# ICES WGNEACS REPORT 2011

SCICOM Steering Group on Ecosystem Surveys Science and Technology

ICES CM 2011/SSGESST:15

Ref. SCICOM, ACOM

# Report of the Working Group for North-east Atlantic Continental Slope Survey (WGNEACS)

14–16 June 2011

ICES HQ, Copenhagen, Denmark

International Council for the Exploration of the Sea

Conseil International pour l'Exploration de la Mer

**International Council for the Exploration of the Sea**
**Conseil International pour l'Exploration de la Mer**

H. C. Andersens Boulevard 44–46
DK-1553 Copenhagen V
Denmark
Telephone (+45) 33 38 67 00
Telefax (+45) 33 93 42 15
www.ices.dk
info@ices.dk

Recommended format for purposes of citation:

ICES. 2011. Report of the Working Group for North-east Atlantic Continental Slope Survey (WGNEACS), 14-16 June 2011, ICES HQ, Copenhagen, Denmark. ICES CM 2011/SSGESST:15. 60 pp.

## Contents

## Executive summary

The present report was prepared by the Working Group on the North-east Atlantic Continental Slope Survey (WGNEACS) in ICES, Copenhagen, from 14–16 June 2011.

WGNEACS reviewed the possibilities provide the following community indices for deep-water species; i)Proportion of fish larger than the mean size of first sexual maturation, ii) mean maximum length across all species found in research vessel surveys. iii) 95th % percentile of the fish length distribution observed in research vessel surveys. In deep-water surveys, length frequency data are widely available, however information on age and reproductive state are available for fewer species. In addressing WGNEACS thought it was useful first to identify those species for which this information is available. Also a case study regarding i-iii for roundnose grenadier was performed.

Last's years meeting identified three subgroups of existing deep-water surveys and new survey requirements (proposals) that were grouped by geographical area, a Nordic, a central and a southern subgroup. At this year's meeting, these three subgroups received a set of specific terms of references to work with.

The Nordic subgroup dealt with deep-water trawl surveys that are currently undertaken by Norway, Iceland, Faroe and Greenland. The subgroup continued the evaluation on the sampling protocols of the existing Nordic deep-water surveys with the aim to standardize them as much as possible. Similarities and differences in sampling design and protocols were highlighted. A set of recommendations were made to the Nordic national laboratories on last meeting in order to improve coordination of surveys. The state of this coordination was evaluated. To share data and initiate joint data analysis and research, a data exchange format was agreed upon at the 2010 meeting and abundance data from four target species (Greenland Halibut, Greater Silver smelt, Beaked Redfish and Roundnose Grenadier) were combined from all Nordic deep-water surveys. Standardized swept-area estimates were updated at the current meeting, and mapped to evaluate the spatial coverage of the surveys in relation to species distribution and to identify any gaps.

The central survey subgroup concentrated on providing cpue estimates using existing data for selected species as well as the corresponding distribution plots for these species. Three species from the central survey area were considered to be suitable candidates for this. Roundnose grenadier, greater forkbeard and black scabbard. A fourth species, blue ling was also considered although it was decided after discussion that it was not an appropriate candidate for index calculation as the numbers caught on the surveys generally are very low. This issue was researched further using GAM models of haul-by haul (tally book) commercial blue ling catch data from French commercial trawlers. These were used to assess the depth distribution of exploited blue ling to the West of Scotland. CPUE estimates were provided for both abundance and biomass and in the case of greater forkbeard and black scabbard these were calculated using the survey data from a single depth strata where peak abundance within the sampled survey depth had been identified.

There has been no intersessional work completed regarding the variance of the individual surveys within the central area and this will recommence once the new expanded survey proposal is implemented in 2013/14. Since there have been no new surveys in 2010 there is no new data.

The ToRs for the southern area raise a number of issues. However, there is currently no survey able to produce abundance indices for the target species (*Aphanopus carbo*) and the deep-sea sharks mentioned in the ToRs for the southern Areas.

The southern subgroup dealt with existing and proposed surveys in the southern area (IX and X). The subgroup proposed longline deep-water surveys off mainland Portugal and in the Bay of Biscay. The main objective for assessment in the southern area is to produce relative index of abundance and other population indicators for black scabbardfish, deep-water sharks and other species caught in sufficient numbers (e.g. red sea bream, bluemouth and greater forkbeard). Abundance indices are essential to get information needed for assessment of the black scabbardfish stock in southern areas. The group considered that as there are two major fisheries for this black scabbardfish stock, there is a priority to collect abundance indices in the area of these two fisheries (southwest of Portugal and around Madeira). Additionally to estimate density throughout the area of distribution, surveys would be needed along all the Portuguese slope, further northwest of Galicia (Spain) and in the Bay of Biscay, as well as along the slope of the gulf of Cadiz. The slope of all these areas are hard rocky bottoms with bottom topography that prohibits trawl surveys with random sampling. Thus the group considered that the appropriate way forwards to obtain abundance indices in the southern area is to develop longline surveys.

# 1 Introduction

## 1.1 ToRs

The **Working Group on North-east Atlantic continental slope surveys** (WGNEACS), chaired by Elvar Halldor Hallfredsson*, Norway, will meet at ICES Headquarters, Copenhagen, Denmark 14–16 June, 2011 to:

a ) Develop a series of data products in terms of spatial distribution maps, time-series of abundance indices and ecosystem indicators for NEA deep-water surveys as required by the Assessment working groups and/or specified in the benchmark workshops.

b ) Nordic surveys:

- i ) Proceed work on sampling protocols for surveys by Faroe, Greenland, Iceland and Norway, and attempt to standardize the protocols as much as possible. Special attention should be given to species identification, especially regarding non-target species.
- ii ) Evaluate survey coverage, density and distribution of all major stocks in the area in other years, in same manner as was done using 2009 data at WGNEACS 2010.
- iii ) Analyse trends in biomass, length and recruitment for major stocks across the area.
- iv ) Evaluate and compile existing data from the Nordic surveys on the physical environment.
- v ) Get an overview of surveys in the area made by countries other than those represented at 2010 WGNEACS (Norway, Faroe Islands, Iceland and Greenland)

c ) Central surveys:

- i ) Evaluate the source of variances in the survey design of the central deep-water surveys
- ii ) Compile abundance data from the different surveys and evaluate, density and distribution of all major stocks in the area
- iii ) Analyse trends in biomass, length and recruitment for major stocks across the area.

d ) Southern surveys:

use survey data to contribute to the following scientific questions:

- Evaluate the feasibility of hypotheses on species dynamics particularly on the species whose life cycle is considered to take place in different areas
  - *A. carbo* juveniles occur in the northern areas (ICES Subareas VI and VII) preadults occur at the ICES IXa. Additionally migration rates can
  - be estimated as well as prerecruitment estimates (Scottish and Irish surveys)
  - *A. carbo* and *A. intermedius* evaluate the distribution area as well as estimate the level of overlap between the two species

- deep-water sharks besides the actual surveyed area is quite restricted the survey will contribute to evaluate the possible migration to southern areas
- of Leafscale gulper shark to reproduce as admitted by WGEF and the existence of local populations of Portuguese dogfish at different areas of NE Atlantic

e ) Prepare methods for delivery of the following information to assessment working groups in 2012:

i ) Proportion of fish larger than the mean size of first sexual maturation

ii ) Mean maximum length of fish found in research vessel surveys

iii ) 95th % percentile of the fish length distribution observed

The information should be provided for all major fish stocks covered by the survey.

## 1.2 Structure of the report

The report is structured in six sections –after the introduction, each section is allocated to one term of references. The second section covers ToR a) and the last section covers ToR e), that both are dealt with by the whole group.

The sections three to five focus on existing and proposed deep-water surveys in different ecoregions. Section four covers deep-water surveys and their potential coordination in the Nordic waters (XIV, V, and II), addressing ToRs b) i–v. Section five covers the central surveys addressing ToRs c) i-iii. Section six covers ToR d) of the southern subgroup.

## 1.3 Participants

A full list of participants is given in Annex 1.

# 2 ToR a) Develop a series of data products in terms of spatial distribution maps, time-series of abundance indices and ecosystem indicators for NEA deep-water surveys as required by the Assessment working groups and/or specified in the benchmark workshops

*" Develop a series of data products in terms of spatial distribution maps, time-series of abundance indices and ecosystem indicators for NEA deep-water surveys as required by the Assessment working groups and/or specified in the benchmark workshops."*

PGNEACS 2009 Table 2.2 gave an overview on survey requirements in terms of gear suitability and area for many of the main deep-water species, to provide fisheries independent data to stock assessment. A revision of this is needed when the situation for central and southern surveys are clearer then now, and the 2011 meeting did not further react on this matter. Time-series for abundance indices for main species in the Nordic and the central surveys are given in Sections 3 and 4 in this report. Ecosystem indicators were not examined during this meeting, with the exception of Section 6 on fish community's indices.

# 3 ToR b) Nordic Deep-water surveys

The Nordic subgroup dealt with following terms of references:

b) *Nordic surveys:*

   i ) *Proceed work on sampling protocols for surveys by Faroe, Greenland, Iceland and Norway, and attempt to standardize the protocols as much as possible. Special attention should be given to species identification, especially regarding non-target species.*

   ii ) *Evaluate survey coverage, density and distribution of all major stocks in the area in other years, in same manner as was done using 2009 data at WGNEACS 2010.*

   iii ) *Analyse trends in biomass, length and recruitment for major stocks across the area.*

   iv ) *Evaluate and compile existing data from the Nordic surveys on the physical environment.*

   v ) *Get an overview of surveys in the area made by countries other than those represented at 2010 WGNEACS (Norway, Faroe Islands, Iceland and Greenland)*

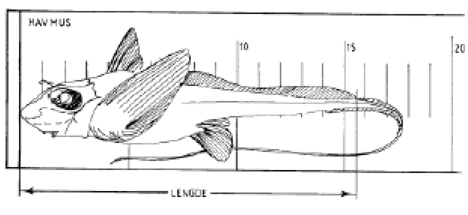
***ToR b (i). Proceed work on sampling protocols for surveys by Faroe, Greenland, Iceland and Norway, and attempt to standardize the protocols as much as possible. Special attention should be given to species identification, especially regarding non-target species.***

A rather thorough work was done to review sampling protocols for the Nordic surveys at last year's meeting and 14 recommendations were proposed to improve standardization of Nordic survey sampling protocols (WGNEACS 2010 Section 4.1.7). Here we comment on if and how these recommendations have been followed up so far:

1 ) *Length measurements methods for special species e.g. chimeara in the Greenlandic surveys should be in accordance with the other nations.*

Information from Greenland was not available. In the PGNEACS 2008 report methods of length measurements from MSSML in Scotland are given. These are consistent with the methods used in Norway for chimaera and those from SAMS in Scotland shown below:

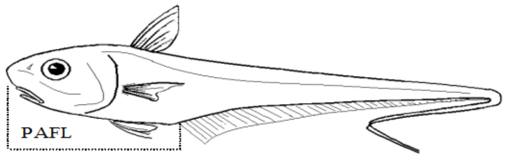
In Norwegian waters chimeara is measured from snout to posterior edge of dorsal fin.




The SAMS deep-water measurement guide was developed as part of the EU funded FAIR 95/655 project "Developing deep-water fisheries: data for their assessment and for understanding their interaction with and impact on a fragile environment":

**Table 1**

| Pre-anal fin length (PAFL) | | Pre-supra caudal length (PSCL) | |
|---|---|---|---|
| Definition | end of snout to first ray of anal fin | Definition | end of snout to start of supra caudal fin |
| Recorded to | half cm below | Recorded to | whole cm below |
| Used for | All Macrourids | Used for | All Holocephalans e.g. Chimaera, Hariotta etc |



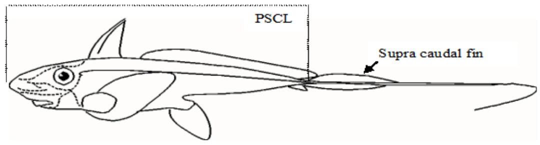
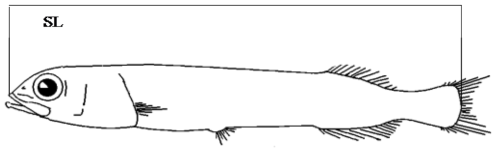



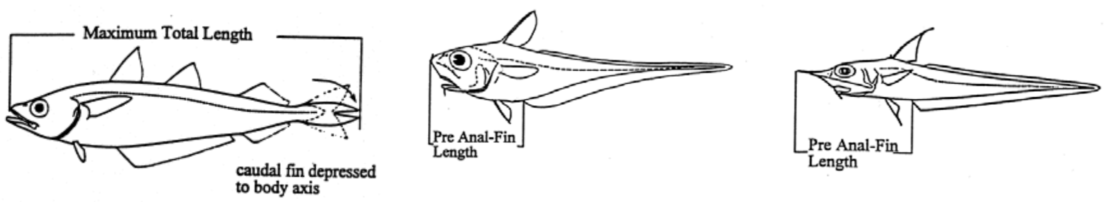

**Table 2**

| Standard length (SL) | | Total length (TL) | |
|---|---|---|---|
| Definition | End of snout to end of caudal peuncle | Used for | Everything else |
| Used for | All Alepocephalids and Searsids | Recorded to | Whole cm below |
| Recorded to | Whole cm below | | |




Length measurements and sampling on Icelandic surveys (Marine Research Institute, 2010):

Length of all fish species is measured (a sample or the whole catch). For the majority of species, total length is measured (from the tip of the snout to the tip of the longer lobe of the caudal fin). For grenadier species, the pre anal-fin length is measured (from the tip of the snout to the base of the first anal-fin ray). The length of the squid *Todarodes sagittatus* is measured as mantle length.



Number of individuals measured: For each station, the general rule is to measure at least 4 times the length interval of the given species. This rule applies to 24 of the 28 species that have been measured since the beginning of the survey. For long-rough dab, starry ray, Norway haddock and whiting the rule is to measure at least 2 times the length interval (Table 1). For other species, it is sufficient to measure 20 individuals at each station (Table 2). If the number of individuals exceeds these limits, the rest must be counted. The quantity of northern shrimp is estimated and recorded as kg, whereas Norway lobster is recorded in numbers.

2 ) *Consider exchange of scientific personal between countries*

It is positive to arrange for an exchange of scientific personal to exchange experience and standardize sampling procedures. On Norwegian IMR cruises this can be done in two different ways:

- Join as a guest scientist/technician. Participation would be free, but all travel cost and salary must be covered by the guests own institution. The guest would normally participate in sampling, but is regarded as an extra person, since the basis scientific manning of the cruise would not be affected by the numbers of guests.
- Exchange personnel between cruises. The easiest way may be that travel cost, salary and cruise compensation is paid by the participants own institution. Since the exchanging personnel will influence the scientific manning of the cruise, it’s essential that the exchange personnel are trained cruise personnel.

It can be assumed that similar measures would apply in other institutes.

3 ) *Make Faroese manual available and translate if not in English*

No information available to the meeting.

4 ) *Update the Norwegian manual in English. Latest version is from 2006*

Due to work on a new field format a total revision of the sampling manual, resources will not be allocated to update present English version of the Norwegian manual.

5 ) *Translate Greenlandic manual from Danish to English*

No information was available to the meeting

6 ) *More weighing of non targeting species in Greenland and Norway*

It is being considered to start this new routine on the Norwegian deep-sea surveys, beginning with the Norwegian Deep Water survey along the Northern Shelf Brake in 2011 (TN in table X.1).

7 ) *Icelandic sub sampling procedure should be evaluated*

The Icelandic survey manual has now been translated into English and this will facilitate future evaluation and comparison to other manuals.

8 ) *Electronic measuring boards could save time.*

Electronic measuring boards have been in use in all Norwegian surveys for some years and are fully integrated into the data system of the research vessels. They are not used on Icelandic surveys.

9 ) *It should be ensured that the core scientific work always is done by trained personnel.*

Information was not available from Greenland. On Norwegian and Icelandic surveys measures are taken to assure sufficient expertise on the surveys.

*10 ) Consider measuring maturity on more species (like S. mentella) in the Greenlandic and for the non target species in Norwegian surveys.*

Measuring maturity on some more non-commercial species is being considered for the Norwegian 2011 TN survey.

*11 ) Greenlandic manual needs text on how to stage maturity and sex the species*

No information available to the meeting.

*12 ) Consider measuring liver weight and gutted weight on target species in Greenland*

No information available to the meeting.

*13 ) Net mounded CTD would give environmental data easily and would not cost anything in time. At least temperature should be logged by mounted temperature loggers.*

Ordinary CTD stations can be very time consuming at depths commonly fished by deep-sea surveys. Net mounted CTDs are being used on Icelandic surveys since last year and they are used on Norwegian deep-sea fish surveys, with good results. An alternative cost-effective and practical solution can be to attach DST tags to the trawl for the survey duration and download data for the whole survey ashore. They can measure e.g. temperature. This is has successfully been done at Scottish surveys, as well as in previous years on Icelandic surveys.

*14 ) National maturity guides should be evaluated to make results comparable between nations*

A Workshop on Sexual Maturity Staging of Redfish and Greenland Halibut (ICES WKMSREGH) is to be held in Vigo, Spain on 16 December 2011.

***ToR ii. Evaluate survey coverage, density and distribution of all major stocks in the area in other years, in same manner as was done using 2009 data at WGNEACS 2010.***

Contour-plots of the distribution of four commercial species obtained from survey catches in Nordic surveys in 2009 were provided in the 2010 WGNEACS report. These are updated using the format agreed in WGNEACS 2010, now using 2010 data from Icelandic, Faroese and Norwegian surveys (Figures 3.1 and 3.2).

***ToR iii. Analyse trends in biomass, length and recruitment for major stocks across the area.***

Figures 3.3–3.4 show trends in biomass for Greenland halibut in Norwegian and Russian surveys in the Barents sea. Figures 3.5–3.6 show trends in biomass for Beaked redfish in German survey in Greenland waters, and in Norwegian surveys in the Barents Sea. Figures 3.7–3.9 show trends in biomass for greater silver smelt in Norwegian and Faroese and Icelandic surveys. (Sources for this section are 2011 reports from ICES expert groups AFWG, NWWG and WGDEEP). Figure X.10 shows vertical distribution for beaked redfish and greater silver smelt, and supports that acoustic methods can be used for these species at slope areas.

***ToR iv. Evaluate and compile existing data from the Nordic surveys on the physical environment.***

Table 4.2 in the WGNEACS 2010 report gives some information on environmental data collection in Nordic surveys. Figure 3.10 shows CTD and Trawl stations done in Norwegian surveys in 2009.

***ToR v. Get an overview of surveys in the area made by countries other than those represented at 2010 WGNEACS (Norway, Faroe Islands, Iceland and Greenland)***

Review of surveys done by other countries in the northern areas was not achievable at the meeting. Getting overview of these surveys and how they can support management would most likely be beneficial.

## 3.1 Reference documents

Marine Research Institute, 2010. Manuals for the Icelandic bottom-trawl surveys in spring and autumn. Hafrannsóknir nr. 156. Reykjavík 2010.

Elvar H. Hallfredsson, Kjell Gamst, Ronald Pedersen, Benjamin Planque and Alf Harbitz 2009. Deepwater fish species in the Norwegian Sea, Norwegian EZZ - with emphasis on distribution and abundance of beaked redfish and greater silver smelt. Survey Mars/April 2009. IMR Norway, survey nr. 2009814.

