ICES WGNEACS REPORT 2010

SCICOM STEERING GROUP ON ECOSYSTEM SURVEYS SCIENCE AND TECHNOLOGY

ICES CM 2010/SSGESST:16

REF. SCICOM, ACOM

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

8–10 June 2010

ICES HQ, Copenhagen, Denmark

ICES International Council for the Exploration of the Sea
CIEM 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. 2010. Report of the Working Group for North-east Atlantic Continental Slope Survey (WGNEACS), 8–10 June 2010, ICES HQ, Copenhagen, Denmark. ICES CM 2010/SSGESST:16. 81 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 8–10 June 2010. Following a special request by NEAFC, WGNEACS drafted guidelines for scientific observer on board fishing vessels that are authorized by NEAFC to fish in so-called new bottom areas. The observer guidelines aim to address the data needs to assess requirements under NEAFC recommendations XVI to produce a harvesting plan for the target species a monitoring plan for all species caught and a mitigation plan for the impact on vulnerable habitats. Following a review by WGDEC and WGDEEP it was agreed to include into the guidelines a recommendation that bottom impacting fishing should only proceed when habitat modelling and non impacting techniques such as acoustics and video transecting can demonstrate that there is no potential impact on vulnerable habitats. It was also agreed that standardized common data formats would aid the utility of the data and it is suggested to use ICES standardized data formats. The revised observer guidelines are published in the report.

WGNEACS reviewed and evaluated the use of deep-water species identification guides in order to share expertise and develop a coordinated approach to the identification of deep-water fish species. Several identification keys have been drafted by Marine Scotland and have been circulated at this year's meeting for the other institutes to trial and review, giving feedback to the author. This will allow disseminating and sharing the expertise and at the same time improving the drafts and make them user friendly. National species identification keys from the Nordic countries have also been circulated and shared among participants.

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 evaluated 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 and a set of recommendations were made to the Nordic national laboratories in order to improve coordination of surveys. To share data and initiate joint data analysis and research, a data exchange format was agreed upon 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 calculated and mapped to evaluate the spatial coverage of the surveys in relation to species distribution and to identify any gaps.

The central survey subgroup evaluated to use of survey data from the central deep-water surveys in the 2010 benchmark process for deep-water species. Most of the deep-water species benchmarked did not have accepted full analytical assessment and the most common suggested assessment methodology was the use of indicators derived from surveys. This emphasizes the importance of a deep-water survey in this region with adequate spatial coverage for the main assessed species. The subgroup presented the logistics of such a coordinated deep-water trawl survey along the Central European slope and associated banks and seamounts stretching from the Faroese Plateau (Vb) to the Bay of Biscay. This survey proposal depends on external funding.

The subgroup also represented its intersessional work on variance estimation and gave recommendations on sampling design and future data analysis.

The southern subgroup dealt with existing and proposed surveys in the southern area (IX and X). The subgroup evaluated the sampling protocols of the existing Azorean longline survey with the aim to standardize the proposed survey along the continental slope as much as possible. Spatial coverage of the combined two surveys was evaluated and gaps identified in terms of depth and extent. Ways of data standardization was explored and recommendations made for the facilitation of data exchange and joint collaboration.

1 Introduction

1.1 ToRs

The ICES Working Group for the North-east Atlantic Continental Slope Survey (WGNEACS) met in ICES, Copenhagen from the 8 to 10 June 2010 to work on the following terms of references:

a) Prepare, by correspondence and prior to the meetings of WGDEC and WGDEEP (March 2010) a first draft of a Best Practice Manual for scientific surveys in areas closed to fishing. This draft to be sent to WGDEC and WGDEEP for their comments;

b) Review comments on the draft for the Best Practice Manual in particular from WGDEC and WGDEEP and finalize the manual. The manual should be available for NEAFC in October 2010;

c) Review the development and evaluation of deep water species identification guides for the NEA deep-water surveys and review progress on the development of a common image library;

d) with regards to the coordination of Nordic deep water surveys:

- d.1) Evaluate present sampling protocols for surveys by Faroe, Greenland, Iceland and Norway, and attempt to standardize the protocols as much as possible.
- d.2) Evaluate the combined total survey coverage in relation to distribution of all major stocks in the area and consider the feasibility of bridging any gaps.
- d.3) Evaluate the extent and quality of information on non-targeted species and the ability to describe larger parts of the fish communities and the physical environment.
- d.4) Evaluate the prospect of making all the combined survey data available to all parties by use of e.g. the ICES DATRAS database, in order to facilitate joint research and analyses.

e) With regards to the central deep water survey

- e.1) Review the use of survey abundance and ecosystem indicators from deep-water surveys during the bench marking process of WGDEEP.
- e.2) Evaluate intersessional work on variance estimates of existing NEA deep-water surveys and based on results optimize proposed survey design in terms of station allocation.
- e.3) Coordinate the timing, area and effort allocation and methodologies for the central European deep-water survey in 2011, if the programme is funded under the new data collection frame work.

f) With regards to the southern deep-water survey

- f.1) Evaluate sampling protocols for Azorean survey and attempt to standardize the protocols as much as possible.
- f.2) Evaluate the combined total survey coverage in relation to distribution of all major stocks in the area and consider the feasibility of bridging any gaps.

f.3) Evaluate the extent and quality of information on non targeted species and the ability to describe larger parts of the fish communities and the physical environment.

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 describes the revised draft of the Observer guidelines for new fishing areas in the NEAFC regulatory area. These revisions are based on comments and new text received by members of WGDEC, WGDEEP, WGFAST and WGFTBE. The following section covers the ToR that is dealt with by the whole group, on improvements of species identification.

The following three sections 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, II), addressing ToRs d)1–4. Survey methods and protocols are compared between the Nordic surveys with regards to sampling protocols for target species, the wiser fish community and the ecosystem, the spatial coverage of the surveys is reviewed and the data are pooled to map the abundance of the key target species Greenland Halibut, Silver Smelt, Red Fish and Roundnose Grenadier. Section five covers the central surveys and contains a review on how existing surveys were used in the Benchmarking process 2010, how variance estimation is used to improve the survey sampling design and how logistics are planned for a potential international deep-water survey in 2011. Section six covers the ToRs of the southern subgroup, reviewing the common methodologies and the survey coverage of the deep-water longlines survey in the Azores and the planned survey off the mainland of Portugal.

1.3 Participants

A full list of participants is given in Annex 1.

2 NEAFC Guidelines for Observer on-board fishing vessels authorized to fish in new bottom fishing areas (ToR b)

2.1 Background to request

In 2008, NEACF adopted recommendation XVI on bottom fishing activities in the NEAFC regulatory areas, which includes procedures for fishing activities in new bottom fishing areas. In areas not previously impacted by bottom fishing gear, fishing should be considered exploratory and shall be conducted in accordance with an Exploratory Bottom Fisheries Protocol. Proposed bottom fishing activities shall be subject to an impact assessment that would determine whether there are significant adverse impacts on vulnerable marine ecosystems (VMEs). Prior to the agreement of an NEACF Exploratory Bottom Fisheries Protocol, an interim protocol, published in Annex 1 of recommendations XVI is to be followed. This protocol is as follows:

Until the Commission adopts a new protocol in accordance with Article 4, paragraph 1 of this Recommendation, exploratory bottom fisheries may commence only when the following information has been provided to the Secretary by the relevant Contracting Party:

(a) A harvesting plan which outlines target species, dates and areas. Area and effort restrictions shall be considered to ensure fisheries occur on a gradual basis in a limited geographical area.

(b) A mitigation plan including measures to prevent significant adverse impact to vulnerable marine ecosystems that may be encountered during the fishery.

(c) A catch monitoring plan that includes recording/reporting of all species caught. The recording/reporting of catch shall be sufficiently detailed to conduct an assessment of activity, if required.

(d) A data collection plan to facilitate the identification of vulnerable marine ecosystems/species in the area fished.

In autumn 2009, NEAFC asked ICES' advice to produce guidelines for observers' on-board fishing vessels that might be authorized to fish in the so-called "new" bottom fishing areas. In this context, NEAFC suggested to consider their interim Exploratory Bottom Fishing Protocol for New Bottom Fishing Areas.

Background material used

In drafting this request, several recent publications were used as guidance, to ensure that methodologies and objectives are consistent with existing international guidelines. The published materials used are:

- International guidelines for the management of deep-sea fisheries in the high seas (FAO, 2009)
- The science behind the guidelines: A Scientific Guide to the FAO Draft International Guidelines (December 2007) for the Management of Deep-Sea Fisheries in the High Seas and Examples of How the Guidelines may be Practically Implemented (IUCN,2008)
- Review of the code of conducts for scientific research in sensitive deep-water habitats (ICES, 2008)
- Definition of Standard Data-Exchange Format for Sampling, Landings, and Effort Data from Commercial Fisheries (Jansen *et al.*, 2009).

- SEAFO guidelines for photographing, fixing and preserving corals and sponges (Conservation Measure 17/09: on Bottom Fishing Activities in the SEAFO Convention Area).

Scope of the request

ICES considers that the observer guidelines would be aimed at an observer programme of scientific nature and that the data collected under such a programme would form the scientific basis to provide information that is required to assess fisheries in new bottom habitats. In this respect, ICES considers that the observers would not act in a regulatory or enforcement capacity and guidelines to aid observers how to enact regulatory requirements are not covered in this document. In drafting the guidelines for observers of bottom fishing activities, ICES adopts NEAFC use of the term "bottom fishing" as fishing activities where the fishing gear is likely to contact the seabed during the normal course of fishing operations (NEACF rec. XVI, 2008). With this in mind the guidelines focus on bottom-trawling and to a lesser extent on gillnetting and longlining.

2.1.1 Aims and objectives of observer programme for fishing in NEAFC exploratory areas

The aims and objectives of such an observer programme should be closely linked to the NEAFC interim exploratory bottom fishing protocol for new fishing areas and the international guidelines for the management of deep-sea fisheries in the high seas (FAO 2009). It therefore needs to address the key issues that characterize deep-seabed fishing activities as stated in FAO, 2009:

- The catches include species that are characterized by low productivity and therefore can only sustain low exploitation rates;
- The fishing gear is likely to contact the seabed during the normal course of fishing operations.

With this in consideration, the observer programme has the following objectives:

Objective 1: Sufficient spatial and temporal information is collected on the vessel operation and effort to determine the fishing footprint and impact of this particular fishery.

Objective 2: Sufficient biological data on the target species is collected to understand the population structure and the productivity of the stock(s) and with this knowledge guide the proposals of sustainable exploitation plans.

Objective 3: Sufficient biological data are collected on all species caught as bycatch and/or discarded to assess the biological and ecological impact of this fishery on the whole fish community.

Objective 4: Sufficient data are collected for the identification and mapping of vulnerable marine ecosystems (VMEs) and to contribute to the assessment of significant adverse effects.

Objective 5: Sufficient data are collected on the incidental catches of marine mammals, seabirds, sea turtles and any protected, endangered or threatened species (PET species) to assess the impact of the fishery on the wider ecosystem.

The fishery data required for Ecosystem Impact Assessments at local and regional scale includes data on vessels, fishing trips, fishing stations, catch and biology of species caught. Such data should be formatted in a way that it makes it easily available to scientific and advisory bodies such as ICES and OSPAR. For efficiency, the observer programme should make use of existing standard data exchange formats. ICES published a standard format for sampling of commercial fisheries in 2009 (Jansen *et al.*, 2009). The format includes records for trips, fishing stations, species caught, length distribution and biology (sex, maturity, age, weight, length).

The explanation of headings for the data exchange formats according to Jansen *et al.* 2009 is as follows:

TR - Trip record (TR) in commercial fisheries sampling data (CS)

HH - Fishing station record

SL - Species list record

HL - Length record

CA- Sex Maturity Age Weight Length record

2.2 Prior consideration before any exploratory fishing can take place

In accordance with UNGA 61/105 – and the 'International guidelines for the management of deep-sea fisheries in the high seas' (FAO 2009) flag states and regional fishery management organizations (RFMOs) are committed to conduct assessments to establish if deep-sea fishing activities are likely to produce 'significant adverse impacts' in a given area. Further to this, UNGA in 2009 adopted resolution 64/72 § 119(a) that requests the assessments called for in paragraph 83 (a) of [its] resolution 61/105 to ensure that vessels do not engage in bottom fishing until such assessments have been carried out:

> "Conduct further marine scientific research and use the best scientific and technical information available to identify where vulnerable marine ecosystems are known to occur *or are likely to occur* [emphasis added] and adopt conservation and management measures to prevent significant adverse impacts on such ecosystems consistent with the Guidelines, or close such areas to bottom fishing until conservation and management measures have been established, as called for in paragraph 83 (c) of its resolution 61/105".

These resolutions effectively transfer the burden of proof to the RFMO/As and require that an Impact Assessment be carried out to identify where fishing activities can be carried out without causing significant adverse impacts to VMEs and associated species.

Thus it is proposed that prior to any fishing occurring the proponent must show that any demersal fishing activity is not going to have an adverse affect on any present VMEs. Depending on modelled VME habitat suitability, this could range from underwater camera work to short tows. This environmental work to assess the occurrence of VME could involve:

- Collection of acoustic data relating to bathymetry, slope and backscatter that can be used to map areas of potential VMEs,

- Towed and/or net mounted camera systems to use for the identification of benthic organisms and ground-truthing of acoustic data.

Once an impact assessment can establish that there are no potentially adverse effects on the bottom habitat, fishing can be permitted on an exploratory basis. The following flow chart illustrates where the observer guidelines sit in the process of permitting the exploratory fishing.

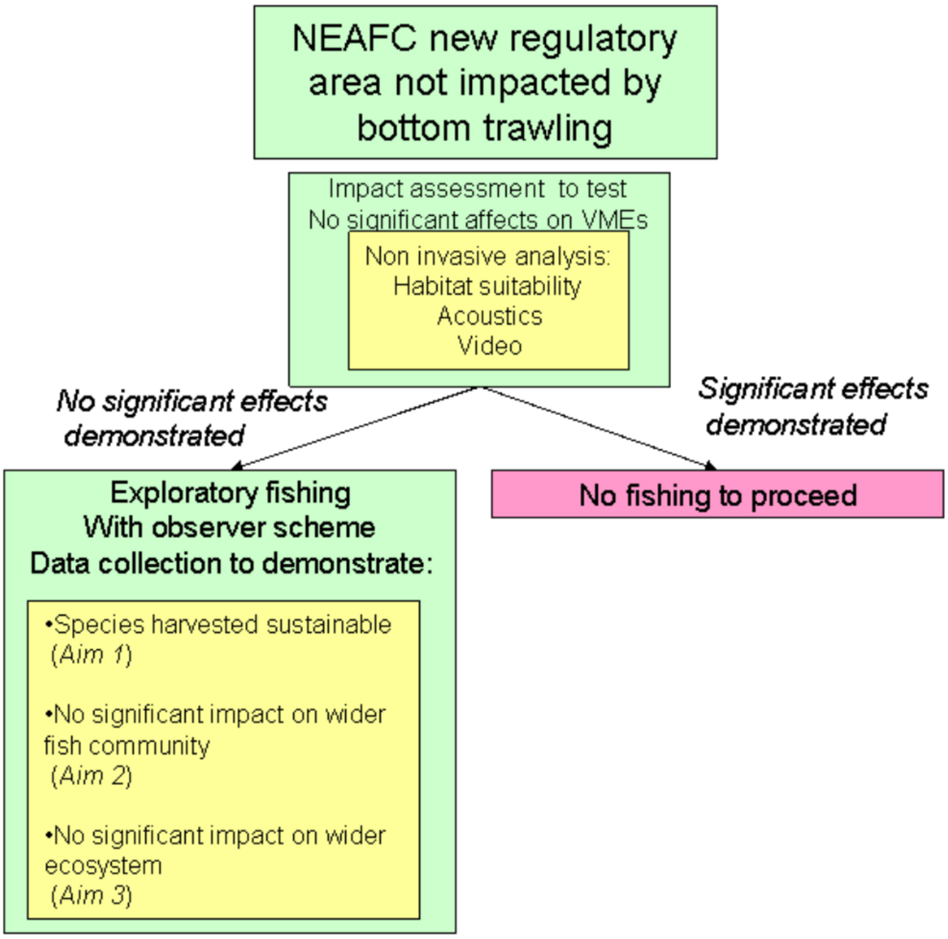


Figure 3.1. Schematic diagram of how the observer guidelines could be included in the NEAFC process of permitting bottom fishing in unimpacted bottom habitats.

In areas where exploratory fishing is permitted and bycatch includes VMEs, the encounter clause applies. NEAFC has updated its threshold levels for an encounter with a VME during fishing operations (NEAFC Recommendation XI: 2010). For both existing and new fishing areas, an encounter with primary VME indicator species is defined as a catch per set (e.g. trawl tow, longline set, or gillnet set) of more than 60 kg of live coral and/or 800 kg of live sponge. These thresholds are set on a provisional basis and may be adjusted as experience is gained in the application of this measure. The predefined management actions upon encounter generally require the vessel concerned to stop its fishing operations in the area; however, in the absence of real-time closures it remains open to others at least on a temporary basis. NAFO and NEAFC differ in what they expect the vessel masters to do to avoid further encounters with VMEs. In the NEAFC area, the vessel master shall cease fishing and move away at least 2 nautical miles from the position that the evidence suggests is closest to the exact encounter location.

2.3 Details on information that should be collected for each objective:

Aim 1.) Sufficient spatial and temporal information is collected on the vessel operation and effort to determine the fishing footprint and link this in with other datasets to aid their interpretation.

The spatial and temporal resolution of the data needs to be high enough to link catch and effort data to individual seabed features and information needs to be collected on a haul by haul basis. This is particularly important in the deep-water environment where serial depletion of deep-water stocks can occur in close proximity such as on adjacent seamounts (Rogers *et al.*, 2008). It should be collected in a manner that it can be linked to VMS data and aid their interpretation to compile a fishing footprint and assess the single and cumulative impact of this particular type of fishing operation. This data can also be used calculate cpue and/or evaluate the intensity of bycatch per unit of effort.

Data that needs to be collected for this aim are:

- Details on vessels: Vessel id and nationality – so it can be linked to NEAFC register (fields: Vessel identifier, Vessel flag country in TR record)
- Details on vessel capacity: Details on gear type and their specifications and a description of any technical measures that are being used to mitigate bottom impact., (fields: vessel length, vessel power, vessel size, vessel type in TR record)
- Details on gear and effort- i.e. number of hooks on longlines, number of nets for gillnetting, mesh size of trawls etc. (fields 28–30 in HH records) - the standard format is mainly trawl-orientated, so that additional fields may be required for longlines and gillnets. A field "total deployed length of the gear" should be added for both and an additional field "Total number of hooks for longlines".
- Details on spatial position and timing of fishing operation including details on tow position and duration on a haul by haul basis (fields 13–24 in HH records).
- Total number of hauls, number of unobserved hauls (fields 13 in TR records).

Examples of standardized data records to log details on trip and station details reproduced from Jansen *et al.* (2009), and are shown in Tables 3.1 and 3.2., and the relationship between the different data headers is shown in Figure. 3.2. Further details on data formats and specifications are given in the reference.

Table 3.1. Headers for vessel details from Jensen *et al.* 2009.

TR (Trip)
1 Record type
2 Sampling type
3 Landing country
4 Vessel flag country
5 Year
6 Project
7 Trip number
8 Vessel length
9 Vessel power
10 Vessel size
11 Vessel type
12 Harbour
13 Number of sets/hauls on trip
14 Days at sea
15 Vessel identifier (encrypted)
16 Sampling country
17 Sampling method

Table 3.2. Headers for station details from Jensen *et al.* 2009.

HH (Fishing Station)
1 Record type
2 Sampling type
3 Landing country
4 Vessel flag country
5 Year
6 Project
7 Trip number
8 Station number
9 Fishing Validity
10 Aggregation level
11Catch registration
12 Species registration
13 Date
14 Time
14 fishing Duration
15 Vessel identifier (encrypted)
16 Pos.Start.Lat.dec
17 Pos.Start.Lon.dec.
18 Pos.Stop.Lat.dec.
19 Pos.Stop.Lon.dec.
20 Area
21 Statistical rectangle
22 Subpolygon
23 Main fishing depth
24 Main water depth
25 Fishing activity category National
26 Fishing activity category European lvl 5
27 Fishing activity category European lvl 6
28 Mesh size
29 Selection device
30 Mesh size in selection device

Objective 2.) Sufficient biological data on the target species is collected to understand the population structure and the productivity of the stock(s) and with this knowledge guide the proposals of sustainable exploitation plans.

The following per haul information is required:

- Catch weight of retained species, (fields 9–18 of SL records),
- Length frequencies of total or subsampled catch (HL records);

- Biological sampling* on total catch or subsamples for weight measurements, sex ratios, maturity ratios, collection of samples for fecundity analysis (CA records);

Collection of hard structures for possible age determination (otoliths, spines scales; fields 25–28 of CA records),
There will be a need to define sampling priorities. Observers should:

1) make sure that trip level data are collected.

2) collect fishing station data exhaustively.

3) collect species list record (SL record) with highest priority given to abundant species, if problems are met with species identification a record for unidentified species should be collected. Special attention should be given to the identification of shark species.

4) collect length record on a number of listed species. The list should include the main commercial species in a given area (i.e. in ICES Subareas and Divisions VIb, X, XII) these should include roundnose grenadier, blue ling, black scabbardfish, Splendid alfonsino (Beryx splendens), orange roughy and could include other prioritized species.

5) for some species at appropriate season, protocols should be given to collect CA record. This primarily applies to blue ling, using the ICES guidelines that were published in 2009 (ICES, WGDEEP 2009). Collecting CA record for blue ling may be priority in March-May over collecting HL record for other commercial species.

