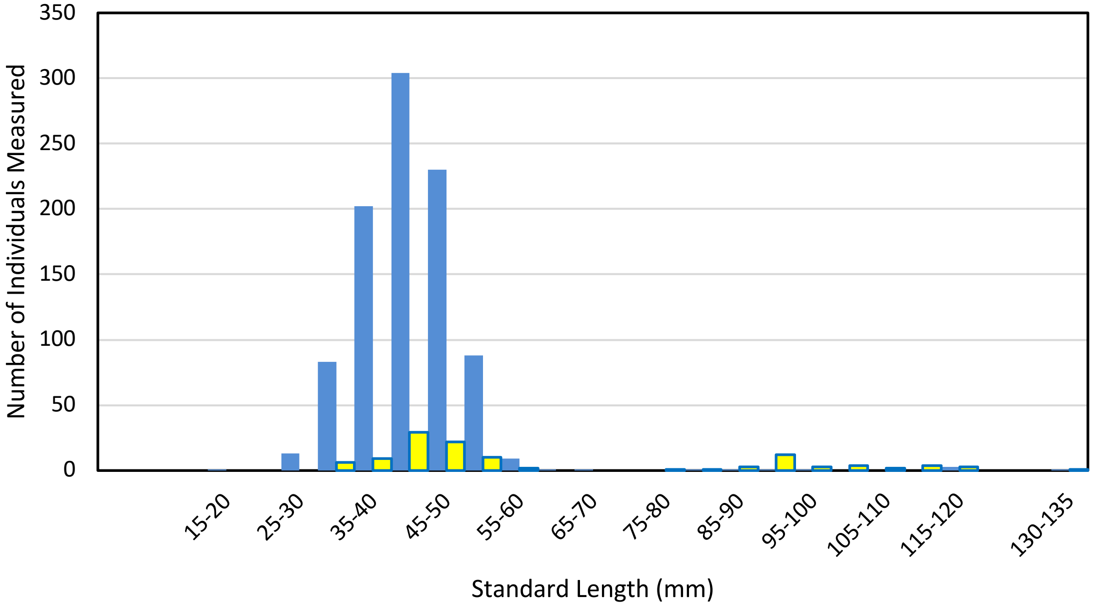


Figure 40 : Length frequencies of *Notoscopelus kroyeri* by diel phase, including all 1,062 measured individuals that could be confidently assigned to this species (Blue: night catches; Yellow: daylight catches)

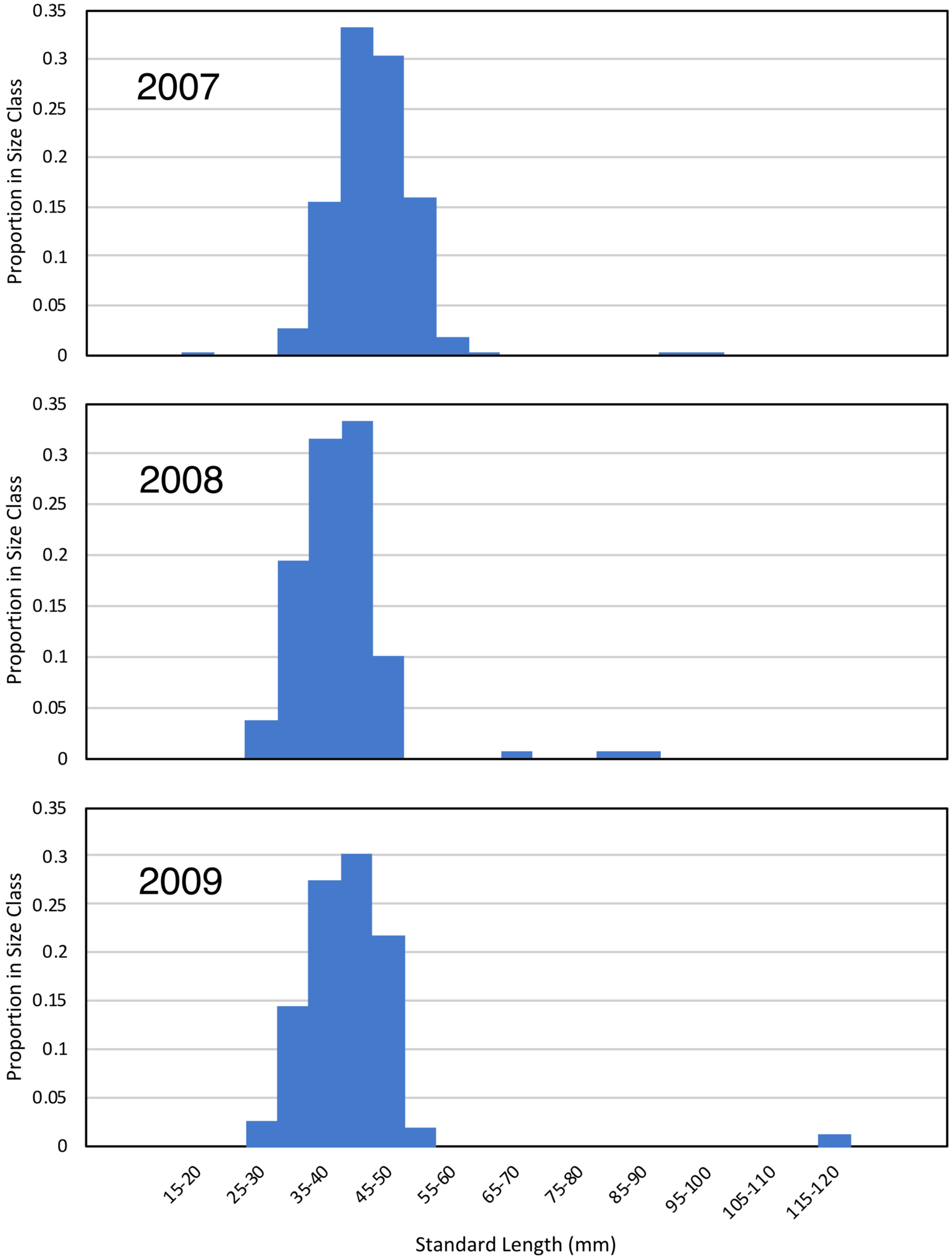


Figure 41 : Length frequencies of *Notoscopelus kroyeri* caught at night in summer (shown as proportions of measured individuals) by year, including data from all 939 measured individuals that could be confidently assigned to this species, by year (Top: 2007 survey; Middle: 2008 survey; Bottom: 2009 survey)

Only four individuals of *N. kroyeri* were taken in March 2010, the smallest being 78 mm SL, while two were very large specimens of 132 mm each. Two were taken by 1,250 m sets on the Main Station, one by an extra-deep set on the Deep Station (Set 2010_35) which reached 2,187 m depth, and one by a 250 m set on the Head Station. Thus, aside from the latter, which showed the common elevation of depth distributions up-canyon, it appears that the only *N. kroyeri* overwintering in The Gully were large individuals at bathypelagic depths.

4.3.16 Notoscopelus resplendens

Figure 42 : *Notoscopelus resplendens*, 55 mm SL, taken on the Deep Station by Set 2008_01

N. resplendens is currently recognized as circumglobal in tropical latitudes, though available genetic data suggest that it may be a species complex (Gaither *et al.* 2016). A warm-water species, in contrast to *N. kroyeri*, it is known in the western Atlantic from off Brazil to Flemish Cap (Moore *et al.* 2003a). It is among the most abundant fish in the WSW off New England (Jahn and Backus 1976), whereas Musick (1973) found only a single individual in the Gulf of Maine. Themelis and Halliday (2012) took large numbers south of Nova Scotia but the species is scarce or absent further to the northeast (see Table 4). *N. resplendens* tends to live deeper than some other myctophids, being found below 800 m in daylight and in the upper 150 m of the water column at night, though some are seen at the surface (Badcock 1970). Off the Canary Islands, specimens with up to four otolith annuli (suspected of representing annual marks) have been found. In that area, the species spawns during December–March (Sarmiento-Lezcano *et al.* 2018).

In the Gully surveys, *N. resplendens* showed a similar distribution (Tables 21A, B) to those of the other warm-water myctophids, *H. hygomii* and *L. dofleini*. However, like its congener, *N. resplendens* was caught in much higher numbers at night than in daylight –more than an order-of-magnitude greater– presumably because of visually-cued net avoidance. It was entirely absent from the catches taken on the Head and Wall stations, as it was from the March 2010 survey. In 2007, when the CIL was strongly developed but the shelf / slope boundary lay near the Offshore Station, almost all of the *N. resplendens* caught were taken there. Only one individual taken on the Deep Station and five on the Main were identified to this species. Lack of replication of the sets on the Offshore Station precludes conclusions on depth distributions but no *N. resplendens* were taken in the set made above 250 m in daylight, while the greatest catches in each diel phase were taken by sets which reached 1,250 m. It is likely that those fish were caught much closer to the surface but that cannot be confirmed.

Table 21A : Arithmetic mean catches of *Notoscopelus resplendens* in each cell of the survey design: numbers of individuals

Year:		**2007**		**2008**		**2009**		**2010**	
Month:		**Sept**		**Aug/Sept**		**Aug**		**March**	
Diel Phase:		**Day**	**Night**	**Day**	**Night**	**Day**	**Night**	**Day**	**Night**
Station	**Depth (m)**								
Head	**250**	0	0	0	0	0	0	0	0
	750	0	0	0	0	0	0	0	0
	Extra		0						
Main	**250**	0.67	0	0	2.5	0	0	0	0
	750	0	0	1	11.5	0	0	0	0
	1250	0.67	0.33	4	53.5	0	3	0	0
	Extra	0							
Wall	**250**	0	0				0		
	750	0	0			0	0		
Deep	**250**	0	0	0	41.5	0	26		0
	750	0.5	0	6	51		81.5	0	0
	1250	0	0	10.5	46	12.5	26		0
	1750				15		24.5	0	0
	Extra					46		0	
Slope	**750**					16		0	
Offshore	**250**	0	95						
	750	1	120						
	1250	21	306						
	Extra		29						

No valid IYGPT sets were made in the shaded cells.

Table 21B : Arithmetic mean catches of *Notoscopelus resplendens* in each cell of the survey design: weights caught (g)

Year:		2007		2008		2009		2010	
Month:		**Sept**		**Aug/Sept**		**Aug**		**March**	
Diel Phase:		**Day**	**Night**	**Day**	**Night**	**Day**	**Night**	**Day**	**Night**
Station	**Depth (m)**								
Head	**250**	0	0	0	0	0	0	0	0
	750	0	0	0	0	0	0	0	0
	Extra	▨	0	▨	▨	▨	▨	▨	▨
Main	**250**	2.67	0	0	3.05	0	0	0	0
	750	0	0	1.175	14.575	0	0	0	0
	1250	1	0.33	4.1	64.8	0	0	0	0
	Extra	0	▨	▨	▨	▨	▨	▨	▨
Wall	**250**	0	0	▨	▨	▨	0	▨	▨
	750	0	0	▨	▨	0	0	▨	▨
Deep	**250**	0	0	0	51.025	0	18.7	▨	0
	750	0.5	0	9.7	51.467	▨	71.5	0	0
	1250	0	0	11.8	57.2167	8	22.5	▨	0
	1750	▨	▨	▨	17.35	▨	21	0	0
	Extra	▨	▨	▨	▨	46		0	
Slope	**750**	▨	▨	▨	▨	9	▨	0	▨
Offshore	**250**	0	110	▨	▨	▨	▨	▨	▨
	750	2	156.5	▨	▨	▨	▨	▨	▨
	1250	26.6	449	▨	▨	▨	▨	▨	▨
	Extra	▨	43.8	▨	▨	▨	▨	▨	▨

No valid IYGPT sets were made in the shaded cells.

In 2008, *N. resplendens* were taken on the Deep and Main stations, the catches on the former averaging higher, though the second largest catch was taken on the Main Station. On the Deep Station at night, approximately equal catches were taken regardless of the depths reached by the sets, suggesting that the fish were mostly in the top 50 m of the water column (above the middle legs of the “W” profile followed by the shallow sets). In contrast, catches on the Main Station increased with the depth reached by the net, the 1,250 m sets taking the most. None were caught above 250 m in daylight on either station.

In 2009, with WSW lying across the mouth of The Gully, rather few *N. resplendens* were taken (445 in all) but almost all of them were caught on the Deep Station. There, and as in the previous year, similar catches were taken at night regardless of the depths reached by the sets. None were caught by the 250 m daylight set on that Station. The Slope Station, fished only in daylight, produced few fish. While that provided very limited data, those did not indicate that the abundance of the fish over the canyon thalweg, on the Deep Station, differed from that over the adjacent continental slope.

The length frequencies of *N. resplendens* showed no noticeable differences with the maximum depths reached by the sets, nor with the diel cycle. The species was taken, in more than very small numbers, on too few stations within each survey for spatial differences in lengths to be discernable. There was, however, a slight shift towards smaller sizes in 2009, compared to the previous surveys, modal length falling within 40–45 mm, rather than 40–55 mm (Figure 43).