## Figures

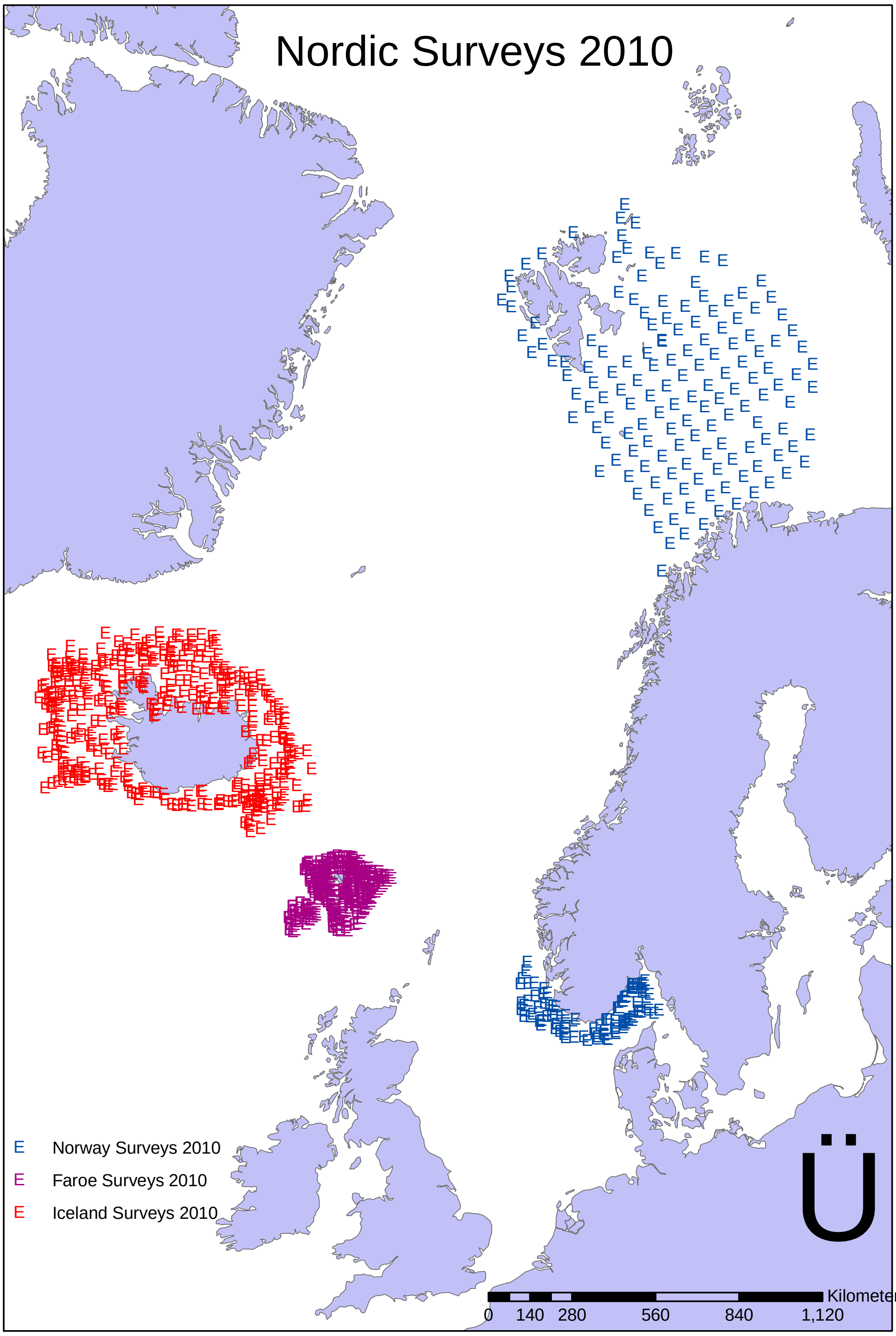



**Figure 3.1. Nordic deep-sea fish surveys in 2010.**

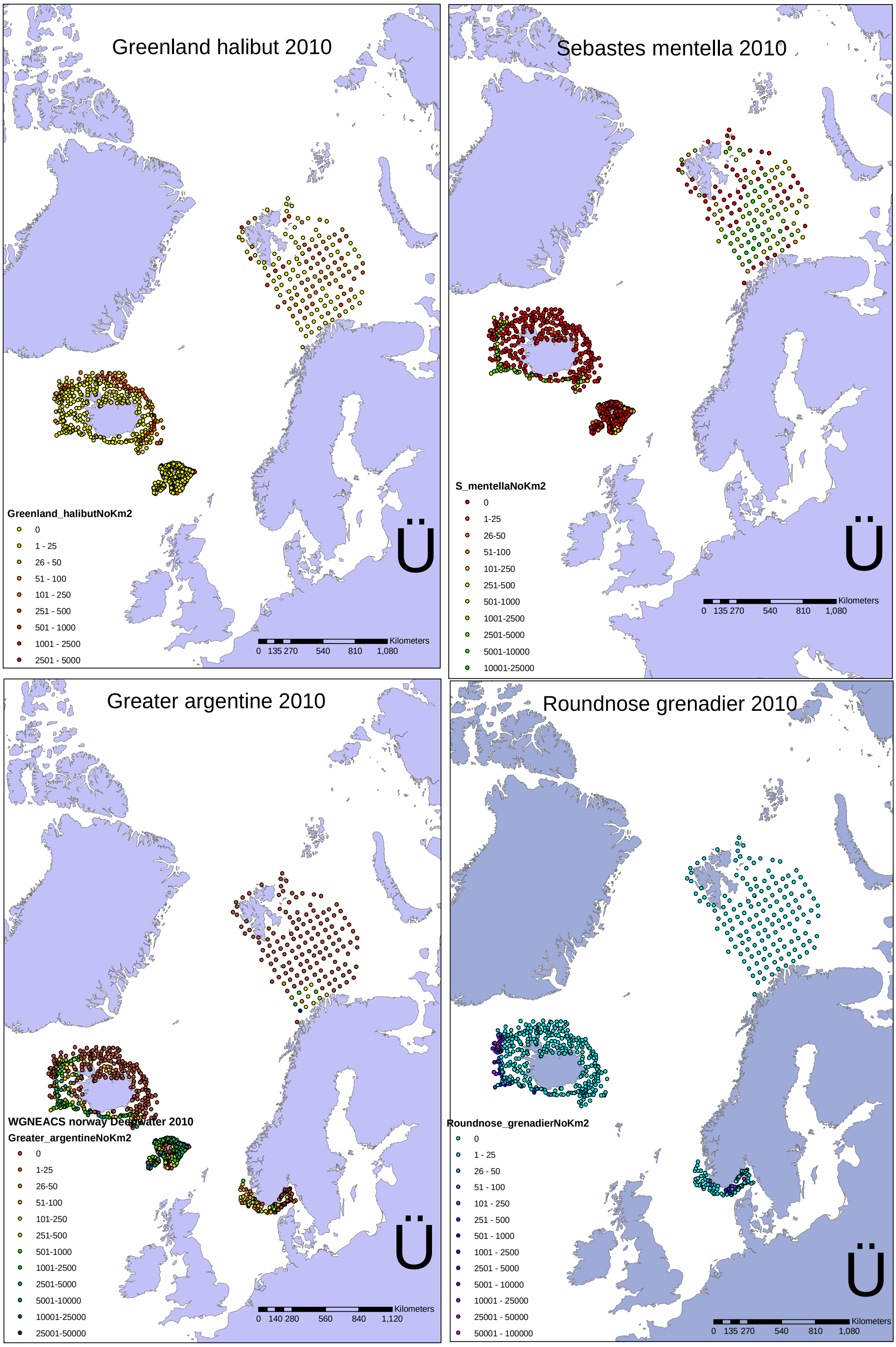



**Figure 3.2. Distribution of main deep-sea fish species in Nordic surveys in 2010.**

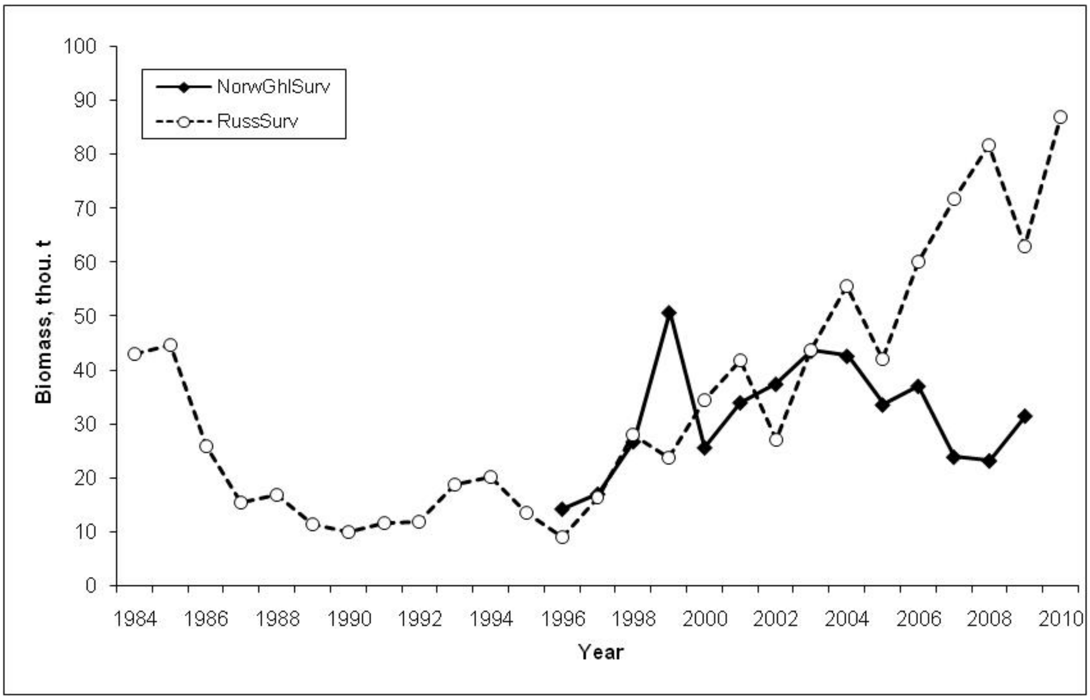



**Figure 3.3. NEA Greenland halibut. Swept-area estimate of the mature female biomass based on the data from the Norwegian Greenland halibut survey along the continental slope in August (not executed in 2010) and Russian trawl survey in October-December (compared to previous reports, 2007–2008 recalculated with using complete data for these years; ICES AFWG, 2011).**

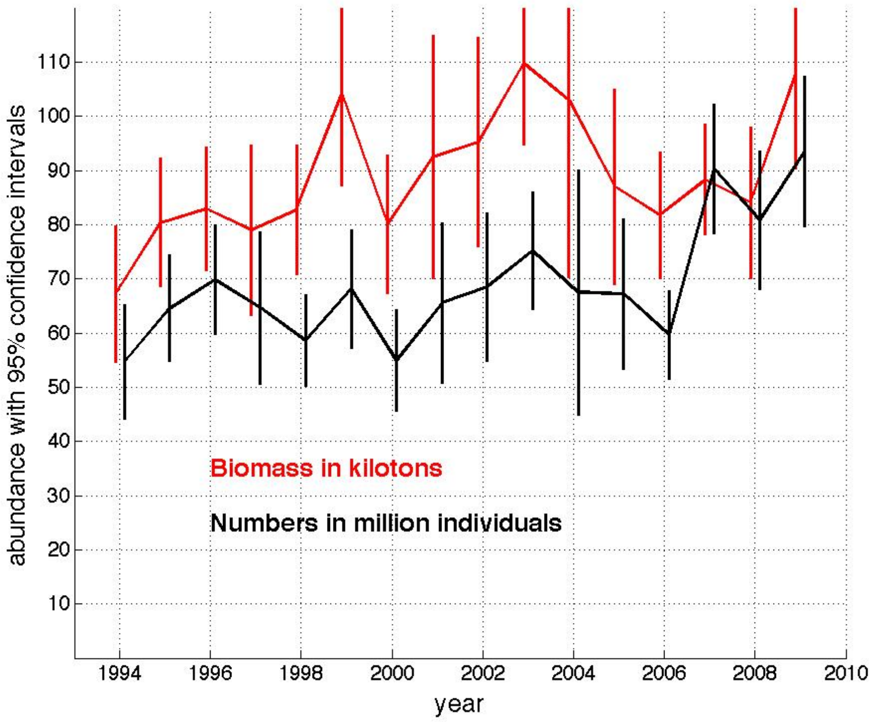



**Figure 3.4. Estimated Greenland halibut total abundance in biomass and by number of individuals from the Norwegian slope surveys 1994–2009. The vertical bars show 95% confidence intervals (ICES AFWG, 2011).**

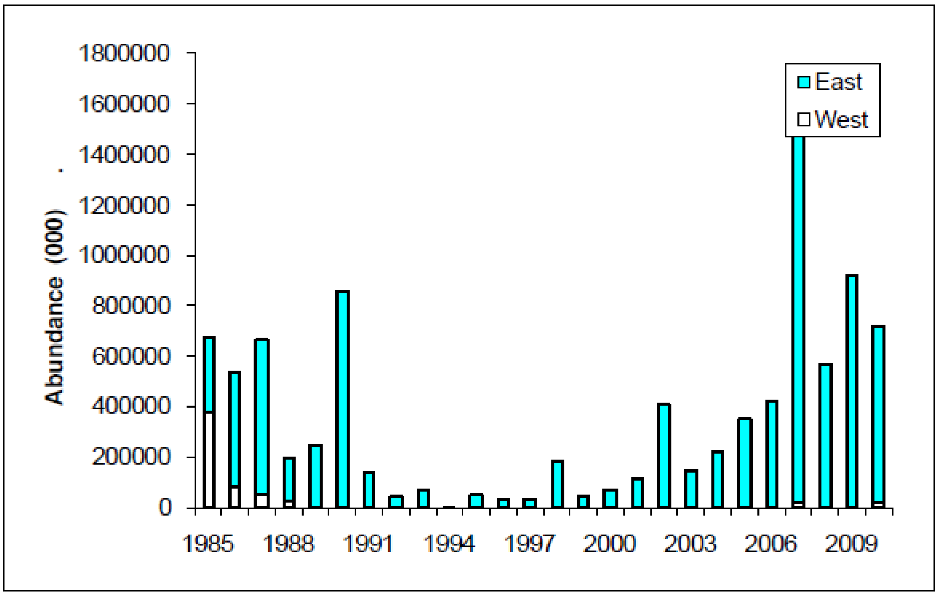
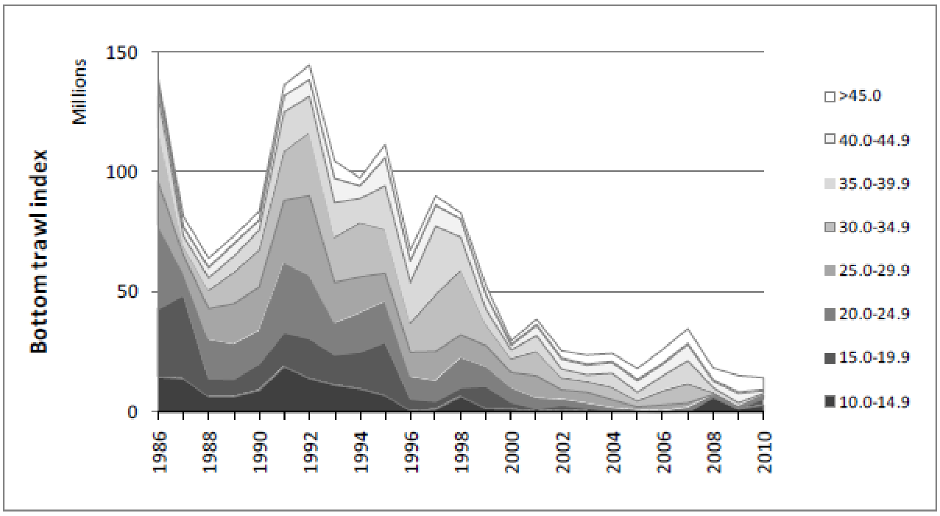



**Figure 3.5. Survey abundance indices of juvenile *Sebastes* spp. (<17 cm) from the German groundfish survey conducted on the continental shelves off East and West Greenland 1985–2010 (NWWG, 2011).**



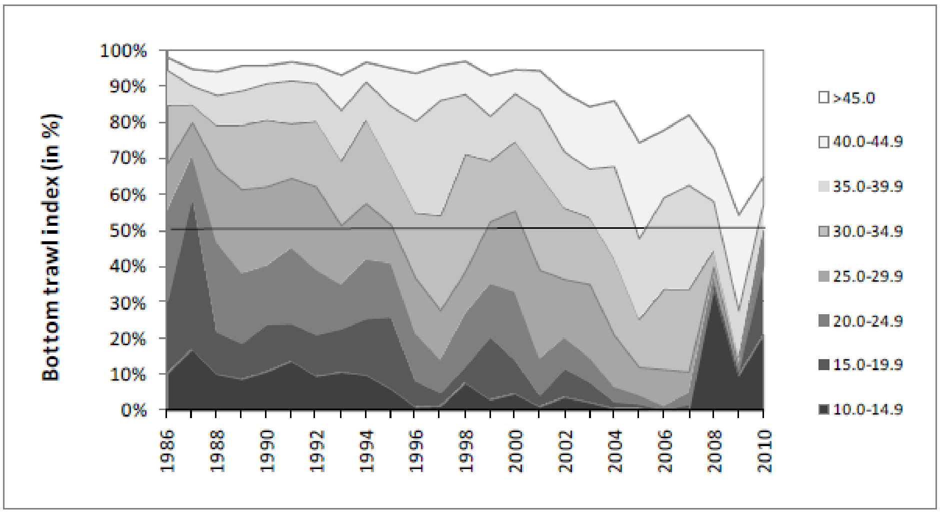




**Figure 3.6.** ***Sebastes marinus*****. Abundance indices disaggregated by length when combining the Norwegian bottom-trawl surveys 1986–2010 in the Barents Sea (winter) and at Svalbard (summer/autumn). Top: absolute index values. Bottom: relative frequencies. Horizontal line indicates the median length in the surveyed population. (ICES AFWG, 2011).**

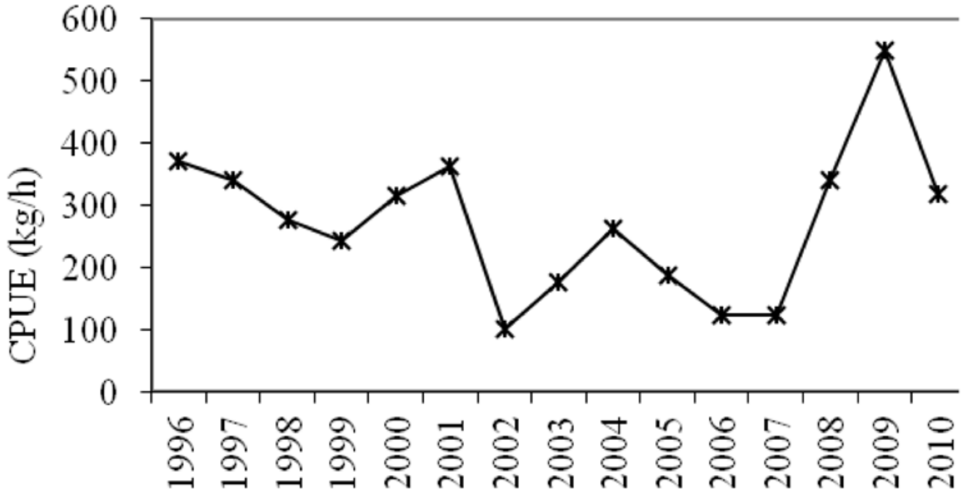



**Figure 3.7. Standardized cpue of greater silver smelt from the annual Faroese groundfish summer surveys (Ofstad and Steingrund 2010 WD WGEEP, 2011).**

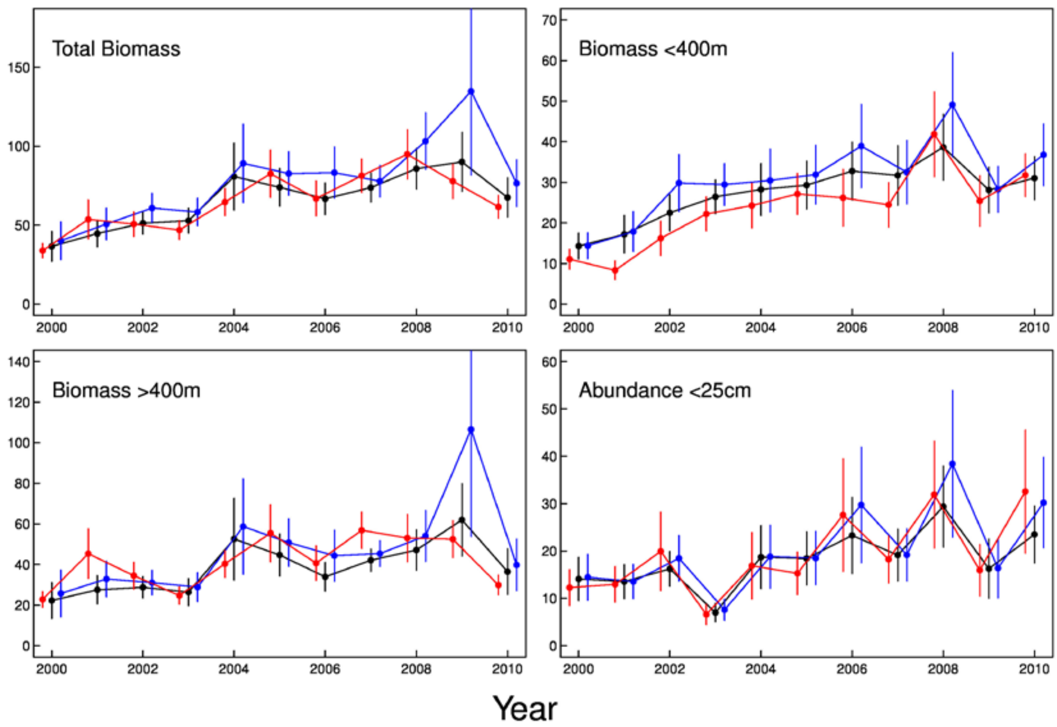



**Figure 3.8. Greater silver smelt in Va. Indices from the autumn survey. Black lines are winsorized indices, blue un-winsorized indices and red lines are indices from a revised stratication of the autumn survey. Vertical lines represent +/- 1 standard error (WGDEEP, 2011).**