6) A priority list may be refined over time according to data missing, ongoing scientific projects and general need for assessment and monitoring.

Objective 3.) Sufficient biological data are collected on all species caught as bycatch and/or discarded to assess the biological and ecological impact of this fishery on the whole fish community.

The information collected under this heading has several purposes. Data is collected to assess the vulnerability of bycatch species which will affect the overall sustainability of the fishery; to determine biodiversity hot spots including the presence of endemic species, which will feed into identification of vulnerable habitats. With the use of indicator species it will further aid the identification of VMEs.

Completion of SL record implies that landings and discards in weight of all species are recorded.

*The sustainability of a fishery can be determined by certain bycatch species which might have a higher vulnerability to fishing than the actual target species. When decisions have to be made on the collection of biological data from bycatch and/or discarded species, one of the criteria for prioritization should be the vulnerability of a species- if a bycatch species has a high vulnerability to fishing (i.e. lower productivity, higher longevity) e.g. deep-water sharks, than this should take a high priority for biological data collection.

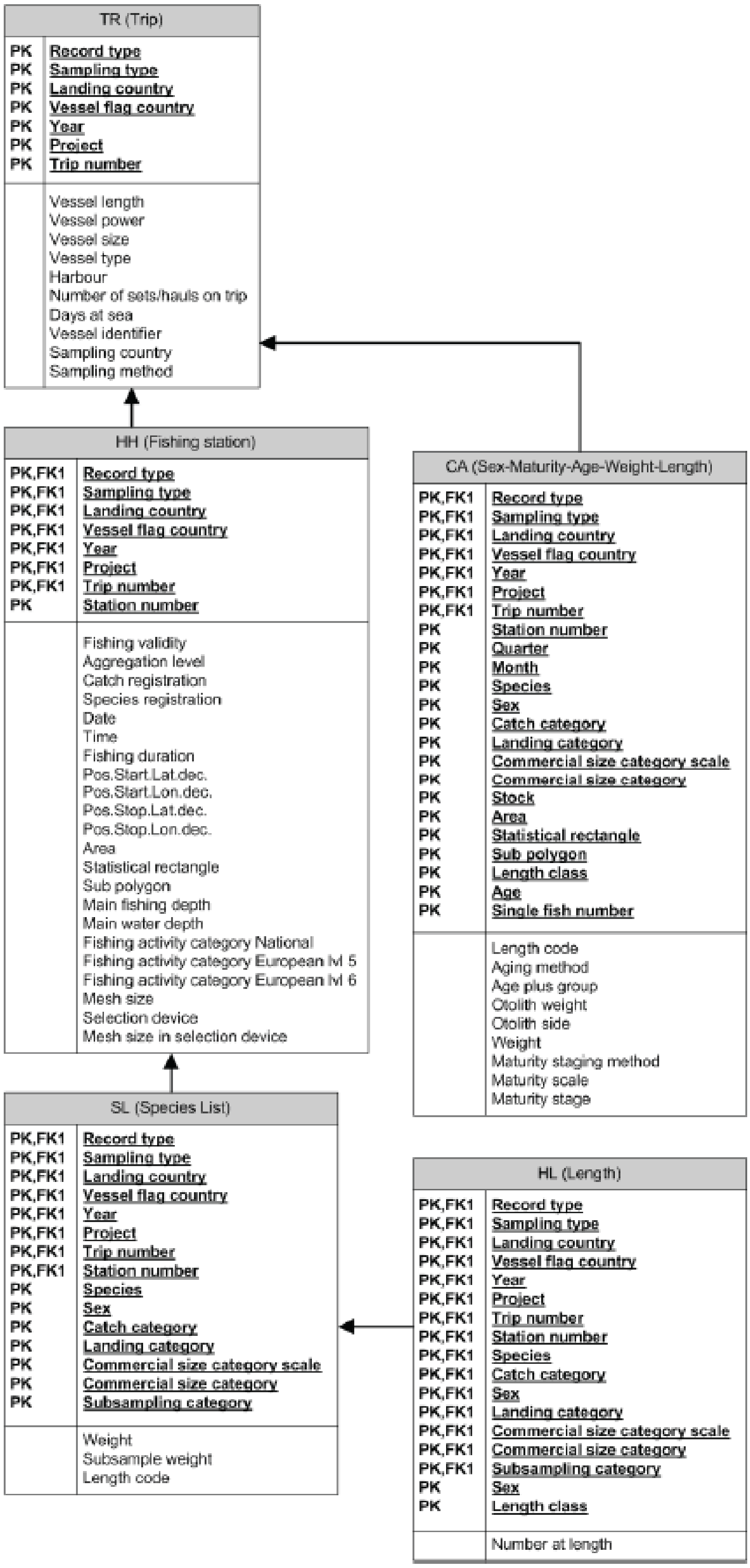


Figure 3.2. headings and relationships between the different header groups for the observer data (from Jansen *et al.*, 2009).

Objective 4). Sufficient data are collected for the identification and mapping of vulnerable marine ecosystems (VMEs).

One of the important aims of the observer programme for bottom fishing in new habitats is the collection of data to aid the identification of VMEs. According to FAO 2009, vulnerable marine ecosystems should be identified according to the criteria of uniqueness, functional ecosystem significance, fragility, life-history traits of component species and/or structural complexity. In their guidelines, FAO have given examples of species that could indicate the presence of VMEs such as cold water corals and hydroids, some sponge dominating communities, communities composed of dense emergent fauna such as sessile protozoas and invertebrates and endemic seep and vent communities. Also listed are examples of topographical, hydrographical or geological features that can potentially support these communities such as submerged edges and slopes, seamounts, guyots, banks, knolls and hills, canyons and trenches, hydrothermal vents and cold seeps.

Section three of these observer guidelines addresses the need to carry out non invasive impact assessments before any bottom-trawling should be allowed to proceed in unfished areas. Following the permission to carry out exploratory fishing the observer programme needs collect adequate data for the identification of VMEs. Data required for the identification of VMEs is the identification and enumeration of the bycatch of benthic species. This could be done either by photographic records with voucher specimen or the collection of the entire bycatch for further scientific investigation (Rogers, 2008). For recording purposes, the species list (SL) records should include benthic invertebrates. Observers deployed should identify corals, sponges and other organisms to the lowest possible taxonomical level, at a minimum this should to five groups (e.g. coral, hydroids, sponges, sessile protozoan and "unidentified benthic fauna (fixed or mobile)"

Observers should also record observations on the terrain, the occurrence of bathymetric features etc.

For the collection and preservation of specimen it is advised to follow the SEAFO Data Collection Protocol for Observers on fishing vessels as published in Annex 3 of Conservation Measure 17/09.

The protocol is reproduced here:

Step 1. For each trip observers are requested to photograph specimens of a representative collection of the corals and sponges observed in catches.

Step 2. Where possible, a specimens' collection should be frozen or preserved using the methods described below. Only specimens in good condition should be preserved. However, if all specimens taken in catches are usually damaged then a representative sample should be preserved.

Preservation methodology

a) For corals - these should be preserved with 80% alcohol.

b) For sponges - these should be preserved with 4% formaldehyde

Preparation of fixatives should be carried out ashore before commencing the trip.

For preservation using formaldehyde or alcohol, keep the specimens in plastic containers of adequate size and add the preservative solution until the specimens are completely submerged.

All samples must be clearly labelled: A label including: vessel; gear, best estimate of spatial position of capture (decimal latitude and longitude to the nearest minute) date, depth and taxon name must be placed inside each container. The labels, made in resistant paper, should be written in pencil. Each container should be also externally labelled with the same information (using a permanent marker)

Table 3.3. FIXATION AND PRESERVATION OF DIFFERENT INVERTEBRATES.

Taxon	Solution
Porifera	
Hexactinellida (SHEET 1)	4% formaldehyde
Demospongia (SHEET 2)	4% formaldehyde
Calcarea	80% alcohol
Cnidaria	
Hydrozoa	
Anthoathecata â€“ Leptothecata (SHEET 3)	80% alcohol
Stylasteridae (SHEET 3)	80% alcohol
Anthozoa	
Alcyonacea (SHEET 4)	80% alcohol
Gorgonacea (SHEET 5)	80% alcohol
Primnoidae	80% alcohol
Isididae (SHEET 5)	80% alcohol
Chrysogorgiidae (SHEET 5)	80% alcohol
Pennatulacea (SHEET 4)	80% alcohol
Antipatharia (SHEET 6)	80% alcohol
Scleractinia (SHEET 7)	80% alcohol
Bryozoa	80% alcohol

Other preservation methods

When it is not possible to use the above methods, samples should, where possible, be stored frozen. In this case, each sample must be placed in a plastic bag and clearly labelled internally (resistant paper label) and externally (permanent marker) with the information described above.

Specimens of some groups: Stylasteridae, Gorgonacea (including Primnoidae, Isididae and Chrysogorgiidae), Scleractinia and some Bryozoa, can be preserved by drying. For storage, the dried specimens must be placed in a plastic bag and clearly labelled (permanent marker) with the information described above.

When collection specimen, tt should be noted that a number of species that could be encountered in the NEAFC Regulatory Area (e.g. stony corals such as *Lophelia*) are listed under appendix II of the CITES convention (Convention on International Trade in Endangered Species of Wild Fauna and Flora) and bringing these to shore would qualify as “Introduction from the sea”. The introduction from the sea of any specimen of a species included in Appendix II requires the prior grant of a certificate from a Management Authority of the State of introduction. A certificate shall only be granted when the following conditions have been met:

Scientific Authority of the State of introduction advises that the introduction will not be detrimental to the survival of the species involved

Management Authority of the State of introduction is satisfied that any living specimen will be so handled as to minimize the risk of injury, damage to health or cruel treatment.

Objective 5.) Sufficient data are collected on the incidental catches of marine mammals, seabirds and sea turtles as well as any protected, endangered or threatened species (PET species) *to assess the impact of the fishery on the wider ecosystem.*

Data required:

- Recording of incidental takes of marine mammal, sea turtle and seabird or protected, endangered or threatened species (PET species)
- Note on survival, death, injury etc.,

2.4 Other data that should be collected on observer trips:

Incorporation of fisher's knowledge- there should be scope in the observer data collection for fishers' comments. The purpose of this log would be to provide fishermen an opportunity to document and record any significant information as it relates to an observed trip (NEFSC, 2010). Recorded comments could relate to gear particulars, unusual species caught, abnormal levels of bycatch, extrapolated weights, uncommon catches, reasons gear was not fishing properly, etc. these data should be on a haul base if possible or trip based.

General notes by observers on the identification of fish behaviours that make them particular vulnerable- e.g. aggregating behaviour in a targeted fishery should also be included.

2.5 Other considerations

- Standard data collection procedures and protocols should be implemented, including standardized logbooks and recording sheets. ICES proposes the standard data exchange formats as published in Jansen *et al*. 2009. All the data needs to be collected with the associated metadata.
- All coding should be standardized, such as species codes should be according to official FAO species codes.
- All biological specimen collected should be carefully labelled to track them back to haul information;
- The mandatory reporting period should be brief in order to allow for rapid responses if management action is required.
- There should be coordinated programmes on the standardization of species identification including benthic invertebrates.

2.6 Mitigation measures

For the publication of the observer guidelines NEAFC asked ICES to consider their interim protocol which includes mitigation measures for fishing in sensitive habitats. WGFTB commented as follows:

2.6.1 Towed Gears

Measures to mitigate benthic impact by towed fishing gear are reported by Rose *et al.*, 2000; He, 2001; Løkkeborg, 2005; Glass *et al.*, 2007 He, 2007 and others. However, due to the complexity and the methodological limitations of most impact studies, the results from individual experiments should be interpreted with great caution as described by Løkkeborg (2005) and in particular to vulnerable marine ecosystems in the deep-seas. Nevertheless there are a number of gear modifications that have been tested and found to reduce benthic impact and are felt worth of mentioning in the context of VME's. Whether these would be effective would of course depend on species being targeted and the benthic habitats encountered in all cases.

These modifications include the use of:

- semi-pelagic trawls;
- groundgear modifications;
- low impact trawl door designs; and
- bridle modifications.

2.6.2 Semi-pelagic Trawls

Lifting the groundgear off the seabed can be achieved by attaching the top bridles directly onto the main warps, forward of the doors e.g. Fork rigging (He and Winger, 2010). This technique was originally developed for targeting fish off the bottom or for towing over uneven ground to reduce gear damage and therefore may have applications in the deep sea, depending on target species. This method reduces bottom contact from the groundgear but not necessarily the doors which still maintain contact with the seabed. A similar effect can be achieved by replacing traditional groundgears with a series of drop chains and weights. This significantly lightens the trawl and has been tested to good effect in fisheries for red snapper in northern Australia (Brewer *et al.*, 1996). This rigging lifts the fishing line clear of the bottom and leaves only a series of shallow furrows. Whether this is applicable to deep sea fisheries is again dependent on target species and prevailing bottom conditions i.e. the drop chains may still damage large sessile structures.

2.6.3 Groundgear Modifications

There have been several different groundgear modifications tested that seek to minimize the area and depth of the footprint made by the groundgear. This is generally done by reducing the number of contact points that impact on the seabed. Some of these are really only suitable for light trawls and for species such as shrimp, prawns or flatfish so are not reported here but experiments have demonstrated that it is possible to reduce the number of footgear bobbins without significantly altering the engineering and catch performance of the gear (He, 2001). In these experiments the area affected by the bobbin footrope was reduced by 69% when the number of bobbins was reduced from 31 to 9. However, in adverse sea and ground conditions, the experimental footrope did not work well and gear damage was found to be excessive. This rig is probably only suitable under favourable sea and fishing ground conditions (He and Winger, 2001). A number of researchers have also looked at roller, wheels and plates. Of most relevance is the work carried out in Denmark and Norway to develop a "plate" groundgear. This groundgear has an increased spreading force allowing door size to be reduced and thus reducing impact. In addition, because the individual plates can flip horizontally in reaction to rocks or other such obstructions, this gear appears to be less intrusive to the bottom. This was tested during a recent

EU project entitled "Degree" and tested a standard rock-hopper footrope against the plate gear. The trials indicated that the plate gear trawl had a lower impact on the bottom substrate and benthic organisms than the conventional rock-hopper trawl. The physical impact on the bottom was visually inspected and measured using ROVs. In addition the turbidity of the water volume above the trawl tracks at different time-steps after trawling was measured. A higher turbidity above the rock-hopper trawl path indicated that the rock-hopper gear raised more sediments than the plate gear trawl (Anon., 2009). Whether either of these modifications are applicable to VME's, however, is untested.

2.6.4 Low impact trawl door designs

A number of newer semi-pelagic trawl door designs, which rely primarily on hydrodynamic forces to spread the trawl and usually have a higher aspect ratio (ratio of height to width) allow doors to fished stably both off and on the bottom. Such designs are now commonly used as are pelagic "Superkrub" doors. For fisheries where herding by sand clouds form the doors are not critical, the use of such doors fished off bottom is feasible and can reduce seabed disturbance. This again was demonstrated in the DEGREE project (Anon., 2009). Such doors also reduce the bottom contact of sweeps behind the door off the seabed (Goudey and Loverich, 1987). However, in some such rigging, depressor weights are sometimes attached to the bridles at a midpoint between the doors and the trawl. Thus while the doors are off the bottom there is still contact from these weights.

2.6.5 Bridle Modifications

Bridles have a lesser impact than the doors and groundgears but nonetheless do create a level of benthic impact. In fisheries for species in which bridle herding is not important then shorter or lighter bridles can be used. Alternatively bridles can be rigged to reduce the effect on sessile animals as tested by Rose *et al.* (2006). In this case to raise the cable off the seabed and to reduce the cutting effect of the cable to sessile animals' disc clusters were placed on the bridles, effectively lifting them off the bottom.

2.6.6 Static Gears

The effect of gillnet and longline fisheries on the benthic community is expected to be fairly low, whereas the fish community may suffer strong effects from the removal of large fish. The direct damage of fixed gears on benthic habitats is thought to be small and caused by individual anchors, weights and groundgear (ICES, 2006). If habitat damage by gillnet fisheries occur, it is most likely to be due to abrasion and/or translocation of seabed features by lost nets (Brown and Macfadyen, 2007), breaking or uprooting structures when hauling or setting anchors and buoy ropes (Chuenpagdee *et al.*, 2003). Therefore no mitigation measures are suggested here for VME's.

Mortality of benthic invertebrates can be caused through a series of mechanisms for bottom-set gillnets and longlines. Direct catch mortality can be high for crustaceans (e.g. Sundet, 1999; Large *et al.*, 2009), but is generally thought to be negligible (e.g. Santos *et al.*, 2002). Again, this is very much area-dependent. Another mechanism through which benthic invertebrates are impacted is by ghost-fishing nets. These can increase food availability for scavengers and/or result in catching, for instance crustaceans, by closing meshes around them (Kaiser *et al.*, 1996; Revill and Dunlin, 2003; Brown and Macfadyen, 2007; Graham *et al.*, 2008). For non-commercial fish species, no major assessments have been found, although indications of discards exist in some areas (Santos *et al.*, 2002; Hareide *et al.,* 2005). Mitigation against ghost netting is easily achieved through good fishing practice and recording. The retrieval of lost nets can be achieved by using creeper gear and this has been extensively reported by Brown and Macfadyen, 2007 and Graham *et al.,* 2008.

2.6.7 Gear Selectivity

Very little is known about the selectivity of towed gears in deep sea fisheries, although due to the morphology, generally sedentary behaviour and low light lives frequented by many deep sea species it is doubtful that simple mitigation measures such as large codend mesh sizes or square mesh panels would be particularly effective in such fisheries. Moreover it is also felt likely that the survival of escaping fish in any case would be low, leading to unaccounted mortality. Sorting grids maybe applicable in some fisheries and are already used in some redfish and deep-water prawn fisheries for size and species selection. It is therefore recommended that codend mesh size used in such fisheries should be well matched to the target species and sorting grids considered in single species fisheries.

2.6.8 Gear Monitoring

There have been a number of developments in gear monitoring systems that have relevance for monitoring and mitigation against benthic impact. There are several systems that allow monitoring of the position of the trawl relative to the seabed based on information from the echosounder and the sonar. One example is the system developed by Simrad in Spain that can monitor fishing parameters and their geographical position of each sensor (installed on the doors and the headrope) of trawl gear relative to a gas pipeline in this case. See http://www.simrad.com/www/01/NOKBG0238.nsf/AllWeb/DAEB7455E3801C3BC125758C001B6719?OpenDocument for more details. This type of approach could well be useful in controlling and monitoring gear usage to demonstrate avoidance of VME's at a much finer resolution than traditional VMS could ever do. In the case of the Simrad project such information is being sent back to a land-based server in real time.

2.7 References for NEAFC Observer guidelines

Anon. 2009. Development of fishing Gears with Reduced Effects on the Environment (DEGREE). Final Report for EU project SSP8-CT-2004-022576. In prep.

Brewer, D., Eayrs, S., Mounsey, R., and Wang, Y. G. 1996. Assessment of an environmentally friendly, semi-pelagic fish trawl. Fish. Res. 26: 225-237.e

Brown, J., and Macfadyen, G. 2007. Ghost fishing in European waters: Impact and management responses. Marine Policy 31: 488-504.

Chuenpagdee, R., Morgan, L. E., Maxwell, S. M., Norse, E. A., and Pauly, D. 2003. Shifting gears: assessing collateral impacts of fishing methods in the US waters. Frontiers in Ecology and the Environment 1(10): 517-524.

FAO. 2009. International Guidelines for the Management of Deep-sea Fisheries in the High Seas, Rome, ISBN 978-92-5-006258-7. pp 21.

Glass, C. W., Walsh, S. J., van Marlen, B., and Amaratunga, T. (eds). 2007. Fishing Technology in the 21st Century: Integrating Fishing and Ecosystem Conservation. ICES J mar. Sci. 64: 1499-1616.

Goudey, C., and Loverich, G. 1987. Reducing the bottom impact of Alaskan groundfish trawls. In: Oceans 87 Proceedings: Vol 2. Marine Engineering, Policy, Education and Technology Transfer. pp 632-637.

Graham, N., Hareide, N-R. Large, P. A., MacMullen P., Mulligan M., Randall, P. J., Rihan, D., and Peach, D. 2009. Recuperation of fishing nets lost or abandoned at sea. FISH/2006/15/Lot No. 5.

He, P., and Winger, P. 2010. Effect of Trawling on the seabed and mitigation measures to reduce impact. In: Behaviour of Marine Fisheries: Capture Processes and Conservation Challenges. pp.295-314. Wiley-Blackwell.

He, P. 2001. Reducing seabed contact of bottom trawls. Proceedings of a workshop on "Fishing Impacts: Evaluation, Solution and Policy". Pp 27-35. Japanese Society for Fisheries Science Roundtable Meeting on Fishign Technology, No. 45. Tokyo. Japan.

He, P. 2007. Technical measures to reduce seabed impact of mobile gears. In: Kennelly S (ED). Bycatch Reduction in World Fisheries. pp 141-179. The Netherlands. Springer.

ICES. 2006. Report of the Working Group on Ecosystem Effects of Fishing Activities (WGECO), 5-12 April 2006 , ICES Headquarters, Copenhagen. ACE:05. 174 pp.

ICES. 2008. Report of the ICES NAFO Joint Working Group on Deep Water Ecology (WGDEC), 10–14 March 2008, Copenhagen, Denmark. ICESCM 2008/ACOM:45. 126 pp.

Jansen, T., Degel, H., Vigneau, J., Jardim, E. 2009. Definition of Standard Data-Exchange Format for Sampling, Landings, and Effort Data from Commercial Fisheries, ICES Cooperative Research Report [Rapport Des Recherches Collectives], No 296, 43 pp.

Kaiser, M. J., Bullimore, B., Newman, P., Lock, K., Gilbert, S. 1996. Catches in 'ghost fishing' set nets. Marine ecology progress series 145, 11–16.