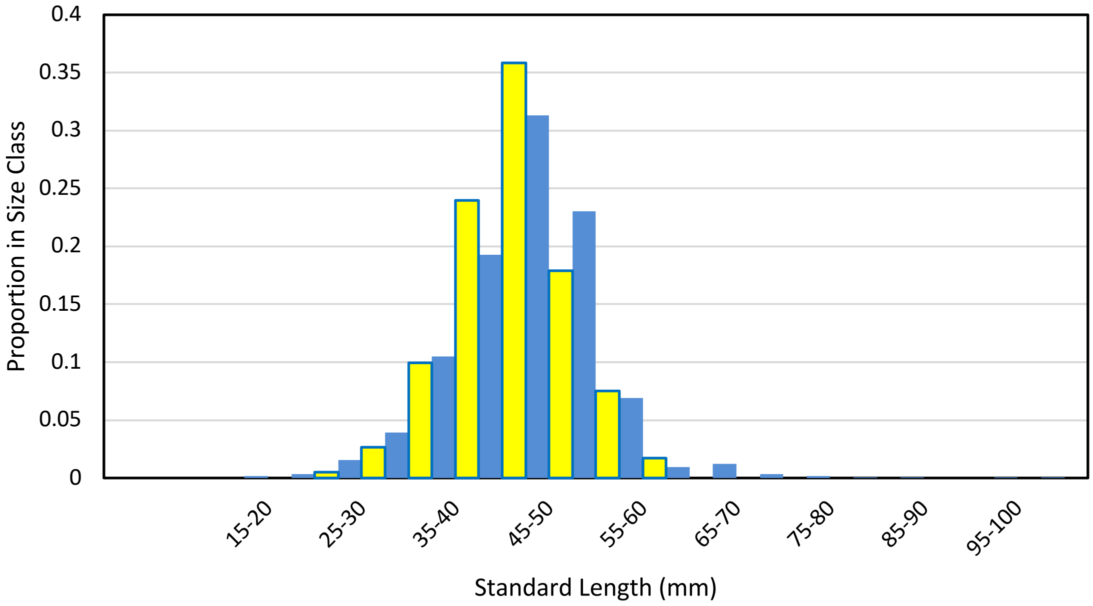


Figure 43 : Length frequencies of *Notoscopelus resplendens* (shown as proportions of measured individuals) contrasting 2007 and 2008 catches (blue) with those from the 2009 survey (yellow), including data from all 1,565 measured individuals that could be confidently assigned to this species

4.3.17 Scopelogadus beanii

Figure 44 : *Scopelogadus beanii*
taken on the Offshore Station by Set 2007_01
(as usual for this species, most of the large, deciduous scales were lost during capture)

Scopelogadus beanii has an extratropical distribution, occurring broadly around the southern temperate zone as well as in the North Atlantic (Kukuev 2014). In the western portion of the latter, it is found from the Gulf of Mexico to Greenland (Moore *et al.* 2003a; Møller *et al.* 2010). The species is deep-living, the adults below 800 m by day and 400 m at night (Moore *et al.* 2003a). Gartner and Musick (1989) suggested that smaller specimens are usually below 400 m and larger ones below 800 m, most being found between 1,500 and 2,000 m. However, Bartow (2010) found that 8% of the catch (by number) on the northern MAR was taken above 200 m. Such shallow occurrences had not previously been reported (Bartow 2010). *Scopelogadus beanii* shows little diel migratory behaviour (Gartner and Musick 1989).

With such a depth distribution, *Scopelogadus beani* has been under-represented in the catches of surveys which have emphasized shallower fishing, such as those of Themelis and Halliday (2012: see Table 4). The surveys on the Azores-to-Reykjanes Ridge portion of the MAR have worked deeper and this species was found to be a major component of the deep-mesopelagic / upper bathypelagic assemblage there (Sutton *et al.* 2008). Bartow (2010) found that 12% of the fish biomass in midwater-trawl catches, from the upper 3,000 m of the water column during that same survey, was composed of members of four species of melamphaids, including *Scopelogadus beanii*. That was the principal species of its genus through much of the study area, though replaced by *Scopelogadus mizolepis* near the Azores. The former species is abundant in the Irminger Sea (Dolgov 2015). The genus was common in the catches from bottom trawling on the Scotian Slope (Halliday *et al.* 2012), though few of the specimens taken were identified to genus.

Scopelogadus beanii appears to be an opportunistic planktivore. Along the continental slope of the western North Atlantic, including in Norfolk Canyon, it has been found to feed on gelatinous plankton, primarily salps, and their associated hyperiid amphipods (Gartner and Musick 1989). It has a specialized form of pectoral-fin “rowing” locomotion which appears adapted to browsing on the dense swarms of salps that can form close to the bottom on the continental slope (Kenaley *et al.* 2014b). However, over deep water it has been found to subsist more on copepods (Gartner and Musick 1989) or larvaceans (Bartow 2010).

In The Gully, there was little sign of diel variation in the catches of this species, though the nine individuals recovered from the catches of 250 m sets were all taken at night[6], while on the Deep and Offshore stations, catches in 750 m sets were larger at night than in daylight (Tables 22A, B). Hence, there appears to be some upward movement at dusk. The 750 m sets regularly took this species but it averaged most abundant in the catches from 1,250 m sets, with no apparent increase in numbers caught by those which fished deeper still.

In the 1,250 m and deeper sets, catches of *Scopelogadus beanii* were substantially lower on the Main and Offshore stations than on the Deep Station. Within each diel phase, the 750 m sets took similar amounts of this species on the Deep, Slope and Offshore stations (though few data were available for the latter two) but about an order-of-magnitude lower numbers (and even less in weight terms) on the Main Station. The Head Station saw catches similar to those on the Main in number terms but much less in weight, while eight sets on the Wall Station took only three individuals – suggesting an avoidance of the upper 750 m of the water column where the fish did not have access to waters below that depth (though that effect seems over-ridden by a concentration in the canyon head). Those trends across depth and the array of stations were broadly maintained in March 2010 but there were generally lower catches than in summer.

There was almost no evident pattern amongst the lengths of the fish taken in summer, when a mode at 100 to 115 mm SL dominated throughout, though a long “tail” of smaller fish was also present (Figure 45). The one indication of more spatial structure was that 10 of the 11 measured fish taken on the Head Station were of ≤62 mm SL (the sole exception being 97 mm). Whether that was a chance effect or a reversal of the trend seen in most other species examined here remains unclear. Larger fish were taken above 750 m on the deeper stations but the apparent reluctance of *Scopelogadus beanii* to live at such depths without access to deeper water below might be particularly true of larger individuals. Unfortunately, none of the three specimens taken on the Wall Station was measured.

In contrast, the relatively small catches of March 2010 were mostly composed of fish of 45–75 mm. The numbers of *Scopelogadus beanii* of that size range that were caught by the one spring survey approximately equalled those taken by the

---

[6] The *Scopelogadus beanii* taken by shallow sets were found in the catches of one set per survey from 2008 onwards, all on the Deep Station. In each case, the set in question had been preceded by one that fished to greater depth and took far more *Scopelogadus beanii* (though in one case there had been a non-fishing period of several hours between those sets). Thus, the presence of the species in the water column above 250 m depth can neither be confirmed nor conclusively rejected.

three summer surveys combined. The 1,250 m sets in spring yielded only a single individual from the 100–115 mm length mode (in 46 measured individuals), whereas 17 of that size were taken by 1,750 m sets (in 117 measured), suggesting that the large fish had moved down into the bathypelagic zone since the previous August. In consequence, although the average catches by 1,250 m and 1,750 m sets on the Deep Station in March 2010 were approximately equal in numbers, in weight terms the deeper sets took twice as much.

Table 22A : Arithmetic mean catches of *Scopelogadus beanii* in each cell of the survey design: numbers of individuals

Year:		**2007**		**2008**		**2009**		**2010**	
Month:		**Sept**		**Aug/Sept**		**Aug**		**March**	
Diel Phase:		**Day**	**Night**	**Day**	**Night**	**Day**	**Night**	**Day**	**Night**
Station	**Depth (m)**								
Head	**250**	0	0	0	0	0	0	0	0
	750	0	0	1.5	1	0	9	0	0
	Extra		0						
Main	**250**	0	0	0	0	0	0	0	0
	750	0.67	0	1.5	2.5	0	2.5	3	1.5
	1250	8.33	6.67	15.5	13.5	32	43	7	6.5
	Extra	11							
Wall	**250**	0	0				0		
	750	0.33	0			1	0.5		
Deep	**250**	0	0	0	1.5	0	3		1
	750	7	19	3.5	20.67		9	7	10
	1250	36.5	38.5	62.5	44.67	92.5	47		23
	1750				33		54.5	32	19.5
	Extra					51		17	
Slope	**750**					3.5		1	
Offshore	**250**	0	0						
	750	3	21						
	1250	27	11						
	Extra		3						

No valid IYGPT sets were made in the shaded cells.

Table 22B : Arithmetic mean catches of *Scopelogadus beanii* in each cell of the survey design: weights caught (g)

Year:		2007		2008		2009		2010	
Month:		Sept		Aug/Sept		Aug		March	
Diel Phase:		Day	Night	Day	Night	Day	Night	Day	Night
Station	Depth (m)								
Head	250	0	0	0	0	0	0	0	0
	750	0	0	14.2	1.35	0	17	0	0
	Extra		0						
Main	250	0	0	0	0	0	0	0	0
	750	1.2	0	3.7	43.9	0	52.5	46	12
	1250	190	113.867	314.5	291.5	955	1142	93	66.5
	Extra	270							
Wall	250	0	0				0		
	750	9.67	0			1	0.5		
Deep	250	0	0	0	22.475	0	59		14.33
	750	297	376.8	25.125	518		147.5	10	140
	1250	787.5	719.5	1742.5	1150.67	2325.5	1345		159.5
	1750				744		1385.5	344	350
	Extra					1589.5		197	
Slope	750					116		15	
Offshore	250	0	0						
	750	30	512						
	1250	607	190						
	Extra		82						

No valid IYGPT sets were made in the shaded cells.

In summary, the observations of *Scopelogadus beanii* in The Gully were generally consistent with previous expectations, though there were indications of some diel change in vertical distribution. Contrary to Gartner and Musick's (1989) conclusion of bottom-associated feeding, the Gully data showed the major catches high in the water column (in the 750–1,250 m depth range) over the deep seabed of the Deep Station. However, truly bottom-associated individuals, if present, would not have been taken by the midwater nets used in The Gully. In contrast to the up-canyon elevation of depth distributions seen in several other species, that of *Scopelogadus beanii* seems truncated by the presence of a shallower seabed, while even its abundance over such a seabed seems diminished by the latter – an effect that may be especially developed in larger individuals.

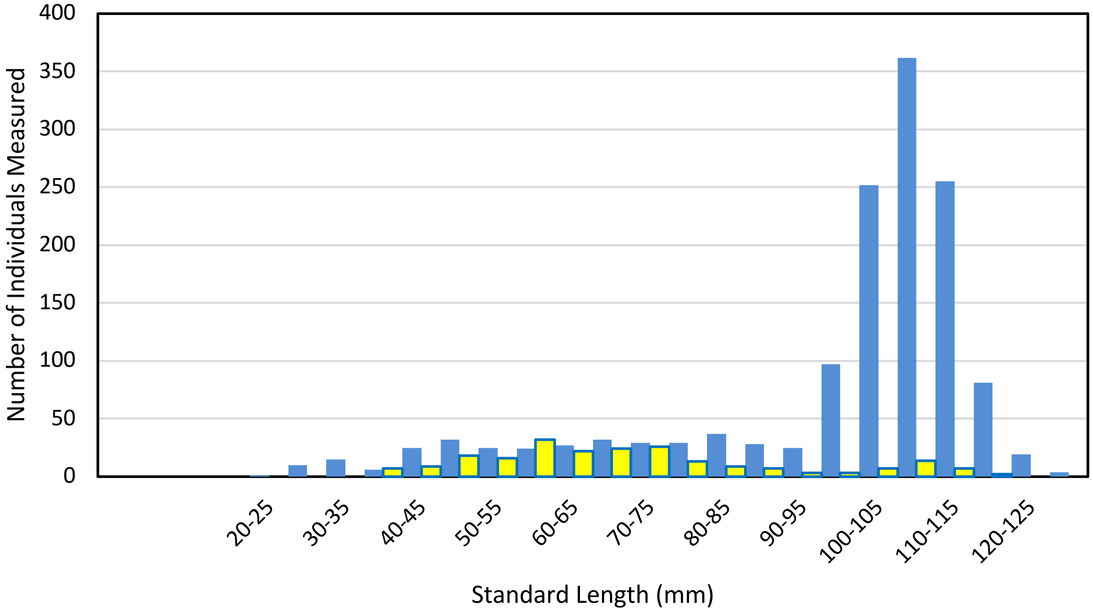


Figure 45 : Length frequencies of *Scopelogadus beanii* by season, including all 1,637 measured individuals (Blue: Summer surveys; Yellow: March 2010 survey)

4.3.18 Anoplogaster cornuta

**Figure 46 : *Anoplogaster cornuta*, 108 mm SL,
taken on the Main Station by Set 2010_14**

A. cornuta is a circumglobal species (Gaither *et al.* 2016). In the western Atlantic, it is known from the Caribbean to Greenland (Moore 2003a; Møller *et al.* 2010) and in the Irminger Sea (Dolgov 2015), though only ever taken in small numbers (see

Table 4). Twenty have been taken when bottom trawling on the Scotian Slope (Halliday *et al.* 2012). Unusually for a deep-living pelagic fish, however, it is stout and well-muscled, hence included in the present selection of species because of the weight taken by the surveys (the average individual weight of those caught being 68 g). *A. cornuta* is a bathypelagic species that is also found in the lower mesopelagic zone (Moore 2003a).

Table 23A : Arithmetic mean catches of *Anoplogaster cornuta* in each cell of the survey design: numbers of individuals

Year:		**2007**		**2008**		**2009**		**2010**	
Month:		**Sept**		**Aug/Sept**		**Aug**		**March**	
Diel Phase:		**Day**	**Night**	**Day**	**Night**	**Day**	**Night**	**Day**	**Night**
Station	**Depth (m)**								
Head	**250**	0	0	0	0	0	0	0	0
	750	0	0	0	0	0.5	1	0	0
	Extra		0						
Main	**250**	0	0	0	0	0	0	0	0
	750	0.33	0	0.5	0	0	0	0	0
	1250	0.33	1.33	1.5	0	1	1.5	1	0.5
	Extra	0							
Wall	**250**	0	0				0		
	750	0.67	0			0	0		
Deep	**250**	0	0	0	0	0	0		0
	750	0.5	0	0.5	0.67		0	0	0.5
	1250	0.5	2	1	0.33	1.5	0.5		1
	1750				0		0.5	1.5	1
	Extra					2.5		2	
Slope	**750**					0		1	
Offshore	**250**	0	0						
	750	1	2						
	1250	0	0						
	Extra		1						

No valid IYGPT sets were made in the shaded cells.

With so few individuals caught by the Gully surveys (Tables 23A, B) few confident conclusions can be drawn about their distribution. None were caught above 250 m depth and most were taken below 750 m. The evidence for a further increase in the catches of those sets which fished below 1,250 m, and even below 1,750 m, is equivocal but a distribution extending deep into the bathypelagic zone cannot be ruled out.

Table 23B : Arithmetic mean catches of *Anoplogaster cornuta* in each cell of the survey design: weights caught (g)

Year:		**2007**		**2008**		**2009**		**2010**	
Month:		**Sept**		**Aug/Sept**		**Aug**		**March**	
Diel Phase:		**Day**	**Night**	**Day**	**Night**	**Day**	**Night**	**Day**	**Night**
Station	**Depth (m)**								
Head	**250**	0	0	0	0	0	0	0	0
	750	0	0	0	0	7.49	58	0	0
	Extra		0						
Main	**250**	0	0	0	0	0	0	0	0
	750	3.66	0	6.53	0	0	0	0	0
	1250	2.14	73.23	75.35	0	86	84.19	90.98	7.31
	Extra	0							
Wall	**250**	0	0				0		
	750	9.68	0			0	0		
Deep	**250**	0	0	0	0	0	0		0
	750	5.90	0	5.18	11.83		0	0	7.26
	1250	11.85	217.67	10.64	2.40	12.56	4.912		119.45
	1750				0		6.07	14.30	48.48
	Extra					107.47		141	
Slope	**750**					0		43	
Offshore	**250**	0	0						
	750	40	93						
	1250	0	0						
	Extra								

No valid IYGPT sets were made in the shaded cells.