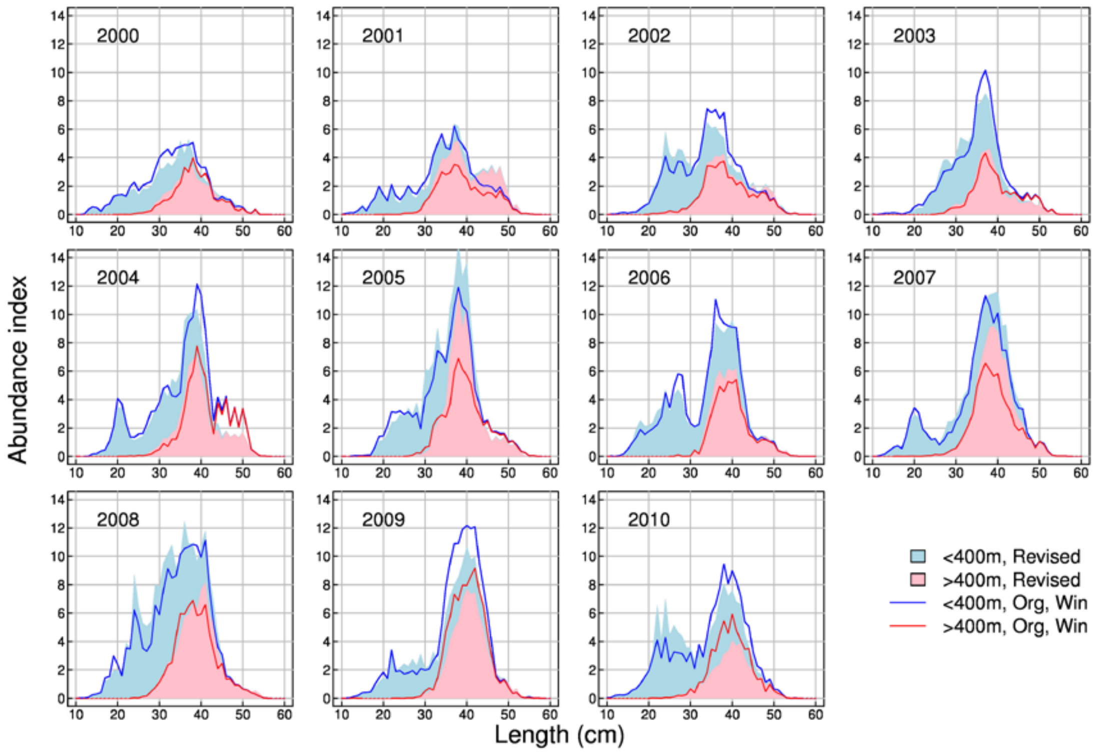



**Figure 3.9. Greater silver smelt in Va. Length disaggregated indices from the autumn survey divided by the 400 m depth contour. Total abundance index is the sum of both red and blue curves. Shaded areas are the indices calculated using the revised stratification scheme and the lines represent the Winsorized indices (WGDEEP, 2011).**

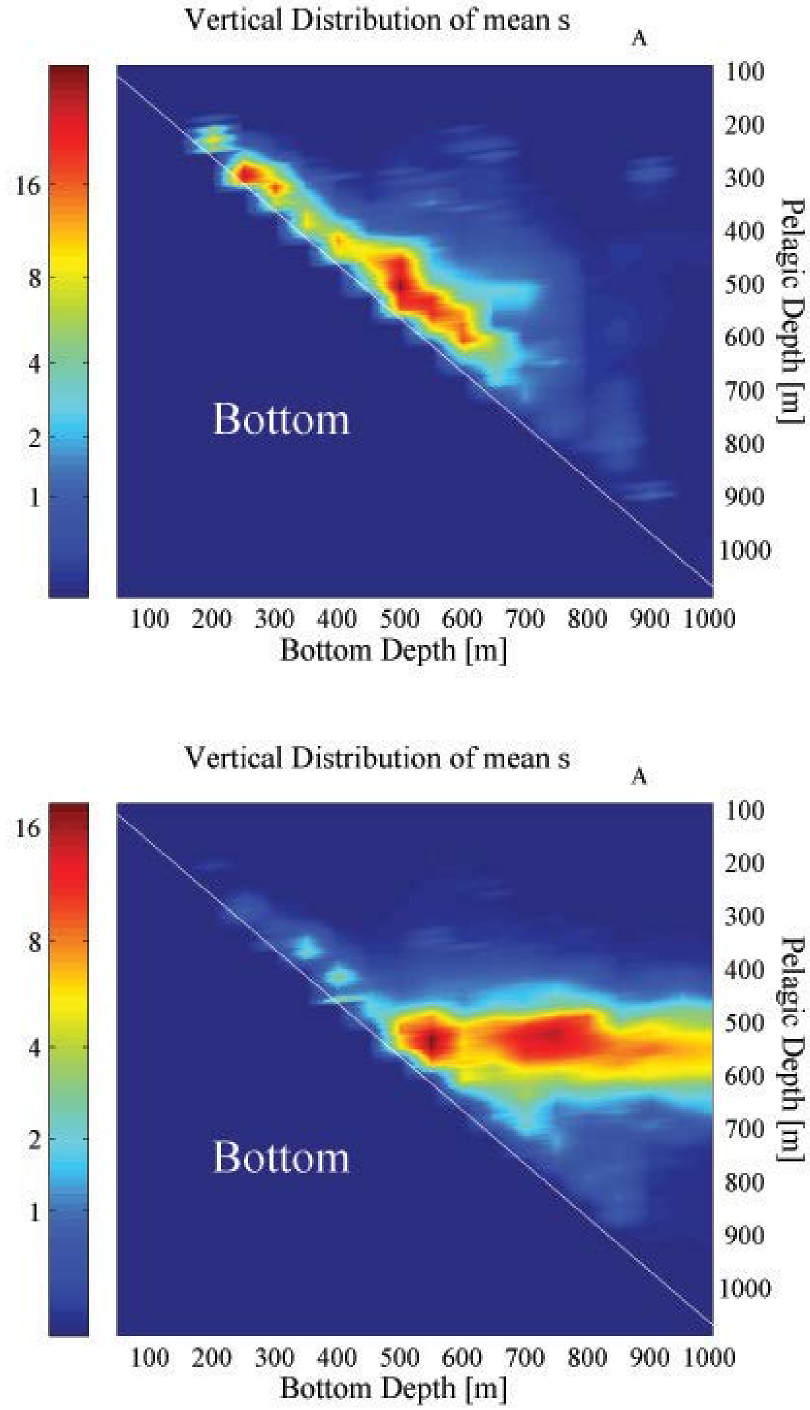
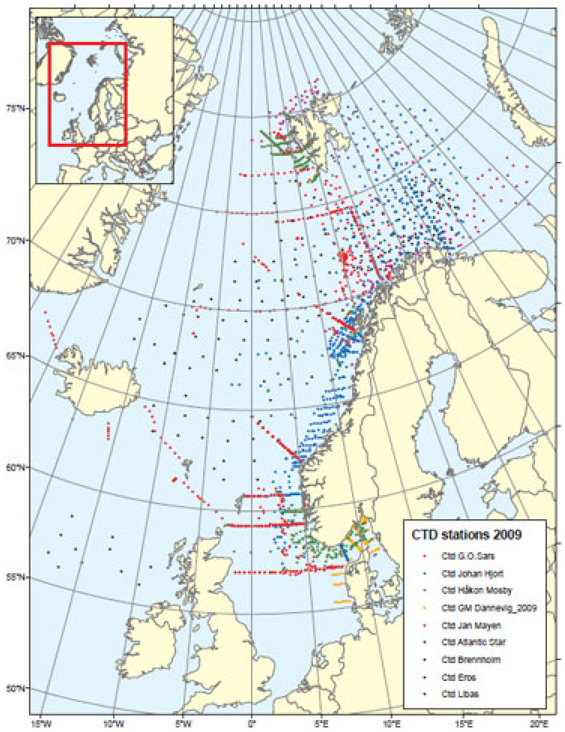



**Figure 3.10. Vertical distribution of mean SA values per 10 m vertical channel for the whole survey. Upper panel is greater silver smelt and lower panel is beaked redfish. The figures show that greater silver smelt is shelf/slope dwelling, bentho-pelagic and found both at depths and in distance from bottom that can be detected by a 38kHz transducer. Beaked redfish is bentho-pelagic at the shelf/slope, but the vertical distribution prolongs into the pelagic at greater depths (Hallfredsson *et al.*, 2010).**



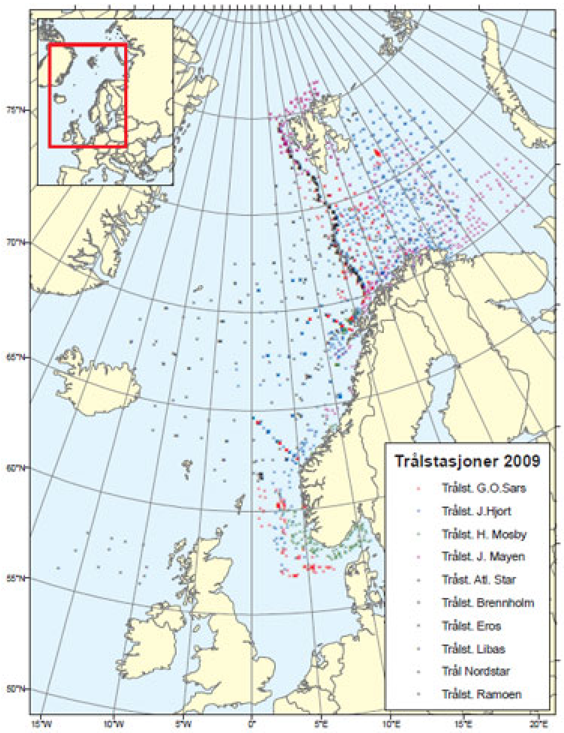




**Figure 3.10. CTD stations and trawl stations by Norwegian vessels in 2009.** http://hinnsiden.imr.no/ressurser/tokt/toktkart

# 4 ToR c) Central surveys

There have been no new surveys in the central area to report on since the 2010 WGNEACS meeting. The Scottish Research vessel *Scotia* was being repaired during much of the second half of 2010 and the Irish Deepwater Survey will recommence if and when the current expanded survey proposal published in the ICES PGNEACS report (ICES, 2009) is successful. A decision on this is expected before the end of 2011 although this would still mean 2013 at the earliest before the next Irish Deepwater Survey was undertaken. A Scottish survey is planned for September 2011.

The following terms of reference were dealt with by the Central Survey subgroup:

i ) Evaluate the source of variances in the survey design of the central deep-water surveys,

ii ) Compile abundance data from the different surveys and evaluate, density and distribution of all major stocks in the area,

iii ) Analyse trends in biomass, length and recruitment for major stocks across the area.

## 4.1 Catch per unit area (cpue) estimates and distribution plots of selected species from the surveys in the Central Area

This section will attempt to address issues pertaining to all three TORs in aiming to compile and evaluate the sources of variance in the survey design of the central deep-water surveys and compile abundance data from the different surveys and evaluate density and distribution on selected stocks in the area. There has been no intersessional work completed regarding the variance of the individual surveys within the central area and this will recommence once the new expanded survey proposal is implemented in 2013/14. Since there have been no new surveys in 2010 there is no new data. This section will therefore concentrate on providing cpue estimates using existing data for selected species as well as the corresponding distribution plots for these species.

Three species from the central survey area were considered to be suitable candidates for this. Roundnose grenadier, greater forkbeard and black scabbard. A fourth species, blue ling was also considered although it was decided after discussion that it was not an appropriate candidate for index calculation as the numbers caught on the surveys generally are very low. This is due in part to the current fixed depth strata sampled on these surveys missing the target peak abundance depth for this species. This issue was researched further using GAM models of haul-by haul (tally book) commercial blue ling catch data from French commercial trawlers. These were used to assess the depth distribution of exploited blue ling to the West of Scotland. The model was similar to that developed in Lorance *et al.* (2010). The model has the form:

log(E[landings]) = s(haul duration) + s(depth) + vessel.id + month + rectangle + year: Area (1)

where E[.] denotes the expected value, s(.) indicates a smooth non-linear function (cubic regression spline), vessel.id the vessel identity, and year: area is an interaction term. Unlike in Lorance *et al.* (2011), the model was fitted assuming a gamma distribution of the dependent variable (therefore ignoring hauls without catch of blue ling) with a log-link function. The dataset was chosen to better represent the situation sampled by the Scottish survey:

This dataset included 1921 hauls from years 2000 to 2010 with the model explaining 66.8% of the deviance. The depth effect suggests that in the studied area and season the peak biomass of blue ling is in depths of between 600–700 m and the abundance is small at about 500 and 1000 m (Figure 4.1.1). As a consequence the Scottish survey which samples at both these depths tends to miss the main depth range of blue ling. This explains the small number caught in the survey and variation in the index could be more related to random catch at the bounds of the depth range that to actual population variation.

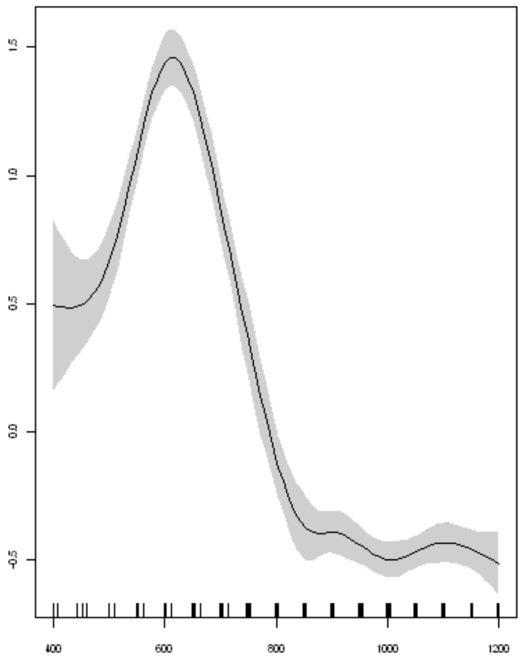



**Figure 4.1.1. Depth effect in the Gam model of blue ling landings in French tally book data. Bars along the x-axis depict the distribution of data (haul) by depth.**

### Material and methods

For the remaining three species separate disaggregated indices were calculated for both the Scottish and Irish deepwater surveys. The reason being that although both surveys sample at similar fixed depths and use a near identical net, the groundgears utilized on both surveys are different and therefore possess different catchabilities. The Scottish deep-water survey from 1998–2008 used 21″ rock-hoppers whereas the Irish groundgear survey uses smaller 16″ hoppers. In 2008/2009 MSS conducted limited trials with groundgear bags to assess the relative catchability of each groundgear. The results being reported in the MSS Deep-water Trawl Survey Manual (Neat *et al.*, 2010). Consequently MSS moved to the 16″ hoppers for the 2009 survey, thereby standardizing the groundgear hopper configuration with the Irish Deep-water survey as well preserving hopper size consistency with the other MSS IBTS surveys in ICES Subarea VIa and VIb. For the purposes of these analyses it was decided to omit the 2009 Scottish Deep-water data from the indices until further stations could be completed with the groundgear bags and a more accurate assessment of the efficiency of the new groundgear could be made. A correction factor will then be applied to the existing indices which should allow for a combined central survey index in future.

The 2009 Irish survey data were also omitted from the cpue calculation as this was a very restricted survey completed towards the end of quarter 4 which is significantly outwith the temporal period occupied by the existing survey dataset and consequently not comparable with the existing dataset. Survey years included are therefore 2000–2008 for the Scottish Deep-water Survey and 2006–2008 for the Irish Deep-water Survey.

CPUE estimates were provided for both abundance and biomass and in the case of greater forkbeard and black scabbard these were calculated using the survey data from a single depth strata where peak abundance within the sampled survey depth had been identified. In the case of greater forkbeard this was 500m and for black scabbard, 1000m. Station data that were within +/- 100m of these rounded target depths were included in the analysis. The station data were then standardized to numbers or kilograms per hour for each survey year. For roundnose grenadier the situation is slightly more complex as significant numbers of this species are recorded in both the 1000m and 1500m stratum. Generalized linear models (GLM) using the R statistical package were used to analyse the combined CPUE data from both depths and a more detailed description of the statistical procedures used can be found in *Neat and Burns, 2010*. Scottish data from 1998 was omitted from the index calculation as the depth range on this survey was restricted to 1200m and therefore the depth range was incomplete for this year. CPUE index plots as well as the corresponding distribution abundance plots for each year are presented below for all 3 species in Figures 4.1.2–4.1.8.

### Roundnose grenadier (*Coryphaenoides rupestris*)

(1000m and 1500m)

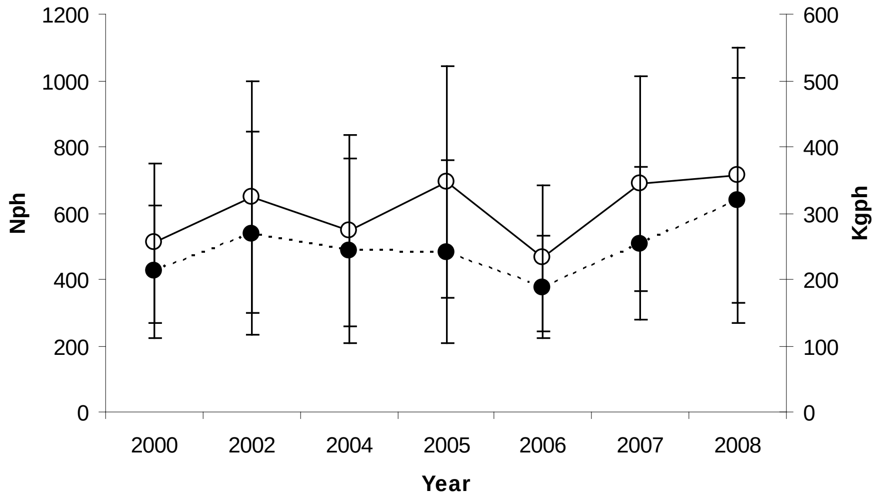



**Figure 4.1.2. Scottish Deep-water cpue Index of abundance (Nph; solid line) and biomass (Kgph; dashed line) for roundnose grenadier (*C.rupestris*) with associated 95% confidence limits.**

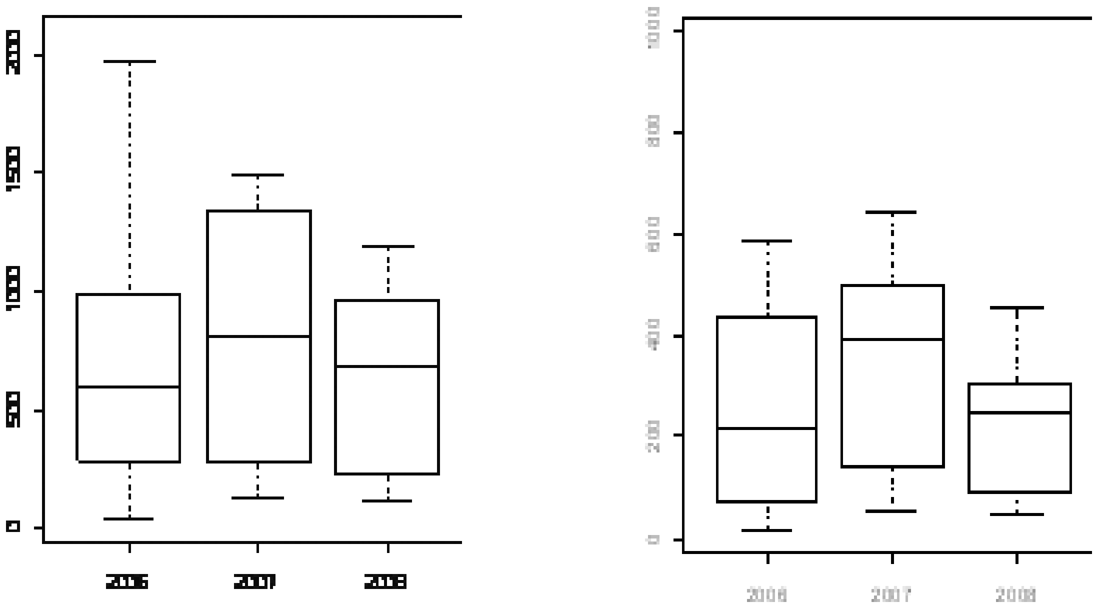



**Figure 4.1.3. Irish Deep-water survey cpue Index of abundance(a; Nph) and biomass(b; Kgph) for roundnose grenadier (*C. rupestris*) with associated 95% confidence limits.**