Large, P. A., Graham, N. G., Hareide, N-R., Misund, R., Rihan, D. J., Mulligan, M. C., Randall, P. J., Peach, D. J., McMullen, P. H., and Harlay, X. 2009. Lost and abandoned nets in deep-water gillnet fisheries in the Northeast Atlantic: retrieval exercises and outcomes. – ICES Journal of Marine Science, 66: 323–333.

Løkkeborg, S. 2005. Impacts of trawling and scallop dredging on benthic habitats and communities. FAO Fis. Tech. Pap. 472: 58pp.

Northeast Fisheries Observer Program (2010) Fisheries Observer Program Manual 2010 http://www.nefsc.noaa.gov/fsb/

Revill, A. S., and Dunlin, G. 2003. The fishing capacity of gillnets lost on wrecks and on open ground in UK coastal waters. Fisheries Research 64, 107-113.

Rogers, Alex D., Malcolm R. Clark, Jason M. Hall-Spencer, Kristina M. Gjerde (2008). The Science behind the Guidelines: A Scientific Guide to the FAO Draft International Guidelines (December 2007) For the Management of Deep-Sea Fisheries in the High Seas and Examples of How the Guidelines May Be Practically Implemented. IUCN, Switzerland, 2008.

Rose, C., Carr, A., Ferro, R. S.T., Fonteyne, R., and MacMullen, P. 2000. Using gear technology to understand and reduce unintended effects of fishing on the seabed and associated communities: background and potential directions, pp 106-122. Annex to ICES FTFB Report 2000.

Santos, M. N., Gaspar, M. B., Monteiro, C. C., and Vasconclos, P. 2002. Gill net and long-line catch comparisons in a hake fishery: the case of Southern Portugal. Sci. Mar., 66 (4): 433-441.

SEAFO guidelines for photographing, fixing and preserving corals and sponges in Conservation Measure 17/09: on Bottom Fishing Activates in the SEAFO Convention Area) Annex 3.

Sundet, J. H. 1999. Bifangst av kongekrabbe i garn- og linefisket i 1999. Fiskeriforskning, p. 14.

3 ToR c

"Review the development and evaluation of deep-water species identification guides for the NEA deep-water surveys and review progress on the development of a common image library"

The development and evolution of the identification keys is an ongoing process and during the most recent update in 2010 several new species have been added to the latest versions of the keys as documented in the PGNEACS report 2009 (ICES, 2009). These updated keys were circulated among working group members through the 2010 WGNEACS sharepoint site. The deep-water shark key is still at present incomplete as there is no definitive taxonomic key that covers all the *Apristurus spp* encountered on the Scottish or Irish deep-water slope surveys available at this moment. Further correspondence with Bernard Serat, of the National Museum of Natural History in France, who is continuing work on these species, is required in 2010 prior to the deep-water surveys so that any progress in classifying this genus can then be incorporated into the keys in time for the survey. Work is also being carried out in the US differentiating between deep-water sharks, especially the *Apristurus* species, by morphometric means, particularly using differences in dentition. A completely new species of Chimaera *(Chimaera opalescens)* is also in the process of being described and again will also need to be added to the Rabbitfish key in time for the 2010 deep-water surveys.

There are no plans in the immediate future to expand these identification keys beyond the current four that exist, although an extensive image library of all species encountered on the Scottish and Irish Deepwater Slope survey has been created. At present none of the images have been submitted to Fishbase.

After some discussion during this year's meeting, the various institutes agreed to draw up a list of the ID keys used on their different surveys. The countries also all use their own individual field identification keys. It was proposed that institutes would share these keys and trial them on each other's surveys. Eventually it is envisaged that these national keys could be merged into one international survey key.

It was also noted that some of the surveys have built up photographic collections of the fish species they encounter. It was suggested that these collections would also be shared among the surveys to assist in identification, particularly of problem species. Any new photographs collected would also be circulated.

During discussions on species identification it was recommended that short dedicated workshops could be added to the end of the annual meetings, if needed, to discuss difficulties in the identification of certain species groups. These meetings need not be on an annual basis but could be organized if persistent difficulties are being encountered by surveys.

Reference

ICES. 2009. Report of the Planning Group on the North-east Atlantic Continental Slope Survey (PGNEACS), 9–11 June 2009, Tromsø, Norway. ICES CM 2009/LRC:03. 59 pp.

4 Nordic Deepwater surveys

The Nordic subgroup dealt with following terms of references:

d.1) Evaluate present sampling protocols for surveys by Faroe, Greenland, Iceland and Norway, and attempt to standardize the protocols as much as possible.

d.2) Evaluate the combined total survey coverage in relation to distribution of all major stocks in the area and consider the feasibility of bridging any gaps.

d.3) Evaluate the extent and quality of information on non-targeted species and the ability to describe larger parts of the fish communities and the physical environment.

d.4) Evaluate the prospect of making all the combined survey data available to all parties by use of e.g. the ICES DATRAS database, in order to facilitate joint research and analyses.

Section 4.1 covers the comparison of survey strategies, biological sampling protocols and auxiliary measurements addressing ToRs d.1 and d.3. Section 4.2 describes the combined survey coverage in relation to the main species distribution (ToR d.2) and section 4.3 addresses the availability and joint use of survey data (ToR d.4).

4.1 Evaluation and standardization of present sampling protocols for surveys by Faroe, Greenland, Iceland and Norway

The survey strategies and sampling protocols of several Nordic deep-water surveys were compared in order to evaluate whether a higher level of coordination and standardization could be achieved. The surveys covered in this review were

- The Icelandic Autumn Groundfish Survey along the continental shelf and slope of Iceland
- The Norwegian Deep Water survey along the Northern Shelf Brake
- The Norwegian argentine and redfish survey along the southern shelf and slope
- The Faroese deep-water survey and
- The Greenland halibut survey in East Greenlandic waters.

Survey specification, gear details and sampling strategies are summarized in Table 4.1. Sampling protocols in relation to target species as well as non – target species and the collection of auxiliary ecosystem data are summarized in Table 4.2. Further details on sampling methods in relation to subsampling, length measurements, determination of maturity stages and species identification are given in the text below.

Table 4.1. Survey specification of the different Nordic deep-water surveys.

leepwater fish survey parameters

Survey	Survey acronyme	IAGS	TN	TS	FD	EG
	Full name	Atumn Groundfish Survey along the continental shelf and slope of Iceland	Norwegian Deep Water survey along the Northern Shelf Brake	Norwegian argentine and redfish survey along the southern shelf and slope		Greenland halibut survey in East Greenlandic waters
	Nation	Iceland	Norway	Norway	Faroe Islands	Greenland
	Month	10	8	3/4	Late 4 to beg. 5	8/9 (until 2008 6)
	Periodicity	annualy	annualy	interannualy (?)	annually	annualy (except 2001)
	First year of time series	1996/2000	1994	2009 (earlier ocational)	1995	1998
Design parameters	Area	Icel. Shelf and slope	Norwegian slope 68°-80°N	Norwegian slope 60°-70°N	Faroe Slope	East greenlandic waters from 61°45' to 67°
	Area coverage	317,000 km^2	20144			37397
	#hauls 0-400m	204	0	14		0
	#hauls 401-600m	74	40	17	Around 40	10
	#hauls 601-800m	45	89	11		12
	#hauls 801-1000m	30	43	0		16
	#hauls 1001-1200m	20	15	0		8
	#hauls >1200m	8	6	0		6
	Depth range	0-1500	400-1350	300-900	400-550	400-1500
	Total # stations	381	190-195	40-50	Around 40	40-55 (depending on icecoverage)
	Design	Stratified random/fixed	Stratified random/fixed	Stratified random/fixed	Random	Buffered stratified random
	Towing speed (knots)	3.8	3.8	3.8	3	3
	Towed distance (nm)	3	2-3.5	2-3.5	9-15	2.5
Gear specifications	Gear type	Bottom trawl	Bottom trawl	Bottom trawl	Bottom trawl	Bottom trawl
	Gear name	Gulltoppur	Alfredo no 5	Alfredo no 5	Star trawl	Alfredo III
	Drawings available	Yes	Yes	Yes	Yes	Yes
	Headrope length	35.6	37.5	37.5		
	Groundrope length	22.6	32.3			
	Mesh-size, roof (mm)	170	170	170		
	Mesh-size, belly (mm)	165	155	135	135	140
	Mesh-size, cod-end (mm)	40	60	60	135	30
	Ground gear	Rockhopper	Rockhopper	Rockhopper	Rockhopper	Rockhopper
	Weight og ground gear (Kg)	2470				
	Door type/area	Polyice no 8/8m2	Various/11.5m2	Various/11.5m2	Thyborøn	Injector/?
	Weight of doors (Kg)	2700	3500	3500		2700
	Door spread (m)	120-130	170-180	170-180		100-150
	Wing spread (m)	15.5/17.8				
	Sweeps (m)		140	140		
Biological sampling	Catch weight and numbers	Yes	Yes	Yes	Yes	Yes
	All species identified	Yes	Yes	Yes	Yes	Yes
	Length distribution of all species	Yes	Yes	Yes	Yes	Yes
	Individual weighs for deep-water species	Yes	R. hippoglossoides and Sebastes	S. mentella and A. silus	Yes	R. hippoglossoides
	Sex and maturity for deep-water species	Most species (~25)	R. hippoglossoides and Sebastes	S. mentella and A. silus	R. hippoglossoides	R. hippoglossoides
	Stomach contents for deep-sea species	Some species (15)	No	No	Seldom	No
Catch composition	Most abundant species below 400m	Sebastes mentella	Reinhardtius hippoglossoides	Reinhardtius hippoglossoides	Reinhardtius hippoglossoides	Sebastes mentella
	2. most abundant	Coryphaenoides rupestris	Sebastes mentella	Greater argentine	Sebastes mentella	Reinhardtius hippoglossoides

Table 4.2. Sampling details of the different Nordic deep-water surveys.

Survey Details	Survey acronyme	IAGS	TN	TS	FD	EG
	Full name	Atumn Groundfish Survey along the continental shelf and slope of Iceland	Norwegian Deep Water survey along the Northern Shelf Brake	Norwegian argentine and redfish survey along the southern shelf and slope		Greenland halibut survey in East Greenlandic waters
	Nation	Iceland	Norway	Norway	Faroe Islands	Greenland
Biological fish sampling	Catch weight and numbers of fish species	Yes	Yes	Yes	Yes	Yes
	All species identified	Yes	Yes	Yes	Yes	Yes
	Species id keys used	Yes	Yes	Yes	Yes	Yes
	Length distribution of all species	Yes (cm below)	Yes (1/2 cm below up to fish of 50 cm, then 1 cm below)	Yes (1/2 cm below up to fish of 50 cm, then 1 cm below)	Yes (cm below)	Yes (cm below)
	Subsampling	Yes	Yes	Yes		Yes
	Method of subsampling and raising (see text for further explanation)	Yes	Yes	Yes		Yes
	Individual weighs for deep-water species	Yes (for ~25 deep water species)	R. hippoglossoides and Sebastes	S. mentella and A. silus	Yes	R. hippoglossoides and S. microcephalus
	Sex and maturity for deep-water species	Most species (~25)	R. hippoglossoides and Sebastes	S. mentella and A. silus	R. hippoglossoides	R. hippoglossoides, Sebastes spp. Ray spp. and M. berglax
	Maturity guides used (see text for further explanation)	Yes	Yes	Yes	Yes	Yes
		A. silus	R. Hippoglossoides, A.silus, S. mentella and other sp.	R. Hippoglossoides, A.silus, S. mentella and other sp.		R. hippoglossoides
	Age Determination					
	Stomach contents for deep-sea species	Some species (~15)	No	No	Seldom	No
		Some species (~10)	No	No		No
	Liver weight/gonad/gutted weight					
Biological invertebrate and fish sampling	#Invertebrate species recorded	~5-10 (squids, shrimps)	Squids	Squids		~20 (squids, crabs and shrimps)
	Taxonomic level of invertebrate identification	Species level	Family level	Family level		Species level
	ID Keys used	Yes	No	No		Yes
	#Elasmobranch species recorded	25	~15	~15		~10
	#Teleost species recorded	~140 (from 0-1500 m)	~60	~60		~140
Environmental data collection	CTD	No	No	No		Sometimes (vertical haul)
	Temperature	Yes	Yes	Yes		Yes
	Other data collection	No	No	No		No

4.1.1 Subsampling

Greenland

Large catches in the Greenlandic deep-water survey are first subsampled by discarding one of the two codends. The other is then sorted by species. Species found in large amounts are collected in 44l fishing baskets and weighed. If the amount of fish still exceeds the amount that should be measured, then random baskets are thrown away and fish from some of the retained baskets are splits until having the desired amount of fish.

Iceland

First, the catch is sorted into species. Each species is then length measured. The general rule is to measure at least 4 or 5 times the length interval of a given species at each station and the fish must be randomly chosen. Example of length measurements using the rule of "4 times the length interval": If the continuous length distribution of a given species is between 20 and 100 cm, the length interval is 80 cm and the number of measurements needed is 320. If the catch of a given species at this station exceeds 320 individuals, the rest must be counted.

For some species (usually non-commercial species) it is sufficient to length measure 20 individuals at each station. If the number of individuals exceeds these limits, the rest is counted.

Usually, every individual of a species exceeding the length measurement limits is counted. If, however, the number of one species (or few species, usually 2–3 species) is large, a subsample of that species is put into a basket and the number in that basket is counted. The rest of the catch is then put into baskets, the number of baskets is counted, and then the number of individuals is raised in accordance the number counted from the first basket.

Norway

Subsampling often depends on the species composition in the catch. When subsampling the routine is normally to sort out all commercial species and then subsample the rest of the catch in baskets (44 litres). If 10 baskets are sorted out, we may use 4–5 baskets for detailed sorting. The 10 baskets and the weight of the different species sorted out, is used to find the total catch for the different species. If 5 baskets are included in the detailed sorting, the total catch of each species would be multiplied by 2. The baskets that are not included in subsample are looked trough, to pick out rare species. The rare species recorded as total. The reason this is done for rare is that occurrence is weighted higher than doing the sub sampling correct for these rare species.

4.1.2 Length measurements

While both the length measurements in both the Icelandic and Greenlandic survey uses the conventional measuring boards from where the lengths are orally transferred to a person that types the numbers into a computer. For the Greenlandic, all lengths are measured in whole centimetres below. In the Norwegian surveys the lengths are measured with an electronic measuring board, which measures all fish smaller than 50 cm in half cm's below.

In Iceland, the length measurement is "to the nearest cm" procedure. The measurement board is designed in the way that the first cm on the board is called the "dead cm". This means that the first cm on the board (from the beginning of the board to 1 cm) is only 0.5 cm. With this method, the fish is put to the nearest cm (the fish can either increase or decrease in size in the end). For example, fish that are actually between 9.5–9.9 cm will be 10.0–10.4 cm. Then the fish is put to the "cm below" and hence, recorded as 10 cm fish. Fish that are actually 9.0–9.4 will be 9.5–9.9 and put to the cm below they will be recorded as 9 cm. All fish between 9.5 and 10.4 cm are therefore recorded as 10 cm fish.

In the Greenlandic survey only two types of length measurements are being used. "Pre Anal Fin Length" for the grenadiers and Total length for all the rest. In both the

Norwegian and Icelandic survey several species-specific methods are being used. Rabbitfish are for example measured as Pre Supra Cordal Fin Length.

4.1.3 Maturity guides

Iceland

For most teleost species in Icelandic waters, the maturity stage is defined as a four stage maturity scale (1-immature, 2 – mature/maturing, 3 – spawning, 4 – post-mature). For female redfish species the spawning scale is divided into three stages. No specific manual (with figures) exists for individual species.

For rays and skates, dogfish, and sharks the maturity scale is based on a manual by M. Stehmann at Institute at Sea Fisheries (ISH), Federal Research Center for Fisheries, Hamburg, Germany.

Norway

In Norwegian cruises sex is recorded only on the target species. It is recommended that more species are have their sex recorded, especially species with external characteristic.

For the maturity Norway uses different stages for different species, as described in the table below. Even the range for the species, the description for the stage is different between the species.

Species	Male	Female
Greenland halibut	1 – 5	1 – 7
Greater silver smelt	1 – 7	1 – 7
Sebastes mentella	1 – 5	1 – 7
Sebastes marinus	1 – 5	1 – 7

On Norwegian cruises non-target species are not recorded with their maturity. Plans to record maturity on several species are planned for elasmobranch fish.

Greenland

Maturity is only being determined on Greenland halibut in the Greenlandic Deep Water survey. However no description of these stages is found in the manual.

4.1.4 Literature that is used to id species

Species id books used in Iceland.

Jónsson, G. 1992. Íslenskir fiskar (*Icelandic fishes*). Reykjavík: Fjölvaútgáfan, pp. 510 [in Icelandic].

Jónsson, G., and Pálsson, J. 2006. Íslenskir fiskar (*Icelandic fishes*). Reyjavík: Vaka-Helgafell, pp. 336 [in Icelandic].

Bertelsen E., Nielsen, J. G., and Nyström, B. O. Fishes of the North-Atlantic.

4.1.5 Species id used in Norway

Fishes of the North-eastern Atlantic and the Mediterranean

Achehougs Store Fiskebok (Aschehoug big fishbook)

Identification sheet on eelpout by Ingvar Byrkjedal, UiB

Fisk i grønlandske farvande by Jørgen G. Nielsen

4.1.6 Species id used in Greenland

Fishes of the North-eastern Atlantic and the Mediterranean

Bertelsen E., Nielsen, J. G., and Nyström, B. O. Fishes of the North-Atlantic.

Fisk i grønlandske farvande by Jørgen G. Nielsen

4.1.7 Recommendations to improve standardization of Nordic survey sampling protocols

1) Length measurements methods for special species e.g. chimeara in the Greenlandic surveys should be in accordance with the other nations
2) Consider exchange of scientific personal between countries
3) Make Faroese manual available and translate if not in English
4) Update the Norwegian manual in English. Latest version is from 2006
5) Translate Greenlandic manual from Danish to English
6) More weighing of non targeting species in Greenland and Norway
7) Icelandic sub sampling procedure should be evaluated
8) Electronic measuring boards could save time
9) It should be ensured that the core scientific work always is done by trained personnel
10) Consider measuring maturity on more species (like *S. mentella*) in the Greenlandic and for the non target species in Norwegian surveys
11) Greenlandic manual needs text on how to stage maturity and sex the species
12) Consider measuring liver weight and gutted weight on target species in Greenland
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
14) National maturity guides should be evaluated to make results comparable between nations

4.2 Evaluation of total survey coverage in relation to distribution of major stocks in the area

This section deals with ToR d.2) to evaluate the combined total survey coverage in relation to distribution of all major stocks in the area and consider the feasibility of bridging any gaps. In order to address the ToR, abundance data of the four species Greenland halibut, beaked redfish (Sebastes mentella), roundnose grenadier and greater argentine were combined from the Nordic surveys. For the analysis several surveys from Greenland, Iceland, Faroe Islands and Norway were used. The deep-water survey specifications can be seen in Table 4.1. In addition data from four surveys that are not primarily targeting deep-water fish were used. This includes the Norwegian ecosystem survey in the Barents sea (which includes stations north of Spitsbergen targeting juvenile Greenland halibut), Norwegian North sea / Skagerrak shrimp survey (includes deep stations in inner part of Norwegian trench targeting roundnose grenadier) and Faroese groundfish surveys in spring and autumn (partly cover distribution of e.g. greater silver smelt).

The total survey coverage with a breakdown of the different stations by nation is shown in Figure 4.1.

Norwegian TS survey that covers the slope west off mid-Norway (approximately 60°N-70°N) has not been annual but was conducted 1980–1994 and again in 2007 and 2009. This survey is primarily acoustic survey but includes trawling.

The deep-water surveys that were compared all use trawls of similar size. Still, different trawls have different selection pattern and a common index will only be approximately comparable between surveys. A smaller trawl is used in the Norwegian ecosystem and shrimp surveys (Campelen research trawl).

A common swept-area index per station (P_s) was calculated for each major species as density of fish at station s per km^2, estimated by:

$$P_s = f_s / a_s$$

where f_s is the estimated frequency of fish (here numbers in catch), and a_s is the swept-area given by:

$$a_s = d_s * EW * 1852$$

where d_s is towed distance (in nautical miles) and EW is effective swept width. Towed distance is assumed to be straight line between start and stop position of trawling. As a proxy for EW, in these particular surveys, wing distance was used, estimated as length of trawl headline, in metres, divided by two. Thus herding by sweeps and bridles is ignored and selection in trawl path is assumed to be 100%.

In the exercise only data from 2009 are used.