The few available length data for *A. cornuta* (Figure 47) are uninformative.

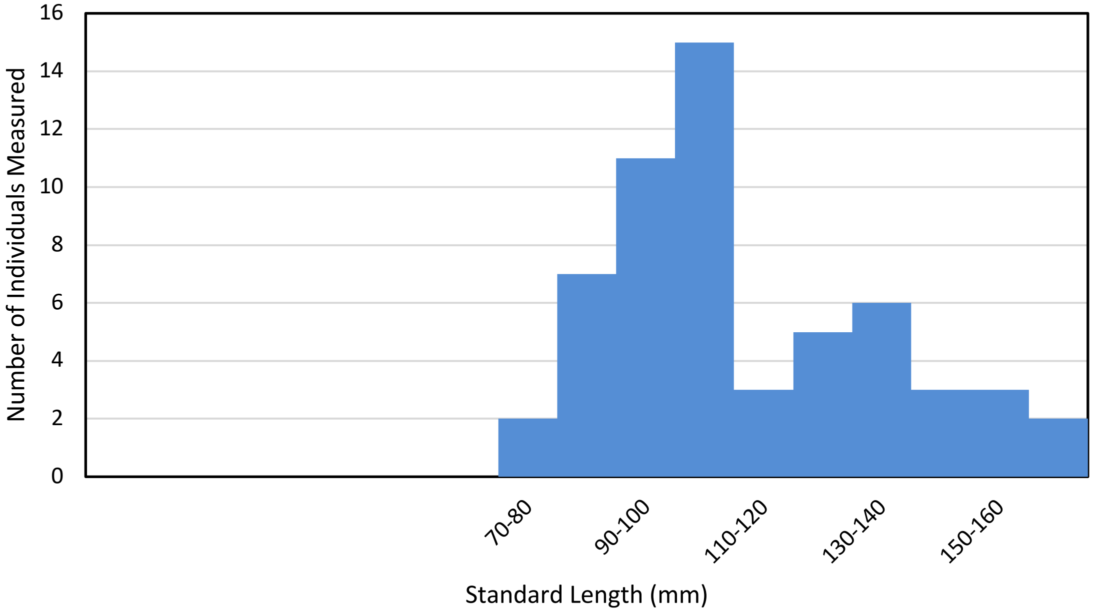


Figure 47 : Length frequency of *Anoplogaster cornuta*, including all 57 measured individuals

4.3.19 Melanostigma atlanticum

Figure 48 : *Melanostigma atlanticum*, 97 mm SL, taken on the Wall Station by Set 2009_44

Uniquely among the 19 species considered here, *M. atlanticum* is a species of North Atlantic continental slopes, rather than open-ocean environments. It is known in the west from Cape Hatteras to Greenland, over a depth range of 275 to 2,000 m (Moore *et al.* 2003a; Møller *et al.* 2010) but is rarely seen in the catches of pelagic surveys away from continental margins (see Table 4 and Dolgov 2015).

Its familial relatives are mostly benthic and *M. atlanticum* is highly unusual amongst fishes regularly found in the mesopelagic zone for its mode of spawning, which takes place in summer (June to September) in burrows in muddy seabeds that can exceed 0.3 m depth (Markle and Wenner 1979; Silverberg *et al.* 1987;

Silverberg and Bossé 1994). In consequence, *M. atlanticum* has been recorded by on-bottom studies (using both ROVs and bottom trawls) in Baltimore and Norfolk canyons (Ross *et al.* 2015) and has been observed from submersibles in canyons on the continental slope of Georges Bank, both near the seabed and in midwater. Those in the latter setting were often observed to drift passively, remaining motionless (Uiblein *et al*. 2005). Curiously, only ten specimens have been reported from the catches taken by bottom trawling on the Scotian Slope (Halliday *et al.* 2012). In contrast, Richard (1987) found *M. atlanticum* to be very common in midwater catches in Bay d'Espoir, a fjord system on the south coast of Newfoundland, at depths down to 635 m. An ROV survey of the continental slope south of Newfoundland, which included a station in Desbarres Canyon, observed 38 *M. atlanticum* between 600 and 1,000 m depth. The species (the only one of the present 19 recorded as more than single individuals) was more prevalent in seapen fields than elsewhere (Baker *et al.* 2012).

M. atlanticum is abundant in the Laurentian Channel, particularly towards its head (Silverberg *et al.*1987; Chouinard and Dutil 2011). The routine groundfish trawl surveys in the southern Gulf of St. Lawrence take this species in the deep waters of the Channel. There, they were unrecorded before changes in the survey protocols in 1985 but thereafter both catches and the area occupied increased dramatically through to the mid-1990s, after which they were maintained into the new century. The progressive nature of that increase suggests that it was not due to the protocol changes alone (Benoît *et al.* 2003). As with the similar increase in *A. risso*, the period of change coincided with both oceanographic changes and the depletion of resource species. During 2004–08, routine groundfish surveys took 7,819 individuals (27 kg in all) in 871 sets, though it is unclear whether those were caught on-bottom or as the nets passed through the water column (Nozères *et al.* 2010).

In Bay d'Espoir, Richard (1987) observed four length modes, of approximately 20-45, 50-80, 70-95 and 95-140 mm total length. The first and last were seen in both 1982 and 1983 but the mid-length modes only in successive years, suggesting the growth of a recruiting year-class. If so, the mode of 95 mm and larger individuals represents fish of Age 4 and older.

As was to be expected of a bottom-associated species, during the Gully surveys no *M. atlanticum* were taken on either the Offshore or Slope Stations, while only three were caught on the intensively fished Deep Station (Tables 24A, B).

In the central and upper canyon, most were caught between 250 and 750 m depth, with a few above 250 (in daylight on the Head Station but only at night on Main and Wall stations). On the Main Station, catches by 1,250 m sets were no greater than those taken by 750 m sets in 2007 or 2008 but perhaps higher in 2009 and again in March 2010.

Table 24A : Arithmetic mean catches of *Melanostigma atlanticum* in each cell of the survey design: numbers of individuals

Year:		**2007**		**2008**		**2009**		**2010**	
Month:		**Sept**		**Aug/Sept**		**Aug**		**March**	
Diel Phase:		**Day**	**Night**	**Day**	**Night**	**Day**	**Night**	**Day**	**Night**
Station	**Depth (m)**								
Head	**250**	0	1	0	0	1	0	1	0.5
	750	3	1	7	2	15	11	0.5	2
	Extra		5						
Main	**250**	0	0	0	0	0	0	0	0.5
	750	2.33	0.33	5	4.5	0.33	0	0	0.5
	1250	1	1	0.5	4	1	0.5	3	2
	Extra	0							
Wall	**250**	0	1				0		
	750	5.67	3			6	2.5		
Deep	**250**	0	0	0	0	0	0		0
	750	0.5	0	0	0		0	0	0
	1250	0	0	0	0	0.5	0		0
	1750				0		0	0.5	0
	Extra					0		0	
Slope	**750**					0		0	
Offshore	**250**	0	0						
	750	0	0						
	1250	0	0						
	Extra		0						

No valid IYGPT sets were made in the shaded cells.

In 2007, the highest average catch by 750 m sets was taken on the Wall Station, with the Main and Head yielding less. The following year, the catch on each of the latter two stations averaged more than three times what it had in 2007. In 2009, the Head Station catches were much the largest, considerably more than doubling over 2007 in numbers and nearly tripling in weight. In contrast, Wall Station catches were little changed from those of the first survey and Main Station catches fell sharply (by two orders of magnitude in weight terms). By March 2010, Head Station catches had dropped back to their level in summer 2007, while those from the Main Station were nearer to the 2008 level, though most specimens were found in the catches of sets which reached 1,250 m – suggesting that the fish were deeper.

Table 24B : Arithmetic mean catches of *Melanostigma atlanticum* in each cell of the survey design: weights caught (g)

Year:		**2007**		**2008**		**2009**		**2010**	
Month:		**Sept**		**Aug/Sept**		**Aug**		**March**	
Diel Phase:		**Day**	**Night**	**Day**	**Night**	**Day**	**Night**	**Day**	**Night**
Station	**Depth (m)**								
Head	**250**	0	7.267	0	0	13	0	8	1.5
	750	21.433	3.38	48	15.25	114	76	5	17.5
	Extra		33.1						
Main	**250**	0	0	0	0	0	0	0	4
	750	10.433	1.33	27.225	12.8	0.33	0	0	1.5
	1250	8.5	5.267	0.5	17.475	1	1	26	13.5
	Extra	0							
Wall	**250**	0	3.25				0		
	750	28.33	12.45			19	6		
Deep	**250**	0	0	0	0	0	0		0
	750	0.5	0	0	0		0	0	0
	1250	0	0	0	0	1.5	0		0
	1750				0		0	1.5	0
	Extra					0		0	
Slope	**750**					0		0	
Offshore	**250**	0	0						
	750	0	0						
	1250	0	0						
	Extra		0						

No valid IYGPT sets were made in the shaded cells.

While some small individuals were caught by the summer surveys, most were 110–150 mm SL (Figure 49) and hence probably reproductive adults (cf. Markle and Wenner 1979; Silverberg *et al.* 1987). No specimens of less than 95 mm SL (presumably juveniles) were taken in March 2010. In summer, there was a higher proportion of smaller individuals on the Main Station than the Head, perhaps because reproductive adults then tended to remain closer to the seabed) but that distinction was not evident in the one spring survey. No other size differences could be seen in the limited available data.

In summary, the Gully surveys took more *M. atlanticum* than many other mesopelagic studies, as was to be expected when fishing close to the seabed. The highest catches were taken where it was closest – on the Wall and Head stations– while almost none were taken outside the canyon's mouth. Some were caught above 250 m depth, including in daylight on the Head Station, suggesting a degree of elevation of depth distribution up-canyon.

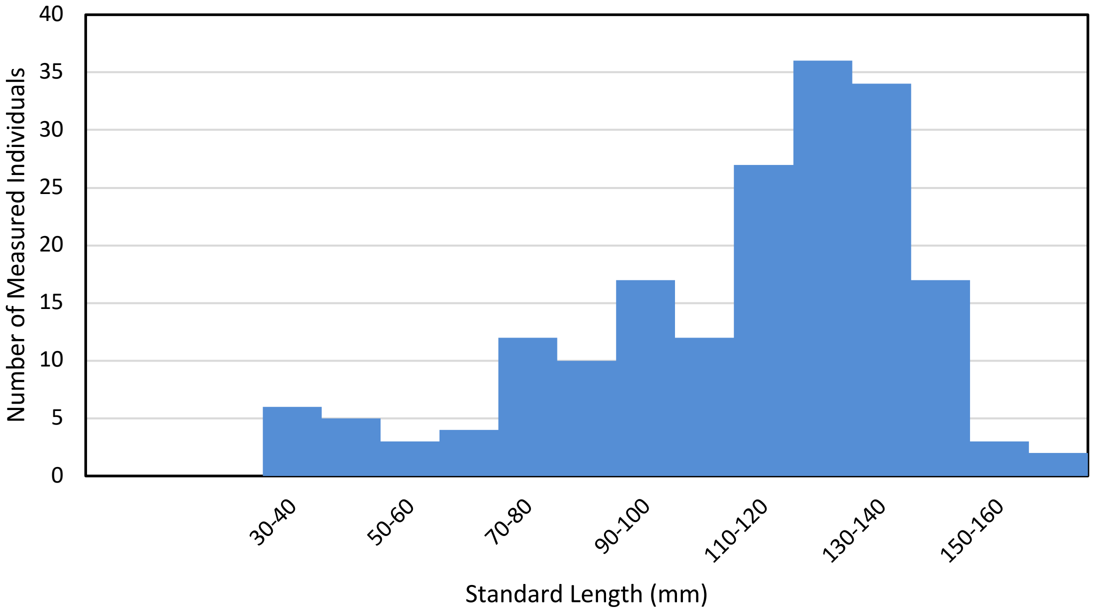


Figure 49 : Length frequency of *Melanostigma atlanticum*, including all 188 measured individuals

ACKNOWLEDGEMENTS

This report builds on work previously presented by Kenchington *et al.* (2009, 2014a,b) and hence on the efforts of the authors of those prior Reports and the other individuals whose contributions were acknowledged therein, particularly the captains, officers and crews of CCGSs *Templeman*, *Needler* and *Teleost*. Maintenance of the fish specimen collection, facilitating the identification process, has been supported by Megan Best, Barry MacDonald and Sarah Thompson. We owe a special and on-going debt to Cam Lirette for his uncomplaining maintenance of the program's catch database, incorporating additions and amendments as they arise, as well as for preparation of the maps illustrating this Report. The specimen images were prepared by the senior author from photographs taken at sea, most by either Andrew Cogswell or Megan Best. Finally, Dr. Javier Murillo and Sarah Thompson provided valuable reviews of the finished work.

The current report was prepared while its senior author was supported by the Oceans and Coastal Management Division at BIO, advancing work on the monitoring of the Gully MPA.

REFERENCES

Backus, R.H., and Craddock, J.E. 1982. Mesopelagic fishes in Gulf Stream cold-core rings. *J. Mar. Res.* 40(Suppl.): 1-20.

Backus, R.H., Craddock, J.E., Haedrich, R.L., Shores, D.L., Teal, J.M., and Wing, A.S. 1968. *Ceratoscopelus maderensis*: Peculiar sound-scattering layer identified with this myctophid fish. *Science* 160: 991-993.

Badcock, J. 1970. The vertical dimension of mesopelagic fishes collected on the SOND cruise. *J. Mar. Biol. Asso. U. K.* 50: 1001-1044.

Baker, K.D., Haedrich, R.L., Snelgrove, P.V., Wareham, V.E., Edinger, E.N., and Gilkinson, K.D. 2012. Small-scale patterns of deep-sea fish distributions and assemblages of the Grand Banks, Newfoundland continental slope. *Deep-Sea Res. I* 65: 171-188.

Bañón Díaz, R., Cerviño, S., and Campelos, J.M. 2001. *Composición, distribución y descripción de mictófidos (Pisces, Myctophidae) encontrados en Flemish Cap (Atlantico noroeste) en verano de 1998. Bol. Inst. Esp. Oceanogr.* 17: 287-294.