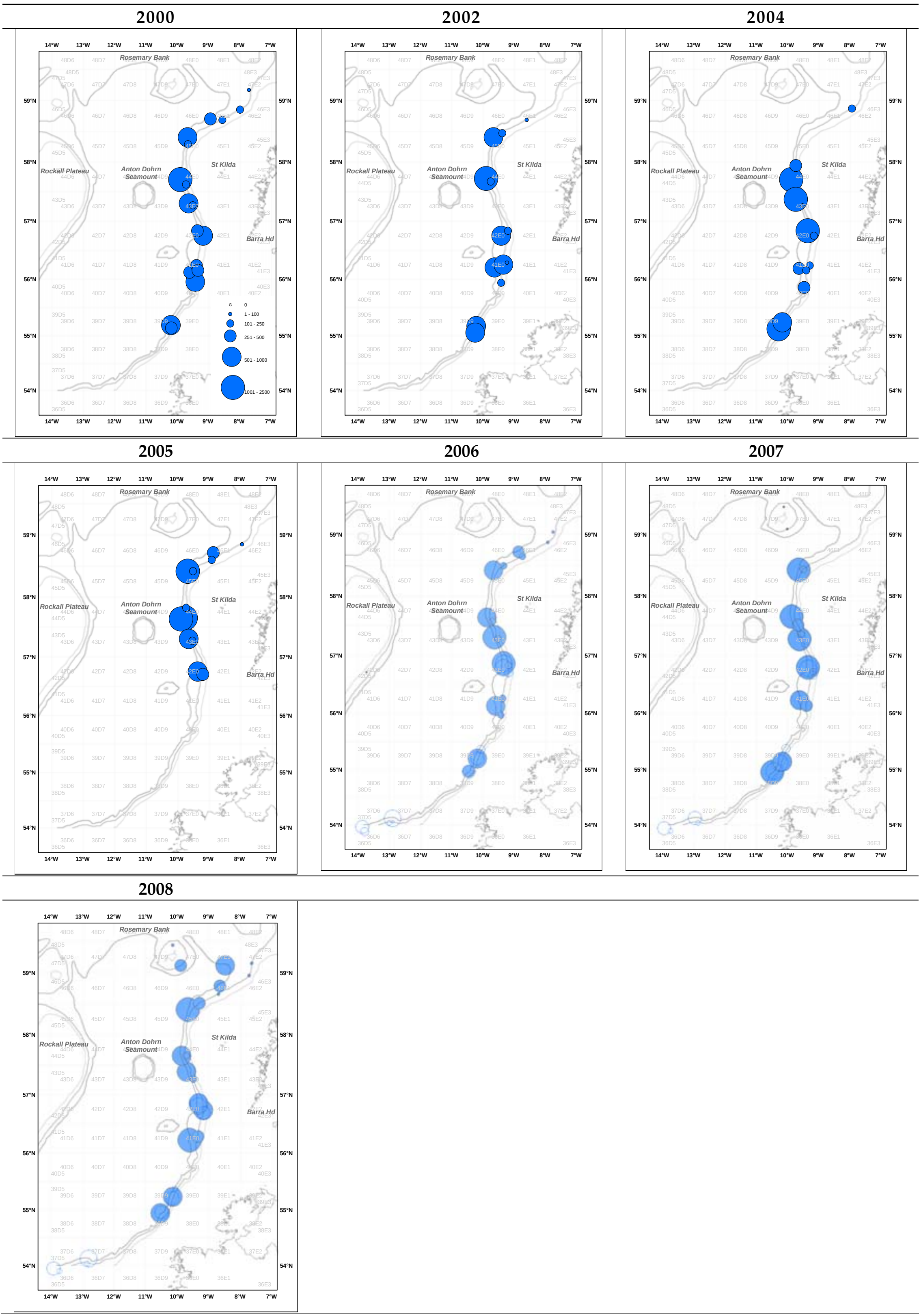
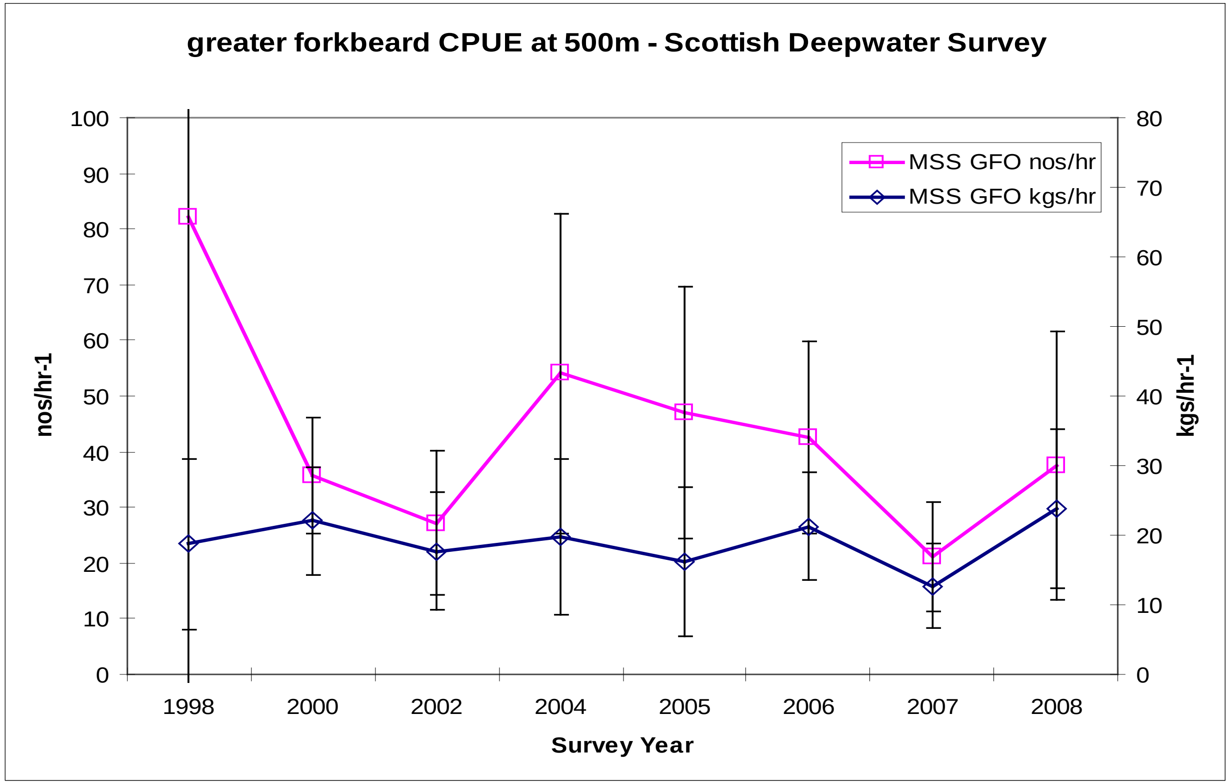



**Figure 4.1.4. Abundance plots for roundnose grenadier for the years 2000–2008. Métier used is numbers/hour trawling/ station and includes data from both 1000m and 1500m stations from both the Scottish (2000–2008), and the Irish (2006–2008) deep-water survey. Filled circles represent Scottish data, with open circles representing Irish data.**

**Greater Forkbeard** (*Phycis blennoides*)

(500m)



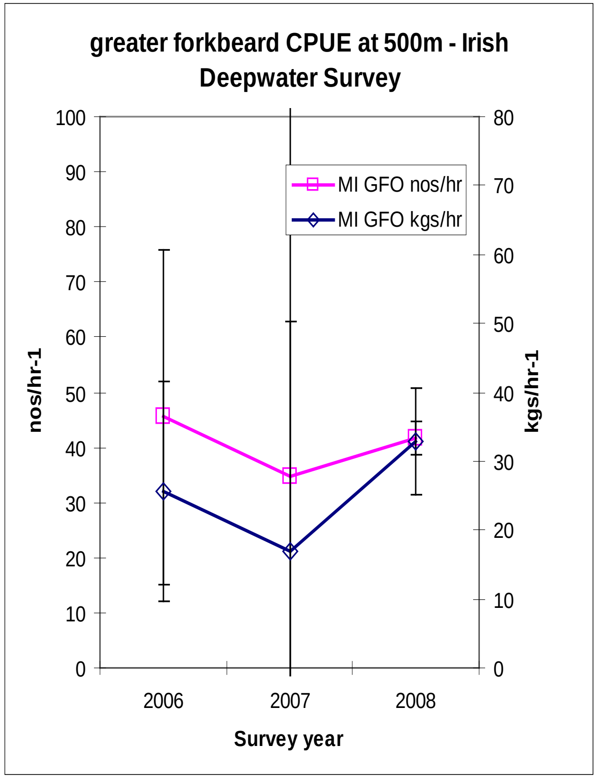




**Figure 3.1.5.Greater forkbeard (*P. blennoides*) cpue (biomass and abundance) for Scottish and Irish deep-water surveys at 500m depth strata with 95% confidence limits.**

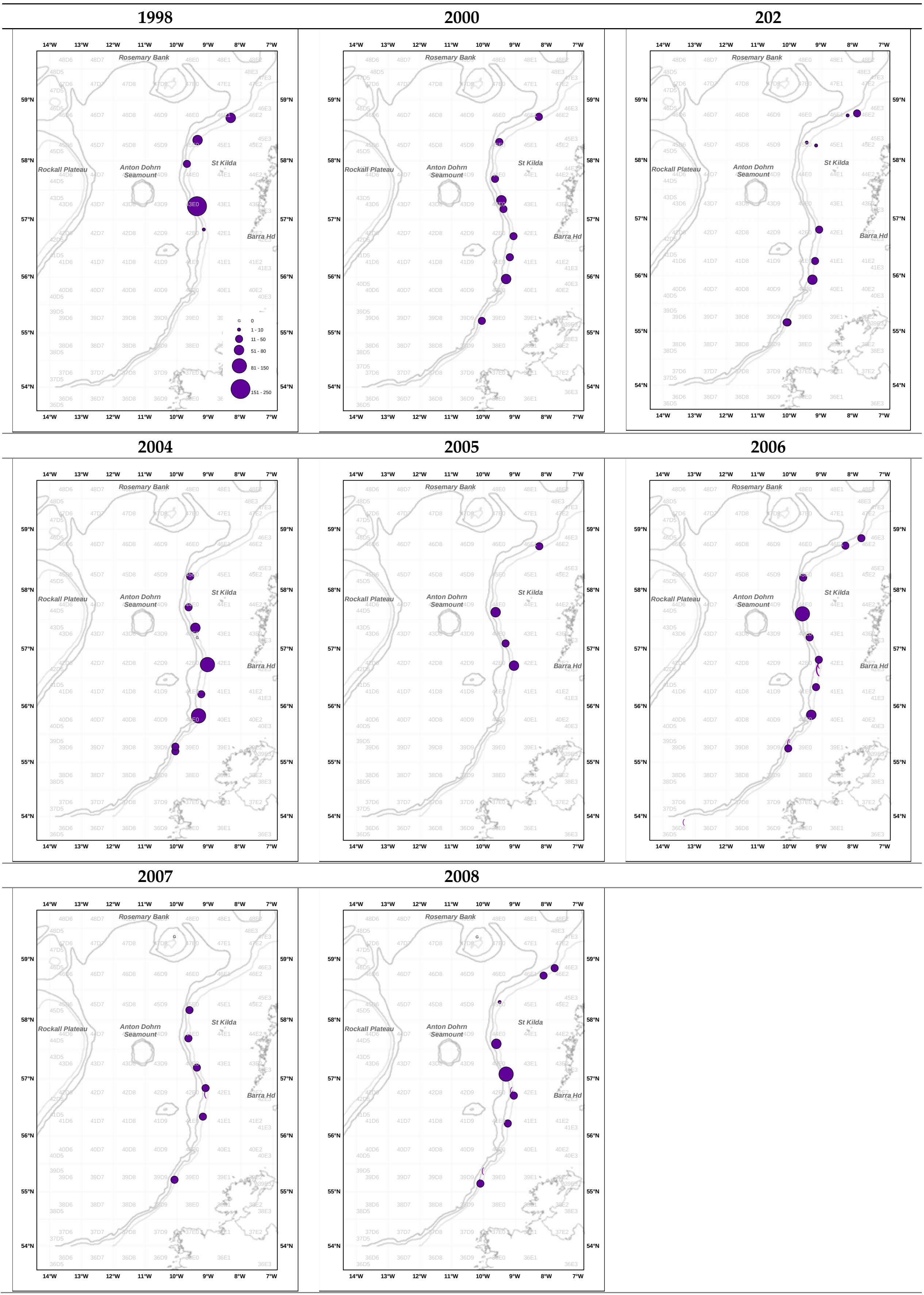
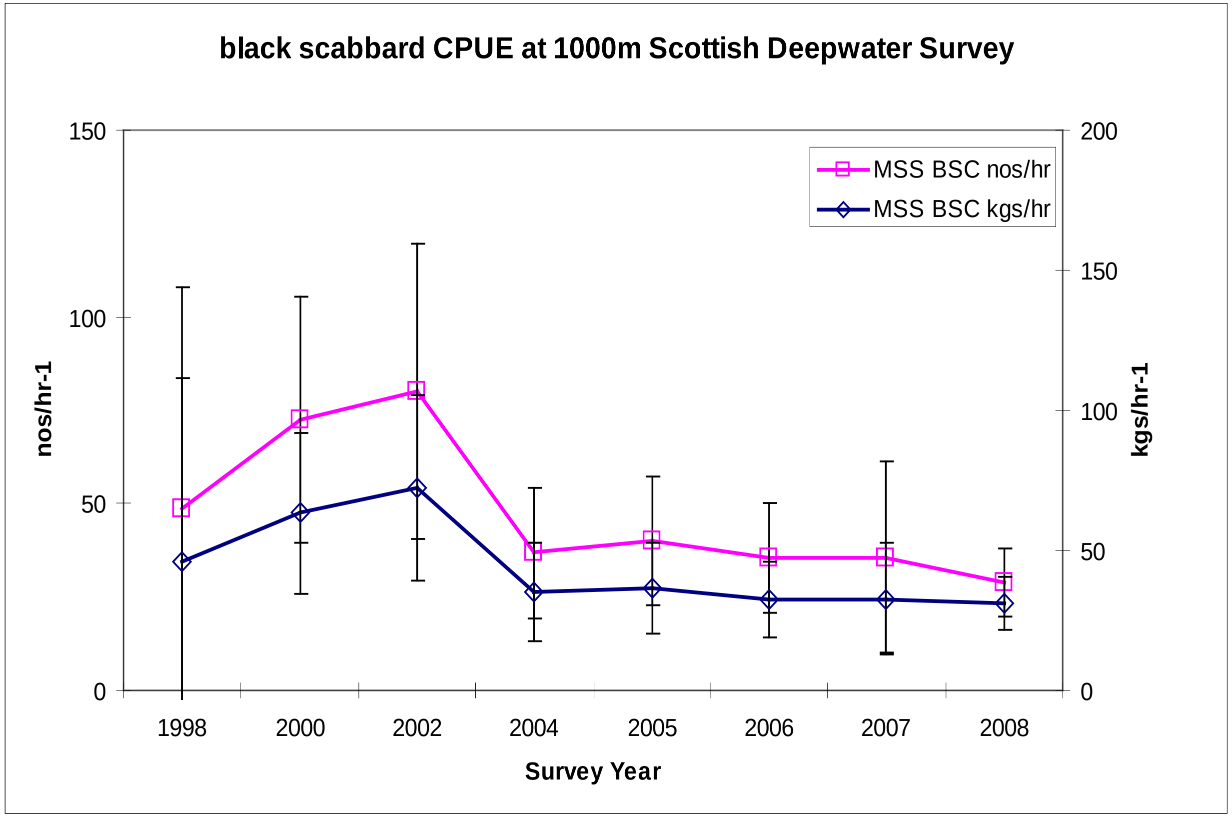



**Figure 4.1.6. Abundance plots for greater forkbeard for the years 1998–2008. Métier used is numbers/hour trawling/ station and includes data from 500m stations from both the Scottish (1998–2008), and the Irish (2006–2008) deep-water survey. Filled circles represent Scottish data, with open circles representing Irish data.**

**Black Scabbard** *(Aphanopus carbo)*

(1000m)



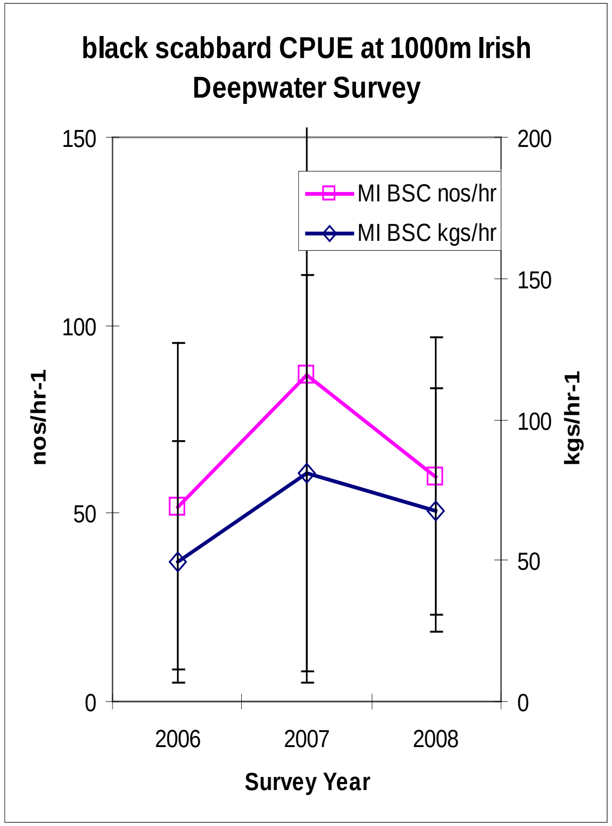




**Figure 4.1.7. Black scabbard (*A. carbo*) cpue (biomass and abundance) for Scottish and Irish deep-water surveys at 1000 m depth strata with 95% confidence limits.**