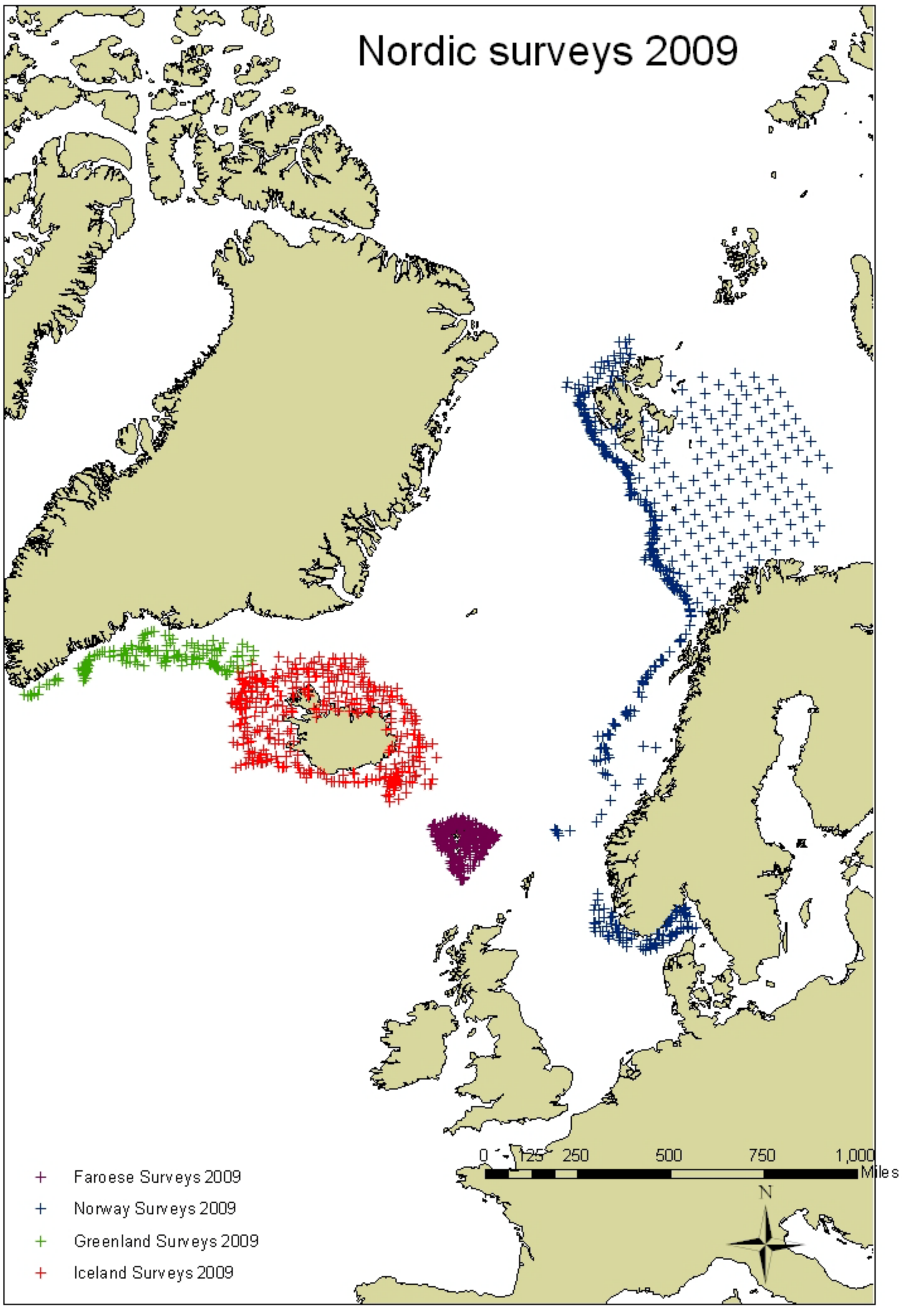


Figure 4.1. Survey coverage of the main Nordic Deepwater surveys.

4.2.1 Greenland Halibut

The known distribution of Northeast Arctic Greenland Halibut in the Norwegian sea/Barents Sea is shown in Figure 4.2. The most important adult area is along the slope from 600–900 m.

The area north and east of Svalbard towards the Franz Josef Land, northern Kara Sea and into the Barents Sea is larvae and juvenile area.

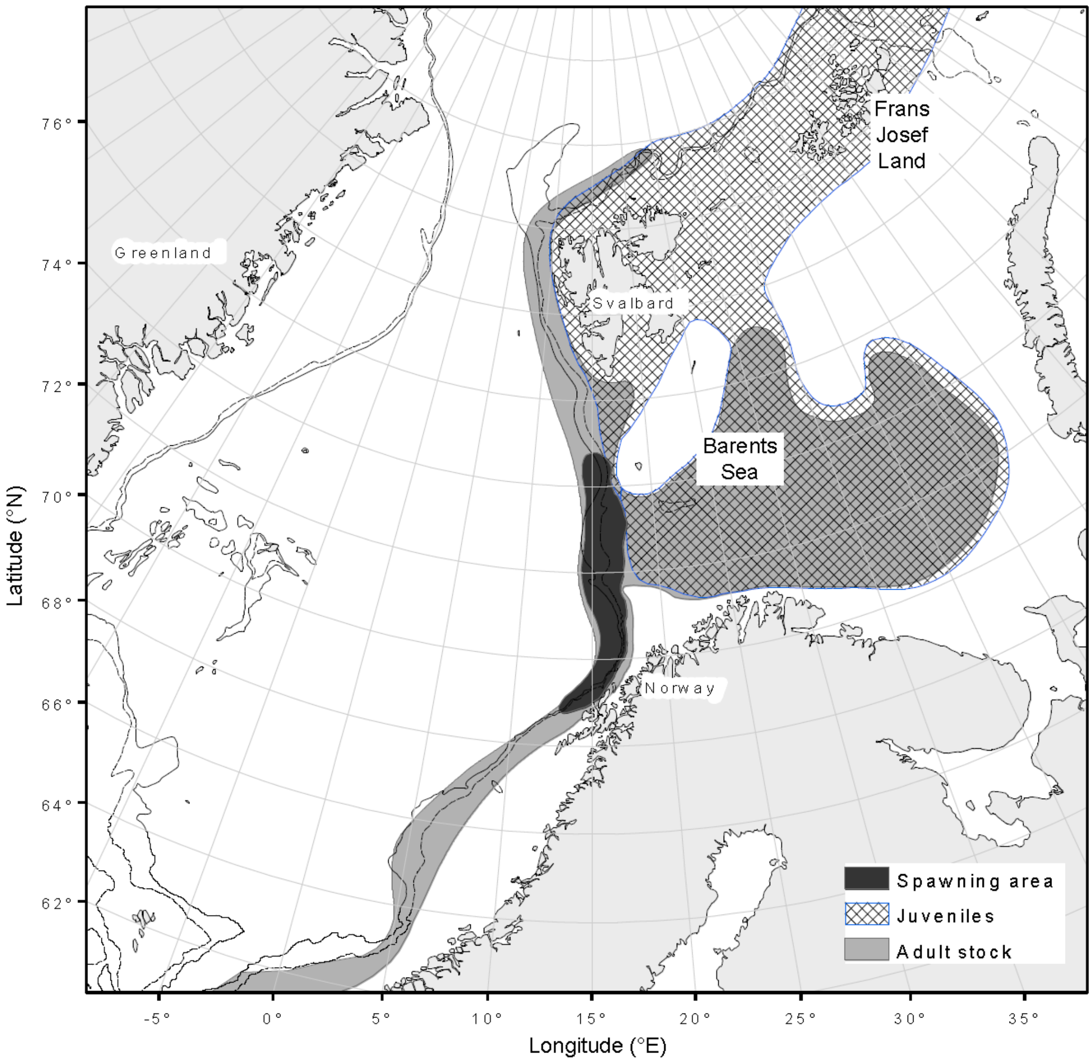


Figure 4.2. Distribution of Northeast Arctic Greenland halibut (Høines and Gundersen 2008).

In the North western part of the Atlantic Ocean, Greenland halibut in waters of east Greenland, Iceland and the Faroese islands (ICES Subareas V, VI, XII and XIV) are assessed in ICES North Western Working Group (NWWG) as one stock unit although precise stock associations are not known. Figure 4.3 provides an overview of the geographical distribution of the fishery over time. Fishery in East Greenland and Iceland occurs continuously along the continental slopes at depths of 500–1000 m.

Available biological information and information on distribution of the fisheries suggest that Greenland halibut in XIV and V belong to the same entity and do mix. Historical information on tag-recapture experiments in Iceland have shown that Greenland halibut migrate around Iceland. Similar information from Greenland suggests some mix, both between West Greenland and Iceland but also between East Greenland and Iceland.

The scientific basis for the assumption on spawning grounds located west of Iceland is weak and based only on a few observed spawning fish and on distribution of eggs and larvae. 0-group surveys suggest that recruits are supplied to East Greenland and might also drift to West Greenland. Nursery grounds have not been found in the entire assessment area. Tag-recapture experiments have shown migrations of adult fish from Greenland to Iceland and also a mix within Icelandic waters, which supports a drift of larvae from west of Iceland to both Greenland and to north of Iceland. Tagging also suggest occasional migrations of adult fish from east Greenland and Iceland to Faroe Islands.

Unpublished preliminary results from recent Norwegian tagging experiments show migrations of Greenland halibut from the Barents Sea to north and east Iceland and to Faroe Islands to some degree. So far it is primarily juveniles tagged around King Karls Land that are found in Icelandic catches.

The distribution of Greenland halibut in waters of East-Greenland, Iceland, the Faroe Islands and Norway from national surveys in 2009 is shown in Figure 4.4. In general it seems that the areas where commercial fishery takes place are covered by the surveys. However no survey takes place in Greenlandic waters north of 67 °N. However between 67°N and 68°N a fishery for Greenland halibut started in recent years. Only in 2006 the Greenlandic deep-water survey extended up to this area. North of 68°N almost no fishery takes place and since the area is covered with ice most of the year, not much is known on occurrence of Greenland halibut in the area.

Norwegian survey of mid Norway (primarily targeting redfish and greater silver smelt) has not been routinely conducted and the future of that survey is uncertain. Concerning Greenland halibut this means that distribution along the slope approximately 62°–70°N would not be covered. The juvenile area around Frantz Joseph Land and in northern Kara Sea has only been covered occasionally by Norwegian and Russian surveys, and is not routinely monitored.

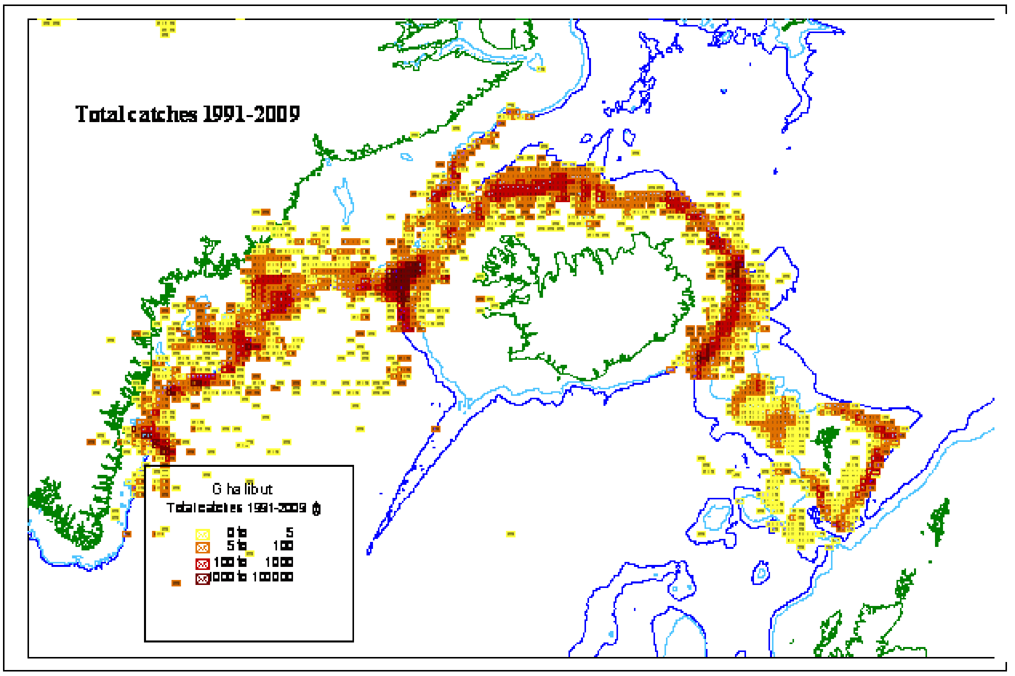


Figure 4.3. Greenland halibut in ICES Subarea V+XIV. Distribution of total catches in the fishery 1991–2009; 500m and 1000 m depth contours are shown. (Taken from the ICES NWWG 2010 report).

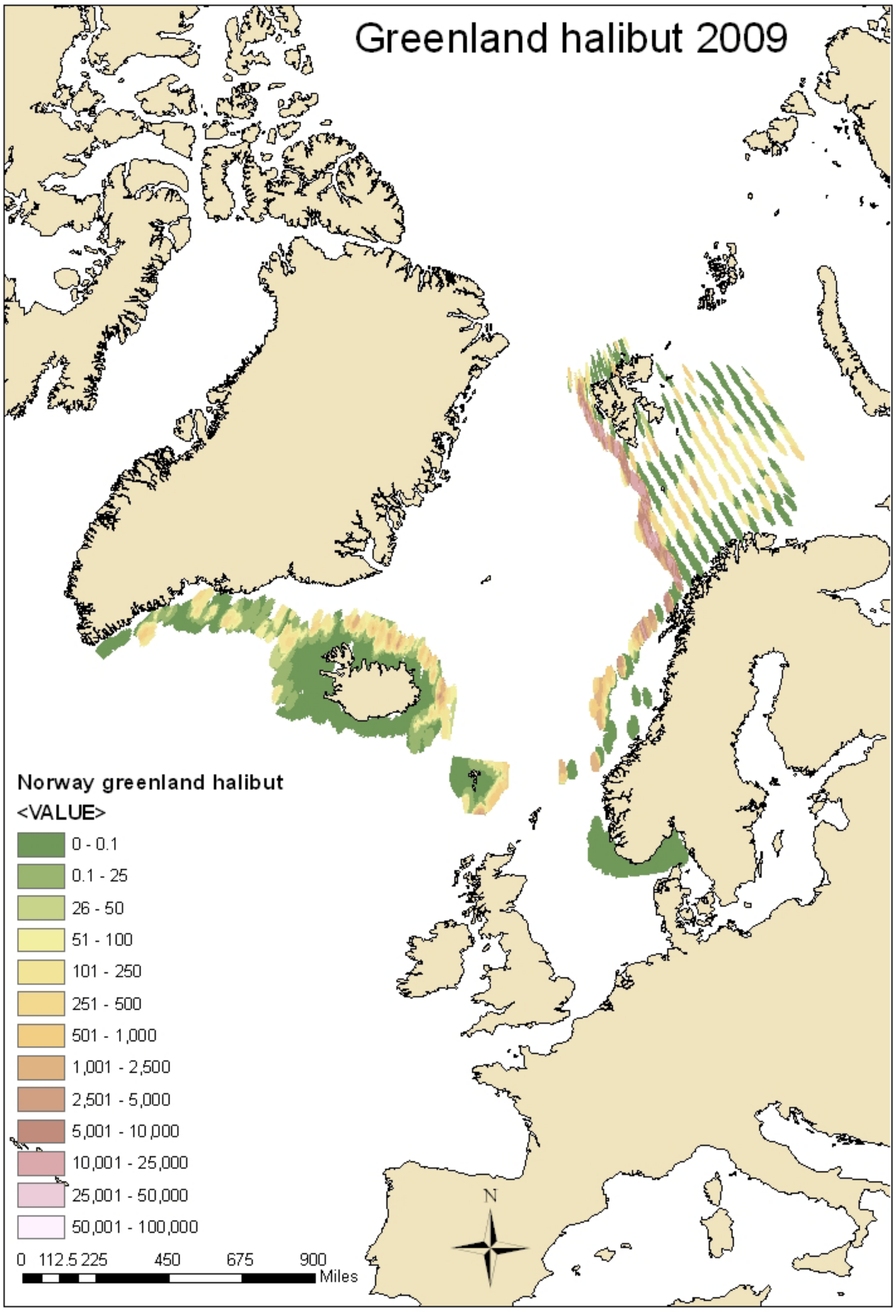


Figure 4.4. Contour-plot of the distribution of survey catches of Greenland Halibut by the Nordic Deepwater surveys (No/km^2) in 2009.

4.2.2 Greater Silver Smelt

The distribution of Greater Silver Smelt is described in the stock annex of this year's WKDEEP benchmark report (ICES, 2010). Greater silver smelt is a bentho pelagic deep-water species and lives in schools close to the bottom. Greater silver smelt is primarily fished in the depth range 100–700 m. An updated distribution map is missing for greater silver smelt but Figure 4.5 shows the distribution as illustrated by Cohen 1984. The figure also indicates location of main direct fisheries in recent years. In late winter/autumn greater silver smelt is primarily found at depths of approximately 300–1000 m and Figure 4.6 shows the distribution of commercial catches of greater silver smelt in ICES Division Va. Figure 4.7 shows distribution of greater silver smelt (kg/h) on the Faroe plateau (area Vb) from Faroese spring (1994–2008) and summer surveys (1996–2008). The location of fisheries is reflected in the distribution of survey catches in Figure 4.8.

The current ICES structure for greater silver smelt is that ICES Subareas I, II, IV, VI, VII, VIII, IX, X, XII and XIV and Divisions IIIa and Vb, are treated as a single assessment unit and greater silver smelt around Iceland (Division Va) is treated as a separate assessment unit.

In Subarea I and II the fishery for greater silver smelt is primarily prosecuted by licenced Norwegian trawlers that have this species as target. They operate specialized greater silver smelt "pelagic" trawls at the seabed. In the Skagerrak (Division IIIa), greater silver smelt has periodically been targeted by Norwegian, Danish and Swedish bottom trawlers. During the last 10 years it is primarily a few Danish vessels that have conducted targeted fisheries for roundnose grenadier and greater silver smelt. However, there is also a bycatch in the Norwegian and Danish small mesh bottom trawl fisheries along the Norwegian Deep (primarily in IVa) that land the catch for reduction. In Subarea IV the Norwegian landings have increased from 11 tonnes in 2005 to over 3000 tonnes in 2006 and 2007, but 1550 tonnes are registered in 2008.

In the Faroese (Division Vb) pairtrawlers have had a direct fishery for greater silver smelt, from spring to autumn, for more or less since 1994. There is a minor bycatch of greater silver smelt in the pelagic fishery for blue whiting in Subarea Vb.

Greater silver smelt is mostly fished along the south, southwest, and west coast of Iceland, at depths between 500 and 800 m (see Figure 4.6). Greater silver smelt was caught in bottom trawls for years as bycatch in the redfish fishery. Only small amounts were reported prior to 1996 as most of the greater silver smelt was discarded. Since 1997, a direct fishery for greater silver smelt has been ongoing and the landings have increased significantly. At the beginning, the fishery was mainly located along the slopes of the south and southwest coast, but in recent years the fishery has expanded and significant catches are taken along the slopes west of Iceland.

Compared with survey coverage (Figure 4.8) an apparent area within the distribution area (Figure 4.5) that is not covered is west of Scotland/Ireland. The area is used by fisheries from EU countries. This area is covered by surveys planed by PGNAPES aimed for blue whiting. Greater silver smelt has shown to be candidate for acoustic abundance estimates, and it would be beneficial if distribution and density of greater silver smelt could be estimated at WGNAPES surveys. Another area with poor coverage regarding greater silver smelt is the North Sea and Skagerrak. This area has historically sustained fisheries but there are indications that the levels of greater silver smelt have severely declined.

References

Cohen, D. M. 1984. Argentinidae. p. 386–391. *In* Whitehead, P. J. P., Bauchot, M. L., Hureau, J. C., Nielsen, J., and Tortonese, E. (Eds.). Fishes of the North-eastern Atlantic and the Mediterranean, Vol I. UNESCO, Paris, 510pp.

Høines, Å.S., and Gundersen, A.C. 2008. Rebuilding the Stock of Northeast Arctic Greenland Halibut (Reinhardtius hippoglossoides). J. Northw. Atl. Fish. Sci., Vol. 41: 107–117 41: 107–117.

ICES. 2009. Report of the Working Group on the Biology and Assessment of Deep Sea. Fisheries Resources (WGDEEP), 9–16 March 2009, Copenhagen, Denmark. ICES CM 2009/ACOM:14. 511 pp.

ICES. 2010. Report of the Benchmark Workshop on Deep-water Species (WKDEEP), 7–24 February 2010, Copenhagen, Denmark. ICES CM 2010/ACOM:38. 247 pp.

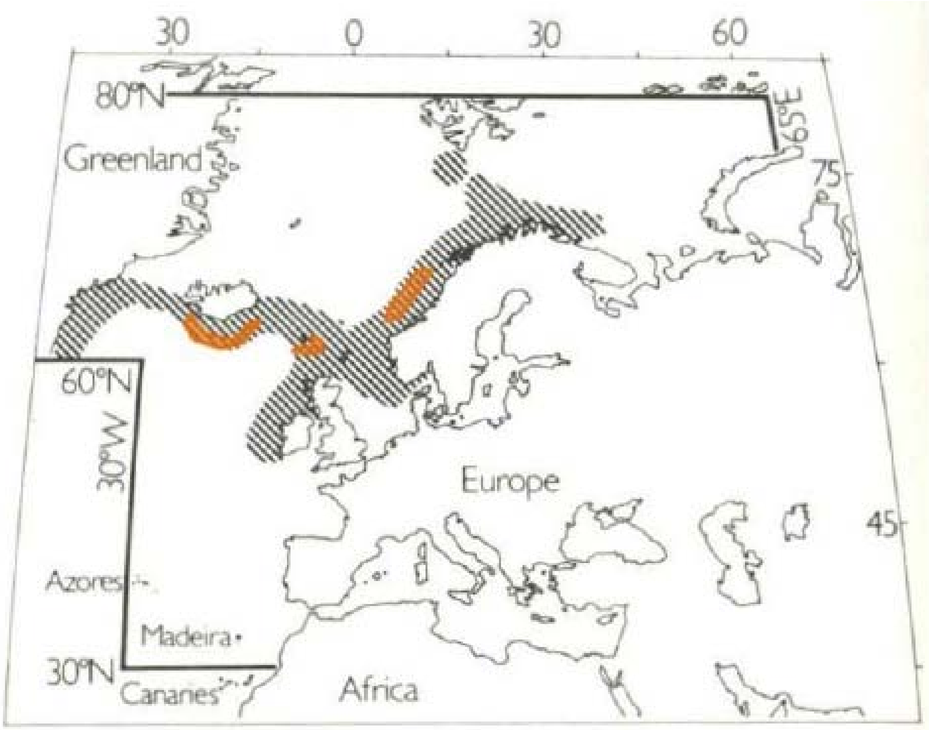


Figure 4.5. Distribution of greater silver smelt in the ICES area (Cohen, 1984). The locations of current direct fisheries are indicated in orange (from ICES WKDEEP 2010).