Bartow, K.A. 2010. Taxonomy and ecology of the deep-pelagic fish family Melamphaidae, with emphasis on interactions with a mid-ocean ridge system. *Ph.D. thesis, Florida Atlantic University*: xiv+185p.

Benoît, H.P., Abgrall, M.-J., and Swain, D.P. 2003. An assessment of the general status of marine and diadromous fish species in the southern Gulf of St. Lawrence based on annual bottom-trawl surveys (1971–2002). *Can. Tech. Rep. Fish. Aquat. Sci.* 2472: iv+183p.

Benoît, H.P., and Swain, D.P. 2008. Impacts of environmental change and direct and indirect harvesting effects on the dynamics of a marine fish community. *Can. J. Fish. Aquat. Sci.* 65: 2088-2104.

Bossé, L. 1991. *Première mention d'une avocette ruban* (Pisces: *Nemichthys scolopaceus* Richardson, 1848) *dans les eaux du Golfe du St-Laurent*. *Can. Field-Nat*. 105: 115-116.

Chouinard, P.-M., and Dutil, J.-D. 2011. The structure of demersal fish assemblages in a cold, highly stratified environment. *ICES J. Mar. Sci.* 68: 1896-1908.

Cook, A.B., Sutton, T.T., Galbraith, J.K., and Vecchione, M. 2013. Deep-pelagic (0–3000m) fish assemblage structure over the Mid-Atlantic Ridge in the area of the Charlie-Gibbs Fracture Zone. *Deep-Sea Res. II* 98: 279-291.

DeVaney, S.C. 2016. Species distribution modelling of deep pelagic eels. *Integr. Comp. Biol.* 56: 524-530.

Dolgov, A.V. 2013. Annotated list of fish-like vertebrates and fish of the Kara Sea. *J. Ichthyol.* 53: 914-922.

Dolgov, A.V. 2015. Composition and structure of the mesopelagic fish communities in the Irminger Sea and adjacent waters. *J. Ichthyol*. 55: 53-68.

Drinkwater, K.F., and Gilbert, D. 2004. Hydrographic variability in the waters of the Gulf of St. Lawrence, the Scotian Shelf and the eastern Gulf of Maine (NAFO Subarea 4) during 1991-2000. *J. Northw. Atl. Fish. Sci.* 34: 83-99.

Dypvik, E., Klevjer, T.A., and Kaartvedt, S. 2012a. Inverse vertical migration and feeding in glacier lanternfish (*Benthosema glaciale*). *Mar. Biol.* 159: 443-453.

Dypvik, E., Røstad, A., and Kaartvedt, S. 2012b. Seasonal variations in vertical migration of glacier lanternfish, *Benthosema glaciale*. *Mar. Biol.* 159: 1673-1683.

Feagans-Bartow, J.N., and Sutton, T.T. 2014. Ecology of the oceanic rim: pelagic eels as key ecosystem components. *Mar. Ecol. Prog. Ser.* 502: 257-266.

Filin, A.A. 1995. Feeding habits and trophic relationships of *Notoscopelus kroeyerii* (Myctophidae). *J. Ichthyol.* 35:79-88.

Gaither, M.R., Bowen, B.W., Rocha, L.A., and Briggs, J.C. 2016. Fishes that rule the world: circumtropical distributions revisited. *Fish and Fisheries* 17: 664-679.

García-Seoane, E., Dalpadado, P., and Vázquez, A. 2013. Feeding ecology of the glacier lanternfish *Benthosema glaciale* (Actinopterygii, Myctophidae) in the Flemish Cap (North Atlantic Ocean). *Hydrobiologia* 717: 133-146.

García-Seoane, E., Fabeiro, M., Silva, A., and Meneses, I. 2015. Age-based demography of the glacier lanternfish (*Benthosema glaciale*) in the Flemish Cap. *Mar. Freshw. Res.* 66: 78-85.

Gartner, J.V., and Musick, J.A. 1989. Feeding habits of the deep-sea fish *Scopelogadus beanii* (Pisces: Melamphaeidae), in the western North Atlantic. *Deep-Sea Res. Part A* 36: 1457-1469.

Gartner, J.V., Sulak, K.J., Ross, S.W., and Necalse, A.M. 2008. Persistent near-bottom aggregations of mesopelagic animals along the North Carolina and Virginia continental slopes. *Mar. Biol.* 153: 825-841.

Gilbert, D., Sundby, B., Gobeil, C., Mucci, A., and Tremblay, G.-H. 2005. A seventy-two-year record of diminishing deep-water oxygen in the St. Lawrence estuary: The northwest Atlantic connection. *Limnol. Oceanogr.* 50: 1654-1666.

Gjösæter, J. 1973a. Age, growth, and mortality of the myctophid fish, *Benthosema glaciale* (Reinhardt), from western Norway. *Sarsia* 52: 1-14.

Gjösæter, J. 1973b. The food of the myctophid fish, *Benthosema glaciale* (Reinhardt), from western Norway. *Sarsia* 52: 52-58.

Gjøsæter, J. 1981. Life history and ecology of the myctophid fish *Notoscopelus elongatus kroeyeri* from the northeast Atlantic. *FiskDir. Skr. Ser. HavUnders.* 17: 133-152.

Greenan, B.J.W., Petrie, B.D., and Cardoso, D.A. 2014. Mean circulation and high-frequency flow amplification in the Sable Gully. *Deep-Sea Res. II* 104: 20-34.

Greenan, B.J.W., Petrie, B.D., Cardoso, D.A., Harrison, W.G., Head, E.J.H., and Li, W.K.W. 2013. Physical, chemical and biological variability of the Sable Gully 2006-07. *Can. Tech. Rep. Hydrogr. Ocean. Sci*. 293: x+261 pp.

Halliday, R.G. 1970. Growth and vertical distribution of the glacier lanternfish, *Benthosema glaciale*, in the northwestern Atlantic. *J. Fish. Res. Bd Can.* 27: 105-116.

Halliday, R.G., Clark, K.J., and Themelis, D.E. 2015. The biology of *Benthosema glaciale* and *Ceratoscopelus maderensis* (Myctophidae) in the Slope Sea off Nova Scotia, Canada. *J. Northw. Atlant. Fish. Sci.* 47: 75-89.

Halliday, R.G., and Scott, W.B. 1969. Records of mesopelagic and other fishes from the Canadian Atlantic with notes on their distribution. *J. Fish. Res. Bd Can.* 26: 2691-2702.

Halliday, R.G., Van Guelpen, L., and Themelis, D.E. 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.

Hudson, J.M., Steinberg, D.K., Sutton, T.T., Graves, J.E., and Latour, R.J. 2014. Myctophid feeding ecology and carbon transport along the northern Mid-Atlantic Ridge. *Deep-Sea Res. I* 93: 104-116.

Jahn, A.E., and Backus, R.H. 1976. On the mesopelagic fish faunas of Slope Water, Gulf Stream, and northern Sargasso Sea. *Deep-Sea Res.* 23: 223-234.

Kaartvedt, S., Røstad, A., Klevjer, T.A. and Staby, A. 2009. Use of bottom-mounted echo sounders in exploring behavior of mesopelagic fishes. *Mar. Ecol. Prog. Ser.* 395: 109-118.

Kenaley, C.P. 2007. Revision of the stoplight loosejaw genus *Malacosteus* (Teleostei: Stomiidae: Malacosteinae):, with description of a new species from the temperate Southern Hemisphere and Indian Ocean. *Copeia* 2007: 886-900.

Kenaley, C.P. 2008. Diel vertical migration of the loosejaw dragonfishes (Stomiiformes: Stomiidae: Malacosteinae): a new analysis for rare pelagic taxa. *J. Fish. Biol.* 73: 888-901.

Kenaley, C.P., DeVaney, S.C., and Fjeran, T.T. 2014a. The complex evolutionary history of seeing red: Molecular phylogeny and the evolution of an adaptive visual system in deep-sea dragonfishes (Stomiiformes: Stomiidae). *Evolution* 68: 996-1013.

Kenaley, C.P., Stote, A., and Flammang, B.E. 2014b. The morphological basis of labriform rowing in the deep-sea bigscale *Scopelogadus beanii* (Percomorpha: Beryciformes). *J. Exper. Mar. Biol. Ecol.* 461: 297-305.

Kenchington, E.L., Baillie, S.M., Kenchington, T.J., and Bentzen, P. 2017. Barcoding Atlantic Canada's mesopelagic and upper bathypelagic marine fishes. *PloS ONE* 12(9), e0185173: 20p.

Kenchington, T.J., Best, M., Bourbonnais-Boyce, C., Clement, P., Cogswell, A., MacDonald, B., MacEachern, W.J., MacIsaac, K., MacNab, P., Paon, L., Reid, J., Roach, S., Shea, E., Themelis, D., and Kenchington, E.L.R. 2009. Methodology of the 2007 Survey of meso- and bathypelagic micronekton of the Sable Gully: Cruise TEM768. *Can. Tech. Rep. Fish. Aquat. Sci*. 2853: vi+91p.

Kenchington, T.J., Benjamin, R., Best, M., Cogswell, A., Cook, A., DeVaney, S., Lirette, C., MacDonald, B., MacIsaac, K., Mallam, P., McIntyre, T., McMillan, A., Moors-Murphy, H., Morton, G., Paon, L., Roach, S., Shea, E., Themelis, D., and Kenchington, E.L.R. 2014a. Field methods of the 2008, 2009 and 2010 surveys of meso- and bathypelagic micronekton in The Gully. *Can. Tech. Rep. Fish. Aquat. Sci*. 3076: iv+73p.

Kenchington, T.J., Cochrane, N.A., Gjerdrum, C., Lirette, C., Greenan, B.J.W., Moors-Murphy, H., and Thompson, S.E. 2014b. The environmental background to the 2008, 2009 and 2010 meso- and bathypelagic trawl surveys of The Gully. *Can. Tech. Rep. Fish. Aquat. Sci.* 3114: vi+251p.

Kenchington, T.J., Themelis, D.E., DeVaney, S.C., and Kenchington, E.L. *In prep*.) The meso- and bathypelagic fish in a large submarine canyon: Assemblage structure and trophic role of the principal species in The Gully. For submission to *Deep-Sea Res. I*

Kukuev, E.I. 2002. Species composition and characteristics of distribution of mesopelagic fishes in the Gulf Stream Zone during the winter of 1981. *J. Ichthyol.* 42: 163-169.

Kukuev, E.I. 2014. Formation of extratropical (moderately cold-water and bipolar) ranges of species of mesopelagic fish of high-latitude areas of the World Ocean. *J. Ichthyol.* 54: 790-807.

MacIsaac, K.G., Kenchington, T.J., Kenchington, E.L.R., and Best, M. 2014. The summer assemblage of large pelagic Crustacea in the Gully submarine canyon: Major patterns. *Deep-Sea Res. II* 104: 51-66.

Markle, D.F., and Wenner, C.A. 1979. Evidence of demersal spawning in the mesopelagic zoarcid fish *Melanostigma atlanticum* with comments on demersal dpaning in the alepocephalid fish *Xenodermichthys copei*. *Copeia* 1979: 363-366.

Mazhirina, G.P., and Filin, A.A. 1987. Gonad development and spawning of *Notoscopelus kroyeri* in the Northwest Atlantic, with observations on other biological characteristics. *J. Northw. Atl. Fish. Sci.* 7: 99-106.

McKelvie, D.S. 1985. The mesopelagic fish fauna of the Newfoundland Basin. *Can. J. Zool.* 63: 2176-2182.

McKelvie, D.S., and Haedrich, R.L. 1985. Mesopelagic fishes (excluding Myctophidae) from research surveys off Newfoundland and Labrador. *NAFO Sci. Coun. Studies* 8: 67-75.

McQuinn, I.H., Bourassa, M.-N., Tournois, C., Grégoire, F., and Baril, D. 2012. Ecologically and biologically significant areas in the Estuary and Gulf of St. Lawrence: small pelagic fishes. *DFO Can. Sci. Advis. Sec. Res. Doc.* 2012/087. iii + 76 p.

Møller, P.R., Nielsen, J., Knudsen, S.W., Poulsen, J.Y., Sünksen, K., and Jørgensen, O.A. 2010. A checklist of the fish fauna of Greenland waters. *Zootaxa* 2378: 1-84.

Moore, J.A., Hartel, K.E., Craddock, J.E., and Galbraith, J.K. 2003a. An annotated list of deepwater fishes from off the New England region, with new area records. *Northeastern Naturalist* 10: 159-248.

Moore, J.A., Vecchione, M., Collette, B.B., Gibbons, R., Hartel, K.E., Galbraith, J.K., Turnipseed, M., Southworth, M., and Watkins, E. 2003b. Biodiversity of Bear Seamount, New England Seamount Chain: Results of exploratory trawling. *J. Northw. Atl. Fish. Sci.* 31: 363-372.

Moore, J.A., Vecchione, M., Collette, B.B., Gibbons, R., and Hartel, K.E. 2004. Selected fauna of Bear Seamount (New England Seamount chain), and the presence of “natural invader” species. *Arch. Fish. Mar. Res*. 51(1-3): 241-250.

Musick, J.A. 1973. Mesopelagic fishes from the Gulf of Maine and the adjacent continental slope. *J. Fish. Res. Bd Can.* 30: 134-137.

Nielsen, J.G., Bertelsen, E., and Jespersen, Å. 1989. The biology of *Eurypharynx pelecanoides* (Pisces, Eurypharyngidae). *Acta Zoologica* 70: 187-197.

Nozères, C., Archambault, D., Chouinard, P.-M., Gauthier, J., Miller, R., Parent, E., Schwab, P., Savard, L., and Dutil, J.-D. 2010. Identification guide for marine fishes of the estuary and northern Gulf of St. Lawrence and sampling protocols used during trawl surveys between 2004 and 2008. *Can. Tech. Rep. Fish. Aquat. Sci*. 2866: xi+243 p.

Opdal, A.F., Godø, O.R., Bergstad, O.A., and Fiksen, Ø. 2008. Distribution, identity, and possible processes sustaining meso- and bathypelagic scattering layers on the northern Mid-Atlantic Ridge. *Deep-Sea Res. II* 55: 45-58.

Pepin, P. 2013. Distribution and feeding of *Benthosema glaciale* in the western Labrador Sea: Fish-zooplankton interaction and the consequence to calanoid copepod populations. *Deep-Sea Res. I* 75: 119-134.

Pusch, C., Schnack-Schiel, S., Mizdalski, E. and von Westernhagen, H. 2004. Feeding ecology of three myctophid species at the Great Meteor Seamount (North-east Atlantic). *Arch. Fish. Mar. Res.* 51: 251-271.