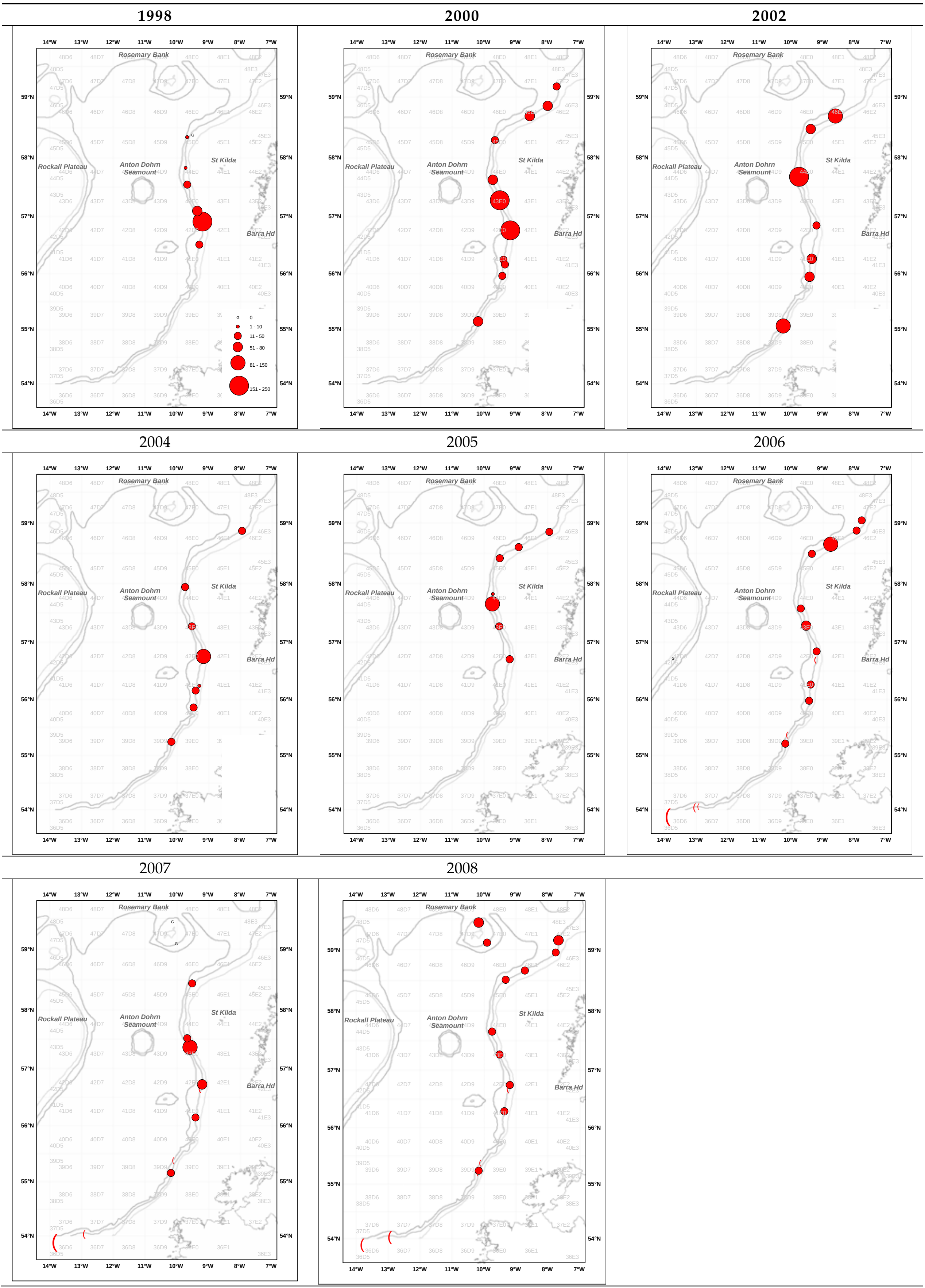



**Figure 4.1.8. Abundance plots for black scabbard for the years 1998–2008. Métier used is numbers/hour trawling/ station and includes data from 1000m stations from both the Scottish (1998–2008), and the Irish (2006–2008) deep-water survey. Filled circles represent Scottish data, with open circles representing Irish data.**

**Brief Evaluation of the cpue estimates for all 3 species in the Central Survey area:**

*Roundnose grenadier*

As can be seen from Figures 4.1.2 and 4.1.3 the indices for both abundance (nph) and biomass (kgph) show remarkable consistency throughout not only the survey period but also between the surveys themselves albeit with wide error bars. Ultimately the precision of the estimates would be enhanced with more survey effort being devoted to these target depths though this would be at the expense of other species such as greater forkbeard that are found shallower. Investigation of the GLM model (Neat and Burns, 2010) yielded no significant effect of survey year, depth (1500m v 1000m) or latitude for the abundance index. For the biomass index the findings were similar although there was a significant effect of depth with 1500m consistently having a higher biomass than those at 1000m.

*Greater forkbeard*

The abundance indices for greater forkbeard appear to show large fluctuations with correspondingly wide error bars (see Figure 4.1.5) compared to that for biomass which shows extremely good consistency throughout the entire survey period. Additionally, both surveys show comparable trends for the years where the surveys overlap which is very encouraging. The precision of these surveys could be increased by diverting more survey effort to the 500m depth stratum although once again this cannot be accomplished without compromising effort elsewhere in the survey. The 500m depth strata is a region that is typically a transitional one combining species more akin to the shallower continental shelf as well as the deeper slope species. Greater forkbeard is one of these such species that straddles both shelf and slope and has a broad depth range from around 100m to 1000m, making it rather unsuitable candidate for creating an index calculation using a single depth strata. Reinstatement of a 750m 'intermediate' depth stratum may increase the precision of the index calculation for this species while at the same time improving the precision estimates other species with similar depth ranges such as black scabbard, blue ling and orange roughy.

*Black scabbard*

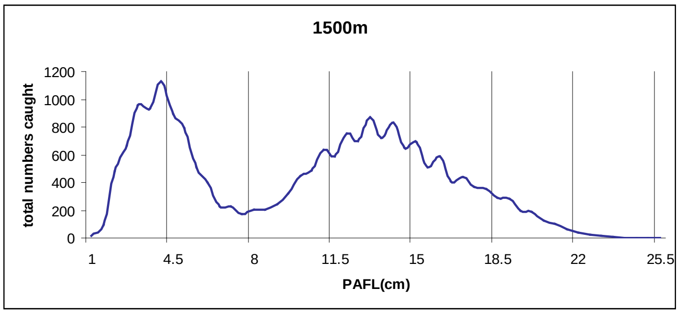
Both indices for black scabbard have shown exceptional stability since 2004 with correspondingly smaller error bars associated with the estimates for each survey year suggesting that the survey stratification as it stands adequately samples this species (Figure 4.1.7).

## 4.2 Recruitment of major stocks in the Central Survey area

Regarding the three (3) species identified for production of cpue indices within the central survey area only the roundnose grenadier would appear to be a suitable candidate for creating a recruitment index for juveniles. Black scabbard encountered during the central surveys are almost exclusively juvenile/subadults and at this point very little is known about the age structure of the population therein. Greater forkbeard as already mentioned are not strictly a 'slope' species rather they occupy both the continental shelf as well as the upper slope and the juveniles tend to be found inshore within shallower areas such as the South Minch. Interrogation of the IBTS dataset within area VI would provide more appropriate data though doubts exist as to whether sufficient numbers of stations are completed in the relevant areas to provide anything beyond presence / absence.

*Roundnose grenadier*

The length frequency data from the 1000m depth strata within the current central survey area is typically bimodal in terms of the length distribution with a peak of small juvenile individuals and a broader second peak comprising of larger and older individuals (See Figure 4.2.1). This is in contrast to length frequency data at 1500m where there is no juvenile component. When creating an abundance index for juvenile roundnose grenadier the data used was therefore restricted to those data within the 1000m depth strata. According to work conducted on growth estimates for this species by Bergstad(1990) and Bergstad and Gordon (1994) individuals of *C. rupestris* with a PAL (pre-anal length) of <5cm would include all of the age-group 0 and I and some of the age-groups II. Abundance data were standardized in order to produce a cpue index of juveniles (PAFL < 5cm) for the central survey area. (See Figure 4.2.2). Significant fluctuations can be seem in the cpue time-series index for juvenile roundnose grenadier and generally are also accompanied by correspondingly large error bars. From the chart 2005 appears to be an extremely good year for juvenile recruitment yielding almost twice the abundance of the next highest year. Another encouraging point to note is the internal comparability within both surveys that shows a steady rise in the numbers of juveniles encountered from 2006–2008. It is acknowledged that PAL (pre-anal length) differs slightly as a length qualifier to PAFL(pre-anal fin length) which is the standard method of measurement for these species in the central survey area however the differences between the two measurement types were not considered to be significant in fish of this length.



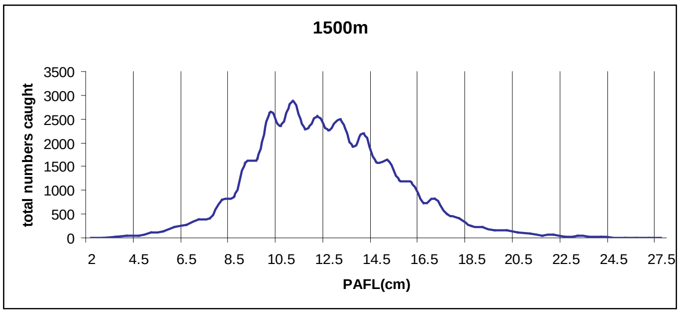




**Figure 4.2.1. Total summed length frequency distribution of roundnose grenadier at 1000 m and 1500m depth strata. Scottish deep-water survey data 2000–2008.**

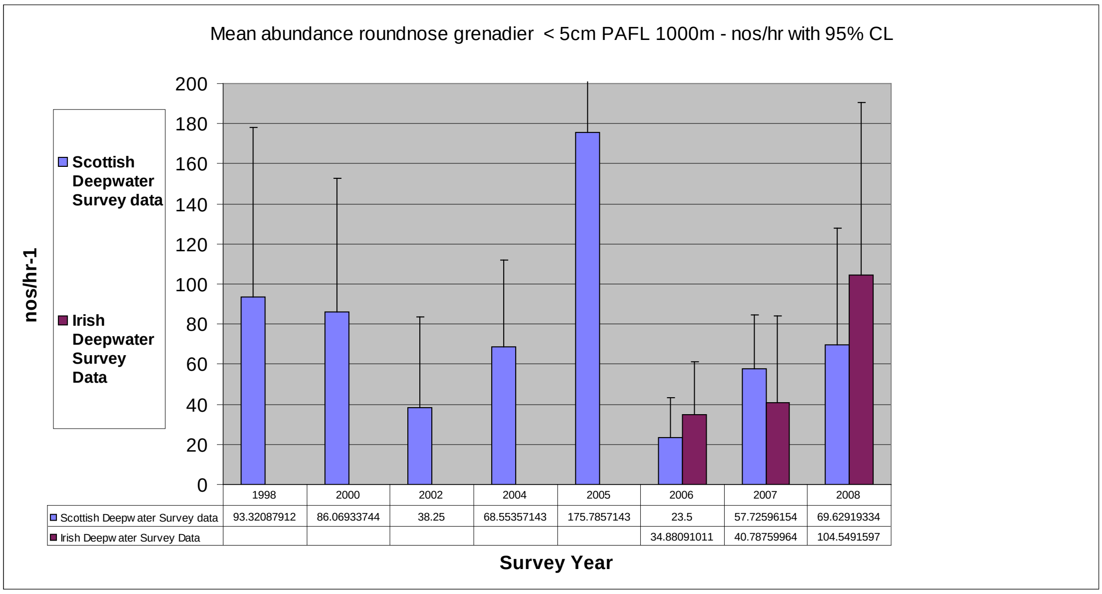



**Figure 4.2.2. CPUE index (nos/hr) for juvenile roundnose grenadier (PAFL <5cm) for both Scottish and Irish Deep-water surveys 1998–2008.**

## 4.3 References

Bergstad, O. A., and J. D. M. Gordon. 1994. Deep-water ichthyoplankton of the Skagerrak with special reference to *Coryphaenoides rupestris* Gunnerus, 1765 (Pisces: Macrouridae) and *Argentina silus* (Ascanius, 1775)(Pisces, Argentinidae). Sarsia, 79:33–43.

Bergstad, O. A. 1990a. Ecology of the fishes of the Norwegian Deeps: Distribution and species assemblages. Netherlands Journal of Sea Research, 25(1/2): 237–266.

Lorance, P., Pawlowski, L., and Trenkel, V. M. 2010. Standardizing blue ling landings per unit effort from industry haul-by-haul data using generalized additive models. ICES Journal of Marine Science, 67: 1650–1658.

Neat, F., and Burns, F. 2010. Stable abundance but changing size structure in grenadier fishes (Macrouridae) over a decade (1998–2008) in which deepwater fisheries became regulated. Deep Sea Research I, 57: 434–444.

Neat, F., Kynoch, R., Drewery, J., and Burns, F. 2010. Marine Scotland Science Report 03/10 Deepwater Trawl Survey Manual, August 2010.

# 5 ToR d) Southern Surveys

The southern subgroup covered the following terms of references:

*d) Southern surveys:*

*use survey data to contribute to the following scientific questions:*

- *Evaluate the feasibility of hypotheses on species dynamics particularly on the species whose life cycle is considered to take place in different areas*
  - *A. carbo juveniles occur in the northern areas (ICES Subareas VI and VII) preadults occur at the ICES IXa. Additionally migration rates can*
  - *be estimated as well as prerecruitment estimates (Scottish and Irish surveys)*
  - *A. carbo and A. intermedius evaluate the distribution area as well as estimate the level of overlap between the two species*
  - *deep-water sharks besides the actual surveyed area is quite restricted the survey will contribute to evaluate the possible migration to southern areas*
  - *of Leafscale gulper shark to reproduce as admitted by WGEF and the existence of local populations of Portuguese dogfish at different areas of NE Atlantic*

The ToRs for the southern area raise a number of issues. However, there is currently no survey able to produce abundance indices for the target species (*Aphanopus carbo*) and the deep-sea sharks mentioned in the ToRs for the southern Areas.

For de southern surveys, the bullet points in the ToRs were edited as follows:

- Evaluate the feasibility of hypotheses on species dynamics particularly on the species whose life cycle is considered to take place in different areas.
  - *A. carbo* juveniles occur in the northern areas (ICES Subareas VI and VII) preadults occur at the ICES IXa. Additionally migration rates can be estimated as well as prerecruitment estimates (Scottish and Irish surveys).
  - *A. carbo* and *A. intermedius* evaluate the distribution area as well as estimate the level of overlap between the two species.
  - deep-water sharks besides the actual surveyed area is quite restricted the survey will contribute to evaluate the possible migration to southern areas of Leafscale gulper shark to reproduce as admitted by WGEF and the existence of local populations of Portuguese dogfish at different areas of NE Atlantic.

These bullet points are addressed further down in this chapter, after a general introduction to current and proposed surveys in the southern area.

## 5.1 Current deep-water surveys in the southern area

### 5.1.1 Surveys in seas around the Azores

There is an ongoing longline survey in the Azores. It provides indices for red sea bream (*Pagellus bogaraveo*) and a number of other species: bluemouth (*Helicolenus dactylopterus dactylopterus*); Alfonsinos (*Beryx Splendens* and *B. Decadactylus*), silver scabbardfish (*Lepidopus caudatus*), conger (*Conger conger*), wreckfish (*Polyprion americanus*), common Mora (*Mora moro*), *Deania profundorum, Deania hystricosa* and greater forkbeard (*Phycis blennoides*; Pinho, 2011, Figure 5.1) and *Etmopterus spinax* and *E.*

*pusilus*. Unfortunately, this survey is not appropriate to black scabbardfish and deep-sea sharks. The gear used in the Azorean survey is not appropriate to black scabbardfish and the survey does not extend deep enough.

### 5.1.2 Surveys off mainland Portugal

There are no ongoing deep-water surveys off mainland Portugal (ICES Division IXa), nor around Madeira. Black scabbardfish from west of Portugal migrate to Madeira for spawning and there is a significant fishery in that area. Therefore abundance indices from both areas would be useful for stock assessment of this species. This implies cooperation between ICES and CECAF as the stock straddles both areas.

A trawl survey was conducted from 1991 to 2001 along part of the Portuguese slope (400-800 m). Diversity of deep-water demersal species were caught but black scabbardfish was only caught in small numbers. Similarly deep-water sharks were caught in small numbers only, suggesting that trawl survey could not be used to derive abundance indices for black scabbardfish (the main deep-water species targeted in fisheries in that area) and deep-sea sharks (a major part of the of the deep-water fish assemblage and presumed to be the most vulnerable to fishing mortality; Figueiredo, *et.al.*, 2011; WD WEGNEACS 2011).

### 5.1.3 Surveys in the Bay of Biscay

Currently there is no deep-water survey in the Bay of Biscay (ICES Subarea VIII). The geological characteristics of the continental slope and the rocky bottoms of the area prevents implementing a deep water bottom-trawl survey using a stratified sampling scheme. The deep-water fisheries in the Bay of Biscay have been developed for many years. Traditionally and small number of artisanal deep-water longliners from the Basque Country targeted mainly deep-water sharks along the continental slope in VIIIc but also in VIIIa and VIIIb. Before the EC Council regulation 1358/2008 legislated that no directed fisheries for these species should be allowed in any ICES area, Basque fleet landed important quantities of some deep-water sharks species of high commercial value (mainly *C. squamosus*, *C. coelolepis* and, *Deania spp*). Unfortunately the series of landing data obtained from this fleet before the closing of the fishery were not split by species, and information on position of hauls was not provided. Therefore the knowledge of the former status of the stocks of deep-water sharks in the area from the data available is currently difficult to assess. As a consequence of lack of information from commercial longliners or surveys it is not possible to obtain estimations of current abundance of the above mentioned species, nor information useful for the evaluation of migratory movements to southern areas of Leafscale gulper shark and black scabbard fish.

### 5.1.4 Proposed deep-water longline surveys

The main objective for assessment in the southern area is to produce relative index of abundance and other population indicators for black scabbardfish, deep-water sharks and other species caught in sufficient numbers (e.g. red sea bream, bluemouth and greater forkbeard).

Abundance indices are essential to get information needed for assessment of the black scabbardfish stock in southern areas. The group considered that as there are two major fisheries for this black scabbardfish stock, there is a priority to collect abundance indices in the area of these two fisheries (southwest of Portugal and around Madeira). Additionally to estimate density throughout the area of distribution, surveys would be needed along all the Portuguese slope, further northwest of Galicia (Spain) and in the Bay of Biscay, as well as along the slope of the gulf of Cadiz. The slope of all these areas are hard rocky bottoms with bottom topography that prohibits trawl surveys with random sampling. Thus the group considered that the appropriate way forwards to obtain abundance indices in the southern area is to develop longline surveys. The aim of such surveys should be to collect not only abundance but a full suite of population indicators for black scabbardfish fish, the two main sharks species (*Centrophorus squamosus* and *Centroscymnus coelolepis*) and any other species that would be caught in sufficient numbers. These population indicators should include abundance, biomass and length distribution by sex. Further relevant biological data should be collected to achieve proportion of mature fish, size at maturity, indices of fecundity etc. Longline surveys are expected to provide less opportunity to calculate biodiversity indicators because of the species-selectivity of longlines. Nevertheless, diversity indicators of predator fish species can be derived. Indicators of species diversity such as species richness can be calculated and the number of species caught may be significant (e.g. Lorance *et al.*, 2002). DCF indicators such as proportion of large fish, mean maximum length and 95% percentile of the fish length distribution can be derived using longline surveys. In this particular case they might provide information about the status of the most vulnerable fish populations.

Because there is no ongoing survey at the slope off Portugal and Bay of Biscay the number of longline sets required to obtain a sufficiently accurate indicators are not known. Therefore it is suggested that a survey is first developed to the west of Portugal mainland and/or around Madeira where fisheries occurs. A reasonable number of days at sea should be allocated. On the basis of two longline sets per day, a 25 days cruise would provide 40 to 50 sets per year. After such a survey is developed in one area it could be extended to other areas (e.g. the Bay of Biscay), standardized with exactly the same gears and survey protocol, to cover the whole distribution area of the main stocks.

The proposal for the implementation of a deep-water longline survey in VIIIc (coordinated with the complementary survey in IXa) would allow for the start of compilation of valuable information that would be used to assess the effectiveness of current management measures, and to monitor the evolution (recovery or not) of the stocks of deep-water sharks and other species like black scabbard fish and red sea bream in the Bay of Biscay area. The survey by commercial longliners should follow a stratified design by depth between the isobaths from 600 to 1200 m in fishing grounds of special scientific interest, and also according to the experience of skippers that were involved in the former fishery.

Sampling for black scabbardfish fish in the Azores would require an additional survey using a different fishing gear than that used in the current survey. The landings of black scabbardfish in ICES Subarea X have varied in recent years with an average of 65 tonnes per year in 2006-2010 (ICES WGDEEP 2011). The fishery cannot develop because it is restricted by the TAC (EU TAC of 3348 tonnes in 2011-2012, the bulk of which has been caught off Portugal mainland in the 2000s). Therefore black scabbardfish is currently not a priority at regional scale in the Azores. However, black scabbardfish in the Azores may (or not) belong to the same stock as black scabbardfish off the Portugal mainland. Thus it may be advisable to collect abundance and biological data for black scabbardfish around the Azores in order to investigate the biology, population identity and dynamics of species in the NE Atlantic.

The worldwide expertise on the use of longline to derive population indicators is limited, so the proposed scheme would need to involve methodological development. There are some known concerns in using abundance indices from longline surveys (Rodgveller *et al.*, 2008). However, some recent studies successfully included longline survey indices in stock assessment (Aires-da-Silva *et al.*, 2008; Hayes *et al.*, 2009). Longline data have also been used to detect non-proportionality between trawl indices and actual population trends (Davies and Jonsen, 2011). Problems such as gear saturation exist but may be overcome (Somerton and Kikkawa, 1995). There are other published and unpublished uses of longline surveys for stock assessment or abundance indices purposes (e.g. Sigler, 2000).