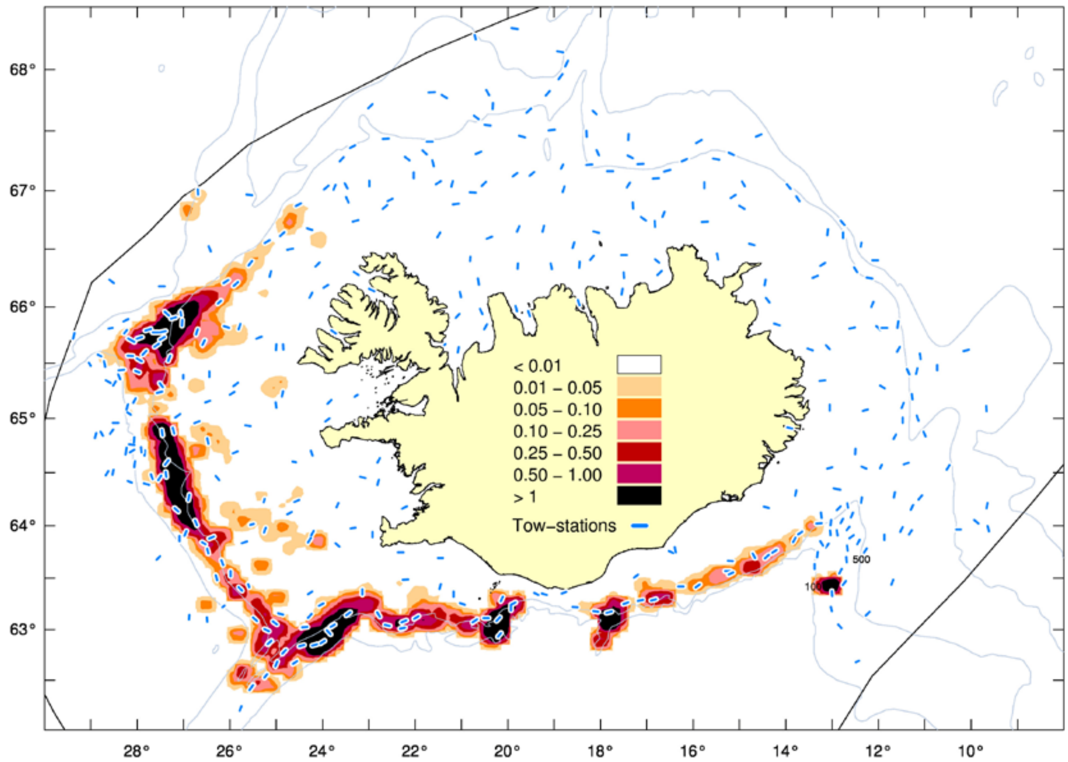


Figure 4.6. Contour-plot of the distribution of commercial catches of greater silver smelt in ICES Division Va (tonnes/square mile) in 2009 and the tow-stations in the Autumn Survey in October (blue lines). The 500 and 1000 m depth contours are shown.

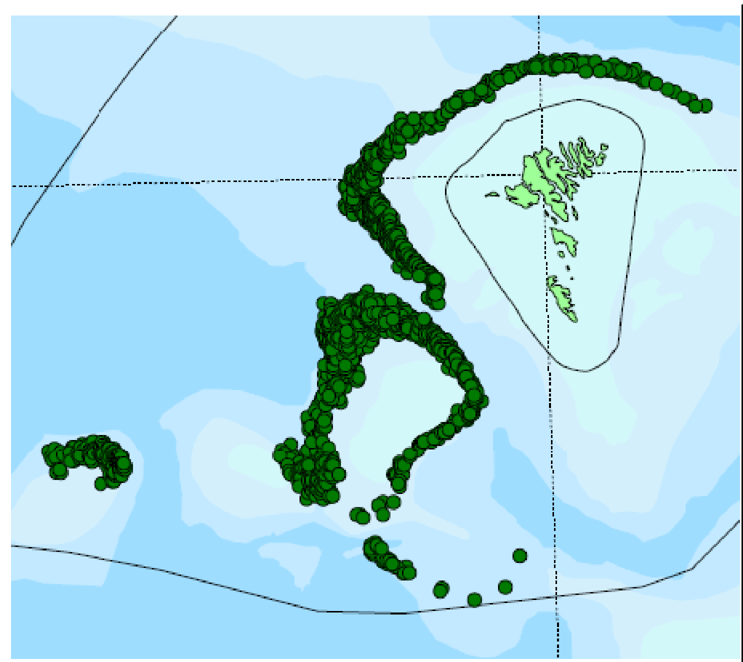


Figure 4.7. Greater silver smelt (Division Vb). Distribution of Faroese pairtrawler hauls with more than 50% greater silver smelt in the hauls (1995–2008).

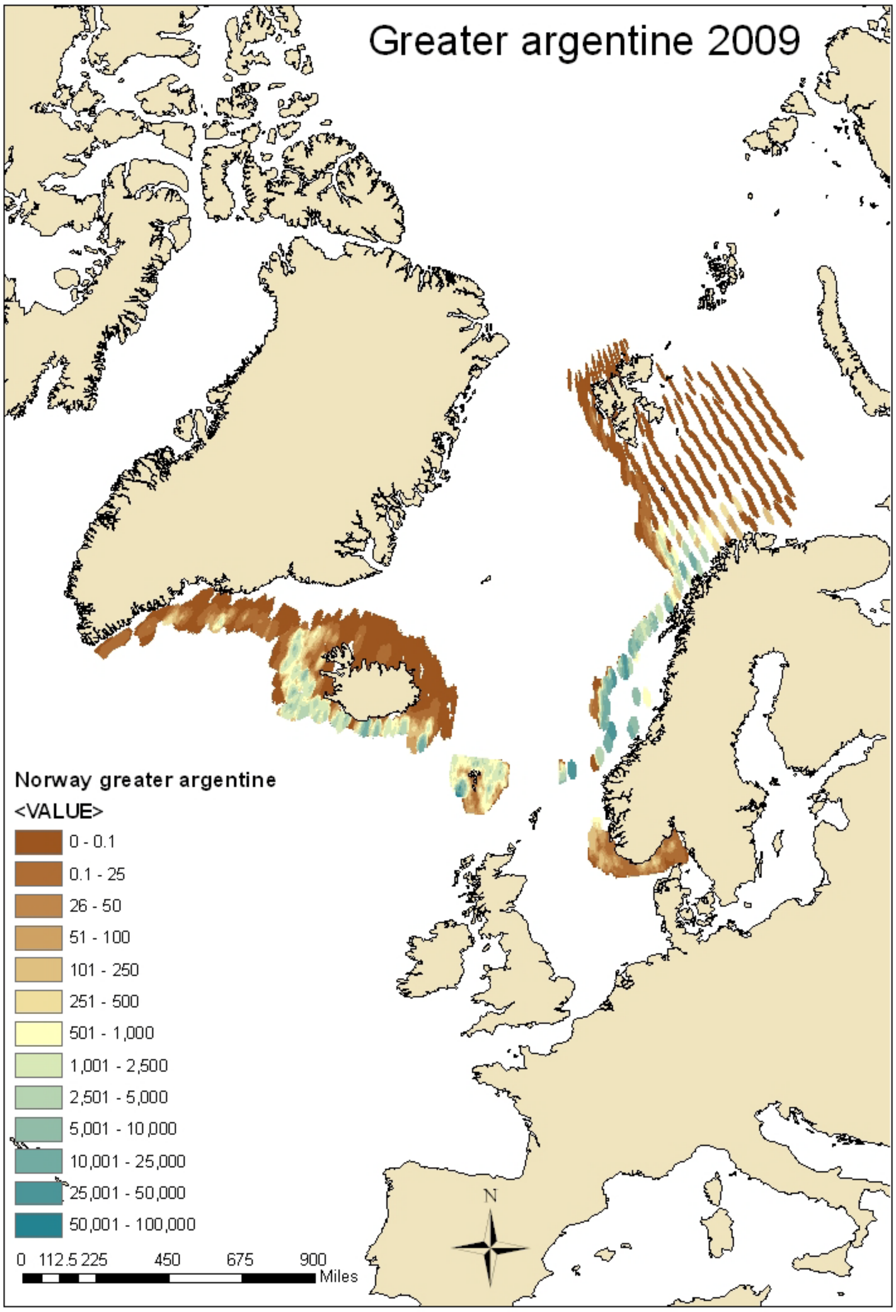


Figure 4.8. Contour-plot of the distribution of survey catches of greater silver smelt by the Nordic Deepwater surveys (No/km²) in 2009.

4.2.3 Beaked Redfish *Sebastes mentella*

The geographic range of beaked redfish (*Sebastes mentella*) extends across the North Atlantic, from the Grand Bank to the Barents Sea (Figure 4.9). The species is found at depths down to 1000 m and inhabits both the pelagic and bottom habitats. It is found along the coast of Norway, in the Barents Sea, and around Spitsbergen, off the Faroe Islands, Iceland, East and West Greenland and along the east coast of America along the coast of Baffin Islands and Newfoundland. It inhabits also the oceanic area of the Irminger Sea and adjacent waters and Norwegian and Barents Seas (Magnússon and

Magnússon, 1995). The relevant stocks for this working group are those found on the continental shelves and slopes East-Greenland, Iceland, and the Faroe Islands (Figure 4.10) and along the shelves and slope in the Norwegian and Barents Seas (Figure 4.11).

The stock structure of beaked redfish in the Northwest Atlantic is very complicated. ICES has, since 2009, defined beaked redfish as three biological stocks (Cadrin *et al.*, 2009; ICES, 2009). Two of the stocks inhabit the open seas of Irminger Sea and adjacent waters: shallow pelagic beaked redfish (found above 500 m) and deep pelagic beaked redfish (found below 500 m). Beaked redfish on the continental shelf and the slope of Iceland is treated as separate stocks. Finally, the redfish found on the continental slope and of the Faroe Plateau is assigned to the two pelagic stocks in the Irminger Sea and adjacent waters: the beaked redfish found west of the Faroe Islands belongs to the deep pelagic stock whereas the fish found east of the islands belong to the shallow pelagic stock. In all these areas only the adult part of the populations is found. The common nursery area for the three biological stocks is believed to be on the East-Greenland shelf. It is, however, not known to what shares recruitment is contributed to the three stocks. The adult part found on the shelf and slope of East-Greenland has not been assigned to any of these three defined biological stocks and is now treated by ICES as a separate management unit.

Beaked redfish in the Northwest Atlantic is most abundant in Icelandic waters and that is where the main fishing grounds are located. It is mainly found along the southwest, southeast, and west coast. Only the adult part of the population is found in Icelandic waters, i.e. mainly fish larger than 30 cm. The Icelandic Autumn Groundfish Survey (IAGS) estimates numbers and biomass of the fishable stock of beaked redfish. Figure 4.12 shows a contour-plot of the distribution of commercial catches of beaked redfish in ICES Division Va in 2008 and the tow-stations in the IAGS. The density of stations corresponds closely with the main fishing area of beaked redfish.

The Greenland halibut survey in East-Greenland waters covers depths from 400–1500 m where most stations are at depth greater than 600 m. Because the survey is aimed at Greenland halibut it does not cover the whole distribution of beaked-redfish in the area. The fish caught in the survey are mainly between 20 and 30 cm.

The Faroese Greenland halibut survey covers the slopes of the Faroe Plateau. Similar to the Greenland halibut survey conducted in East-Greenland, the Faroese survey is aimed at Greenland halibut and hence, does not cover the distribution of beaked redfish in the area.

In the Barents and Norwegian Seas, the main areas of occurrence include the Barents Sea shelf and trenches, including waters surrounding the Svalbard archipelago, the continental shelf and slope to the west of Norway and the Atlantic waters in the Norwegian Sea. The Continental Slope Groundfish Survey is aimed at beaked redfish among other species. The survey is at 400–1350 m depth on the continental slope between 68° and 80°N and estimates numbers and biomass of the fishable stock of beaked redfish. The Norwegian argentine and redfish survey was carried out for the first time in 2009 from 62°N to 74°N to investigate the distribution of beaked redfish and greater argentine, in the Norwegian and Spitsbergen Archipelago areas at depths from 200 m down to 750 m.

The distribution of beaked redfish on the continental slopes of East-Greenland, Iceland, the Faroe Islands and Norway from surveys in 2009 is shown in Figure 4.13. The distribution of the species is large and in some areas the spatial coverage is limited. For example, the Greenland halibut surveys on the slopes of East-Greenland and the Faroe Islands are aimed at Greenland halibut. For this reason, the surveys are not designed to cover the whole distribution of beaked redfish. In Norwegian waters combination of surveys is needed because a single survey does not cover the whole distribution of the species in the area. The spatial coverage of beaked redfish in Icelandic waters is adequate as the survey is designed to cover the distribution of the stock (only adults are found in Icelandic waters).

There are some areas that are not covered. This includes the slopes of the Icelandic-Faroe Ridge, the area between Iceland and the Faroe Islands, and slopes between the Faroe Islands and Norway.

The Nordic deep-water continental slope surveys only cover the distribution of the adult populations. Recruitment of beaked redfish and distribution of juveniles are therefore not monitored in these surveys. In Norwegian waters, the 0-group and ecosystem surveys cover most of the distributional area of juveniles. The German survey conducted on the shelf of West- and East-Greenland down to 400 m since 1985, covers some to some extent the distribution of juvenile beaked redfish.

References:

Cadrin, S., Bernreuther, M., Hjörleifsson, E., Johansen, T., Kerr, L., Kristinsson K., Mariani, S., Pampoulie, C., Reinert, J., Saborido-Rey, F., Sigurdsson, Th., and Stransky, C. 2009. Mechanisms and consequences of life cycle diversity of beaked redfish, *Sebastes mentella*. ICES CM 2009/H:01.

ICES. 2009. Report of the Workshop on Redfish Stock Structure. ICES CM 2009/ACOM:37.

Magnússon, J., and J.V. Magnússon. 1995. Oceanic redfish (*Sebastes mentella*) in the Irminger Sea and adjacent waters. Scientia Marina, 59: 241–254.

Sigurðusson, T., Thorsteinsson, V., and Gústafsson, L. 2006. In situ tagging of deep-sea redfish: application of an underwater, fish-tagging system. ICES Journal of Marine Science, 63: 523–531.

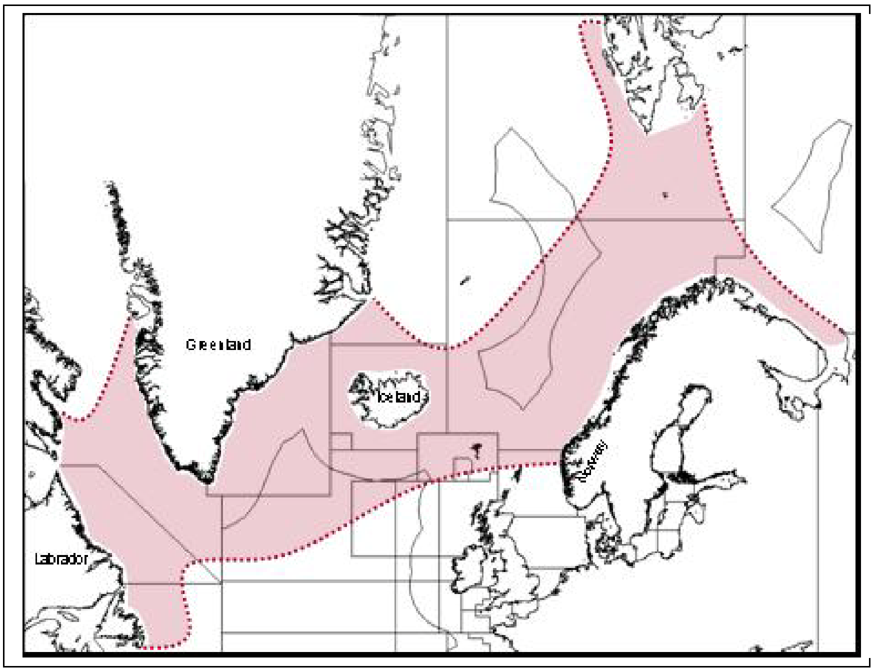


Figure 4.9. Geographic range of beaked redfish (*Sebastes mentella*) in the North Atlantic (from Cadrin *et al.*, 2009).

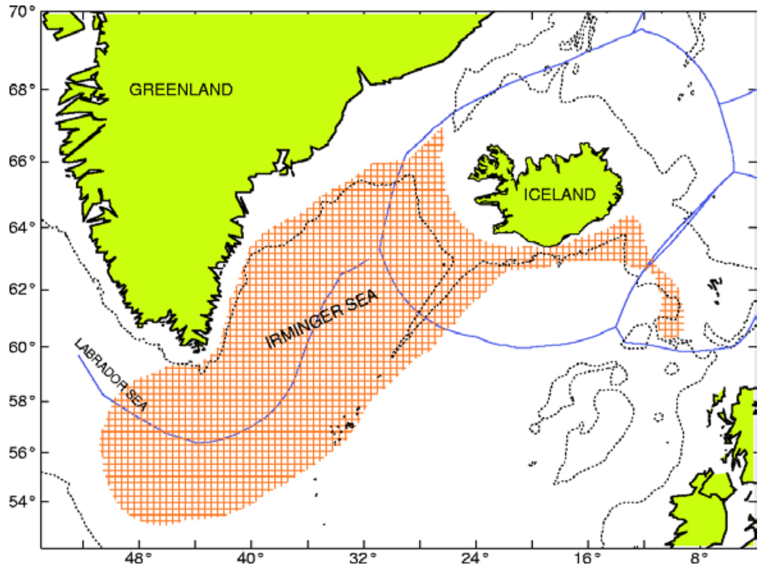


Figure 4.10. Geographical distribution of beaked redfish in the North Atlantic, Irminger Sea and adjacent waters (from Sigurdsson *et al.*, 2006).

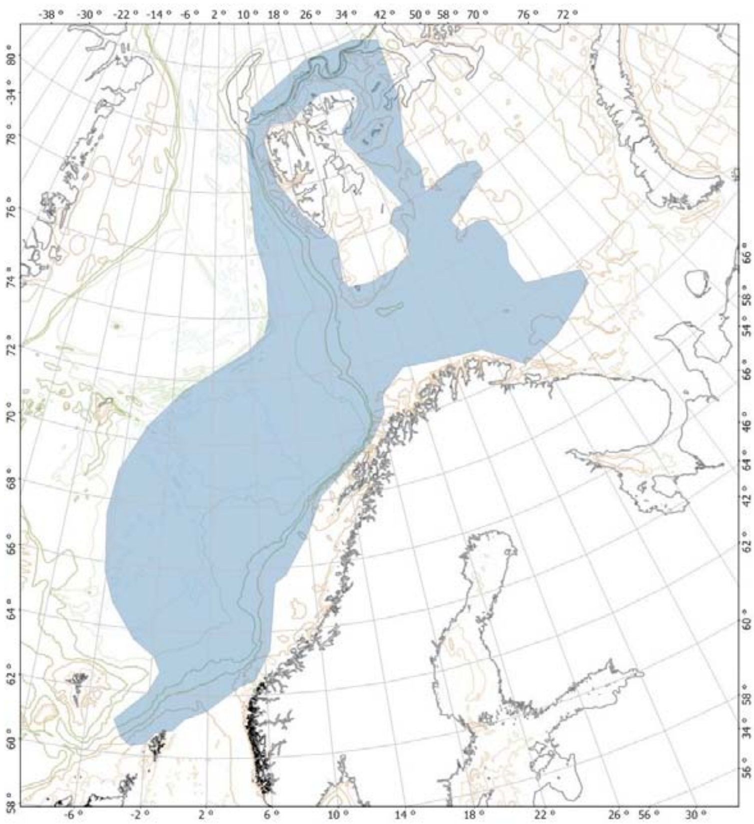


Figure 4.11. Map showing the distribution of occurrence of beaked redfish (*S. mentella*) in the Northeast Atlantic. The bottom topography is illustrated by selected isobaths (from the Deep-fishMan, WP2 – Case study 4 Report – Part I, by Benjamin Planque and Kjell Nedreaas, 2010. Not published).

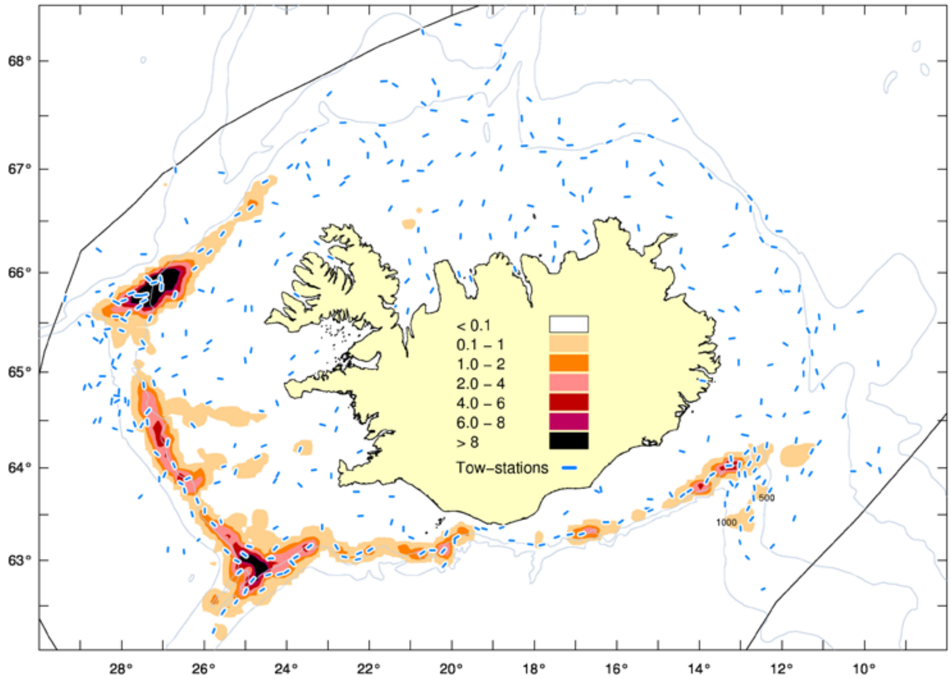


Figure 4.12. Contour-plot of the distribution of commercial catches of beaked redfish in ICES Division Va (tonnes/square mile) in 2008 and the tow-stations in the Autumn Survey in October (blue lines). The 500 and 1000 m depth contours are shown.