Richard, J.M. 1987. The mesopelagic fish and invertebrate faunas of two Newfoundland fjords with differing physical oceanography. *MSc thesis, Memorial University of Newfoundland*: xiii+182p.

Roe, H.S.J., and Badcock, J. 1984. The diel migrations and distributions within a mesopelagic community in the north east Atlantic. 5. Vertical migrations and feeding of fish. *Prog. Oceanogr.* 13: 389-424.

Ross, S.W., Rhode, M., and Quattrini, A.M. 2015. Demersal fish distribution and habitat use within and near Baltimore and Norfolk canyons, U.S. middle Atlantic slope. *Deep-Sea Res. I* 103: 137-154.

Sameoto, D.D. 1988. Feeding of lantern fish *Benthosema glaciale* off the Nova Scotia Shelf. *Mar. Ecol. Prog. Ser.* 44: 113-129.

Sameoto, D.D. 1989. Feeding ecology of the lantern fish *Benthosema glaciale* in a Subarctic region. *Polar Biol.* 9: 169-178.

Sarmineto-Lezcano, A.-N., Triay-Portella, R., Castro, J.J., Rubio-Rodríguez, U., and Pajuelo, J.G. 2018. Age-based life-history parameters of the mesopelagic fish *Notoscopelus resplendens* (Richardson, 1845) in the central eastern Atlantic. *Fisheries Research* 204: 412-423.

Savenkoff, C., Castonguay, M., Chabot, D., Hammill, M.O., Bourdages, H., and Morissette, L. 2007a. Changes in the northern Gulf of St. Lawrence ecosystem estimated by inverse modelling: Evidence of a fishery-induced regime shift? *Estuarine Coast. Shelf Sci.* 73: 711-724.

Savenkoff, C., Swain, D.P., Hanson, J.M., Castonguay, M., Hammill, M.O., Bourdages, H., Morissette, L. and Chabot, D. 2007b. Effects of fishing and predation in a heavily exploited ecosystem: Comparing periods before and after the collapse of groundfish in the southern Gulf of St. Lawrence (Canada). *Ecological Modelling* 204: 115-128.

Scallon-Chouinard, P.-M., Dutil, J.-D. and Hurtubise, S. 2007. *Liste des espèces de poissons inventoriés dans l'estuaire maritime du Saint-Laurent entre 1930 et 2005*. *Rapp. Tech. Can. Sci. Halieut. Aquat*. 2719 : vi+58p.

Silverberg, N., and Bossé, L. 1994. Additional observations of endobenthic behaviour in the early life history of *Melanostigma atlanticum* (Zoarcidae) in muddy bottom sediments of the Laurentian Trough, eastern Canada. *Environ. Biol. Fish.* 39: 43-49.

Silverberg, N., Edenborn, H.M., Ouellet, G., and Béland, P. 1987. Direct evidence of a mesopelagic fish, *Melanostigma atlanticum* (Zoarcidae) spawning within bottom sediments. *Environ. Biol. Fish.* 20: 195-202.

Sutton, T.T., Letessier, T.B., and Bardarson, B. 2013. Midwater fishes collected in the vicinity of the Sub-Polar Front, mid-North Atlantic Ocean, during ECOMAR pelagic sampling. *Deep-Sea Res. II* 98: 292-300.

Sutton, T.T., Porteiro, F.M., Anderson, C.I.H., Horne, J., Søiland, H., Falkenhaug, T., Godø, O.R., and Bergstad, O.A. 2008. *Deep-Sea Res. II* 55: 161-184.

Swain, D.P., and Benoît, H.P. 2015. Extreme increases in natural mortality prevent recovery of collapsed fish populations in a northwest Atlantic ecosystem. *Mar. Ecol. Prog. Ser.* 519: 165-182.

Sweetman, C.J., Sutton, T.T., Vecchione, M., and Latour, R.J. 2013. Distribution of the biomass-dominant pelagic fish, *Bathylagus euryops* (Argentiniformes: Microstomatidae), along the northern Mid-Atlantic Ridge. *Deep-Sea Res. I* 78: 16-23.

Sweetman, C.J., Sutton, T.T., Vecchione, M., and Latour, R.J. 2014. Diet composition of *Bathylagus euryops* (Osmeriformes: Bathylagidae) along the northern Mid-Atlantic Ridge. *Deep-Sea Res. I* 92: 107-114.

Themelis, D.E., and Halliday, R.G. 2012. Species composition and relative abundance of the mesopelagic fish fauna in the Slope Sea off Nova Scotia. *Northeastern Naturalist* 19: 177-200.

Uiblein, F., Youngbluth, M., Jacoby, C., Pagès, F., Picheral, M., and Gorsky, G. 2005. *In situ* observations of deep-water fishes in four canyons off the Georges Bank, NW Atlantic. *in:* Shotton, R. (*ed.*) *Conference on the Governance and Management of Deep-Sea Fisheries. Part 1: Conference reports. FAO Fisheries Proceedings*, Rome 3(1): 98-106.

van Utrecht, W.L. and van Utrecht-Cock, C.N. 1987. *Serrivomer beani* Gill & Ryder, 1884 (Pisces, Anguilliformes, Serrivomeridae): Some aspects of seasonal variation in numbers and distribution in the mid North Atlantic. *Bijdragen tot de Dierkunde* 57: 53-58.

Winger, P.D., Munden, J.G., Nguyen, T.X., Grant, S.M., and Legge, G. 2017. Comparative fishing to evaluate the viability of an aligned footgear designed to reduce seabed contact in northern shrimp bottom trawl fisheries. *Can. J. Fish. Aquat. Sci.* 75: 203-210.

Zurbrigg, R.E., and Scott, W.B. 1972. Evidence for expatriate populations of the lanternfish *Myctophum punctatum* in the northwest Atlantic. *J. Fish. Res. Bd Can.* 29: 1679-1683.

APPENDIX

DATA MATRICES

The following pages contain the final data matrices, prepared for the analyses of Kenchington *et al.* (in prep.) following the steps presented in this Technical Report. The first matrix contains the catches in numbers and the second the catches in weight (in units of grams). Each matrix is presented across four two-page spreads, with information on the sets in the six left-hand columns (in red) and the catches in black. The nominal maximum depth of each set is shown as the depth of the stratum to which it was deployed (in metres). Sets which fished below the deepest regular stratum on a particular station are given the maximum depth of that stratum with a ">" sign. The "set description" column contains codes which capture the station, depth and diel-phase information. The sets are numbered by a code used for the Gully survey program's internal purposes, combining the survey year with the set number. That column is repeated on the right-hand page of each pair to aid users.

These matrices are available on-line in electronic format, in association with Kenchington *et al.* (*in prep.*).

Year	Station	Stratum	Diel Phase	Set Description	Year-Set	Nemichthys scolopaceus	Serrivomer beani	Eurypharynx pelecanoides	Bathylagus euryops	Chauliodus sloani
2007	Offshore	250	N	O 250 N	2007_07	11	0	0	0	7
2007	Offshore	250	D	O 250 D	2007_09	2	1	0	0	0
2007	Offshore	1250	N	O 1250 N	2007_12	3	25	5	8	25
2007	Offshore	>1250	N	O Extra N	2007_13	2	22	8	9	13
2007	Offshore	750	D	O 750 D	2007_14	16	38	0	0	42
2007	Offshore	1250	D	O 1250 D	2007_15	12	58	12	4	17
2007	Offshore	750	N	O 750 N	2007_18	7	27	2	1	25
2007	Main	250	N	M 250 N	2007_19	12	5	0	0	0
2007	Main	750	D	M 750 D	2007_21	6	12	1	11	1
2007	Main	1250	D	M 1250 D	2007_22	1	9	6	20	4
2007	Main	750	D	M 750 D	2007_23	7	19	0	5	3
2007	Main	250	D	M 250 D	2007_24	0	0	0	0	0
2007	Main	1250	N	M 1250 N	2007_26	4	20	3	5	10
2007	Main	750	N	M 750 N	2007_27	8	15	1	5	3
2007	Main	1250	N	M 1250 N	2007_28	7	20	1	5	4
2007	Main	1250	D	M 1250 D	2007_29	1	17	5	21	16
2007	Main	750	D	M 750 D	2007_30	7	14	0	11	6
2007	Main	250	D	M 250 D	2007_31	0	0	0	0	0
2007	Main	750	N	M 750 N	2007_33	1	15	6	5	3
2007	Main	1250	N	M 1250 N	2007_34	6	28	2	6	11
2007	Main	1250	D	M 1250 D	2007_35	16	19	2	13	15
2007	Main	250	D	M 250 D	2007_36	2	2	0	0	1
2007	Wall	750	D	W 750 D	2007_38	5	17	0	6	10
2007	Main	250	N	M 250 N	2007_41	5	1	0	0	2
2007	Main	750	N	M 750 N	2007_42	2	13	0	6	6
2007	Main	250	N	M 250 N	2007_43	3	0	0	0	0
2007	Head	750	D	H 750 D	2007_44	0	9	3	13	1
2007	Head	250	D	H 250 D	2007_45	0	0	0	0	0
2007	Head	750	N	H 750 N	2007_49	0	3	0	2	3
2007	Head	250	N	H 250 N	2007_51	0	0	0	0	1
2007	Head	750	N	H 750 N	2007_52	0	2	0	2	0
2007	Wall	250	D	W 250 D	2007_53	0	0	0	0	0
2007	Wall	750	D	W 750 D	2007_54	1	8	2	15	7
2007	Wall	750	D	W 750 D	2007_56	1	7	1	7	0
2007	Wall	250	N	W 250 N	2007_58	1	2	0	0	0
2007	Wall	750	N	W 750 N	2007_59	7	9	0	4	4
2007	Wall	250	N	W 250 N	2007_60	4	0	1	0	0
2007	Wall	750	N	W 750 N	2007_61	1	8	4	2	1
2007	Deep	750	D	D 750 D	2007_62	10	24	1	10	13
2007	Deep	1250	D	D 1250 D	2007_64	19	37	4	10	24

Year-Set	Malacosteus niger	Stomias boa	Arctozenus risso	Benthosema glaciale	Ceratoscopelus maderensis	Hygophum hygomii	Lampanyctus macdonaldi	Lobianchia dofleini	Myctophum punctatum	Notoscopelus kroyeri	Notoscopelus resplendens	Scopelogadus beanii	Anoplogaster cornuta	Melanostigma atlanticum
2007_07	0	4	81	438	5	30	0	215	0	11	95	0	0	0
2007_09	0	6	16	2	0	9	0	2	0	0	0	0	0	0
2007_12	1	10	31	955	3	200	0	9	2	0	306	11	0	0
2007_13	1	8	19	347	2	67	4	17	3	0	29	3	1	0
2007_14	4	35	36	564	1	17	0	17	4	0	1	3	1	0
2007_15	2	25	25	267	2	3	0	5	0	0	21	27	0	0
2007_18	5	18	17	781	30	51	0	34	1	0	120	21	2	0
2007_19	0	13	40	417	25	0	0	0	18	0	0	0	0	0
2007_21	1	17	20	415	4	0	0	0	9	0	0	1	0	5
2007_22	6	32	9	867	0	0	3	0	5	1	0	8	0	1
2007_23	0	43	25	527	11	0	0	0	20	0	0	0	1	0
2007_24	0	3	12	52	0	0	0	0	15	0	0	0	0	0
2007_26	11	28	12	230	2	0	2	0	32	0	0	7	2	2
2007_27	3	39	10	472	39	0	1	0	21	7	0	0	0	0
2007_28	4	34	4	196	7	0	0	0	8	0	0	12	1	0
2007_29	1	27	12	554	1	0	5	0	18	1	1	12	0	1
2007_30	2	38	25	588	2	0	0	0	23	0	0	1	0	2
2007_31	0	0	14	12	0	0	0	6	11	0	2	0	0	0
2007_33	0	15	18	414	51	0	0	0	48	35	0	0	0	1
2007_34	8	42	10	627	20	0	2	0	15	48	1	1	1	1
2007_35	4	34	11	476	0	0	0	0	7	2	1	5	1	1
2007_36	0	3	6	0	0	0	0	0	2	0	0	0	0	0
2007_38	3	42	20	334	3	0	0	0	17	4	0	0	1	0
2007_41	0	13	35	683	53	0	0	0	25	148	0	0	0	0
2007_42	2	29	5	1069	54	0	4	0	64	65	0	0	0	0
2007_43	0	7	55	1042	69	0	0	0	21	114	0	0	0	0
2007_44	2	5	9	64	1	0	8	0	13	3	0	0	0	2
2007_45	0	0	7	0	0	0	0	0	6	2	0	0	0	0
2007_49	1	1	10	153	15	0	5	0	24	0	0	0	0	1
2007_51	0	2	4	6	4	0	0	0	3	0	0	0	0	0
2007_52	0	1	11	66	2	0	10	0	8	0	0	0	0	1
2007_53	0	0	2	1	1	0	0	0	7	0	0	0	0	0
2007_54	1	20	21	423	1	0	2	0	24	2	0	1	1	10
2007_56	3	23	15	370	1	0	0	0	16	1	0	0	0	7
2007_58	0	6	10	147	34	0	0	0	10	0	0	0	0	0
2007_59	5	15	4	266	7	0	1	0	12	3	0	0	0	0
2007_60	0	6	8	108	31	0	0	0	16	15	0	0	0	2
2007_61	5	14	6	307	17	0	0	0	3	12	0	0	0	6
2007_62	3	21	7	356	0	0	1	0	5	0	1	5	0	1
2007_64	4	28	4	240	0	0	0	0	1	1	0	35	0	0