## 5.2 Estimation of migration rates and recruitment based upon Scottish and Irish surveys

The ToR is "*A. carbo* juveniles occur in the northern areas (ICES Subareas VI and VII), preadults occur at the ICES IXa. Additionally migration rates can be estimated as well as prerecruitment estimates (Scottish and Irish surveys)."

Abundance indices of *A. carbo* from the Scottish and Irish surveys are presented in Section 4. These series are currently disrupted as no survey was carried out in 2010. However, such indices will be a part of the standard survey product from the suggested standardized trawl survey in the central area (ICES Subareas VI and VII). The current time-series from the Scottish and Irish surveys are available for stock modelling carried out as part of the ongoing EU funded DEEPFISHMAN project where a Bayesian state-space model of *Aphanopus carbo* is being developed. Survey products will not provide migration rates as these are rather parameter that can be estimated by statistical model using fishery dependent- , survey- and life-history data as input.

### 5.2.1 Estimation of the distribution area and level of overlap between the two species *A. carbo and A. intermedius*

In the ICES area, this topic is relevant only to the Azores because *A. intermedius* is not known to occur to any significant level to the west of Portugal, nor does it occur in ICES Subareas VI and VII. The group considered that this subject is rather marginal in terms of assessment of the stock(s) of *Aphanopus carbo* in the ICES area. There is a mixture of the two species south of the Azores where there is no significant fishery. This area is likely to correspond rather to the limit of the area of distribution of *A. carbo* towards the south along the Mid-Atlantic Ridge and therefore it might not be an area of high density. Although this topic is of scientific interest in terms of biogeography and phylogeny of the genus *Aphanopus* it is not an essential stock assessment matter which should drive the design of deep-water surveys in the southern areas.

### 5.2.2 Survey indicators for deep-water sharks

The ToR reads as "deep-water sharks besides the actual surveyed area is quite restricted the survey will contribute to evaluate the possible migration to southern areas of Leafscale gulper shark to reproduce as admitted by WGEF and the existence of local populations of Portuguese dogfish at different areas of NE Atlantic".

Like for the black scabbardfish, surveys cannot directly produce migration information. Survey data may be used in statistical and/or simulation models to derive migration rate estimates. However, such approach will probably be data demanding in terms of number of individuals observed in every area between which migrations are being estimated. Length distribution, sex and maturity stage are required for such modelling. These data have been collected during Scottish and Irish surveys for the leafscale gulper sharks and the Portuguese dogfish and have been extended to all shark species from 2008 in the Irish survey. However, the number of individuals caught in the survey have been small so that the problems is not on the type of data required but on the sampling effort that would be needed to collect enough shark individuals. Therefore, surveys alone are unlikely to provide sufficient data for statistical analyses and state-space models to assess migrations of sharks. Because of small numbers of Portuguese dogfish and Leafscale gulper shark caught indicators of abundance, mean length and maturity derived by the central surveys will be of low accuracy (see Section 4).

It is unclear what catches of deep-water sharks can be expected in longline survey in the southern area. An attempt to assess this was based upon a literature review. The bycatch of deep-water sharks was reported to be high in the black scabbardfish fishery off mainland Portugal (port of Sesimbra) in the 1990s (Figueiredo *et al.*, 2005). In that period about 250 tonnes of each species of Portuguese dogfish and leafscale gulper shark were landed. These landings were a bycatch of the fishery for black scabbardfish. The Portuguese landing of black scabbardfish (mainly landed in Sesimbra) in the same period declined from about 4400 tonnes in 1992 to 2400 tonnes in 2000. Therefore the catch of sharks on commercial longlines (500 tonnes both species) might have been about 10% or more in weight. Higher shark bycatch proportions, up to 20% in weight, were suggested by Bordalo-Machado and Figueiredo, (Bordalo-Machado and Figueiredo, 2009) for the period 1995-2004. In an Azorean experimental fishery for black scabbardfish, the bycatch was 4 to 7.5% of the total number of fish caught. The leafscale gulper shark was the most abundant bycatch species, over the five years of experimental fishery 2 to 8 leafscale gulper sharks were caught per 1000 hooks (Machete *et al.*, 2011/Table 5.1). Assuming a survey of 40 sets of about 3000 hooks a year this catch rate would yield around 200-1000 sharks per year. These data suggest that it is achievable to design longline surveys so that they provide population indicators not only for black scabbardfish but also for Portuguese dogfish and leafscale gulper shark.

## 5.3 References


Aires-da-Silva, A. M., Hoey, J. J., and Gallucci, V. F. 2008. A historical index of abundance for the blue shark (*Prionace glauca*) in the western North Atlantic. Fisheries Research, 92: 41–52.

Bordalo-Machado, P., and Figueiredo, I. 2009. The fishery for black scabbardfish (A*phanopus carbo* Lowe, 1839) in the Portuguese continental slope. Reviews in Fish Biology and Fisheries, 19: 49–67.

Davies, T. D., and Jonsen, I. D. 2011. Identifying nonproportionality of fishery-independent survey data to estimate population trends and assess recovery potential for cusk (*Brosme brosme*). Canadian Journal of Fisheries and Aquatic Sciences, 68: 413–425.

Figueiredo, I., Machado, P. B., and Gordo, L. S. 2005. Deep-water sharks fisheries off the Portuguese continental coast. J. Northwest Atl. Fish. Sci., 35: 291–298.

Hayes, C. G., Jiao, Y., and Cortes, E. 2009. Stock Assessment of Scalloped Hammerheads in the Western North Atlantic Ocean and Gulf of Mexico. North American Journal of Fisheries Management, 29: 1406–1417.

Lorance, P., Souissi, S., and Uiblein, F. 2002. Point, alpha and beta diversity of carnivorous fish along a depth gradient. Aquat. Living Resour., 15: 263–271.

Machete, M., Morato, T., and Menezes, G. 2011. Experimental fisheries for black scabbardfish (*Aphanopus carbo*) in the Azores, Northeast Atlantic. ICES Journal of Marine Science, 68: 302–308.

Pinho, M. R. 2011. Update of survey data from the Azores. Working document 22 to ICES WGDEEP 2011 meeting. 19pp.

Rodgveller, C. J., Lunsford, C. R., and Fujioka, J. T. 2008. Evidence of hook competition in longline surveys. Fishery Bulletin, 106: 364–374.

Sigler, M. F. 2000. Abundance estimation and capture of sablefish (*Anoplopoma fimbria*) by longline gear. Canadian Journal of Fisheries and Aquatic Sciences, 57: 1270–1283.

Somerton, D. A., and Kikkawa, B. S. 1995. A stock survey technique using the time to capture individual fish on longlines. Canadian Journal of Fisheries and Aquatic Sciences, 52: 260–267.

**Table 5.1. Catch of black scabbardfish and leafscale gulper shark in an experimental fishery for black scabbardfish in the Azores, data from Machete *et al.* (2011).**

| Year | 1999 | 2000 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|
| Number of longline sets | 13 | 47 | 45 | 10 | 125 |
| Mean number of hook per set | 3705 | 4026 | 3245 | 2498 | 3625 |
| Total number of black scabbardfish | 7817 | 23720 | 28755 | 3576 | 46376 |
| Total number of Leafscale gulper sharks | 419 | 897 | 930 | 124 | 1043 |
| Number of leafscale gulper sharks for 100 black scabbardfish | 5.4 | 3.8 | 3.9 | 3.5 | 2.2 |
| Number of leafscale gulper sharks per 1000 hooks | 8.7 | 4.7 | 6.4 | 5.0 | 2.3 |

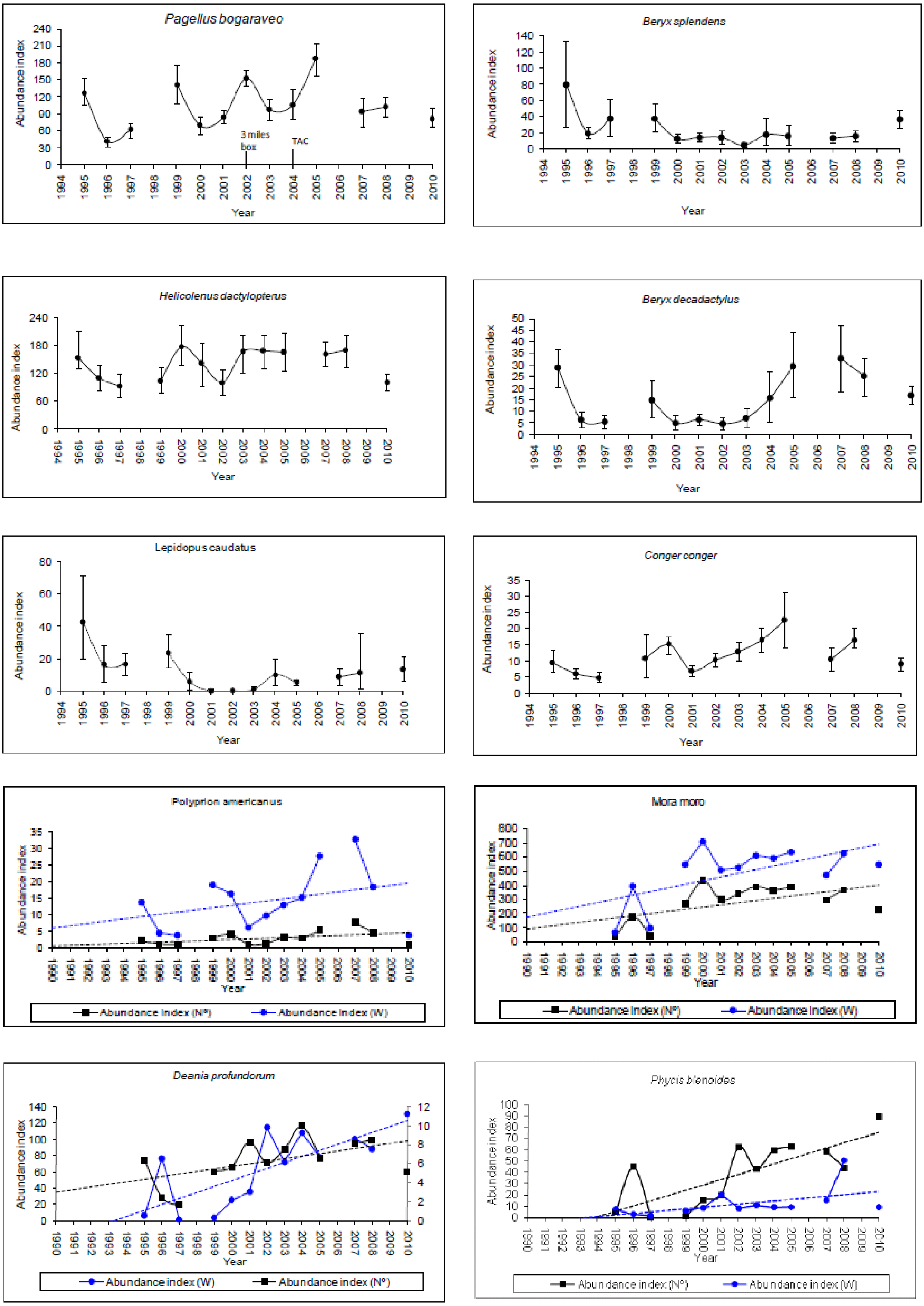



**Figure 5.1. Abundance indices available from the Azorean longline survey (from Pinho, 2011).**

# 6 ToR e) Prepare methods for delivery of the following information to assessment working groups in 2012

e) Prepare methods for delivery of the following information to assessment working groups in 2012:

*i ) Proportion of fish larger than the mean size of first sexual maturation*

*ii ) Mean maximum length of fish found in research vessel surveys*

*iii ) 95th % percentile of the fish length distribution observed*

## 6.1 Background

The EC has provided example criteria for assessing progress towards Good Environmental Status (GES) under the Marine Strategy Framework Directive (MSFD) for commercial fish stocks (European Commission, 2010).

Descriptor 3 of the MSFD is to assess whether "*populations of all commercially exploited fish and shellfish are within safe biological limits, exhibiting a population age and size distribution that is indicative of a healthy stock*".

The decision document considers that "*Healthy stocks are characterized by large proportion of old, large individuals. Indicators based on the relative abundance of large fish include:*

- *Proportion of fish larger than the mean size of first sexual maturation (3.3.1)*
- *Mean maximum length across all species found in research vessel surveys (3.3.2)*
- *95th % percentile of the fish length distribution observed in research vessel surveys (3.3.3)"*

In addition to these 'primary indicators', the "*size at first sexual maturation*" may be a 'secondary indicator', as a reduced size at maturity "*may reflect the extent of undesirable genetic effects of exploitation*" (European Commission, 2010).

Information of size structure of populations is also useful for developing metrics for assessing the impact of fishing and the degree of truncation of the size structure of the population which are important components of descriptor 3 for Good Environmental status of the MSFD. High fishing intensity reduces the relative abundance of large fish because large individuals are generally older and have had more exposure to fishing gear. Furthermore most fisheries target and catch large fish more effectively. Hence a stock lacking large or old fish is more likely to be overfished and under-productive economically. The corollary is that increasing proportions of large or old fish imply better survival with age and a recovery of the stock, whether from reduced fishing or other influences.

In deep-water surveys, length frequency data are widely available, however information on age and reproductive state are available for fewer species. In addressing (i) WGNEACS thought it was useful first to identify those species for which this information is available. The most commonly used measure of 'average' size at maturity is the $L_{50}$ or the length at which 50 % of individuals are mature. It is assumed that this is for females as is usually the case. Males and females often differ significantly in this respect and proportion of fish in length over $L_{50}$ can vary significantly by sex (Figure 6.1). It is not clear if this ToR is asking for a methodology with respect to numbers of individuals or biomass of individuals. These provide very different indices and should be considered separately. Table 6.1 provides a list of $L_{50}$ values available for deepsea species.

**Table 6.1. Species for which L50 (females) data are available.**

| Species | L50 | Reference |
|---|---|---|
| Greenland halibut | 56.99 cm (TL) | Hallfredsson and Jørgensen, 2011 |
| Roundnose grenadier | 12 cm (PAFL) | Kelly *et al.* (1997) |
| Black scabbardfish | 103 cm (TL) | Viera *et al.* |
| Blue ling | 79 cm (TL) | Magnussen, 2007 |
| Leafscale gulper shark | 128 cm (TL) | Clark (2002) |
| Forkbeard | 26 cm (TL) | Bahamon (2007) |
| Orange roughy | 37 cm (TL) | Minto (2006) |
| Hake | 35 cm (TL) | Bahamon (2007) |
| Greater silver smelt | 27.7 cm (TL) | Hallfredsson (2010) |
| Beaked redfish | 22-26 cm | Ni and Templeman 1984 |
| Common redfish | 43.00 cm | Raitt and Hall (1967) |

On the basis of these data it is fairly straightforward process to calculate the proportion of fish in a population that are larger than the average size at maturity.

## 6.2 Case study – Roundnose grenadier (Scottish survey data 2000–2008)

Length frequency data were available for *C. rupestris*. The number and biomass of fish in each year was presented as a proportion of the total catch for each year. Generally around 40 % of the individuals were greater than the $L_{50}$ for this species (12 cm PAFL) and 80 % of the biomass (Figure 6.2).

The mean maximum length for this species was calculated for each year. There was no significant change in mean maximum length of this species over the period 2000-2008 (Neat and Burns, 2011). More generally regarding mean maximum length across all species found in research vessel surveys caution must be shown regarding comparability of measurements, as for example length of chimaerans that usually is registered as gut length.

The 95$^{th}$ percentile of the fish length distribution observed was taken to mean the length associated with the upper 95% of individuals or biomass. In the case of roundnose grenadier results are shown in Table 6.2.

**Table 6.2. Length associated with upper 95% of individuals and biomass for roundnose grenadier in the Scottish surveys.**

| Year | Length of 95th percentile (Numbers) | Length of 95th percentile (Biomass) |
|---|---|---|
| 2000 | 17 | 19 |
| 2002 | 17 | 19 |
| 2004 | 16 | 19 |
| 2005 | 16 | 19 |
| 2006 | 17 | 20 |
| 2007 | 16 | 19 |
| 2008 | 17 | 20 |

These metrics can be simply calculated and are potentially useful for indicators of fishing pressure. What is clear from the case study of roundnose grenadier is that time-series in excess of a decade are probably necessary to detect any significant change in deep-water species. It should be noted that the distribution area for the survey might not be representative for the whole distribution area for the population.

## 6.3 References

Bahamon, N., Sardà, F., Suuronen, P. 2007a. Potential benefits from improved selectivity in the northwest Mediterranean multispecies trawl fishery. ICES J Mar Sci., 64:757–760.

Clarke, M. 2002. Age estimation of the exploited deepwater shark *Centrophorus squamosus* from the continental slopes of the Rockall Trough and Porcupine Bank. Journal of Fish Biology, 60(3), p.501–514. Available at:http://doi.wiley.com/10.1006/jfbi.2001.1861.

Magnussen, E. 2007. Interpopulation comparison of growth patterns of 14 fish species on Faroe Bank: are all fishes on the bank fast-growing? Journal of Fish Biology, 71(2),p.453–475. Available at:http://www.blackwell-ynergy.com/doi/abs/10.1111/j.1095-8649.2007.01502.x.

Minto, C., and Nolan, C. P.2006. Fecundity and Maturity of Orange Roughy (*Hoplostethus atlanticus Collett* 1889) on the Porcupine Bank, Northeast Atlantic. Environmental Biology of Fishes.Volume 77, Number 1 (2006), 39-50, DOI: 10.1007/s10641-006-9053-0

Hallfredsson, E. H. 2010. Greater silver smelt in Norway, growth and Maturity. WD ICES WKDEEP 2010 GSS-9.

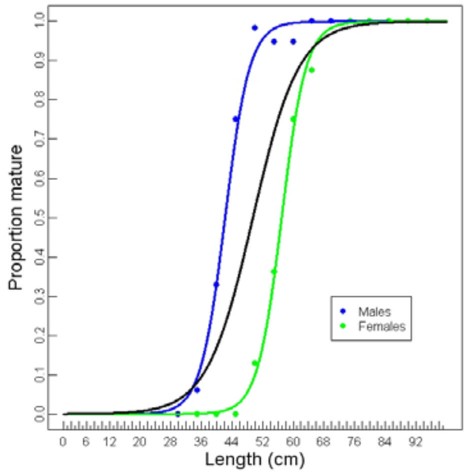
Hallfredsson, E. H., and Jørgensen, T. 2011.Technical measures in targeted Greenland halibut fisheries in the Barents Sea, synopsis of earlier Norwegian selection experiments and preliminary analysis of minimum legal size. Working document to the meeting between Russian and Norwegian scientists in Murmansk, Russia, 14–18 March 2011.

Kelly, C. J., Connolly, P. L., Bracken, J. J. 1997. Age estimation, growth, maturity and distribution of the roundnose grenadier from the Rockall Trough. J. Fish Biol., 50, 1–17.

Ni, I.-H., and E. J. Sandeman 1984 Size at maturity for Northwest Atlantic redfishes (*Sebastes*). Can. J. Fish. Aquat. Sci., 41:1753–1762.

Raitt, D. F. S., and W. B. Hall. 1967. On the fecundity of the redfish. J. Cons. pem. int. Explor. Mer, 31: 237–245.

Vieira, A. R., Farias, I., Figueiredo, I., Neves, A., Morales-Nin, B., Sequeira, V., Martins, M. R., Gordo, L. S. 2009. Age and growth of black scabbardfish (*Aphanopus carbo* Lowe, 1839) in the southern NE Atlantic. Sci. Mar., 73S2: 33–46.