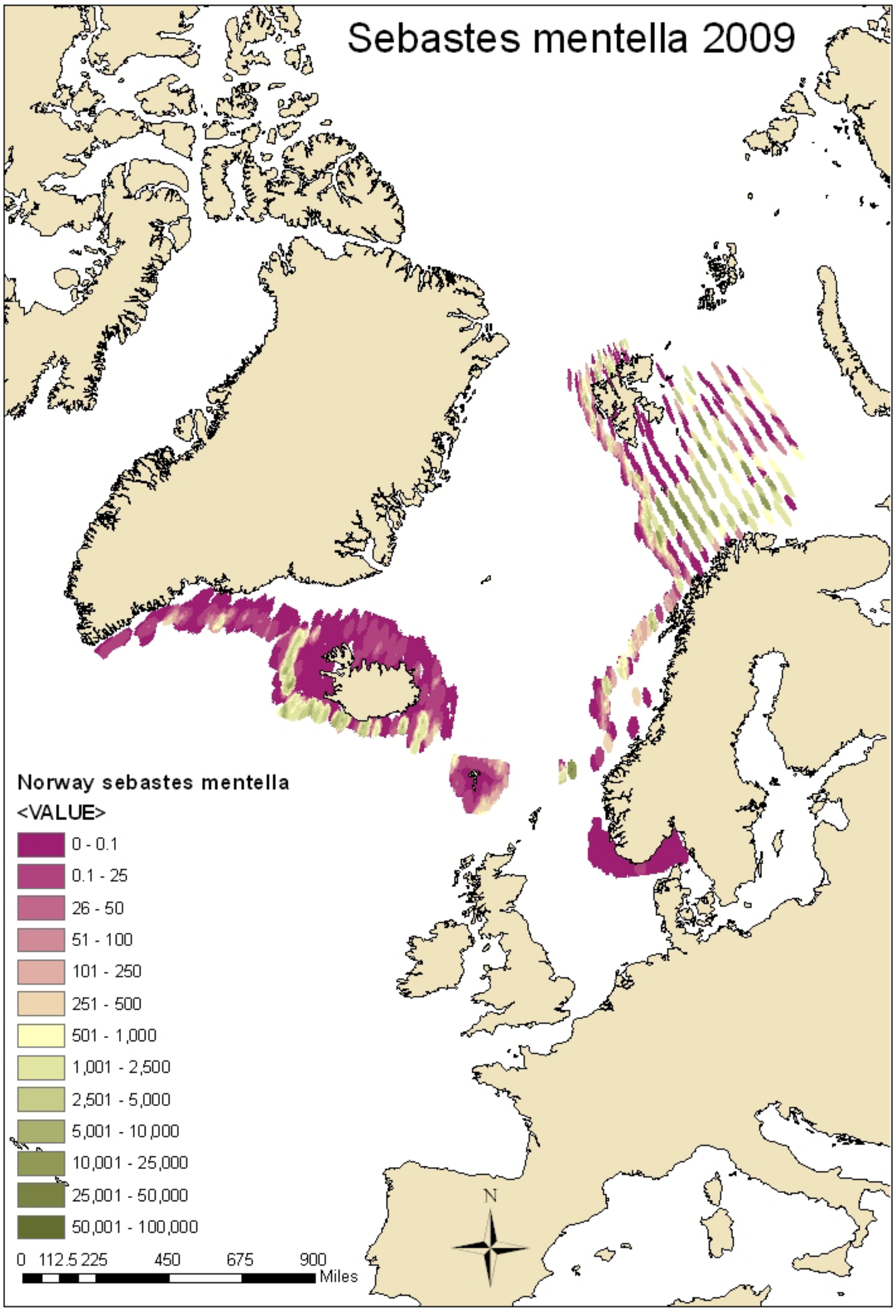


Figure 4.13. Contour-plot of the distribution of survey catches of beaked red fish (*S. mentella*) by the Nordic Deepwater surveys (No/km^2) in 2009.

4.2.4 Roundnose grenadier (Coryphaenoides rupestris)

The distribution of Roundnose Grenadier is described in the stock annex of this year's WKDEEP benchmark report (ICES, 2010). Roundnose Grenadier is widely distributed in the North Atlantic. Its area stretches from Norway to northwest Africa in the east to the Canadian Greenland coasts and the Gulf of Mexico in the west, and from Iceland in the north to the areas south of the Azores in the south. Aggregations of this species are found on the continental slope of Europe and Canada, on the MAR seamounts, in the Faroe-Hatton area (banks Hatton, Rockall, Louzy, Bill Baileys, etc.)

and in the Skagerrak and Norwegian fjords. ICES WGDEEP has in the past proposed four assessment units of roundnose grenadier in the NE Atlantic (Figure 4.14):

- Skagerrak (IIIa) The Faroe-Hatton area;
- Celtic seas (Divisions Vb and XIIb, Subareas VI, VII);
- the Mid-Atlantic Ridge 'MAR' (Divisions Xb, XIIc, Subdivisions Va1, XIIa1, XIVb1);
- All other areas (Subareas I, II, IV, VIII, IX, Division XIVa, Subdivisions Va2, XIVb2).

The current perception is based on what is believed to be natural restrictions to the dispersal of all life stages. The Wyville Thomson Sill may separate populations further south on the banks and slopes off the British Isles and Europe from those distributed to the north along Norway and in the Skagerrak. Considering the general water circulation in the North Atlantic, populations from the Icelandic slope may be separated from those distributed to the west of the British Isles. It has been postulated that a single population occurs in all the areas south of the Faroese slopes, including also the slopes around the Rockall Trough and the Rockall and Hatton Banks but the biological basis for this remains hypothetical.

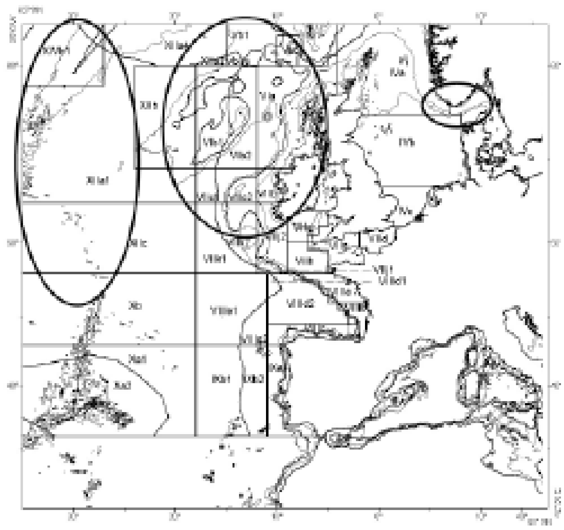


Figure 4.14. Areas of the main fisheries for roundnose grenadier, Skagerrak, west of the British Isles and mid Atlantic Ridge. The isobaths displayed are 100, 200, 1000 and 2000 m (from WKDEEP 2010, reprinted from Lorance *et al.*, 2008).

In the Nordic Area, catches of Roundnose Grenadier were mainly taken in the Norwegian zone of Skagerrak in Division IIIa but this fishery has ceased now (ICES, 2010b). The recent geographical distribution of the fishery is shown in Figure 4.15.

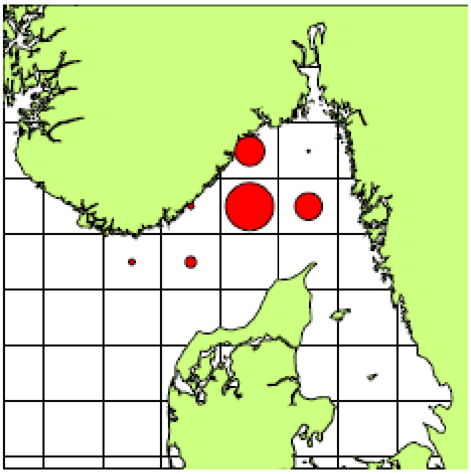


Figure 4.15. Geographical distribution of the fishery for roundnose grenadier in IIIa in 2006.

The majority of landings of Roundnose grenadier are taken from the Celtic Seas area to the west of the British Isles, in Divisions Vb, VIa, VIb2 and Subareas VII, by bottom trawlers. French trawlers catch roundnose grenadier in a multispecies deep-water fishery. The Spanish trawl fleet operates further offshore along the western slope of the Hatton Bank in ICES Divisions VIb1 and XIIb. Over recent years, the spatial distribution of the French deep-water fishing effort as contracted to a smaller area mainly along the West of Scotland slope and southern Wyville Thomson Ridge (Figure 4.16).

Other fisheries for Roundnose Grenadier are executed on the Northern Mid-Atlantic Ridge (MAR) in Divisions Xb, XIIc and subareas Va1, XIIa1, XIVb1. However there has been little information about target fishery of roundnose grenadier on the MAR in recent years (ICES 2010b). Outside the main fisheries described above, catches of roundnose grenadier in the NEA are currently not significant (ICES, 2010).

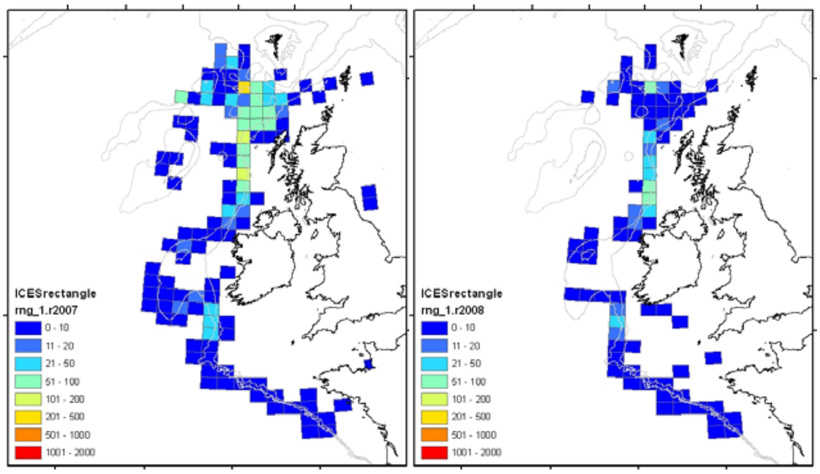


Figure 4.16. Landings of Roundnose Grenadier by statistical rectangles 2007 to 2008. Data include only those countries for which data were available at this level (Spain, France, Ireland, and UK Scotland, England and Wales (from ICES, 2009).

The distribution of Roundnose Grenadier on the continental slopes of East-Greenland, Iceland, the Faroe Islands and Norway from the five Nordic deep-water surveys in 2009 is shown in Figure 4.17. The distribution of the species is concentrated around the Icelandic slope and the slopes of East-Greenland. Highest catches have been recorded along the southwestern Icelandic Slope. No Roundnose Grenadier was caught in the Faroese deep-water survey. The results of the Norwegian surveys reflect the abundance of catches in IIIa.

Roundnose Grenadier is caught in large numbers in the central deep-water surveys, i.e. the Scottish and the Irish surveys; however the limit of the distribution of RNG in the assessment unit of the Celtic Seas (Vb, VI and VII) cannot be determined as the current surveys do not extend far enough north. Currently there is no adequate survey coverage across the Wyville Thompson ridge and the southern Faroese slope to determine the extent of the population distribution.

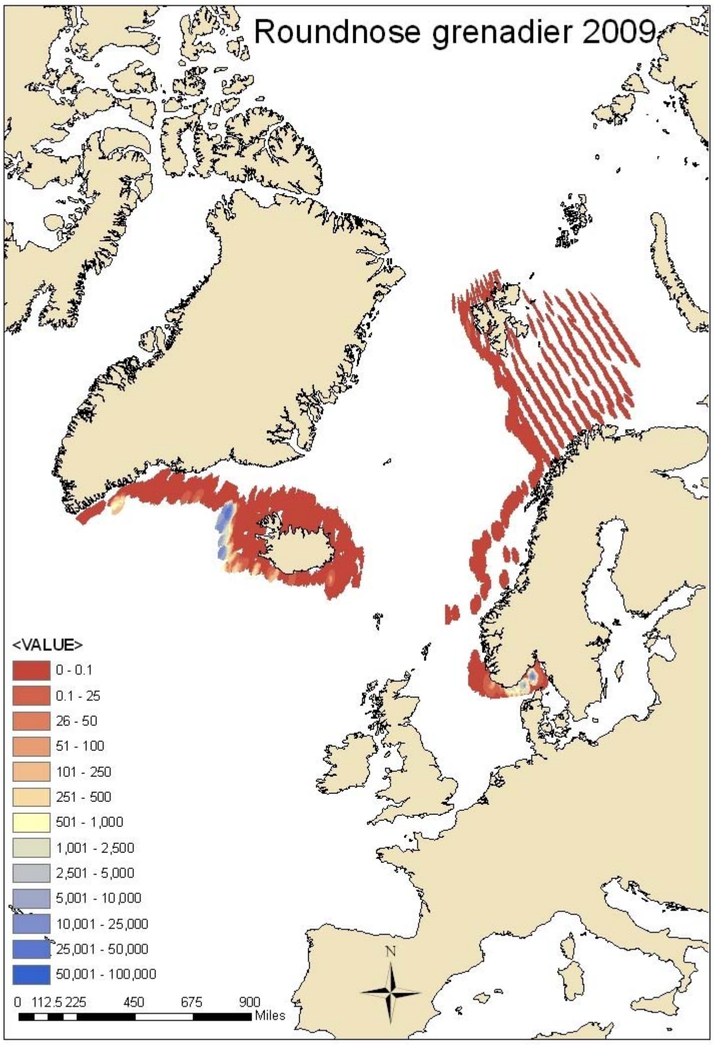


Figure 4.17. Contour-plot of the distribution of survey catches of Roundnose grenadier by the Nordic Deepwater surveys (No/km2) in 2009.

References:

ICES. 2009. Report of the Working Group on the Biology and Assessment of Deep Sea. Fisheries Resources (WGDEEP), 9–16 March 2009, Copenhagen, Denmark. ICES CM 2009/ACOM:14. 511 pp.

ICES. 2010. Report of the Benchmark Workshop on Deep-water Species (WKDEEP), 7–24 February 2010, Copenhagen, Denmark. ICES CM 2010/ACOM:38. 247 pp.

4.3 d.4) Evaluate the prospect of making all the combined survey data available to all parties by use of e.g. the ICES DATRAS database, in order to facilitate joint research and analyses.

The intention of facilitating joint research by making data more easily available between countries is acknowledged. Survey data from the institutes in Greenland, Iceland, Faroe Iceland and Norway are currently stored in different national data formats. To evaluate ways of converting data to fit the ICES DATRAS database was considered not achievable at the WGNEACS meeting, and it was considered an institute level task to decide on whether data should be stored in DATRAS. For the purpose of joint data evaluation and analysis, the subgroup decided to develop a common data exchange format to be used within this working group.

For calculations on distributions and survey coverage for four selected commercially important deep-sea fish species at WGNEACS data were compiled into the agreed data exchange format according to the following headings:

Nation

Cruise_ID

Station_ID

Gear_code

Date_dd_mm_yyyy

Start_longitude_decimal_degree

Start_latitude_decimal_degree

End_longitude_decimal_degree

End_latitude_decimal_degree

Door_spread_m

Headrope_length_m

Depth_m

Distance_Nm

Trawl_time_min

Temperature_degC

S_mentella_catch_no

S_mentella_catch_weight_kg

Greenland_halibut_catch_no

Greenland_halibut_catch_weight_kg

Greater_argentine_catch_no

Greater_argentine_catch_weight

Roundnose_grenadier_catch_no

Roundnose_grenadier_catch_weight_kg

Explanation of headers:

Nation: Official ICES country codes, except Greenland = 69 and Faroe Island = 5

Cruise_ID: Codes from national databases for Norway and Iceland. For Faroese surveys; summer groundfish survey =1, spring ground survey = 2 and Greenland halibut survey = 3. For surveys in Greenland, east-Greenlandic deep-water survey; gear code AL03 = 4 and gear code CO26 =6

Station_ID; Codes from national databases

Gear_code; Codes from national databases

5 Central surveys

The following terms of references were dealt with by the Central survey subgroup:

e.1) Review the use of survey abundance and ecosystem indicators from deep-water surveys during the bench marking process of WGDEEP.

e.2) Evaluate intersessional work on variance estimates of existing NEA deep-water surveys and based on results optimize proposed survey design in terms of station allocation.

e.3) Coordinate the timing, area and effort allocation and methodologies for the central European deep-water survey in 2011, if the programme is funded under the new data collection frame work.

5.1 Use of survey abundance and ecosystem indicators in the bench marking process of WGDEEP

ToR e.1) was a review of the use of survey abundance and ecosystem indicators from deep-water surveys during the bench marking process of deep-water species (WGDEEP and WGEF). The use of data from the central deep-water surveys (Scottish and Irish) during the 2010 benchmark workshop is summarized in Table 5.1

Species	Stock distribution	Surveys used in benchmark	Suggested used for assessment/advice
Deepwater Sharks: Portuguese dogfish Leaf Scale Gulper shark	All Areas	Scottish Deepwater survey Irish Deepwater survey	Presence/absence in Scottish and Irish surveys disaggregated by depth
Greater Forkbeard	All Areas	Spanish Porcupine trawl survey, Irish and Scottish IBTS, Irish and Scottish deep-water surveys	abundance, log abundance, mean length, quantiles of mean length, biomass, per strata and for the whole survey
Greater silver Smelt	Subareas I, II, IV, VI, VII, VIII, IX, X, XII and XIV, and Divisions IIIa and Vb	Spanish Porcupine Trawl survey (other surveys are from the Nordic survey area)	
Roundnose Grenadier	Vb, VI, VII, XIIb	Scottish Deepwater survey Irish Deepwater survey	Time series of survey indicators to be used in addition to the dynamic population model.

Table. 5.1 Stocks assessed in WKDEEP that used central deep-water survey data

For the deep-water sharks Portuguese dogfish (*Centroscymnus coelolepis*) and Leaf-scale gulper shark (*Centrophorus squamosus*) the conclusions from the benchmark process was that the assessment methodology should be based on trends of a number of indicators. These were a number of commercial cpue series and presence/absence data from the central deep-water surveys (Scottish and Irish) disaggregated by depth.

For Greater forkbeard, a number of surveys were evaluated. Greater Forkbeard is a bycatch species with significant discards in a number of shelf and upper slope fisheries. As a consequence, fisheries dependant data are not reliable and for some shelf fisheries there are discards only. Population indicators from surveys are seen as the most reliable information in the next few years. WKDEEP therefore recommended that survey based population indicators of greater forkbeard should be calculated from relevant surveys and commercial lpue series and provided to WGDEEP. The recommended indicators are: abundance, log abundance, mean length, quantiles of mean length, and biomass, per strata and for the whole survey. Interpretation of trends by survey and strata should be used to define the overall trend for stocks of greater forkbeard.

WKDEEP's recommendation for the benchmark methodology of Roundnose grenadier was that the time-series of indicators from surveys and commercial fisheries including on-board observations should be used in addition to a dynamic population model. WKDEEP further recommended that there is a need for extensive survey coverage across the whole geographical area inhabited by the stock in Vb, VI, VII, XIIb.

Overall, it can be concluded from the benchmark process that most stocks rely heavily on independent survey indicators for trend analysis as full analytical assessments have not been accepted. Thus the central deep-water surveys are important in providing fisheries independent information. There are some issues with the length of the time-series with regard to the Irish survey and the overall spatial coverage of the surveys. These issues have been addressed in the 2009 PGNEACS proposal where an internationally coordinated survey is described with increased spatial coverage to cover the extent of the deep-water fisheries. A summary of the survey proposal is given in section 5.3 of this year's report.

WGNEACS recognizes the importance of good communication between assessment scientists and survey data providers and therefore recommends that there is a close dialogue early in the benchmark process between the stock coordinators and the scientists responsible for the survey data so that data use from the survey can be optimized. One way to formalize this process would be for the Assessment working groups to draft a ToR to the survey group specifying the survey data products they require for future benchmark and update assessments including abundance indices, population and ecosystem indicators and others as required.

References:

ICES. 2009. Report of the Planning Group on the North-east Atlantic Continental Slope Survey (PGNEACS), 9–11 June 2009, Tromsø, Norway. ICES CM 2009/LRC:03. 59 pp.

ICES. 2010. Report of the Benchmark Workshop on Deep-water Species (WKDEEP), 17–24 February 2010, Copenhagen, Denmark. ICES CM 2010/ACOM:38. 247 pp.

5.2 Variance estimation of existing NEA deep-water surveys and optimization of proposed survey design

This section addresses ToR e.2) to evaluate intersessional work on variance estimates of existing NEA deep-water surveys and based on results optimize proposed survey design in terms of station allocation.