Year	Station	Stratum	Diel Phase	Set Description	Year-Set	Nemichthys scolopaceus	Serrivomer beani	Eurypharynx pelecanoides	Bathylagus euryops	Chauliodus sloani
2007	Deep	750	D	D 750 D	2007_65	12	16	0	17	15
2007	Deep	250	D	D 250 D	2007_67	0	0	0	0	0
2007	Deep	250	N	D 250 N	2007_69	6	1	0	0	9
2007	Deep	1250	N	D 1250 N	2007_70	5	24	7	16	25
2007	Deep	750	N	D 750 N	2007_71	15	24	4	10	31
2007	Deep	1250	N	D 1250 N	2007_72	15	29	6	8	16
2007	Deep	750	N	D 750 N	2007_76	17	28	2	10	24
2007	Deep	250	N	D 250 N	2007_77	12	1	0	0	6
2007	Main	>1250	D	M Extra D	2007_80	8	16	4	28	11
2007	Head	750	D	H 750 D	2007_81	3	5	1	19	3
2007	Head	>750	N	H Extra N	2007_83	0	7	1	25	3
2007	Head	250	N	H 250 N	2007_84	1	0	0	0	0
2007	Head	250	N	H 250 N	2007_85	0	0	0	0	0
2007	Head	750	D	H 750 D	2007_86	0	2	0	2	1
2008	Deep	750	N	D 750 N	2008_01	7	8	0	9	26
2008	Deep	750	D	D750 D	2008_02	14	1	0	5	2
2008	Deep	1250	N	D 1250 N	2008_06	8	18	2	6	21
2008	Deep	250	N	D 250 N	2008_07	25	1	0	3	22
2008	Deep	1250	D	D 1250 D	2008_08	16	24	7	14	43
2008	Deep	750	N	D 750 N	2008_11	7	11	0	5	22
2008	Main	1250	D	M 1250 D	2008_14	10	17	4	9	28
2008	Main	750	D	M 750 D	2008_15	10	11	0	8	3
2008	Main	750	N	M 750 N	2008_19	9	14	0	14	8
2008	Main	1250	N	M 1250 N	2008_20	13	45	0	21	24
2008	Main	250	N	M 250 N	2008_21	5	0	0	1	2
2008	Main	250	D	M 250 D	2008_22	3	0	0	0	0
2008	Head	750	D	H 750 D	2008_23	0	12	2	5	2
2008	Head	250	N	H 250 N	2008_27	0	0	0	0	0
2008	Head	750	N	H 750 N	2008_28	0	15	5	14	2
2008	Head	250	N	H 250 N	2008_29	0	0	0	0	0
2008	Head	750	D	H 750 D	2008_31	0	10	4	8	5
2008	Head	250	D	H 250 D	2008_32	0	0	0	0	0
2008	Main	750	N	M 750 N	2008_36	8	9	0	8	2
2008	Main	1250	N	M 1250 N	2008_37	10	22	1	16	18
2008	Main	250	N	M 250 N	2008_38	11	1	0	1	0
2008	Main	750	D	M 750 D	2008_39	15	10	0	15	0
2008	Deep	750	N	D 750 N	2008_43	14	27	0	8	43
2008	Deep	250	N	D 250 N	2008_44	15	5	0	1	21
2008	Deep	750	D	D 750 D	2008_46	17	28	0	7	52
2008	Deep	250	D	D 250 D	2008_47	4	0	0	0	1

Year-Set	Malacosteus niger	Stomias boa	Arctozenus risso	Benthosema glaciale	Ceratoscopelus maderensis	Hygophum hygomii	Lampanyctus macdonaldi	Lobianchia dofleini	Myctophum punctatum	Notoscopelus kroyeri	Notoscopelus resplendens	Scopelogadus beanii	Anoplogaster cornuta	Melanostigma atlanticum
2007_65	0	18	1	369	3	0	0	0	6	1	0	9	1	0
2007_67	0	0	0	0	0	0	0	1	1	0	0	0	0	0
2007_69	0	4	11	236	24	0	0	0	31	29	0	0	0	0
2007_70	3	17	4	742	15	0	4	0	21	34	0	41	1	0
2007_71	5	22	13	440	26	0	4	0	16	25	0	21	0	0
2007_72	5	19	6	465	17	0	0	0	34	32	0	36	3	0
2007_76	1	42	15	657	23	0	5	0	25	37	0	17	0	0
2007_77	0	15	12	285	33	0	0	0	15	74	0	0	0	0
2007_80	1	22	10	700	1	0	11	0	8	4	0	11	0	0
2007_81	2	6	5	161	0	0	7	0	6	2	0	0	0	5
2007_83	4	26	4	342	3	0	18	0	24	0	0	0	0	5
2007_84	0	2	5	67	0	0	0	0	3	0	0	0	0	1
2007_85	0	0	7	32	1	0	0	0	4	1	0	0	0	2
2007_86	0	0	34	132	1	0	15	0	9	1	0	0	0	2
2008_01	4	10	33	638	7	64	1	5	5	0	67	16	0	0
2008_02	3	29	13	209	1	4	2	1	0	0	9	1	1	0
2008_06	4	16	32	885	13	25	3	1	6	4	82	88	0	0
2008_07	0	6	79	514	5	30	1	2	2	4	51	0	0	0
2008_08	3	21	14	298	1	1	0	3	0	0	18	74	2	0
2008_11	2	10	17	342	6	26	0	3	1	0	65	20	1	0
2008_14	5	19	15	275	1	0	10	0	8	5	8	22	1	1
2008_15	0	13	8	146	1	0	0	0	0	1	1	2	1	10
2008_19	2	15	10	607	13	1	0	0	3	6	1	1	0	9
2008_20	9	20	9	210	17	9	7	1	7	3	72	18	0	3
2008_21	0	5	13	1144	16	0	0	2	2	27	4	0	0	0
2008_22	3	0	0	53	1	0	0	0	0	1	0	0	0	0
2008_23	0	8	3	55	0	0	2	0	5	3	0	1	0	12
2008_27	0	0	0	15	0	0	0	0	1	0	0	0	0	0
2008_28	4	0	6	21	6	0	4	0	2	0	0	1	0	2
2008_29	0	0	2	1	0	0	0	0	0	0	0	0	0	0
2008_31	4	2	6	25	0	0	4	0	1	0	0	2	0	2
2008_32	1	1	0	0	0	0	0	0	0	10	0	0	0	0
2008_36	0	34	16	1087	13	8	0	1	1	21	22	4	0	0
2008_37	4	38	7	611	11	44	0	3	11	14	35	9	0	5
2008_38	0	13	18	376	4	1	0	0	0	6	1	0	0	0
2008_39	3	39	24	311	3	5	1	0	5	7	1	1	0	0
2008_43	4	15	26	201	29	82	2	26	0	7	21	26	1	0
2008_44	2	9	53	255	25	76	0	14	4	39	32	3	0	0
2008_46	6	25	17	162	3	21	2	4	1	1	3	6	0	0
2008_47	0	3	1	10	0	0	0	0	0	0	0	0	0	0

Year	Station	Stratum	Diel Phase	Set Description	Year-Set	Nemichthys scolopaceus	Serrivomer beani	Eurypharynx pelecanoides	Bathylagus euryops	Chauliodus sloani
2008	Deep	1750	N	D 1750 N	2008_49	14	32	6	13	17
2008	Deep	1250	N	D 1250 N	2008_51	8	24	5	6	28
2008	Deep	1250	D	D 1250 D	2008_52	26	40	13	16	53
2008	Main	1250	D	M 1250 D	2008_53	23	10	3	15	18
2009	Slope	750	D	S 750 D	2009_03	17	26	0	3	65
2009	Deep	1750	N	D 1750 N	2009_04	11	53	8	26	31
2009	Deep	750	N	D 750 N	2009_05	15	44	0	0	30
2009	Deep	1250	D	D 1250 D	2009_06	23	82	4	22	46
2009	Deep	250	N	D 250 N	2009_10	13	9	0	2	13
2009	Deep	1250	N	D 1250 N	2009_11	16	48	6	19	23
2009	Deep	750	N	D 750 N	2009_12	17	20	1	23	24
2009	Deep	250	D	D 250 D	2009_13	8	0	0	0	0
2009	Main	250	N	M 250 N	2009_17	5	2	0	0	0
2009	Main	750	N	M 750 N	2009_18	9	14	0	8	5
2009	Main	1250	N	M 1250 N	2009_19	17	33	2	21	19
2009	Deep	1250	D	D 1250 D	2009_20	14	57	3	26	58
2009	Main	250	N	M 250 N	2009_25	21	1	0	0	0
2009	Deep	1250	N	D 1250 N	2009_26	9	57	2	23	34
2009	Main	750	N	M 750 N	2009_27	27	14	1	12	16
2009	Deep	1750	N	D 1750 N	2009_32	9	57	8	21	31
2009	Wall	250	N	W 250 N	2009_33	14	5	1	0	5
2009	Main	250	D	M 250 D	2009_34	8	0	0	0	0
2009	Main	750	D	M 750 D	2009_35	34	5	0	6	11
2009	Deep	>1750		D Extra X	2009_38	10	81	3	24	42
2009	Main	1250	N	M 1250 N	2009_39	21	37	7	15	24
2009	Main	750	D	M 750 D	2009_40	48	12	1	7	15
2009	Wall	750	D	W 750 D	2009_41	22	8	1	9	6
2009	Deep	>1750		D Extra X	2009_43	15	40	8	14	47
2009	Wall	750	N	W 750 N	2009_44	27	11	2	7	1
2009	Wall	750	N	W 750 N	2009_45	30	10	0	9	1
2009	Main	1250	D	M 1250 D	2009_46	47	27	12	29	22
2009	Head	250	N	H 250 N	2009_52	8	1	2	1	1
2009	Head	750	N	H 750 N	2009_54	2	16	4	8	3
2009	Head	250	N	H 250 N	2009_55	3	1	0	0	2
2009	Head	750	D	H 750 D	2009_56	0	4	4	12	1
2009	Head	250	D	H 250 D	2009_57	0	0	0	0	0
2009	Head	750	D	H 750 D	2009_58	1	11	7	9	2
2010	Slope	750	D	S 750 D	2010_02	13	57	5	7	31
2010	Deep	250	N	D 250 N	2010_04	12	4	0	0	3
2010	Deep	750	N	D 750 N	2010_05	9	12	0	3	13

Year-Set	Malacosteus niger	Stomias boa	Arctozenus risso	Benthosema glaciale	Ceratoscopelus maderensis	Hygophum hygomii	Lampanyctus macdonaldi	Lobianchia dofleini	Myctophum punctatum	Notoscopelus kroyeri	Notoscopelus resplendens	Scopelogadus beanii	Anoplogaster cornuta	Melanostigma atlanticum
2008_49	9	19	12	231	4	72	16	12	4	15	15	33	0	0
2008_51	3	16	18	127	20	57	5	18	5	15	11	27	0	0
2008_52	9	28	19	178	12	7	3	26	1	2	3	51	0	0
2008_53	5	44	6	208	4	8	8	0	3	4	0	9	2	0
2009_03	2	26	17	339	0	18	0	19	4	0	3	6	0	0
2009_04	3	15	11	666	12	4	10	66	2	0	41	53	1	0
2009_05	0	53	4	246	10	154	1	166	8	0	106	12	0	0
2009_06	5	44	27	348	1	20	2	27	4	0	19	100	3	1
2009_10	0	16	82	678	73	187	0	157	5	67	26	3	0	0
2009_11	0	42	12	385	9	176	0	162	6	0	52	42	1	0
2009_12	0	38	18	454	9	87	0	25	7	0	57	6	0	0
2009_13	0	5	0	31	0	7	0	0	0	0	0	0	0	0
2009_17	0	1	16	613	34	1	0	1	16	12	0	0	0	0
2009_18	2	18	26	502	20	1	0	2	12	8	0	3	0	0
2009_19	2	16	11	661	2	0	0	5	4	4	6	46	2	1
2009_20	1	92	15	527	0	43	0	75	3	9	6	85	0	0
2009_25	0	7	8	683	27	1	0	1	16	27	0	0	0	0
2009_26	0	24	17	683	13	32	3	126	0	54	0	52	0	0
2009_27	0	36	4	606	4	0	0	6	18	13	0	2	0	0
2009_32	1	41	17	747	7	45	9	108	0	26	8	56	0	0
2009_33	0	3	15	639	9	1	1	4	54	69	0	0	0	0
2009_34	0	0	1	23	0	0	0	0	6	12	0	0	0	0
2009_35	1	37	8	280	0	0	1	1	33	11	0	0	0	0
2009_38	3	21	13	557	19	86	6	147	0	6	63	59	4	0
2009_39	3	24	2	864	16	1	3	1	7	11	0	40	1	0
2009_40	1	43	3	317	1	0	0	1	18	2	0	0	0	1
2009_41	0	52	5	274	3	0	0	0	27	4	0	1	0	6
2009_43	0	15	7	367	2	17	5	102	0	0	29	43	1	0
2009_44	2	29	7	332	29	0	0	2	47	28	0	0	0	4
2009_45	2	34	1	559	9	0	0	0	47	25	0	1	0	1
2009_46	7	30	4	347	1	0	2	0	15	1	0	32	1	1
2009_52	0	6	1	15	0	0	0	0	3	0	0	0	0	0
2009_54	5	0	5	79	0	0	4	0	3	3	0	9	1	11
2009_55	0	0	1	0	0	0	0	0	0	0	0	0	0	0
2009_56	1	0	17	121	0	0	4	0	4	0	0	0	1	12
2009_57	0	1	0	1	0	0	1	0	7	0	0	0	0	1
2009_58	8	0	16	37	0	0	11	0	0	0	0	0	0	18
2010_02	3	8	3	94	3	0	2	1	0	0	0	1	1	0
2010_04	0	13	25	721	5	0	0	0	0	0	0	0	0	0
2010_05	8	9	5	505	0	0	0	0	0	0	0	8	0	0

Year	Station	Stratum	Diel Phase	Set Description	Year-Set	Nemichthys scolopaceus	Serrivomer beani	Eurypharynx pelecanoides	Bathylagus euryops	Chauliodus sloani
2010	Deep	250	N	D 250 N	2010_06	7	3	0	0	1
2010	Main	750	D	M 750 D	2010_08	4	16	1	6	4
2010	Main	250	D	M 250 D	2010_09	8	1	0	0	0
2010	Main	750	D	M 750 D	2010_10	10	16	0	9	11
2010	Deep	1250	N	D 1250 N	2010_11	19	58	6	10	27
2010	Main	1250	D	M 1250 D	2010_14	36	55	2	13	16
2010	Deep	750	N	D 750 N	2010_16	13	22	4	11	19
2010	Deep	250	N	D 250 N	2010_17	26	11	1	0	3
2010	Deep	1250	N	D 1250 N	2010_18	15	18	2	16	19
2010	Head	250	D	H 250 D	2010_22	13	4	0	0	1
2010	Main	250	N	M 250 N	2010_23	22	1	0	0	3
2010	Main	750	N	M 750 N	2010_24	19	15	0	16	13
2010	Main	1250	N	M 1250 N	2010_25	40	44	4	14	15
2010	Head	750	D	H 750 D	2010_29	19	2	0	2	1
2010	Head	750	D	H 750 D	2010_30	3	0	3	0	0
2010	Main	750	N	M 750 N	2010_31	4	14	1	5	13
2010	Main	250	N	M 250 N	2010_32	6	0	0	0	0
2010	Main	1250	N	M 1250 N	2010_33	15	32	4	9	11
2010	Deep	>1750	D	D Extra D	2010_35	14	28	13	22	28
2010	Head	750	N	H 750 N	2010_36	7	6	2	0	7
2010	Head	250	N	H 250 N	2010_39	2	1	0	0	0
2010	Head	750	N	H 750 N	2010_40	12	6	0	1	1
2010	Deep	1750	D	D 1750 D	2010_43	10	66	6	24	32
2010	Deep	750	D	D 750 D	2010_44	12	56	0	13	30
2010	Deep	1750	N	D 1750 N	2010_45	13	140	1	21	54
2010	Head	250	N	H 250 N	2010_46	7	12	1	0	8
2010	Deep	1750	D	D 1750 D	2010_50	16	126	6	27	45
2010	Deep	1750	N	D 1750 N	2010_51	14	145	8	23	61