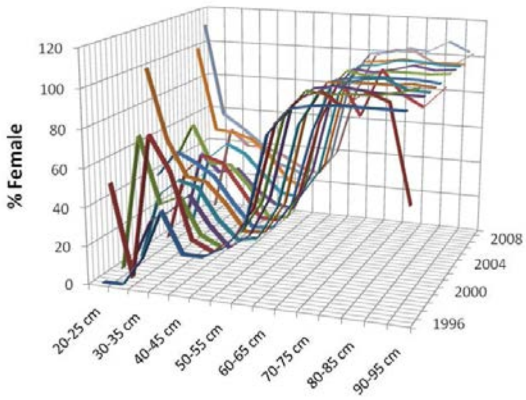




**Figure 6.1. A) Maturity ogives by length for Greenland halibut in 2009 survey, $L_{50}$ males = 49 cm, L50 females = 57 cm. B) Proportion females in survey catches by length 1994-2009 (data from Norwegian Deep Water survey along the Northern Shelf Brake).**

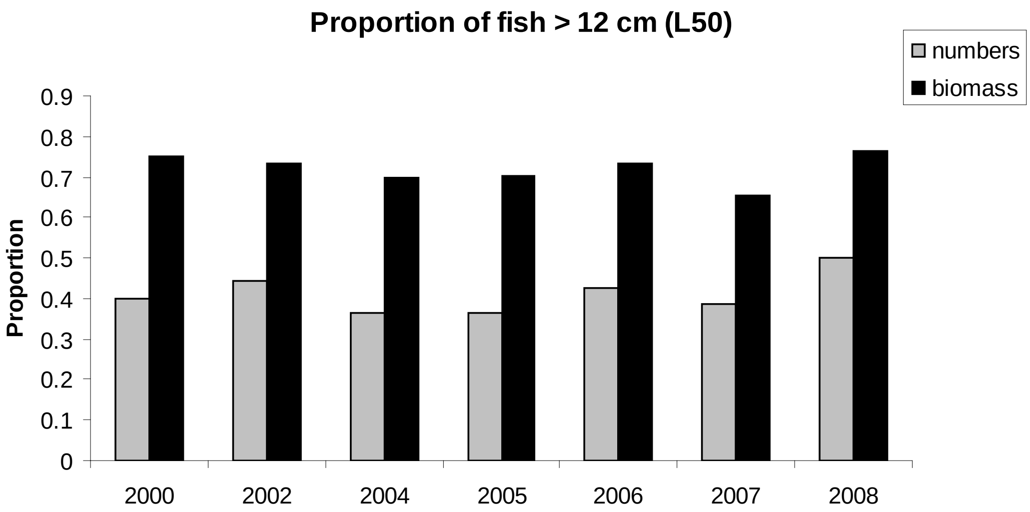



**Figure 6.2. Proportion of roundnose grenadiers females larger than L50 in Scottish deep-sea surveys.**

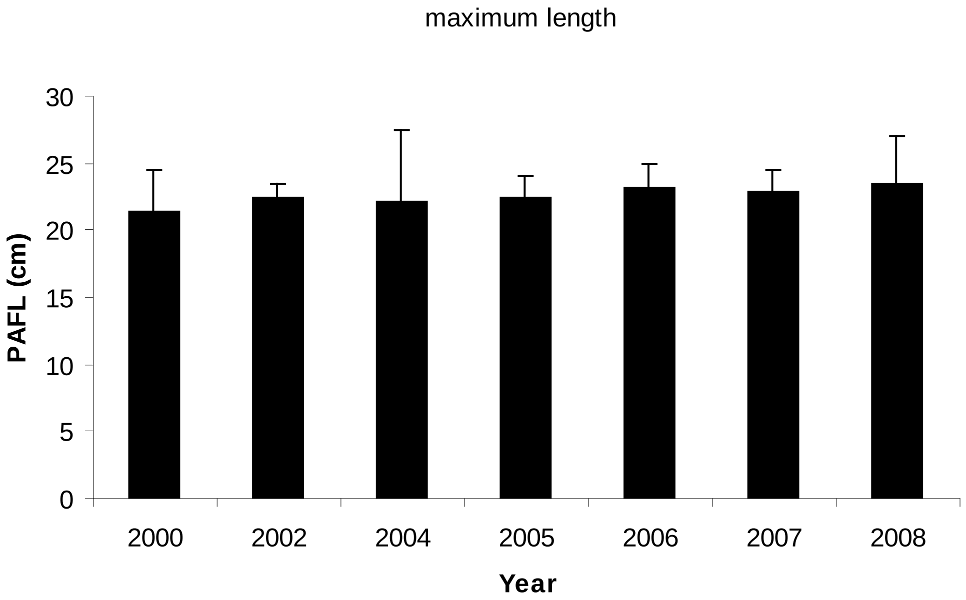



**Figure 6.3. Figure X.2. Mean maximum length by stations of roundnose grenadiers L50 in Scottish deep-sea surveys.**

# Annex 1: List of participants

| Name | Address | Phone/Fax | E-mail |
|---|---|---|---|
| Finlay Burns | Marine Scotland Science<br>Marine Laboratory<br>375 Victoria Road<br>PO Box 101<br>Aberdeen AB11 9DB<br>UK | | F.Burns@marlab.ac.uk |
| Elvar Halldor Hallfredsson<br>Chair | Institute of Marine Research<br>Nordnesgt 33<br>PO Box 1<br>N-5817 Bergen<br>Norway | +47 77609756;<br>Cell: +47 92609745<br>+47 77609701 | elvarh@imr.no |
| Pascal Lorance | Ifremer<br>Nantes Centre<br>rue de l'Ile d'Yeu<br>PO Box 2<br>F-44311 Nantes Cédex 03<br>France | +33 240374085<br>+33 240374075 | pascal.lorance@ifremer.fr |
| Brendan O'Hea | Marine Institute<br>Rinville<br>Oranmore Co.<br>Galway<br>Ireland | | brendan.ohea@marine.ie |
| **Working by Correspondence** | | | |
| Thomas de Lange Wenneck | Institute of Marine Research<br>Nordnes<br>PO Box 1870<br>5817 Bergen<br>Norway | +47 55 23 86 78 | thomas.de.lange.wenneck@imr.no |
| Leonie Dransfeld | Marine Institute<br>Rinville<br>Oranmore Co.<br>Galway<br>Ireland | +353 91 387200<br>+353 91 387201 | leonie.dransfeld@marine.ie |
| Graham Johnston | Marine Institute<br>Rinville<br>Oranmore Co.<br>Galway<br>Ireland | +353 91 387200 | graham.johnston@marine.ie |
| Francis Neat | Marine Scotland Science<br>Victoria Quay<br>1st floor<br>Edinburgh EH6 6QQ<br>UK | +44 1224 295516<br>+44 1224 295511 | F.Neat@marlab.ac.uk |

| Name | Address | Phone/Fax | E-mail |
|---|---|---|---|
| Petur Steingrund | Faroe Marine Research Institute<br>Noatun<br>PO Box 3051<br>110 Tórshavn<br>Faroe Islands | +298 353 900<br>+298 353 901 | peturs@hav.fo |

## Annex 2: WGNEACS terms of reference for the next meeting

The **Working Group on North-east Atlantic Continental Slope Survey** (WGNEACS), chaired by Elvar H. Hallfredsson, Norway, will meet in Lisbon, Portugal, 12–14 June 2012 to:

a ) Develop a series of data products in terms of spatial distribution maps, time-series of abundance indices and ecosystem indicators for NEA deep-water surveys as required by the Assessment working groups and/or specified in the benchmark workshops.

b ) Nordic surveys:

i ) Continue work on sampling protocols for surveys by Faroe, Greenland, Iceland and Norway, and attempt to standardize the protocols as much as possible. Special attention should be given to species identification, especially regarding non-target species.

ii ) Evaluate survey coverage, density and distribution of all major stocks in the area in other years, in same manner as was done using 2010 data at WGNEACS 2011.

iii ) Analyse trends in biomass, length and recruitment for major stocks across the area.

iv ) Evaluate and compile existing data from the Nordic surveys on the physical environment.

v ) Continue an overview of surveys in the area made by countries other than those represented at 2010 WGNEACS (Norway, Faroe Islands, Iceland and Greenland)

c ) Central surveys:

i ) Evaluate the sources of variance in the survey design of the central deep-water surveys

ii ) Compile abundance data from the different surveys and evaluate, density and distribution of all major stocks in the area

iii ) Analyse trends in biomass, length and recruitment for major stocks across the area.

d ) Southern surveys:

i ) Evaluate and review the appropriateness of longline surveys in general and provide recommendations as appropriate.

ii ) In particular evaluate the appropriateness of longline surveys in the southern area as defined by WGNEACS (Bay of Biscay and Iberian waters, ICES X (Azores)). This includes evaluation of existing longline survey series from the area and the capacity of longline surveys to provide:

1 ) Full suite of population indicators for black scabbardfish fish, the two main sharks species (*Centrophorus squamosus* and *Centroscymnus coelolepis*) and any other species that would be caught in sufficient numbers, including other target demersal/deep-water species in the Azores. This should include indicators on abundance, biomass and length distribution by sex. Additionally the surveys should collect

relevant biological data to achieve proportion of mature fish, size at maturity, indices of fecundity etc.

2 ) Opportunity to calculate biodiversity indicators such as diversity indicators of predator fish species can, indicators of species diversity such as species richness. DCF indicators such as proportion of large fish, mean maximum length and 95% percentile of the fish length distribution. Information about the status of the most vulnerable fish populations.

iii ) Develop longline survey design for abundance estimates in the southern area using available information.

WGNEACS will report by 20 July 2012 (via SSGESST) for the attention of SCICOM and ACOM.

## Supporting Information

| | |
|---|---|
| Priority | High. The work of the Group is essential if ICES is to collate even the most basic data and to progress the application of assessment techniques. |
| Scientific justification | This working group would fulfill the need of internationally coordinating the existing dedicated deep-water surveys that are currently being carried out along the European continental shelf and Nordic seas. These internationally coordinated deep-water surveys would be a potential source of abundance indices for roundnose grenadier, black scabbardfish, deep-water sharks, Greenland halibut, bluemouth redfish, greater silver smelt and greater forkbeard and also be a platform for carrying out studies of seamounts identified by WGDEC and any related studies of the efficacy of closed areas. |
| Resource requirements | None specific, beyond the need for members to prepare for and participate in the meeting. Some of the international deep-water surveys are subject to funding |
| Participants | The Group is normally attended by some 10–15 members and guests. |
| Secretariat facilities | None. |
| Financial | No financial implications. |
| Linkages to advisory committees | ACOM |
| Linkages to other committees or groups | Close links with WGDEEP and WGEF and also for the Nordic deep-water surveys NWWG and AFWG to provide abundance indices on deep-water species including deep-water sharks; links with WGDEC for the collection and analysis of environmental data and deep-water habitat characterization. Links with IBTS in order to benefit from expertise in the international coordination of trawl surveys. |
| Linkages to other organizations | NEAFC |

# Annex 3: Recommendations

| Recommendation | For follow up by: |
|---|---|
| 1. WGNEACS recommends to Nordic laboratories running deep-water surveys to consider adopting the 14 points highlighted in the report towards closer coordination and standardization of Nordic deep-water surveys sampling protocols. WGNEACS recommends the Nordic laboratories to increase numbers of deep stations on existing groundfish surveys with special attention on Greenland halibut, and consider coverage of areas further north in east Greenland (67°N-68°N). Additionally slopes of the Icelandic-Faroe Ridge, the area between Iceland and the Faroe Islands, and slopes between the Faroe Islands and Norway are not covered, that are important also regarding beaked redfish. Considering greater silver smelt WGNEACS recommends that the possibilities for distribution and density estimates for the species by acoustic surveys west of Scotland/Ireland are examined, e.g. WGIPS surveys | Nordic national laboratories<br>WGIPS |

## Annex 4 Working document presented to this working group meeting

There were two working documents presented at this year's meeting:

**Southern Survey (Bay of Biscay and Iberian waters, ICES X (Azores))**

**Ivone Figueiredo[1]; Guzman Diez[2] and Mario Rui Pinho[3]**

1 ) Marine Resources and Sustainability Unit (U-REMS), INRB, L-IPIMAR, I.P. Lisbon, Portugal

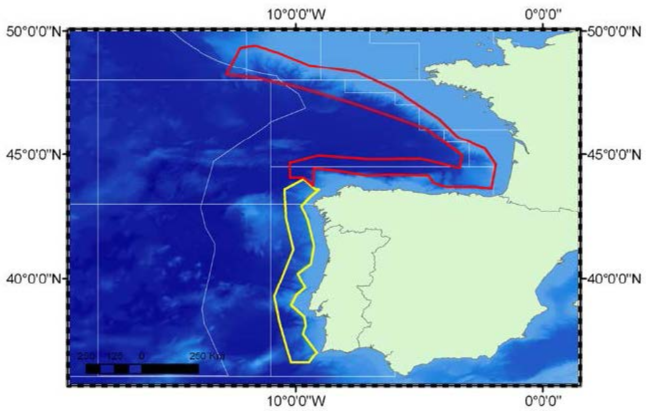
2 ) Azti-tecnalia Txatxarramendi Ugatea z/g 48395 Sukarrieta (Bizkaia) Spain

3 ) Department of Oceanography and Fisheries (DOP), University of the Azores:

## Introduction (extracted from WGDEEP2011)

For most deep-water stocks fished by EU fleets, there are no adequate surveys that currently provide data to be used in stock assessments at a spatial scale corresponding to the distribution area of these stocks. With these surveys additional data should also be collected to meet the ecosystem monitoring requirements under the EU Data Collection Framework (DCF), Marine Strategy Framework Directive (MSFD), and OSPAR.

NE Atlantic deep-water surveys have been proposed by the ICES Working Group for North-east Atlantic Continental Slope Survey (WGNEACS) for the central Northeast Atlantic (ICES Subareas VI and VII and Divisions Vb and XIIb) and the Iberian Shelf/Bay of Biscay (Subareas VIII and IX; ICES, 2010).




**IberianShelf/Bay Biscay - Area coverage of the proposed deep-water longline survey (ICES, 2011). Polygons represent proposed sample regions.**

If fully implemented, these surveys would meet current and near-future (and long term) requirements for stock assessment and ecosystem monitoring.

Additional data will require separate surveys, namely the spatial extension of the Azores longline survey (Subarea X) to cover offshore seamounts. This survey is expected to provide improved abundance indices for red sea bream, bluemouth, and deep-water sharks.

## Longline vs. trawl )

(**Underlying idea** Reasons for not using trawl)

In **Portugal mainland** bottom-trawl surveys for deep-water fisheries west of the Portuguese coast were discontinued in 2003, due to the fact that the deep-water resources with more commercial importance for Portugal, namely black scabbard fish and deep‐water sharks, were not adequately sampled in these surveys. Yields from trawl gears are expected to be very low and thus cannot be used as abundance indicators.

The deep-water species usually caught by the commercial fleet derived from fishing grounds not suitable for trawling. Furthermore, deep‐water species show a very steep vertical distribution, being associated with areas of very irregular seabed morphology. In these areas, trawl gears are not appropriate for sampling. As a consequence, it is proposed to use longline gears instead of trawl.

Results from short experimental surveys made by IPIMAR using longline gear were promising. Several deep‐water species were caught, indicating that this fishing technique is adequate to obtain abundance estimates of the targeted species. Hence in this area it is proposed to carry out a longline survey which would be scientifically coordinated by WGNEACS at level two as it would not have technical standardization with the trawl survey in the central area of NEACS.

Additional constrains might be also invoked. Among these it is worth to stress that in ICES Subarea X EU has approved a ban on bottom-trawling around deep waters around the Azores, Madeira and the Canary Islands and restrictions on access to the waters concerned by vessels from other Member States so that habitats in these areas are protected under the CFP (Reg CE 1568/2005).

The Deep-water fishing grounds in the southern of the **Bay of Biscay** (ICES Division VIIIc) are very close to the coastal areas. In the waters of the Basque Country the 400 m isobath is reached at 12 miles from the coast, leaving a very narrow continental platform. In the areas deeper than 100 m, trawling is only allowed for the Basque's trawlers. Last year this fishery involved only two PTB that usually work at less than 200 m depth. Very little is known about the biodiversity and fish communities of deep-water areas because the deep-water fishing grounds are not suitable for trawling. Besides, according the EU regulation (CE 43/2009) the fishing for deep-water gillnetters (tanglenets) that traditionally operated in these grounds targeting monkfish is banned below 600 m since 2009. A small sized longliner fleet that operated along the slope of the continental platform targeting deep-water sharks has also been stopped fishing since 2008 thanks to the TAC = 0 for these species.

### Topography

The **Bay of Biscay and Iberian Coast region** extends from 48°N to 36° N and from 11° W to the coastlines of France, Portugal and Spain. The bottom topography of region is highly variable, from continental shelf to abyssal plain. In this Region there are some remarkable topographic features such as seamounts, banks and submarine canyons. The bottom topography and coastlines are highly diversified, including the continental shelf and slope and parts of the abyssal plain. Ecosystems in Region IV are very rich, supporting a rich fish fauna. The Bay of Biscay and Iberian Coast region are situated in temperate latitudes with a climate that is strongly influenced by the inflow of oceanic water from the Atlantic Ocean and by the large-scale westerly air circulation which frequently contains a low pressure system. Large storms occur in the Bay of Biscay, especially during winter months. Due to oceanographic conditions, many species reach their southern or northern limits of distribution. The majority of fish in region IV are species living near the bottom of the sea (for example sole, dog-fish or blue whiting) with limited geographical range, besides the deep-water species.

The Iberian Atlantic coast extends from the Gulf of Cadiz to Galicia Bank off the northwest edge of the Iberian Peninsula. The continental shelf along the coast varies in width from 15 to nearly 400 km [LME, 2004]. The region is influenced by Atlantic eastern boundary currents as well as by upwelling in spring and summer (April to August).

**Azorean Archipelago** is situated in Ospar Region V- the Wider Atlantic. Region V represents the deep-waters of the North-East Atlantic across the abyssal plain and the Mid-Atlantic Ridge. The predominant feature in this area is the occurrence of sea-mounts. They extend between 62° N and 36° N and from 42° W to 10° W off Iberia and France and the 200 m depth contour off Ireland and the British Isles. The prevailing winds are southwesterly. The winds are influenced by depressions, which typically track across the region from the southwest. The frequency and violence of storms increase in winter, and from south to north.

The bottom topography in this Region ranges from continental slopes, through the sharply fluctuating seabed associated with seamounts, banks of fragmented continental rocks and the Mid-Atlantic Ridge, to extensive areas of almost featureless abyssal plain. There are also a number of different fragile deep-sea habitats such as hydrothermal vents, carbonate mounds, cold-water coral reefs, coral gardens, and sponge communities. The benthic communities are much richer in species than the pelagic communities. Species richness to the south of 40º N is twice as diverse as to the north, but their biomass shows the reverse. Bottom sediments vary according to the topography and the local currents. Where the topography is rugged, crustal rocks may be exposed, especially along the Mid-Atlantic Ridge and in the Charlie Gibbs Fracture Zone where the seabed was formed relatively recently. However, on the abyssal plains the seabed is generally covered with thick accumulations of sediment.

The Azores have been classified as a temperate warm or subtropical region (Gorshkov, 1978). Ocean circulation around the Azores is complex and not well understood (Juliano, 1989, 1994; Alves, 1990, Santos *et al.*, 1995).

The surface is dominated by the Gulf Stream water mass flowing from the west, approximately at 40°N, which then splits into the North Atlantic current and the Azores current. Each of these currents divides into two further branches. The actual system is more complex because it may change during the year affected by the complex bottom topography of the Azores (see Juliano, 1994, Santos *et al.*, 1995). Overall, the general current flow is west to east.

However, despite the dominance of the oceanic system from the west, marine littoral flora and fauna have more affinities with the Eastern Atlantic (Santos *et al.*, 1995), showing the complexity of the Azorean ecosystem. About 460 fish species have been identified as occurring in the Azores, (Santos, Porteiro and Barreiros, 1997) but endemic fish species are almost absent. Thus, the Azores region has been described as a “cross-road” where fauna and flora from different origins meet and serves as a “stepping-stones" area for dispersion of organisms. The marine Azores environment is considered to be a deep-water fisheries area characterized by narrow island coastal areas (the strata from 0 to 1000 m represents about one percent of the total EEZ area); seamount (including knolls, hills or guyots) areas (strata from 0 to 1000m) represent about two percent of the total EEZ (Martins, 1986, Isidro 1996, Menezes, 2003, Pinho, 2003). Areas down to 1000m, considered as less productive for fisheries, represents about 97 percent of the total EEZ. The interactions between coastal areas and the different seamounts are not yet well understood. This deep-water ecosystem is complex because of the particular features and interactions of the different dynamic areas. The dynamics of some areas, such as seamounts, are in general poorly known (Rogers 1994).

## Existing deep-water surveys – Azores

In **Azores** one deep-water survey is currently taking place in the southern area, which is the Azores longline survey. The survey specification, gear details and sampling strategies are summarized in a working document presented to the 2010 WGNEACS meeting (WD Pinho, 2010- full text in Annex 4).

Abundance data, independent of the fishery, are collected annually from the Azorean spring bottom longline survey (Pinho 2003). The surveys are conducted on the RV 'Arquipélago' around all nine Azorean islands and some major seamounts of the EEZ, following a random stratified design by area and depth. A standardized bottom longline gear is used The design of the gear is similar to that used by the commercial fishery: J-hooks no 9, baited with salted sardine chops, spaced 1 m apart in an alternated 'stone-buoy' design (Pinho, 2003). Annual surveys were conducted between March and June each year, with number of stations allocated proportional to the area/strata size.