Intersessional work on variance estimation was carried out on the Scottish and Irish deep-water surveys by Campell *et al.* and presented in a working document to this year's WGNEACS. The complete working document can be found in Annex 4 to this report.

The working document examined the spatial distribution and the stratification methods of the surveys and how these relate to variance estimates. The first scientific question it addressed was how well the distribution of survey effort represents the strata it is sampling. For this analysis the spatial survey coverage was compared to the spatial distribution of the main deep-water fisheries in ICES Subareas VI and VII using fishing effort derived from VMS data. The study concluded that while the survey coverage was adequate in the southern survey area and along the main Scottish continental slope, the northern part of the study area along the Wyville Thompson ridge was not adequately covered by current deep-water surveys. The working group agreed with the conclusions drawn in the working document and noted that any current shortcomings in relation to survey spatial coverage are addressed in the new sampling proposal published in ICES 2009 and summarized in Section 5.3 of this year's report, whereby survey coverage is extended to the north across Wyville Thompson ridge.

The second scientific question the working document addressed was in relation to sampling design and the choice of depth strata: whether there should be more intermediate depths and how variance estimates of different depth strata relate to the overall variance estimate. The study concluded that enough depths were sampled to describe the depth distributions of the selected species and that the choice of strata was species-specific in terms of how different depth strata contributed to the overall variance.

In relation to these conclusions the working group had following observations:

- Fixed stations along a depth gradient assumes random distribution of fish along the slope and this cannot be ascertained. The diagrams in the working document indicate that the distribution is not random.
- When sufficient data are available, the difference in variance between a fixed stations design and randomly selected stations along the depth gradient should be evaluated.
- The working document addressed the problem of species-specific distribution patterns along the slope. It is difficult to assign depth strata that give the best variance estimate for all species. An alternative approach would be to use a sampling design of random stations along the depth transect. The number of stations for certain depth bands could be fixed to ensure adequate sampling effort along the depth gradient. Hence the data can be used to generate species-specific depth strata whereby optimization is based on the lowest variance estimation per species.
- The group recommends continuing work on the variance estimation and the optimization of survey design and to further to increase the numbers of random hauls along the depth transect.

5.3 Coordination of timing, area and effort allocation and methodologies for the central European deep-water survey in 2011

This section addresses ToR e.3 to coordinate the timing, area and effort allocation and methodologies for the central European deep-water survey in 2011, if the programme is funded under the new data collection frame work. A detailed proposal of the survey strategy and sampling methods for an internationally coordinated deep-water trawl survey along the central European slope and the associated submarine banks and seamounts is presented in last year's ICES PGNEACS report (ICES, 2009). The logistical details are given in the text below.

The central NEA surveys should be carried out in the third quarter of the year (ideally September). There are 2 main reasons for this, first the existing time-series are from this period and second aggregating species such as blue ling are not spawning at this time of year and so are more evenly dispersed which is advantageous from a sampling perspective.

The total survey area coverage is presented in Figure 5.1.

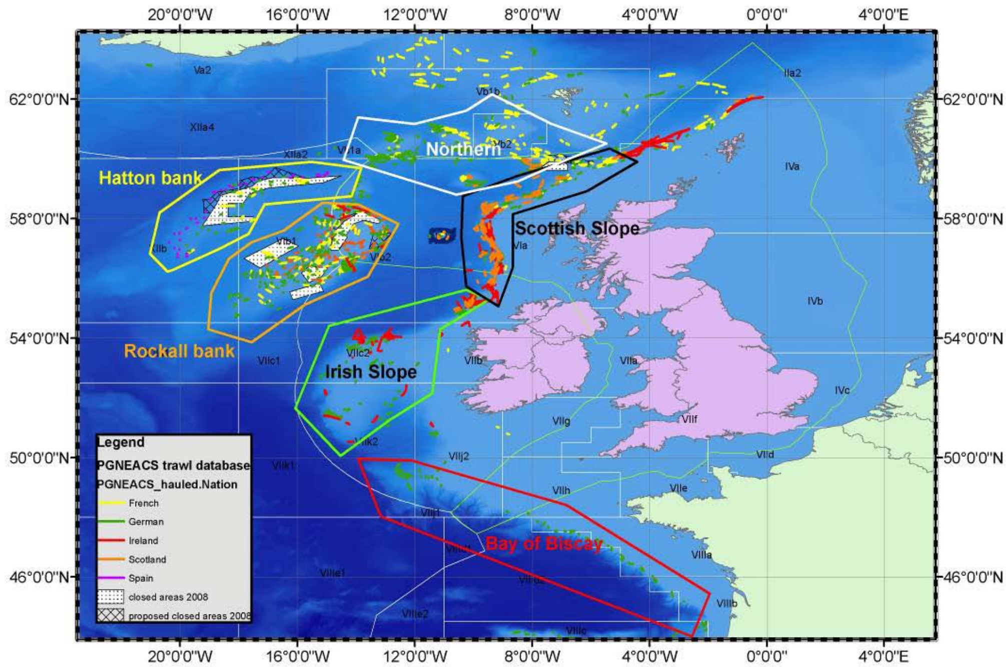


Figure 5.1. Map of the central NE Atlantic showing the 6 areas proposed to be covered by the central deep-water survey. Also plotted are closed areas and current and historical research vessel trawl station positions (colour coded by country (from ICES, 2009).

To cover all areas in this region adequately is challenging and requires a heavy investment in shiptime. There are 6 areas (Bay of Biscay, Porcupine/Irish slope, Scottish slope, Rockall Bank, Hatton bank and the Northern banks). There are 4 depth strata to sample (although in some areas the deepest strata are not present). At least 4 sites within each area need to be covered. This means each area requires a bare minimum of 12 hauls (Table 5.1).

Table 5.1. Survey sampling strategy by area (from ICES, 2009). Colour blocks present survey sections by three different ships).

Region	N sample areas	Depth range	Min N hauls per area	Total number
Scottish slope	4	500–1800	4Depths +1Random	20
Wyville-Thomson ridge	2	500–1500	3 Depths +1Random	8
Rosemary bank	1	500–1500	3 Depths +1Random	4
Rockall bank	4	500–1800	4Depths +1Random	20
Faroe, Lousy, Bill Bailey	3	500–1000	2Depths +1Random	12
Hatton bank	4	1000–1500	4Depths +1Random	16
Irish slope and Porcupine	4	500–1800	4Depths +1Random	20
Goban Spur and Biscay	3	500–1800	4Depths +1Random	15
Total				115

Ideally 4 sites per area (16 hauls) should be undertaken, but this may not be logistically possible. Vessels can expect to complete 4–5 1-hour hauls per day meaning each site takes approximately 3 days.

At least 3 ships are necessary to cover the central NE Atlantic.

Ship 1 (Scotia- Scotland). A 23 day survey is proposed with a 1 day break half-way through. This will cover the Scottish slope (3 days), Rockall (3 days), Hatton bank (3 days), 1 day of rest, the Northern seamounts (4 days) with 8 days passage time and 1 day in hand for bad weather.

Day 1–2 – passage from Aberdeen to Scottish slope (~ 300 miles)

Day 3,4,5 – survey Scottish slope (3 sites)

Day 6,7,8 – passage to (140 miles) and survey of Rockall (3 sites)

Day 9,10,11, - passage to (100 miles) and survey of Hatton (3 sites)

Day 12, 13 – passage to Ullapool (~ 320 miles)

Day 14 – rest

Day 15 – passage to Northern seamounts (~ 200 miles)

Day 16,17,18, 19 – Northern seamounts and Wyville Thomson ridge (4 sites)

Day 20, 21 – passage to Northern end of Scottish slope (~100 miles) and survey (1 site)

Day 22 - passage to Aberdeen (~ 240 miles)

Day 23 – in hand for bad weather and repairs etc

Ship 2 (Celtic Explorer - Ireland). A 14 day survey is proposed covering the Porcupine Bank and slope to the west and southwest of Ireland.

Day 1 – Steam to Area 4 (~ 220 miles)

Day 2, 3 – Survey Area 4

Day 4 – Steam to Area 5 (~ 120 miles)

Day 5, 6 – Survey Area 5

Day 7 – Steam to Area 6 (~ 80 miles)

Day 8, 9 – Survey Area 6

Day 10 – Steam to Area 7 (~ 120 miles)

Day 11, 12 – Survey Area 7

Day 13, 14 – Steam home (~ 210 miles)

The new survey protocols require that at least one tow at each of four depths, 500m, 1000m, 1500m, 1800m, should be carried out. To assist in variance estimation at least one random tow should be carried out as well. The proposed Porcupine survey will allow time for two to three random tows to be carried out in each area.

Areas 4 and 5 have previously been surveyed by Ireland, and have known tows at the required depths. Areas 6 and 7 are new survey areas and suitable tows will need to be found. These tows can be obtained from verified tows of historical surveys or by surveying the areas using sonar. This survey work would be done at night.

Ship 3 (Thalassa) – This vessel would cover the Goban Spur - Bay of Biscay slope.

Most of the Bay of Biscay slope has a rugged bottom and only a few flat terraces are suitable for bottom-trawling. Little commercial trawling has been carried out, except for these flat terraces, over the rougher areas and these seem unlikely to be suitable for quantitative fish abundance estimates. Therefore, it is proposed to sample only the flat terraces. On the Goban Spur (48–50°N, around 12°W) more of the bottom is suitable for trawling so that survey tows may be distributed in a more standard manner. The two terraces that would be sampled on the Bay of Biscay slope are the Meriadzek terrace and Belle Ile terrace further south. Five tows can be located in every area.

Day 1–2 – passage from Brest to Goban Spur slope (~ ? miles)

Day 3,4 – survey Goban Spur slope (5 tows)

Day 5,6 – passage to (140 miles) and survey of Meriadzek Terrace (5 tows)

Day 7,8 - passage to (100 miles) and survey of Belle Ile terrace (5 tows)

Day 9 – passage to Brest (~ ? miles)

Day 10 – Steam to Area 7 (~ 120 miles)

Day 11, 12 – Survey Area 7

Day 13, 14 – Steam home (~ 210 miles)

Standardised survey protocols and sampling methodologies are described in ICES 2008 and ICES 2009.

References

ICES. 2008. Report of the Planning Group on the North-east Atlantic Continental Slope Survey (PGNEACS), 29 January-1 February 2008, Galway, Ireland. ICES CM 2008/LRC:02. 38pp.

ICES. 2009. Report of the Planning Group on the North-east Atlantic Continental Slope Survey (PGNEACS), 9–11 June 2009, Tromsø, Norway. ICES CM 2009/LRC:03. 59 pp.

6 Southern Surveys

The southern subgroup covered the following terms of references:

f.1) Evaluate sampling protocols for Azorean survey and attempt to standardize the protocols as much as possible.

f.2) Evaluate the combined total survey coverage in relation to distribution of all major stocks in the area and consider the feasibility of bridging any gaps.

f.3) Evaluate the extent and quality of information on non targeted species and the ability to describe larger parts of the fish communities and the physical environment.

f.4) Evaluate the prospect of making all the combined survey data available to all parties by use of e.g. the ICES DATRAS database, in order to facilitate joint research and analyses.

6.1 Evaluation of sampling protocols for Azorean survey with attempt to standardize the protocols as much as possible (ToR f1)

Only 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):

The Azorean Demersal Spring Longline survey is running annually from May to June. The survey follows a random stratified design. A box of 70 miles around the islands of the Archipelago is divided in six statistical areas (including the Este, Central and West group of islands and seamounts). Each statistical area includes one or more subareas, considered a more homogenous area (like an individual island or a seamount) and each is further divided in 24 depth strata from 50 to 1200 m. Bottom longline was adopted as a sampling survey technology in the Azores because the seabed is very rough, which does not permit use of other gears (e.g. trawl). Time, position (GPS) and depth (echosounder) were recorded for every quarter-skate (every 30 hooks) during gear deployment. Fish species and hook condition was recorded while the sampling gear was retrieved. Hook condition was classified as baited, unbaited, with fish, or ineffective (i.e. missing, broken or tangled). All fish were tallied by species and strata, measured and weighed and some were tagged and released. So, total catch and catch by species are measured directly. Relative abundance indices are estimated for the species for the strata 50–800m.

In the longline survey in IXa fishing hauls will be randomly set within each cell of the regular grid established for the Portuguese continental slope. The total number of fishing hauls will be set in accordance to the pre-established level of precision for species abundance estimates, which will be in agreement with sampling effort adopted by the Azorean deep-water longline survey.

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.

6.2 Evaluation of the combined total survey coverage in relation to distribution of all major stocks in the area (ToR f2)

The main objective of the Southern longline survey, proposed to be scientifically co-ordinated 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, Leafscale gulper shark.

It is worth to note that the use of longline as fishing gear in the southerm area is strictly related to the bottom topography of the region and to the insufficient number of trawlable areas identified at depth range adopted by WGNEACS. 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 Azorean survey covers a box area of about 70 miles off the islands coast and since 2004 until the 800m depth strata. This area corresponds to a very significant distribution area of the most abundant and commercially important species, *Pagellus bogaraveo and Helicolenus dactylopterus*. However, other important seamounts off that box area are not covered. Some small seamounts (D. João de Castro and Formigas) in the sampling area are also not systematically covered due to limited ship time. It should also be noted that for some species, particularly the deep-water species whose distribution goes behind that depth strata, the survey is not designed for abundance estimation because the distribution area is broader than the survey area, the gear is not design or the sampling effort is not appropriately allocated (down to 800m). So, extending the Azorean survey to 1200m and covering additional offshore seamounts would add very important coverage for the area X.

Implementing the survey in ICES area IXa complete the area coverage of the most important commercially deep-water species matching the species distribution with the fishing areas.

6.2.1 Red sea bream

This species is actually distributed on the North eastern Atlantic from the northern areas (British islands) to the west coast of Africa, including the Azores, Madeira and canaries. In the Azores it is found on the island coastal areas and seamounts from the littoral down to 800m depth, with the mode of distribution on 300–400 m. All the life cycle is developed annually on the area (ICES, Xa2). Juveniles are pelagic and found exclusively on the coastal areas but spawning stock is found on both ecosystems (seamounts and coastal areas; ICES, WGDEEP 2006).

Recent evidences from genetics and tagging suggest that the Azores stock may be considered has a management unit for assessment (ICES, 2006, 2010).

So, the actual Azores survey covers a very significant proportion of the distribution area of the stock particularly of those areas considered as the essential species habitat (shallow coastal areas and seamount areas with shallow summit).

6.2.2 Bluemouth

The bluemouth, *Helicolenus dactylopterus* belongs to the Sebastidae family and is widely spread by the Atlantic Ocean. It occurs in the eastern Atlantic, from the coasts of Norway to the southwest coast of Africa, around the Macaronesian archipelagos and in the Mediterranean except in the Black Sea. On the west coast of the Atlantic it is found from Canada to Venezuela. This species is considered benthonic and in the Azores the commercial captures of this species are located between the depths 150 and 1000 m with a mode on the 600m (Menezes *et al.,* 2006). It is found on the islands coastal areas and seamounts. All the life cycle is developed annually in the area (ICES, Xa2; Mendonça *et al.,* 2006).

The stock structure is uncertain. Around ICES area Xa2 tagging shows that there are no significant fish movements. Genetic studies demonstrated marked genetic differentiation between populations in different geographical regions specifically the Mid-Atlantic Ridge (Azores)/Northeast Atlantic (Portugal, Madeira) compared to populations around the Cape Verde Islands and in the Northwest Atlantic. Some evidence of intraregional genetic differentiation between populations was found. Considering this is a very sedentary species the Azores stock may be considered a management unit. However, this species is not actually assessed by ICES being included on the other species section of the WGDEEP report.

It is considered that the actual Azores survey may be appropriate to monitoring the species stock abundance. However, the species depth distribution (200–1000m) is broader than the actual survey coverage for abundance estimation (50–800m) and so; the survey should be expanded to 1200m.

6.2.3 Black scabbardfish (*Aphanopus carbo)*

The species is distributed on both sides of the North Atlantic and on seamounts and ridges south to about 30ºN. It occurs only sporadically north of the Scotland/Iceland/Greenland ridges. Juveniles are mesopelagic and adults are benthopelagic.

It is admitted that the species life cycle is not completed in just one area and also that either small or large-scale migrations occur seasonally. It has been postulated that fish caught to the west of the British Isles are pre-adults that migrate further south (possibly down to Madeira) as they reach maturity.

The stock structure is uncertain although recent evidences suggest the existence of a unique stock in NE Atlantic. The analysis Irish/Scottish deep-water trawl survey data analysis is consistent with the hypothesis about the species spatial dynamics in NE Atlantic, particularly, the fact about younger individuals.

In face of uncertainty three management units are considered by ICES WGDEEP for advice purposes:

- Northern (Divisions Vb and XIIb and Subareas VI and VII);
- Southern (Subareas VIII and IX);
    - Other areas (Divisions IIIa and Va Subareas I, II, IV, X, and XIV).

The Northern component comprises fish exploited mainly by trawl fisheries while the southern component by a longline fishery in Subarea IXa. In other areas the species is exploited by both longliners and trawlers, but the overall landings are much lower than at the other two management units.

The proposed southern deep-water slope survey in IXa will be designed to cover the distribution of the adult premature population.

In addition, the Azorean survey will mainly contribute to clarify the spatial overlap between *A. carbo* and *A. intermedius* that coexist in Azores. In a recent genetic study using specimens caught in Azores and initially identified as *A. carbo* it was admitted that two species of Aphanopus (*A. carbo* and *A. intermedius*) live sympatrically in the Azores (Stefanni and Knudsen, 2007). Due to their similarity morphologically the two species are hardly distinguished. *A. intermedius* (Parin, 1983), found in tropical and subtropical waters at similar range of depths of A. carbo differs from this by smaller adult size (100cm vs. 110 cm), larger number of vertebrae (102–108 vs. 97–100).

6.2.4 Portuguese dogfish (*Centroscymnus coelolepis*)

Centroscymnus coelolepis species is distributed worldwide and very common in the NE Atlantic, between 128 and 3675 m depth, although mostly common below 400 m depth.

Stock structure and dynamics are poorly understood. Specimens below 70 cm have been recorded very rarely in the NE Atlantic. There is a lack of knowledge of migrations, though it is known that females move to shallower waters for parturition and vertical migration seems to occur. The same size range and maturity stages exist in both the northern and southern ICES continental slopes. This information may suggest that this species is not so highly migratory, though it is widely distributed.

However, two preliminary genetic works presented at WGEF meetings did not reject the null hypothesis of no existence significant difference between areas and one in particular found no evidence of genetic population structure. But, in both studies, the authors expressed some concerns on the interpretation of the results. The mtDNA (used in both) is not very adequate for analysing the population structure of elasmobranchs and the number of microsatellites analysed, considered a more powerful tool for stock discrimination, could be insufficient to infer about existence of a single, well-mixed population.

As recently mentioned on ICES/WGEF 2010 the use of fishery dependent data on Portuguese dogfish for assessment purposes is not expected to continue to be used in future due existing EU restrictive quotas (TAC 0 in 2010). The available fishery-independent data are just derived from surveys which take place in a restricted part of their whole distribution areas. WGEF 2010 considered that the information available was insufficient to monitor the stock of this species, as well as, to evaluate the evolution of its status in future.

This species is also collected on the Azorean deep-water survey on the strata down to 800m. With the survey extension to 1200m it is expected to increase the number of individuals collected. However, it should be noted that the gear used on the survey may be not designed for this species.

6.2.5 Leaf scale gulper shark (*Centrophorus squamosus*)

Centrophorus squamosus has a wide distribution in the NE Atlantic from Iceland and Atlantic slopes south to Senegal, Madeira and the Canary Islands. On the Mid-Atlantic Ridge it is distributed from Iceland to the Azores (Hareide and Garnes, 2001).

Available evidence suggests that this species is highly migratory (Clarke *et al.*, 2001; 2002). Recent information revealed that in contrast to other NE Atlantic areas, where males are predominant, the sex ratio at the Faroes was approximately 1:1 (Vinnichenko and Fomin, 2009 WD).

Available information reveals that pregnant females and pups are found in Portugal, both the mainland (Moura *et al.*, 2006 WD) and Madeira, whereas pre-pregnant and spent females are found in the northern areas (Clarke *et al.*, 2001; 2002; Garnes, pers. comm.) and in the Faroes (Vinnichenko and Fomin, 2009, WD).

In the absence of more clear information on stock identity, a single assessment unit of the Northeast Atlantic has been adopted.

As recently mentioned on ICES/WGEF 2010 the use of fishery dependent data on Portuguese dogfish for assessment purposes is not expected to continue to be used in future due existing EU restrictive quotas (TAC 0 in 2010). The available fishery-independent data the Scottish and Irish surveys give information for a small portion of the overall stock. In 2010 WGEF considered that the information available was insufficient to monitor the stock of this species, as well as, to evaluate the evolution of its status in future. Furthermore if the dynamics of species is agreement with what has been postulated, southern deep-water slope survey is likely to give information on recruitment and spawning stock abundances.

This species is also collected on the Azorean deep-water survey on the strata down to 600m with a mode on the 900m. With the survey extension to 1200m it is expected to increase the number of individuals collected. However, it should be noted that the gear used on the survey may be not designed for this species.

6.2.6 Evaluation of the extent and quality of information on non-targeted species and the ability to describe larger parts of the fish communities and the physical environment (ToRf.3)

The fishing gear proposed to be used in Portugal mainland 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 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 referred at the 4.1. Nordic Section 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 this aspects is quite scarce.

The Azorean survey covers the depth strata until 1200m. It is considered very difficult to operate the longline down to 800m. 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 800m), corresponding to the most 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 the 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.