Year-Set	Malacosteus niger	Stomias boa	Arctozenus risso	Benthosema glaciale	Ceratoscopelus maderensis	Hygophum hygomii	Lampanyctus macdonaldi	Lobianchia dofleini	Myctophum punctatum	Notoscopelus kroyeri	Notoscopelus resplendens	Scopelogadus beanii	Anoplogaster cornuta	Melanostigma atlanticum
2010_06	0	2	0	3	0	0	0	0	0	0	0	0	0	0
2010_08	0	1	0	137	0	0	0	0	0	0	0	1	0	0
2010_09	0	0	4	1	0	0	0	0	0	0	0	0	0	0
2010_10	2	8	5	294	1	0	0	0	0	0	0	5	0	0
2010_11	3	9	22	473	1	0	0	0	2	0	0	25	1	0
2010_14	6	3	4	115	0	0	0	0	0	0	0	7	1	2
2010_16	5	11	15	207	1	0	0	0	0	0	0	12	1	0
2010_17	0	5	10	157	4	0	0	0	0	0	0	3	0	0
2010_18	4	5	1	117	0	0	1	0	0	0	0	21	1	0
2010_22	0	0	0	15	0	0	0	0	0	1	0	0	0	1
2010_23	0	5	12	1001	2	0	1	0	0	0	0	0	0	1
2010_24	1	9	4	468	1	0	3	0	0	0	0	1	0	1
2010_25	5	4	2	259	1	0	0	0	0	1	0	5	1	1
2010_29	0	0	1	3	0	0	0	0	0	0	0	0	0	1
2010_30	0	0	1	0	0	0	0	0	0	0	0	0	0	0
2010_31	2	2	1	152	0	0	0	0	0	0	0	2	0	0
2010_32	0	0	4	190	0	0	0	0	0	0	0	0	0	0
2010_33	2	4	4	177	0	0	0	0	0	0	0	8	0	3
2010_35	3	2	3	192	0	0	0	0	0	1	0	17	2	0
2010_36	1	2	0	6	0	0	0	0	0	0	0	0	0	1
2010_39	0	0	0	0	0	0	0	0	0	0	0	0	0	1
2010_40	0	0	0	2	0	0	0	0	0	0	0	0	0	3
2010_43	1	7	0	219	2	0	0	0	0	0	0	19	0	1
2010_44	2	9	1	249	0	0	0	0	0	0	0	7	0	0
2010_45	4	13	2	609	2	0	23	0	0	0	0	16	1	0
2010_46	0	5	1	32	1	0	0	0	0	0	0	0	0	0
2010_50	12	4	0	323	0	0	0	0	0	0	0	45	3	0
2010_51	6	10	16	764	1	0	0	0	0	0	0	23	1	0

Year	Station	Stratum	Diel Phase	Set Description	Year-Set	Nemichthys scolopaceus	Serrivomer beani	Eurypharynx pelecanoides	Bathylagus euryops	Chauliodus sloani
2007	Offshore	250	N	O 250 N	2007_07	30	0	0	0	25
2007	Offshore	250	D	O 250 D	2007_09	10	5	0	0	0
2007	Offshore	1250	N	O 1250 N	2007_12	21	594	187	93	336
2007	Offshore	>1250	N	O Extra N	2007_13	7	500	485	135	219
2007	Offshore	750	D	O 750 D	2007_14	140	165	0	0	580
2007	Offshore	1250	D	O 1250 D	2007_15	65	785	170	46	400
2007	Offshore	750	N	O 750 N	2007_18	59	208	8	12	390
2007	Main	250	N	M 250 N	2007_19	358	12	0	0	0
2007	Main	750	D	M 750 D	2007_21	174	180	8	28	15
2007	Main	1250	D	M 1250 D	2007_22	17	150	95	100	135
2007	Main	750	D	M 750 D	2007_23	300	185	0	14	30
2007	Main	250	D	M 250 D	2007_24	0	0	0	0	0
2007	Main	1250	N	M 1250 N	2007_26	142	358	25	81	406
2007	Main	750	N	M 750 N	2007_27	394	475	5	45	5
2007	Main	1250	N	M 1250 N	2007_28	204	323	27	73	64
2007	Main	1250	D	M 1250 D	2007_29	55	575	80	184	325
2007	Main	750	D	M 750 D	2007_30	325	325	0	40	100
2007	Main	250	D	M 250 D	2007_31	0	0	0	0	0
2007	Main	750	N	M 750 N	2007_33	52	202	110	20	99
2007	Main	1250	N	M 1250 N	2007_34	314	455	90	90	245
2007	Main	1250	D	M 1250 D	2007_35	340	380	16	85	230
2007	Main	250	D	M 250 D	2007_36	86	7	0	0	1
2007	Wall	750	D	W 750 D	2007_38	195	245	0	20	225
2007	Main	250	N	M 250 N	2007_41	203	12	0	0	3
2007	Main	750	N	M 750 N	2007_42	70	185	0	81	96
2007	Main	250	N	M 250 N	2007_43	111	0	0	0	0
2007	Head	750	D	H 750 D	2007_44	0	165	8	45	49
2007	Head	250	D	H 250 D	2007_45	0	0	0	0	0
2007	Head	750	N	H 750 N	2007_49	0	16	0	3	157
2007	Head	250	N	H 250 N	2007_51	0	0	0	0	6
2007	Head	750	N	H 750 N	2007_52	0	60	0	15	0
2007	Wall	250	D	W 250 D	2007_53	0	0	0	0	0
2007	Wall	750	D	W 750 D	2007_54	52	60	1	24	184
2007	Wall	750	D	W 750 D	2007_56	63	168	3	28	0
2007	Wall	250	N	W 250 N	2007_58	57	7	0	0	0
2007	Wall	750	N	W 750 N	2007_59	66	269	0	19	117
2007	Wall	250	N	W 250 N	2007_60	189	0	1	0	0
2007	Wall	750	N	W 750 N	2007_61	42	613	25	5	47
2007	Deep	750	D	D 750 D	2007_62	121	428	1	63	136
2007	Deep	1250	D	D 1250 D	2007_64	232	653	56	67	319

Year-Set	Malacosteus niger	Stomias boa	Arctozenus risso	Benthosema glaciale	Ceratoscopelus maderensis	Hygophum hygomi	Lampanyctus macdonaldi	Lobianchia dofleini	Myctophum punctatum	Notoscopelus kroyeri	Notoscopelus resplendens	Scopelogadus beanii	Anoplogaster cornuta	Melanostigma atlanticum
2007_07	0	37	82	399	5	49	0	125	0	8	110	0	0	0
2007_09	0	65	25	1	0	1	0	1	0	0	0	0	0	0
2007_12	34	155	47	865	1	635	0	7	2	0	449	190	0	0
2007_13	6	68	31	731	3	103	37	11	1	0	44	82	70	0
2007_14	55	420	90	705	1	24	0	7	1	0	2	30	40	0
2007_15	33	245	55	706	0.4	4	0	3	0	0	27	607	0	0
2007_18	157	273	37	977	17	85	0	19	4	0	157	512	93	0
2007_19	0	170	111	489	56	0	0	0	48	0	0	0	0	0
2007_21	10	660	78	787	12	0	0	0	43	0	0	2	0	20
2007_22	225	500	35	1085	0	0	25	0	14	1	0	182	0	13
2007_23	0	695	105	1095	25	0	0	0	67	0	0	0	100	0
2007_24	0	41	32	73	0	0	0	0	30	0	0	0	0	0
2007_26	305	596	86	583	5	0	25	0	193	0	0	131	142	8
2007_27	12	625	43	1023	95	0	28	0	45	66	0	0	0	0
2007_28	150	590	12	294	16	0	0	0	22	0	0	203	42	0
2007_29	70	625	35	1141	4	0	45	0	81	1	1	243	0	8
2007_30	40	835	120	735	6	0	0	0	65	0	0	2	0	11
2007_31	0	0	47	14	0	0	0	1	29	0	8	0	0	0
2007_33	0	360	74	597	125	0	0	0	101	39	0	0	0	4
2007_34	132	524	22	940	49	0	25	0	24	40	1	8	65	8
2007_35	60	480	26	1047	0	0	0	0	22	3	2	145	30	5
2007_36	0	25	22	0	0	0	0	0	10	0	0	0	0	0
2007_38	36	840	114	501	8	0	0	0	90	34	0	0	27	0
2007_41	0	177	79	855	133	0	0	0	67	132	0	0	0	0
2007_42	15	695	16	867	138	0	18	0	143	77	0	0	0	0
2007_43	0	65	120	803	159	0	0	0	39	110	0	0	0	0
2007_44	90	54	90	135	2	0	55	0	56	4	0	0	0	1
2007_45	0	0	28	0	0	0	0	0	33	25	0	0	0	0
2007_49	1	10	68	108	40	0	2	0	126	0	0	0	0	1
2007_51	0	99	13	6	5	0	0	0	8	0	0	0	0	0
2007_52	0	12	67	111	7	0	75	0	18	0	0	0	0	6
2007_53	0	0	10	1	2	0	0	0	42	0	0	0	0	0
2007_54	9	565	78	557	2	0	6	0	132	16	0	29	42	47
2007_56	87	372	87	541	3	0	0	0	51	6	0	0	0	38
2007_58	0	64	35	124	88	0	0	0	46	0	0	0	0	0
2007_59	99	316	13	367	2	0	1	0	43	4	0	0	0	0
2007_60	0	133	29	70	79	0	0	0	27	17	0	0	0	7
2007_61	62	365	57	270	43	0	0	0	15	14	0	0	0	25
2007_62	32	259	19	456	0	0	6	0	18	0	1	69	0	1
2007_64	156	275	9	352	0	0	0	0	2	2	0	669	0	0

Year	Station	Stratum	Diel Phase	Set Description	Year-Set	Nemichthys scolopaceus	Serrivomer beani	Eurypharynx pelecanoides	Bathylagus euryops	Chauliodus sloani
2007	Deep	750	D	D 750 D	2007_65	161	194	0	122	87
2007	Deep	250	D	D 250 D	2007_67	0	0	0	0	0
2007	Deep	250	N	D 250 N	2007_69	39	1	0	0	20
2007	Deep	1250	N	D 1250 N	2007_70	75	290	10	180	765
2007	Deep	750	N	D 750 N	2007_71	90	375	69	67	305
2007	Deep	1250	N	D 1250 N	2007_72	326	596	136	66	365
2007	Deep	750	N	D 750 N	2007_76	301	292	26	61	209
2007	Deep	250	N	D 250 N	2007_77	95	7	0	0	179
2007	Main	>1250	D	M Extra D	2007_80	176	598	70	308	329
2007	Head	750	D	H 750 D	2007_81	26	134	1	85	44
2007	Head	>750	N	H Extra N	2007_83	0	259	26	163	133
2007	Head	250	N	H 250 N	2007_84	18	0	0	0	0
2007	Head	250	N	H 250 N	2007_85	0	0	0	0	0
2007	Head	750	D	H 750 D	2007_86	0	32	0	6	42
2008	Deep	750	N	D 750 N	2008_01	64	100	0	81	302
2008	Deep	750	D	D750 D	2008_02	173	15	0	47	7
2008	Deep	1250	N	D 1250 N	2008_06	68	524	33	82	267
2008	Deep	250	N	D 250 N	2008_07	151	64	0	66	46
2008	Deep	1250	D	D 1250 D	2008_08	95	492	50	152	363
2008	Deep	750	N	D 750 N	2008_11	154	215	0	20	231
2008	Main	1250	D	M 1250 D	2008_14	148	335	26	57	442
2008	Main	750	D	M 750 D	2008_15	271	455	0	36	30
2008	Main	750	N	M 750 N	2008_19	330	380	0	82	110
2008	Main	1250	N	M 1250 N	2008_20	116	823	0	246	334
2008	Main	250	N	M 250 N	2008_21	130	0	0	3	12
2008	Main	250	D	M 250 D	2008_22	46	0	0	0	0
2008	Head	750	D	H 750 D	2008_23	0	672	5	16	115
2008	Head	250	N	H 250 N	2008_27	0	0	0	0	0
2008	Head	750	N	H 750 N	2008_28	0	305	25	33	74
2008	Head	250	N	H 250 N	2008_29	0	0	0	0	0
2008	Head	750	D	H 750 D	2008_31	0	148	31	22	189
2008	Head	250	D	H 250 D	2008_32	0	0	0	0	0
2008	Main	750	N	M 750 N	2008_36	159	189	0	12	72
2008	Main	1250	N	M 1250 N	2008_37	254	325	8	178	430
2008	Main	250	N	M 250 N	2008_38	291	6	0	16	0
2008	Main	750	D	M 750 D	2008_39	215	187	0	51	0
2008	Deep	750	N	D 750 N	2008_43	116	250	0	45	297
2008	Deep	250	N	D 250 N	2008_44	78	8	0	3	28
2008	Deep	750	D	D 750 D	2008_46	190	364	0	39	491
2008	Deep	250	D	D 250 D	2008_47	27	0	0	0	2