## Proposed international longline survey in the southern area (ICES Subarea VIII and Division IXa) from WGDEEP2011

For deep-water surveys in Subarea VIII and Division IXa, trawl surveys are not appropriate due to rough bottom topography. Previous trawl surveys in Division IXa, discontinued in 2003, were considered inadequate to sample the main commercial deep-water species. Therefore, an internationally coordinated longline survey was proposed by WGNEACS 2009 and 2010.

ICES evaluated the proposed survey design and believe that the proposed survey will meet current and near-future data requirements for stock assessment, and also address several ecosystem monitoring needs in this region. ICES further indicated that the survey should be expanded to cover the Bay of Biscay. The main objective of the survey is to produce abundance estimates for:

- black scabbardfish
- deep-water sharks.

For the Azores other target demersal/deep-water species will be covered.

The TAC for the latter group is currently zero, and hence its recovery and stock status can only be monitored using survey data.

The proposal for spatial extension of the Azores (ICES Subdivision Xa2) longline survey was also considered and it was agreed that it should be further developed. Spatial extension of the survey is proposed to cover offshore seamounts which will facilitate coverage of the entire area of the stocks and improve the applicability of the survey indices in stock assessments. Additional resource requirements to meet this objective are currently being considered by the Department of Oceanography and Fisheries of the University of the Azores (DOP/UAz).

## Objectives

(**Underlying idea** i) Enumerate the main species ii) how to deal with MFS?)

i ) The main objective of the survey would be to produce abundance estimates for black scabbardfish and deep-water sharks using the longline (most appropriate fishing gear for the target species). The main objective of the Southern longline survey, proposed to be scientifically coordinated by WGNEACS at level two, is to produce fishery-independent abundance indices estimates for the following target species: red sea bream, bluemouth, black scabbardfish, Portuguese dogfish, and leafscale gulper shark. It is worth to note that the use of longline as fishing gear in the southern area is strictly related to the bottom topography of the region and to the insufficient number of areas identified at depth range that can be trawled adopted by WGNEACS.

ii ) In terms of ecosystem and biodiversity indicators it is questioned whether the whole community is adequately sampled with longlining. Longlining traces the main predators but not the whole spectrum of the community including invertebrates. It is, however, the best strategy in hard substratum unsuitable for trawling and, in particular, in vulnerable habitats to carry out longlining thus limiting damage to the seabed. Indicators such as the DCF indicator on the conservation status of fish focuses on large species such as sharks and longline surveys should be adequate to provide data for such indicators.

## Design

(**Underlying idea** i) not enough previous information to make a design so the first survey will constitute a pilot study that will allow to make improvements in face of the budget available).

**Portugal Mainland** - A sampling grid proposal for deep‑water species to be adopted by surveys in the Portuguese continental slope is illustrated in Figure 1. Since not enough previous information is available to make the design, the first survey to be held under WGNEAC in Iberian (IXa) will constitute a pilot study that will allow making improvements in face of the budget available.

**Azores -** In Azores the actual longline survey covers an area of about 70 nautical miles around the islands of the archipelago. This area includes the major fishing banks and seamounts. The survey follows a random stratified design by area and depth with effort proportional to the area size. Sets were randomly located around a given island or seamount and deployed on a straight line from the shallowest point available (usually 30–40 m around the islands) down to 600 or 1200 m depth. On average about 30 sets (transepts) are done annually, covering about 504 stations, due to time and cost constrains. The survey is designed for abundance estimation until the 600 m. This depth range has been extended to 800 m since 2004. One set per statistical area is extended to 1200 m for ecological studies.

During the last decade the fleets expanded the demersal/deep-water fishery to the offshore seamounts, particularly for the seamounts around the area of the Mid Atlantic Ridge. This is nowadays one of the most important fishing areas and so under WGNEACS it is proposed to expand the actual survey in order to cover it and match reasonable stock/area survey coverage**.**

**Bay of Biscay**: As for Portugal mainland, since not enough previous information is available to make the design, the first survey to be held in east VIIIc will constitute a pilot study that should be designed in function of the budget available. The survey will take place in commercial artisanal deep-water longliners in the area bounded by the western (3º.15'W) and eastern (1º78'W) limits of the Basque coast, in the traditional fishing grounds where this fleet operated in former years. Survey will follow a design by depth between the isobaths from 600 to 1200 m in fishing grounds according to the experience of skippers and the areas of interest for the objectives defined above.

## Fishing gear

(**Underlying idea** i) commercial longlinear are described for Mainland Portugal, bay of Biscay and Azores)

i ) **Mainland Portugal** - For longline survey the gear will be adapted from the traditional longline used by the commercial boats in Portugal. The main characteristics of this gear are: bottom longline with mainline detached from the seabed by floats. It will be composed by 2000 gangeons spaced about 4.15 m apart, each 1.50 m long fitted with hooks number 5. Connected to each hook there is a piece of brass wire 120 to 150 mm long to prevent loss of catches from fish biting.

ii ) **Azores -** Survey gear was very similar to that used by the commercial fishery (see Pinho, 2003). The gear consisted of several mainline units, of approximately 30 hooks each, called quarter-skate. Four quarter-skates arranged on a wood cage constitute a skate. The quarter-skate are connected each other alternatively by a stone or a buoy during the deployment. The buoy is used to connect the mainline to the main-rope. This gear is locally known as a "stone/buoy" longline and is effective at fishing for benthic and bentho-pelagic species. Line setting started one hour before sunrise and line retrieval started about 1.5 hours after setting. The sampling gear was set from the shallow to deep strata and generally was retrieved in the same order. The soaking time, computed as the difference between setting and retrieval times, varied from about two to six hours. The bait was chopped with salted sardine (*Sardina pilchardus*). Time, position (GPS) and depth (echosounder) were recorded for every quarter-skate during gear deployment. During the retrieval fish species caught were recorded and hook condition sampled by quarter-skate.

iii ) **Bay of Biscay**: The survey will adapt the traditional gear used by the commercial longline artisanal fleet targeting in the past for deep-water sharks and according to the size, soaking time and numbers of hooks agreed by the researchers in order to standardize the effort units. The traditional gear was a single mainline with buoys and weights in the tips of the lines and at intervals of the mainline to maintain the hooks at the depth suitable for fishing. Hooks were usually attached to the mainline by a single line ended in a short chain (1 m length) to strength the resistance and weight of the gear. The bait were pieces of mackerel (*Scomber scombrus*) and/or squid (*Loligo* spp). The duration of the trips was around 5 days and the soaking time depended on the size of the fishing gear, but it used to be from 5 to 7 hours.

## Sampling procedures

i ) **Portugal Mainland** Fishing hauls will be randomly set within each cell of the regular grid established for the Portuguese continental slope. The regular grid is presented in Figure 1. The total number of fishing hauls will depend on available budget and the required level of precision for species abundance estimates. The gear will be settled each day during the morning and retrieved late in the afternoon. Each fishing haul will have an approximate duration of 10 hours. The intended sampling effort will be of two fishing sets per day. Achieving this target will, however, depend on operational and weather conditions.

ii ) **Bay of Biscay**: Survey in the eastern of Bay of Biscay will follow a sampling design agreed by the researchers responsible for the survey but the experience of the skippers will also be taken into account for the fine design of the placement of the hauls. The number of fishing hauls will depend on available budget for the allocation of the vessel and the required level for abundance estimates. Due to the characteristics of the fishing gear it is foreseen as much as one fishing haul by day. The survey will be stratified by depth in the areas covered between the isobaths from 600 to 1200 m along the Basque Country waters. The set and recovery positions of the gear will be recorded by GPS. Species caught in each haul will be identified, measured and weighted, and sexed (deep-water sharks).

**iii ) Azores (in this are the target species of the survey are neither black scabbardfish nor deep-water sharks ):** The survey follows a random stratified design by area and depth strata. The area of offshore seamounts should be clearly identified, mapped and divided by statistical areas (clustered). Within each statistical area representative seamounts should be selected for sampling using the actual survey sampling protocol.

## Abundance indices estimators

(**Underlying idea** i) estimators for the southern survey ii) how to analyse the estimates from longline and trawl surveys?)

i ) The estimator adopted in both surveys will be comparable and standardization of the data using statistical techniques, e.g. GLM and GAM, will be defined to get standardized estimates.

ii ) Investigate the possibility of combining abundance indices between the trawl survey in the central area and the longlining survey in IXa in future it will be necessary to carry out comparative studies between the trawl gear and the longline.

## Data management –DATRAS

The current DATRAS database was specially designed to accommodate information from trawl surveys. In order to include and further compare catch yields between longline and trawl gears it will be necessary to introduce some changes to the data structure existent in DATRAS to contain data on aspects relevant to longline gears, such as mainline length, number of hooks and bait. However, this is not likely to occur in the short term.

## Information on non-targeted species and the ability to describe larger parts of the fish communities and the physical environment

i ) The fishing gear proposed to be used in **mainland Portugal** is an adaptation of longline gear used by the commercial boats in Portugal. The main characteristics of this gear are: bottom longline with mainline detached from the seabed by floats. The survey will allow to get information on all the species caught by the longline other than the target ones.

The IPIMAR research vessel is considered inadequate to carry out the survey so other solutions must be studied. If a commercial vessel will be used the collection on information on the physical environmental are envisaged and the portable solutions will be also used. Mounded CTD would give environmental data easily and would not cost anything in time. At least temperature should be logged by mounted temperature loggers For the survey taking place in IXa habitat mapping that allow the identification vulnerable habitats (particularly coral areas etc.) using video/TV system are envisaged. For this area the information available on these aspects are scarce.

The **Azorean survey** covers the depth strata until 1200 m. It is considered very difficult to operate the longline down to 800 m. However, on the actual design one station per subarea is extended to cover that depth for ecological studies (not for abundance estimation). Under this design the deepest assemblage (down to 800 m), corresponding to most of the non target species, is poorly covered, not only due to the small effort allocated but also due to the catchability problems related with the gear configuration. This data has been useful for describing the fish community although there are gear selectivity effects when compared for example with the trawls. It would be desirable however to replicate these deep sets by subarea. The longline survey on the Azores as not been used for environmental description, mainly because time, logistics and resources available do not permits such extensions. Temperature profiles and bathymetry have been recorded frequently. Other types of oceanographic information are collected sporadically.

## WGNEACS 2011 – TORs

d) Southern surveys:

*use survey data to contribute to the following scientific questions:*

1 ) Evaluate the feasibility of hypotheses on species dynamics particularly on the species *A. carbo*, black scabbardfish, whose life cycle is considered to take place in different areas: juveniles occur in the northern areas (ICES Subareas VI and VII), whereas pre-adults occur at the ICES IXa. Additionally migration rates can be estimated as well as prerecruitment estimates (Scottish and Irish surveys).

2 ) Evaluate the distribution area of *A. carbo* and *A. intermedius* as well as estimate the level of overlap between the two species.

3 ) Evaluate the possible migration of deep-water sharks to southern areas (although the actual surveyed area is quite restricted).

4 ) Evaluate the possible migration of Leafscale gulper shark to southern areas to reproduce as admitted by WGEF and the existence of local populations of Portuguese dogfish at different areas of NE Atlantic.

TOR´s Contributions

## 1- Evaluate the feasibility of hypotheses on species dynamics

**Background (extracted from several sources)**

In the NE Atlantic, information available on the dynamics of the black scabbardfish is mainly derived from the fisheries that occur in this area (Bordalo-Machado and Figueiredo, 2009). These observations lead to the hypothesis that the dispersion of the different stages of the life cycle of this species might be associated with extensive migrations along the NE Atlantic related to feeding and reproduction (Anon, 2000). It is commonly admitted that this species, during its first years of life, migrates in search of food to more northern waters (areas north of 40ºN) after the spawning season, whereas the adults move away to the oceanic waters of Macaronesia in order to spawn (Kelly *et al.*, 1998; Morales-Nin *et al.*, 2002; Figueiredo *et al.*, 2003). The distribution and migration of black scabbardfish along the NE Atlantic particularly for its prerecruited phases is yet to be fully understood.

**Comment**

Independent fishery information is required to address this TOR. It implicitly implies the analysis of information collected by the two surveys: central and southern central.

## 2- *A. carbo and A. intermedius*

**Background (extracted from a recent paper on *A. carbo* and *A. intermedius*)**

Until recently, *A. carbo* was the only recognized species in this genus, although several other junior synonyms were described, including one from Madeira, *A. acus* Maul, 1948 (Parin, 1983; Nakamura and Parin, 1993). In 1983, a description of *A. intermedius*, partially sympatric with *A. carbo*, was published and now the genus *Aphanopus* comprises seven species distributed throughout all oceans except in the Polar Regions and the Mediterranean Sea (Parin, 1983, 1995).

It is worthwhile pointing out that the main differences by which *A. carbo* may be separated from *A. intermedius* (dorsal fin and vertebral counts; Nakamura and Parin, 1993; Parin, 1995) are not easy to use in the field and are totally unsuitable for large-scale fisheries-purpose identification, on board or at landing sites.

The genetic structure obtained from the two mtDNA markers supports the findings reported by Stefanni and Knutsen (2007) therefore confirming the validity of both species (*A. carbo* and *A. intermedius*).

Geographical distribution: It is confirmed that the only species that reaches mainland Europe is *A. carbo* and extending southwards to at least 27ºN, off the Western Sahara coast. This southern limit of distribution of *A. carbo* was until present set with certitude to about 30ºN (Nakamura and Parin, 1993). *A. intermedius* has been found living in sympatry in the islands of the Azores, Madeira and the Canaries and off the coasts of Morocco and Western Sahara, therefore contributing to the clarification of the northern limit of its distribution, as already proposed by Nakamura and Parin (1993).

| Aphanopus carbo | Aphanopus intermedius |
| --- | --- |
| • dorsal-fin spines 38-41;<br>• dorsal-fin soft rays 51-57;<br>• total dorsal-fin elements 89-96;<br>• anal-fin rays II+42-48;<br>• precaudal vertebrae 40-44;<br>• caudal vertebrae 55-60;<br>• total vertebrae 97-101.<br>• In percentage of SL: head length 18.4-22.1;<br>• pre-dorsal length 15.3-18.8;<br>• pre-first dorsal soft ray length 50.3-60.2;<br>• pre-anal length 58.6-64.4;<br>• pre-first anal spine length 55.6-60.5;<br>• pre-anus length 54.2-59.2;<br>• pre-pectoral length 18.3-20.9;<br>• maximum body depth 7.5-13.2;<br>• depth of body at level of first anal spine 6.0-14.2;<br>• least depth of caudal peduncle 0.4-0.5;<br>• length of caudal peduncle 1.2-2.9.<br>• In percentage of HL: snout length: 37.4-49.8;<br>• eye diameter 16.5-26.8;<br>• interorbital width 13.6-19.2;<br>• upper jaw length 43.8-51.0;<br>• pre-opercular length 77.7-82.8;<br>• head height 32.3-42.3.<br>• 11.6-21.7;<br>• upper jaw length 45.6-49.8;<br>• pre-opercular length 77.0-83.9;<br>• head height 31.4-42.1. | • dorsal-fin spines 39-44;<br>• dorsal-fin soft rays 52-60;<br>• total dorsal-fin elements 92-102;<br>• anal-fin rays II+45-50;<br>• pre-caudal vertebrae 43-47;<br>• caudal vertebrae 56-61;<br>• total vertebrae 101-107.<br>• In percentage of SL: head length 17.9-22.5;<br>• pre-dorsal length 14.9-18.5;<br>• pre-first dorsal soft ray length 50.4-59.2;<br>• pre-anal length 57.0-63.8;<br>• Pre-first anal spine length 55.2-60.0;<br>• pre-anus length 52.7-64.0;<br>• pre-pectoral length 18.6-20.8;<br>• maximum body depth 6.1- 12.7;<br>• depth of body at level of first anal spine 6.0-10.5;<br>• least depth of caudal peduncle 0.3-0.5;<br>• length of caudal peduncle 2.0-4.2.<br>• In percentage of HL: snout length: 36.7-50.4;<br>• eye diameter 13.8-24.8;<br>• interorbital width 11.6-21.7;<br>• upper jaw length 45.6-49.8;<br>• pre-opercular length 77.0-83.9;<br>• head height 31.4-42.1. |

**Comment**

To address this TOR it is necessary that the southern survey include the Azorean area, where both *Aphanopus* species occur.

## 3. - Deep-water sharks

**Background**

Deep-water sharks constitute a considerable bycatch of the directed and multispecific fisheries taking place in the NE Atlantic. However, despite the effort done to monitor deep-water sharks from the southern ICES waters (e.g. Bay of Biscay, Galicia, mainland Portugal), the fishery-dependent character of the datasets available hamper a good picture of the dynamics of these resources. It is important to understand the complete range distribution of the species, by depth and in geographical areas outside the fishing grounds. For example, in Portuguese data for the Portuguese dogfish the LPUE series might not be a good index of abundance of the species since the fishing grounds where this fleet operates correspond to those that provide fishers better catches of black scabbardfish (Machado and Figueiredo, 2009). Effectively an inverse relationship between catches of the Portuguese dogfish and the black scabbardfish was detected (Moura, in preparation). It is reported that the former usually distributes deeper than the latter in the west of British Isles and this might also occur in Portuguese waters. In the west of British Isles black scabbardfish is the dominant species between 600-1000 m (Bridger, 1978; Ehrich, 1983) while Portuguese dogfish is more frequent deeper than 1100 m down to 1500 m (Girard and Du Buit, 1999; Clarke *et al.*, 2001). These are evidences that a considerable part of Portuguese dogfish population lives outside fishing grounds exploited by the longline fleet. Another aspect to consider is the inexistence of reports of catches of juveniles smaller than 70 cm of many species, such as *Centroscymnus coelolepis* and *Centrophorus squamosus*, for which the length-at-birth is estimated as 30 cm and 44 cm, respectively (Figueiredo *et al.*, 2008). This absence should not be attributed to selectivity of the fishing gear but to the aggregation of these specimens somewhere not yet identified (never reported by any study in the world), probably at deeper grounds (Yano and Tanaka, 1988; Girard and Du Buit, 1999; Clarke *et al.*, 2001). In addition, such information must be coupled with information on the reproductive phase of the shark, in order to have information on potential aggregation areas with particular ecological importance. Most of elasmobranch species, including deep-water ones, present complex reproductive strategies, which comprise segregation among sexes and maturity condition and, for some species long-scale migrations. Sexual segregation is defined as the separation of members of a species such that the sexes live apart, either singly or in single-sex groups (Wearmouth and Sims, 2008). Geographical sexual segregation is thought to result from sex differences in habitat preferences, as for example, the migration of females to designated inshore nursery areas for parturition (Wearmouth and Sims, 2008). The existence of sexual segregation in sharks' populations puts into question the potential fishing impact if removing more frequently specific fractions of the population (e.g. juveniles, females, males, females near parturition). Thus it should be essential to assess the fraction of the population being harvested.

**Comment**

Fishery-independent data are fundamental for the understanding of deep-water shark dynamics since they will provide information from places other than those of fishing grounds.

## 4. - Leafscale gulper-shark and Portuguese dogfish

*Centroscymnus coelolepis* (Portuguese dogfish) and *Centrophorus squamosus* (leafscale gulper-shark) are the deep-water sharks more frequently caught in the deep-water fisheries taking place in the NE Atlantic. Despite their frequency in the catches there are still many deficiencies in the knowledge of their biology and population dynamics. Two hypotheses were set based on reproductive information available for the NE Atlantic:

i ) since all the maturity stages, i.e. all reproductive stages such as juveniles, mature and pregnant specimens, are found throughout all the sampled area (Girard and Du Buit, 1999; Clarke *et al.*, 2001; Bañon *et al.*, 2006; Figueiredo *et al.*, 2008), it seems probable that *C. coelolepis* forms local populations in restricted areas, within which individuals are able to undergo the entire life cycle;

ii ) for C. *squamosus*, it is admitted that the different stages of the life cycle occur in different regions of its distribution area. In fact, pregnant females were never recorded in the northern areas (Girard and Du Buit, 1999; Clarke *et al.,* 2001) and were just found in the southern waters, particularly in Madeira Archipelago (Severino *et al.*, 2009), although with scarce occurrences in mainland Portugal (Figueiredo *et al.,* 2008) and in Galicia (Bañon *et al.,* 2006). These evidences indicate that this deep-water shark is highly migratory and spawns in the Portuguese waters off Madeira archipelago (Severino *et al.,* 2009).