Year-Set	Malacosteus niger	Stomias boa	Arctozenus risso	Benthosema glaciale	Ceratoscopelus maderensis	Hygophum hygomi	Lampanyctus macdonaldi	Lobianchia dofleini	Myctophum punctatum	Notoscopelus kroyeri	Notoscopelus resplendens	Scopelogadus beanii	Anoplogaster cornuta	Melanostigma atlanticum
2007_65	0	363	1	606	6	0	0	0	17	8	0	525	47	0
2007_67	0	0	0	0	0	0	0	1	2	0	0	0	0	0
2007_69	0	28	150	198	64	0	0	0	62	31	0	0	0	0
2007_70	37	170	19	664	36	0	8	0	41	33	0	804	137	0
2007_71	89	273	22	411	60	0	33	0	30	27	0	410	0	0
2007_72	177	117	8	636	46	0	0	0	60	34	0	635	346	0
2007_76	9	394	17	621	54	0	50	0	40	41	0	344	0	0
2007_77	0	109	17	273	78	0	0	0	33	78	0	0	0	0
2007_80	36	279	13	1172	3	0	110	0	23	5	0	270	0	0
2007_81	263	157	24	277	0	0	64	0	44	15	0	0	0	44
2007_83	195	374	17	430	9	0	143	0	125	0	0	0	0	33
2007_84	0	8	13	61	0	0	0	0	7	0	0	0	0	8
2007_85	0	0	27	22	3	0	0	0	7	12	0	0	0	13
2007_86	0	0	244	156	3	0	161	0	34	18	0	0	0	20
2008_01	34	106	67	660	17	83	2	2	2	0	57	260	0	0
2008_02	40	398	12	391	2	5	30	1	0	0	9	6	37	0
2008_06	49	315	43	1064	19	36	43	1	3	3	102	2401	0	0
2008_07	0	37	85	598	12	54	13	1	1	5	64	0	0	0
2008_08	20	163	11	571	3	2	0	2	0	0	20	2086	134	0
2008_11	28	185	60	475	9	48	0	1	1	0	72	612	45	0
2008_14	102	212	89	414	3	0	63	0	39	4	8	513	36	1
2008_15	0	349	49	228	2	0	0	0	0	15	1	7	56	54
2008_19	17	291	25	643	27	1	0	0	15	3	4	1	0	26
2008_20	210	345	13	355	41	13	82	0.45	20	3	82	399	0	11
2008_21	0	57	30	1305	41	0	0	1	2	18	6	0	0	0
2008_22	73	0	0	31	1	0	0	0	0	0.25	0	0	0	0
2008_23	0	285	28	95	0	0	21	0	30	52	0	4	0	94
2008_27	0	0	0	11	0	0	0	0	6	0	0	0	0	0
2008_28	109	0	78	42	16	0	21	0	14	0	0	1	0	15
2008_29	0	0	30	1	0	0	0	0	0	0	0	0	0	0
2008_31	36	57	55	50	0	0	18	0	7	0	0	24	0	2
2008_32	7	19	0	0	0	0	0	0	0	12	0	0	0	0
2008_36	0	542	22	1291	25	13	0	0.3	6	15	25	87	0	0
2008_37	202	527	19	765	16	76	0	1	6	9	48	184	0	24
2008_38	0	171	58	474	8	1	0	0	0	4	1	0	0	0
2008_39	21	549	73	530	9	9	17	0	11	31	1	1	0	0
2008_43	47	295	28	440	29	128	16	10	0	4	25	682	45	0
2008_44	19	42	57	274	51	115	0	6	3	27	38	45	0	0
2008_46	100	270	20	331	7	33	47	2	0.3	1	11	44	0	0
2008_47	0	54	0.25	24	0	0	0	0	0	0	0	0	0	0

Year	Station	Stratum	Diel Phase	Set Description	Year-Set	Nemichthys scolopaceus	Serrivomer beani	Eurypharynx pelecanoides	Bathylagus euryops	Chauliodus sloani
2008	Deep	1750	N	D 1750 N	2008_49	148	1121	244	242	168
2008	Deep	1250	N	D 1250 N	2008_51	62	610	74	109	296
2008	Deep	1250	D	D 1250 D	2008_52	175	662	186	173	608
2008	Main	1250	D	M 1250 D	2008_53	398	207	46	60	380
2009	Slope	750	D	S 750 D	2009_03	130	253	0	43	376
2009	Deep	1750	N	D 1750 N	2009_04	131	800	166	275	610
2009	Deep	750	N	D 750 N	2009_05	143	315	0	0	260
2009	Deep	1250	D	D 1250 D	2009_06	209	1660	64	244	526
2009	Deep	250	N	D 250 N	2009_10	137	43	0	17	60
2009	Deep	1250	N	D 1250 N	2009_11	193	851	74	174	306
2009	Deep	750	N	D 750 N	2009_12	252	257	1	196	220
2009	Deep	250	D	D 250 D	2009_13	121	0	0	0	0
2009	Main	250	N	M 250 N	2009_17	23	4	0	0	0
2009	Main	750	N	M 750 N	2009_18	220	311	0	37	78
2009	Main	1250	N	M 1250 N	2009_19	454	1022	136	304	379
2009	Deep	1250	D	D 1250 D	2009_20	151	873	90	202	549
2009	Main	250	N	M 250 N	2009_25	172	3	0	0	0
2009	Deep	1250	N	D 1250 N	2009_26	61	989	39	331	590
2009	Main	750	N	M 750 N	2009_27	429	217	18	59	155
2009	Deep	1750	N	D 1750 N	2009_32	112	779	452	413	558
2009	Wall	250	N	W 250 N	2009_33	167	59	17	0	86
2009	Main	250	D	M 250 D	2009_34	98	0	0	0	0
2009	Main	750	D	M 750 D	2009_35	571	97	0	17	79
2009	Deep	>1750		D Extra X	2009_38	144	1103	160	231	585
2009	Main	1250	N	M 1250 N	2009_39	368	448	146	128	498
2009	Main	750	D	M 750 D	2009_40	1020	72	3	67	121
2009	Wall	750	D	W 750 D	2009_41	507	165	6	50	140
2009	Deep	>1750		D Extra X	2009_43	158	648	327	132	483
2009	Wall	750	N	W 750 N	2009_44	513	134	13	38	12
2009	Wall	750	N	W 750 N	2009_45	686	231	0	137	32
2009	Main	1250	D	M 1250 D	2009_46	884	1095	162	237	541
2009	Head	250	N	H 250 N	2009_52	92	16	17	31	6
2009	Head	750	N	H 750 N	2009_54	38	394	82	49	107
2009	Head	250	N	H 250 N	2009_55	115	20	0	0	41
2009	Head	750	D	H 750 D	2009_56	0	144	6	119	4
2009	Head	250	D	H 250 D	2009_57	0	0	0	0	0
2009	Head	750	D	H 750 D	2009_58	22	425	84	85	57
2010	Slope	750	D	S 750 D	2010_02	119	795	7	32	461
2010	Deep	250	N	D 250 N	2010_04	42	4	0	0	11
2010	Deep	750	N	D 750 N	2010_05	33	119	0	16	120

Year-Set	Malacosteus niger	Stomias boa	Arctozenus risso	Benthosema glaciale	Ceratoscopelus maderensis	Hygophum hygomi	Lampanyctus macdonaldi	Lobianchia dofleini	Myctophum punctatum	Notoscopelus kroyeri	Notoscopelus resplendens	Scopelogadus beanii	Anoplogaster cornuta	Melanostigma atlanticum
2008_49	184	193	16	399	10	102	124	6	1	24	17	744	0	0
2008_51	53	205	22	232	45	97	25	10	2	5	16	721	0	0
2008_52	67	265	15	386	10	16	65	16	0.4	1	4	1399	0	0
2008_53	70	585	7	315	3	10	69	0	13	17	0	116	156	0
2009_03	11	305	46	539	0	29	0	11	2	0	2	116	0	0
2009_04	75	160	51	947	31	4	64	24	1	0	32	1162	49	0
2009_05	0	357	5	254	25	236	7	84	22	0	94	198	0	0
2009_06	139	486	60	529	2	35	32	13	7	0	11	2506	183	3
2009_10	0	202	98	637	177	280	0	80	8	48	19	59	0	0
2009_11	0	442	11	482	17	271	0	72	3	0	45	1083	34	0
2009_12	0	543	16	531	18	136	0	12	9	0	49	97	0	0
2009_13	0	93	0	33	0	11	0	0	0	0	0	0	0	0
2009_17	0	6	27	588	87	2	0	2	57	10	0	0	0	0
2009_18	36	187	57	551	61	2	0	2	33	13	0	69	0	0
2009_19	12	213	21	960	5	0	0	4	10	3	7	990	176	2
2009_20	6	998	43	856	0	74	0	37	11	6	5	2145	0	0
2009_25	0	66	14	855	73	1	0	1	45	24	0	0	0	0
2009_26	0	227	29	936	29	55	19	54	0	28	0	1607	0	0
2009_27	0	552	3	758	12	0	0	2	15	8	0	36	0	0
2009_32	33	566	15	1010	8	87	74	51	0	13	10	1609	0	0
2009_33	0	21	30	544	22	1	35	1	81	60	0	0	0	0
2009_34	0	0	2	20	0	0	0	0	32	13	0	0	0	0
2009_35	1	616	36	350	0	0	20	1	81	10	0	0	0	0
2009_38	66	315	31	889	13	161	28	63	0	6	54	1939	317	0
2009_39	58	514	13	1081	36	1	33	1	8	10	0	1294	40	0
2009_40	13	679	29	397	3	0	0	1	61	3	0	0	0	1
2009_41	0	916	47	343	9	0	0	0	82	2	0	1	0	19
2009_43	0	182	17	584	5	25	31	37	0	0	38	1240	36	0
2009_44	103	393	24	417	64	0	0	1	66	25	0	0	0	10
2009_45	49	578	7	538	27	0	0	0	89	18	0	1	0	2
2009_46	154	577	19	653	2	0	40	0	60	12	0	955	86	1
2009_52	0	116	6	29	0	0	0	0	21	0	0	0	0	0
2009_54	206	0	45	166	0	0	32	0	24	59	0	17	58	76
2009_55	0	0	8	0	0	0	0	0	0	0	0	0	0	0
2009_56	34	0	146	151	0	0	24	0	28	0	0	0	71	94
2009_57	0	10	0	1	0	0	13	0	43	0	0	0	0	13
2009_58	169	0	132	73	0	0	91	0	0	0	0	0	0	134
2010_02	40	71	9	119	9	0	24	2	0	0	0	15	43	0
2010_04	0	49	19	423	4	0	0	0	0	0	0	0	0	0
2010_05	127	111	10	375	0	0	0	0	0	0	0	106	0	0

Year	Station	Stratum	Diel Phase	Set Description	Year-Set	Nemichthys scolopaceus	Serrivomer beani	Eurypharynx pelecanoides	Bathylagus euryops	Chauliodus sloani
2010	Deep	250	N	D 250 N	2010_06	33	7	0	0	3
2010	Main	750	D	M 750 D	2010_08	86	145	7	44	26
2010	Main	250	D	M 250 D	2010_09	102	11	0	0	0
2010	Main	750	D	M 750 D	2010_10	100	153	0	75	237
2010	Deep	1250	N	D 1250 N	2010_11	274	783	113	154	345
2010	Main	1250	D	M 1250 D	2010_14	635	695	8	118	343
2010	Deep	750	N	D 750 N	2010_16	201	360	25	158	256
2010	Deep	250	N	D 250 N	2010_17	212	54	3	0	20
2010	Deep	1250	N	D 1250 N	2010_18	125	223	25	261	382
2010	Head	250	D	H 250 D	2010_22	214	20	0	0	35
2010	Main	250	N	M 250 N	2010_23	297	1	0	0	10
2010	Main	750	N	M 750 N	2010_24	186	158	0	165	172
2010	Main	1250	N	M 1250 N	2010_25	577	968	11	138	251
2010	Head	750	D	H 750 D	2010_29	546	94	0	48	13
2010	Head	750	D	H 750 D	2010_30	55	0	9	0	0
2010	Main	750	N	M 750 N	2010_31	47	262	5	89	240
2010	Main	250	N	M 250 N	2010_32	84	0	0	0	0
2010	Main	1250	N	M 1250 N	2010_33	240	334	38	128	206
2010	Deep	>1750	D	D Extra D	2010_35	106	376	436	307	359
2010	Head	750	N	H 750 N	2010_36	54	28	123	0	39
2010	Head	250	N	H 250 N	2010_39	33	6	0	0	0
2010	Head	750	N	H 750 N	2010_40	521	97	0	9	16
2010	Deep	1750	D	D 1750 D	2010_43	161	798	163	293	438
2010	Deep	750	D	D 750 D	2010_44	136	510	0	107	304
2010	Deep	1750	N	D 1750 N	2010_45	110	2018	63	311	744
2010	Head	250	N	H 250 N	2010_46	95	57	70	0	65
2010	Deep	1750	D	D 1750 D	2010_50	151	1187	107	480	569
2010	Deep	1750	N	D 1750 N	2010_51	121	1964	303	218	974

Year-Set	Malacosteus niger	Stomias boa	Arctozenus risso	Benthosema glaciale	Ceratoscopelus maderensis	Hygophum hygomi	Lampanyctus macdonaldi	Lobianchia dofleini	Myctophum punctatum	Notoscopelus kroyeri	Notoscopelus resplendens	Scopelogadus beanii	Anoplogaster cornuta	Melanostigma atlanticum
2010_06	0	25	0	2	0	0	0	0	0	0	0	0	0	0
2010_08	0	7	0	84	0	0	0	0	0	0	0	1	0	0
2010_09	0	0	2	1	0	0	0	0	0	0	0	0	0	0
2010_10	52	95	6	245	1	0	0	0	0	0	0	91	0	0
2010_11	39	93	14	346	2	0	0	0	3	0	0	142	155	0
2010_14	62	25	2	91	0	0	0	0	0	0	0	93	59	21
2010_16	128	137	14	252	4	0	0	0	0	0	0	174	67	0
2010_17	0	19	8	160	16	0	0	0	0	0	0	43	0	0
2010_18	120	71	4	125	0	0	19	0	0	0	0	177	92	0
2010_22	0	0	0	5	0	0	0	0	0	24	0	0	0	8
2010_23	0	20	9	677	5	0	15	0	0	0	0	0	0	8
2010_24	7	55	6	333	1	0	8	0	0	0	0	5	0	3
2010_25	49	25	1	203	3	0	0	0	0	25	0	79	68	6
2010_29	0	0	11	4	0	0	0	0	0	0	0	0	0	10
2010_30	0	0	8	0	0	0	0	0	0	0	0	0	0	0
2010_31	12	37	1	139	0	0	0	0	0	0	0	19	0	0
2010_32	0	0	1	116	0	0	0	0	0	0	0	0	0	0
2010_33	93	44	1	172	0	0	0	0	0	0	0	54	0	21
2010_35	43	21	1	256	0	0	0	0	0	5	0	197	141	0
2010_36	26	34	0	17	0	0	0	0	0	0	0	0	0	6
2010_39	0	0	0	0	0	0	0	0	0	0	0	0	0	3
2010_40	0	0	0	2	0	0	0	0	0	0	0	0	0	29
2010_43	24	75	0	242	6	0	0	0	0	0	0	106	0	3
2010_44	22	40	1	292	0	0	0	0	0	0	0	10	0	0
2010_45	77	77	3	762	6	0	137	0	0	0	0	240	35	0
2010_46	0	29	1	22	2	0	0	0	0	0	0	0	0	0
2010_50	198	58	0	281	0	0	0	0	0	0	0	582	233	0
2010_51	137	123	5	733	1	0	0	0	0	0	0	460	67	0