6.2.7 Evaluate the prospect of making all the combined survey data available to all parties by use of e.g. the ICES DATRAS database, in order to facilitate joint research and analysis (ToR f4)

The intention of facilitating joint research by making data more easily available between countries is acknowledged. Survey data from the Azorean survey are stored in a national data format. To evaluate ways of converting data to fit the ICES DATRAS database was considered not achievable at the WGNEACS meeting. Furthermore 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. So intersessionally both IPIMAR and DOP will work together to evaluate the feasibility of having to a common data exchange format that will provide standardized abundance estimates as well as other information on deep-water species covered by ICES WGDEEP and WGEF.

The southern Subgroup recommends further studies in relation to the work addressed in these ToRs should be carried out. These are:

- 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 estimate as well as prerecruitment estimates (Scottish and Irish surveys)
- In relation to *A. carbo* and *A. intermedius* evaluate the distribution area as well as estimate the level of overlap between the two species
- The understanding of the distribution of Deep-water sharks besides the actual surveyed area is quite restricted, the southern deep-water 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.
- In relation to Orange roughy further comprehend the dynamics and exchanges between "core" zones (genetic studies are required "mixing purposes") understand differences on recovery response between core units.

References:

Clarke, M. W., Connolly, P. L., and Bracken, J. J. 2001. Aspects of reproduction of deep-water sharks Centroscymnus coelolepis and Centrophorus squamosus from west of Ireland and Scotland. Journal of the Marine Biological Association of the United Kingdom, 81: 1019–1029.

Clarke, M. W., Connolly, P. L., and Bracken, J. J. 2002. Age estimation of the exploited deep-water shark *Centrophorus squamosus* from the continental slopes of the Rockall Trough and Porcupine Bank. Journal of Fish Biology, 60: 501–514.

Hareide, N. R., and Garnes, G. 2001. The distribution and catch rates of deep-water fish along the Mid-Atlantic Ridge from 43 to 61 N. Fisheries Research, 519: 297–310.

ICES. 2006. Report of the Working Group for North-east Atlantic Continental Slope Survey (WGNEACS), 8–10 June 2010, ICES HQ, Copenhagen, Denmark. ICES CM 2010/SSGESST:16. 496 pp.

ICES. 2010. Report of the Working Group on the Biology and Assessment of Deep-sea Fisheries Resources (WGDEEP), 7–13 April 2010, Copenhagen, Denmark. ICES CM 2010/ACOM:17. 616 pp.

Mendonça, A. Isidro, E. G. Menezes, Pinho, M. R. Melo, O., and Estácio, S. (2006). New contribution to the reproductive features of bluemouth Helicolenus .dactylopterus dactylopterus from the Northeast Atlantic (Azores Archipelago). (Sci. Mar., 70(4): 679–688).

Meneses, G. M., M. F. Sigler, H. M. Silva, and M. R. Pinho. 2006. Structure and zonation of demersal and deep-water fish assemblages off the Azores Archipelago (mid-Atlantic). Marine Ecology Progress Series, 324:241–260.

Stefanni, S., and Knutsen, H. 2007. Phylogeography and demographic history of the deep-sea Aphanopus carbo (Lowe, 1839) in the NE Atlantic: Vicariance followed by secondary contact or speciation? Molecular Phylogenetics and Evolution 42: 38–46.

Vinnichenko, V. I., and Fomin K.Yu. 2009 WD. Russian research and fisheries of sharks and skates in the Northeast Atlantic in 2008. Working document presented to ICES WGEF 12 pp.

Annex 1: List of participants

Name	Address	Telephone/Fax	Email
Thomas de Lange Wenneck	Institute of Marine Research PO Box 1870 N-5817 Bergen Norway	+47 55 23 86 78	thomas.de.lange.wenneck@imr.no
Leonie Dransfeld **Chair**	Marine Institute Rinville Oranmore Co. Galway Ireland	+353 91 387200 +353 91 387201	leonie.dransfeld@marine.ie
Elvar Halldor Hallfredsson	Institute of Marine Research Nordnesgt 33 PO Box 1 N-5817 Bergen Norway	+47 77609756 +47 77609701	elvarh@imr.no
Kristjan Kristins-son	Marine Research Institute Skúlagata 4 PO Box 1390 IS-121 Reykjavík Iceland	+354 575 2000 +354 575 2001	krik@hafro.is
Brendan O'Hea	Marine Institute Rinville Oranmore Co. Galway Ireland	+353 91 387200 +353 91 387201	brendan.ohea@marine.ie
Kaj Sünksen	Greenland Institute for Natural Resources PO Box 570 GL-3900 Nuuk Greenland		Kasu@natur.gl
Pascal Lourance *(by correspondence)*	Ifremer Département Ecologie et Modèles pour l'Halieutique rue de l'île d'Yeu B.P. 21105 44311 Nantes Cedex 03 France	+33(0)2 4037 4085 f +33(0)2 4037 4075	pascal.lorance@ifremer.fr
Neil Campbell *(by correspondence)*	Fisheries Research Services Marine Laboratory PO Box 101 Victoria Road Aberdeen AB11 9DB UK	+44 1224 876544 +44 1224 295511	n.cambell@marlab.ac.uk

Name	Address	Telephone/Fax	Email
Findlay Burns *(by correspondence)*	Fisheries Research Services Marine Laboratory PO Box 101 Victoria Road Aberdeen AB11 9DB UK	+44 1224 876544 +44 1224 295511	F.Burns@marlab.ac.uk
Mário Rui Rilho de Pinho *(by correspondence)*	University of the Azores Departament of Occeanography and Fisheries DOP Universidade dos Açores Caiz Sta Cruz PT-9909 862 Horta Azores Portugal	+351 292 200 400 +351 292 200 411	maiuka@uac.pt
Ivone Figueiras *(by correspondence)*	INRB, I.P. / L – IPI-MAR Av. Brasilia 1449-006 Lisbon Portugal	+351 213027 131 +351 213015948	ivonefig@ipimar.pt
Petur Steingrund *(by correspondence)*	Marine Research Institute Nóatún 1, PO Box 3051 FO 110 Tórshavn Faroe Islands	+298 353900 +298 353901	Peturs@hav.fo

Annex 2: WGNEACS terms of reference for the next meeting

The **Working Group on North-east Atlantic continental slope surveys (**WGNEACS) chaired by E. Halfredson*, Norway, will meet in Copenhagen, Denmark 14–16 June, 2011 to:

c) 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.

d) 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)

e) 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.

f) 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

WGNEACS will report by 22 July 2011 to the attention of the SSGESST.

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 and relation to action plan	This planning group would fulfil 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 surveys west of Scotland/Ireland are examined, e.g. WGNAPES surveys	Nordic national laboratories WGNAPES
2. WGNEACS recommends that there is a close dialogue early in the benchmark process between the stock coordinators and the scientists responsible for the survey data so that data use from surveys can be optimized. WGNEACS recommends formalizing this process by requesting Assessment working groups to draft ToRs to the survey group specifying the survey data products they require for future benchmark and update assessments including abundance indices, population indicators and others as required.	Assessment working groups assessing deep-water species, i.e. WGDEEP, WGEF, WGNWW, AFWG, NWWG
3. The group recommends continuing work on the variance estimation and the optimization of survey design and to further to increase the numbers of random hauls along the depth transect.	Central deep-water surveys
4. WGNEACS recommends Elvar H. Hallfredsson as the next chair of the working group.	

Annex 4 Working documents presented to this working group

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

WD 1: Optimising Survey Design and Stratification in the Scottish and Irish Deepwater Surveys to Produce Population and Community Indices

By N. Campbell, L. Dransfeld, F. Neat.

WD2: AZOREAN SPRING DEMERSAL LONGLINE SURVEY (ICES XA2)

By Mário Rui Pinho

The full text of both working documents is attached below:

WD 1: Optimising Survey Design and Stratification in the Scottish and Irish Deepwater Surveys to Produce Population and Community Indices

By N. Campbell, L. Dransfeld, F. Neat.

Absolute indices of fish population sizes are frequently constructed by combining count data recorded from a probability-based survey design, such as the stratified sampling of spatially coherent survey units, with an estimate of probability of detecting animals; in trawl surveys this measure is the specific catchability of the gear used. On a more simple level, stratum-specific estimates of abundance expressed in terms of catch-per-unit-effort may be of interest in themselves, for example, if strata are defined in terms of significant regional boundaries. When strata are sampled independently, stratum specific estimates of the mean number of observable animals will be mutually independent, and therefore, a meaningful index of population abundance and its variance can be determined by summing stratum-specific estimates of these.

The importance of correcting estimates for survey bias has been emphasized in fisheries literature, but considerably less attention has been given to the precision of stratified estimates. Measures of strata variance inform upon the appropriateness of the survey design to the measure being derived from the data, and can inform managers as to the reliability of the signal contained in the data and, as such, are important to consider when making decisions. Precision of population estimates will be determined by sample design, and by the precision with which detection parameters can be estimated. Any strata with an undue influence on the total variance of the estimate would benefit from increased sampling effort.

Whilst in the early days of a survey, questions such as which stratification variable (or variables) should be used, how should strata be demarcated and how many strata should there be can be addressed with some degree of flexibility, once a survey is used to derive abundance indices for assessment, retaining temporal consistency of the survey generally takes precedence over optimizing survey design. In this paper we examine the stratification currently employed in the Scottish and Irish deep-water trawl surveys of ICES Subdivision VIa and VIIc (Figure 1). The Scottish survey took place biennially between 1998 and 2004, then annually from 2005 onwards. The Irish survey has taken place annually since 2006.

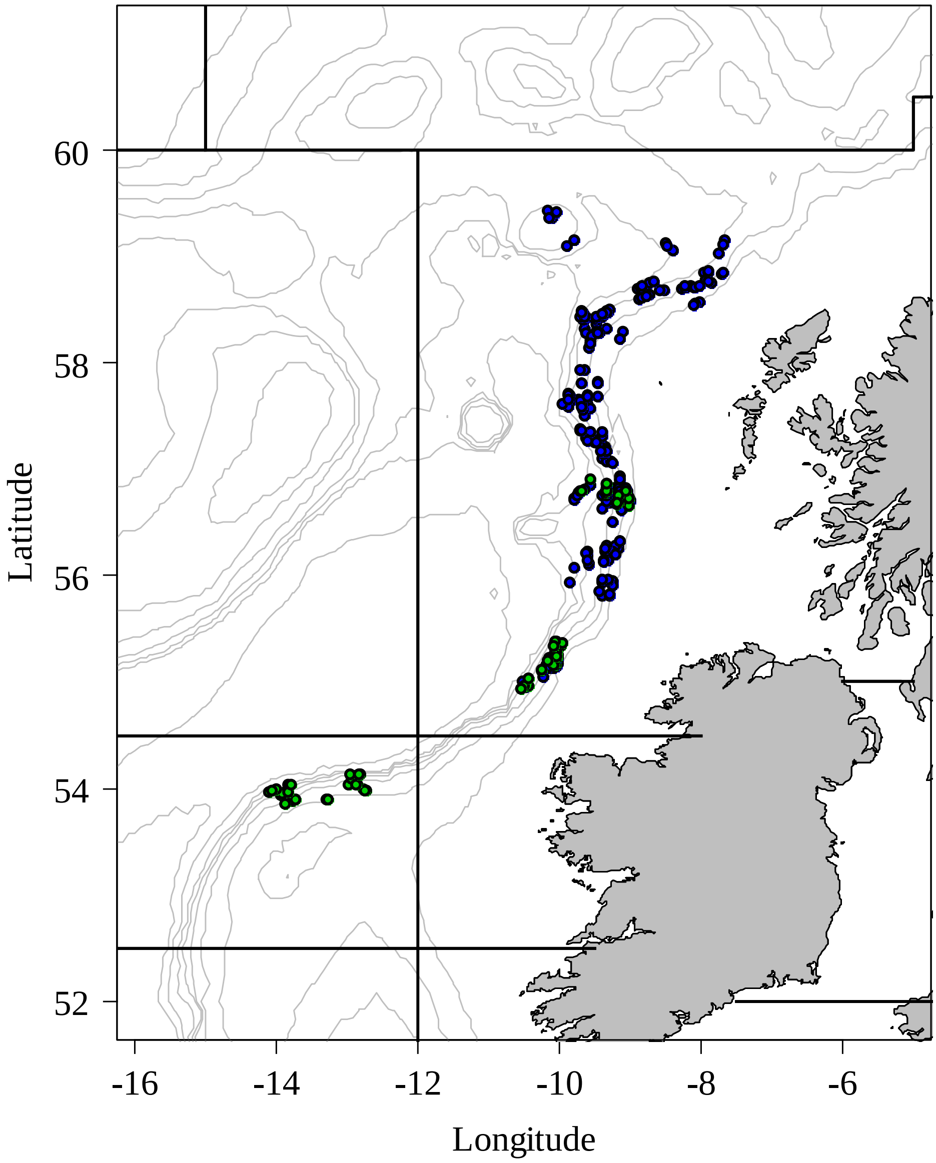


Figure 1. Distribution of hauls in the Scottish (blue circles) and Irish deep-water surveys, used in calculation of survey indices at WGDEEP 2010 (depth contours at 200m intervals).

First, we address the question of how comprehensively the distribution of survey effort represents the strata which they are sampling spatially. Figure 2 shows the distribution of Scottish survey effort in all years overlain on bathymetric data corresponding to the depth strata sampled. In recent years, the survey has focused hauls on the shelf-slope at depths of 500m, 1000m, 1500m and 1800m, with some individual hauls ranging between 400–1900m. Figure 2 represents the area contiguous with the 500m (400–750m isobaths), 1000m (750–1200m) 1500m (1250–1650m) and 1800 (1650–1950m) sampling strata. Whilst lack of sampling on the floor of the Rockall Trough to the south of the Rosemary Seamount may not be strictly relevant to deep-water fisheries in Subdivision VIa, there are some extensive areas which are not currently sampled in the northern part of the area, and care should be taken when extrapolating from survey trends which may be derived from areas other than where the fisheries are prosecuted.

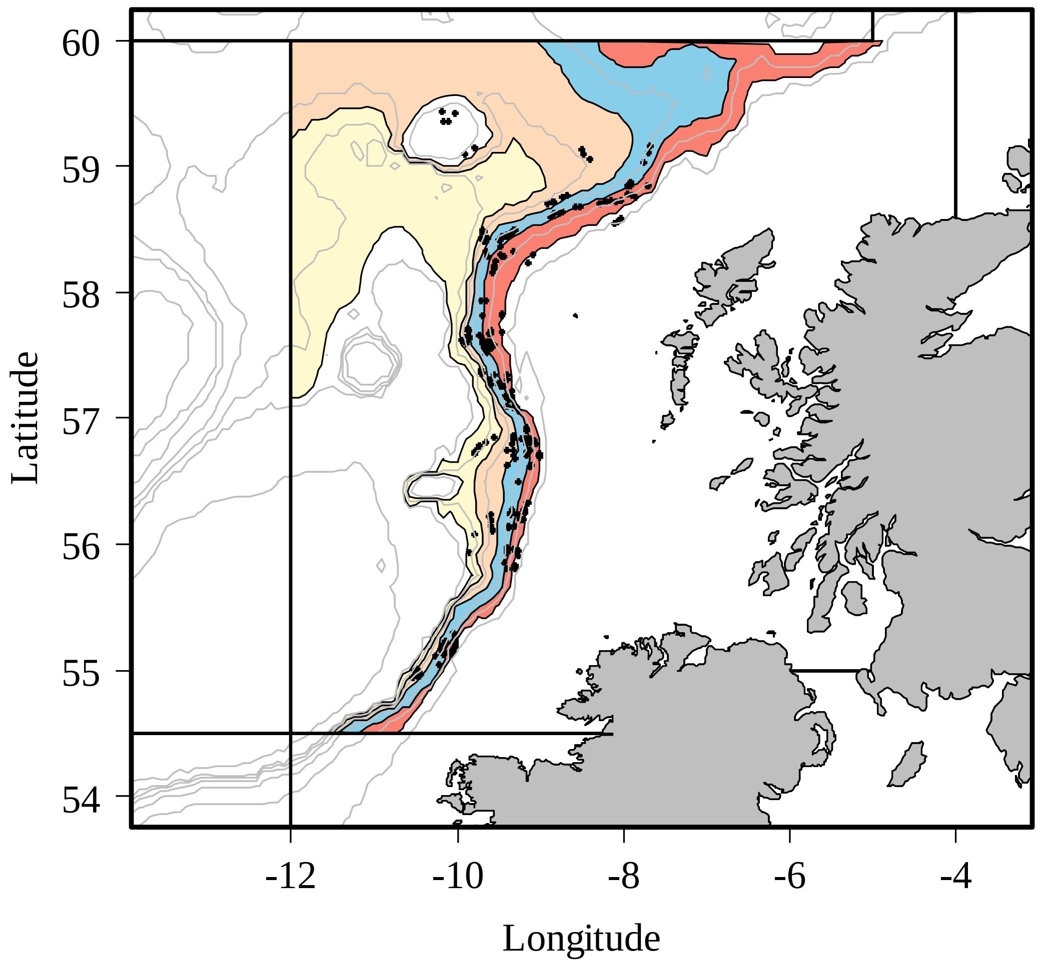


Figure 2. Distribution of Scottish deep-water survey effort with respect to depth strata (pink - 500m; blue - 1000m; orange - 1500m, cream - 1800m)

Figure 3 shows the same survey haul information overlain on a gridded output of international (UK vessels and vessels transiting UK waters at some point in a trip) VMS derived fishing effort metric (logged summation of all pings recorded at sub-5kt speeds in a grid of 7x7n.m. squares). This echoes the previous point about the absence of significant levels of fishing to the south of the Rosemary Seamount. The effort to the south of the Anton Dohrn Seamount is likely to represent some form of pelagic fishing, as closer inspection of the data shows vessels are not fishing in the direction of the depth contours. There is significant effort taking place on the Wyville-Thompson Ridge, to the north of the current survey extent.

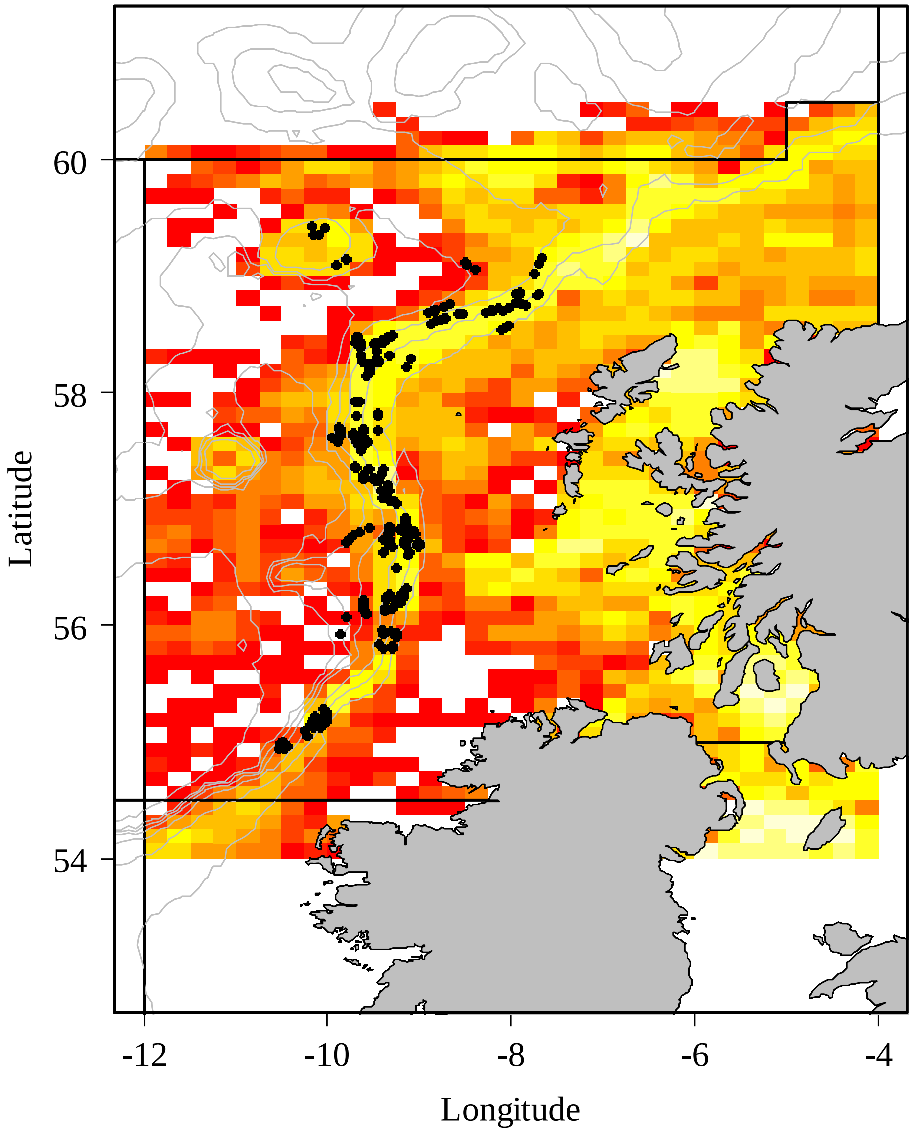


Figure 3. Positions of Scottish deep-water hauls overlain on a gridded output of VMS derived international fishing effort (red – low, yellow – high).

The Scottish and Irish deep-water survey series were used at WGDEEP 2010 as indicators of abundance for the assessment of blue ling (Vb, VI and VII) and black scabbardfish (Vb, XIIb, VI and VII) and indices were presented to the working group for roundnosed grenadier (Celtic Seas) and greater forkbeard (all areas). Whilst these surveys do not cover the entire extent of these assessment areas, they have produced indices which are internally consistent and show comparable trends between the surveys. Figure 4 shows the extent of these depth strata in the Celtic Seas area (ICES divisions VI and VII), and demonstrates that they extend considerably beyond the extent of these surveys.

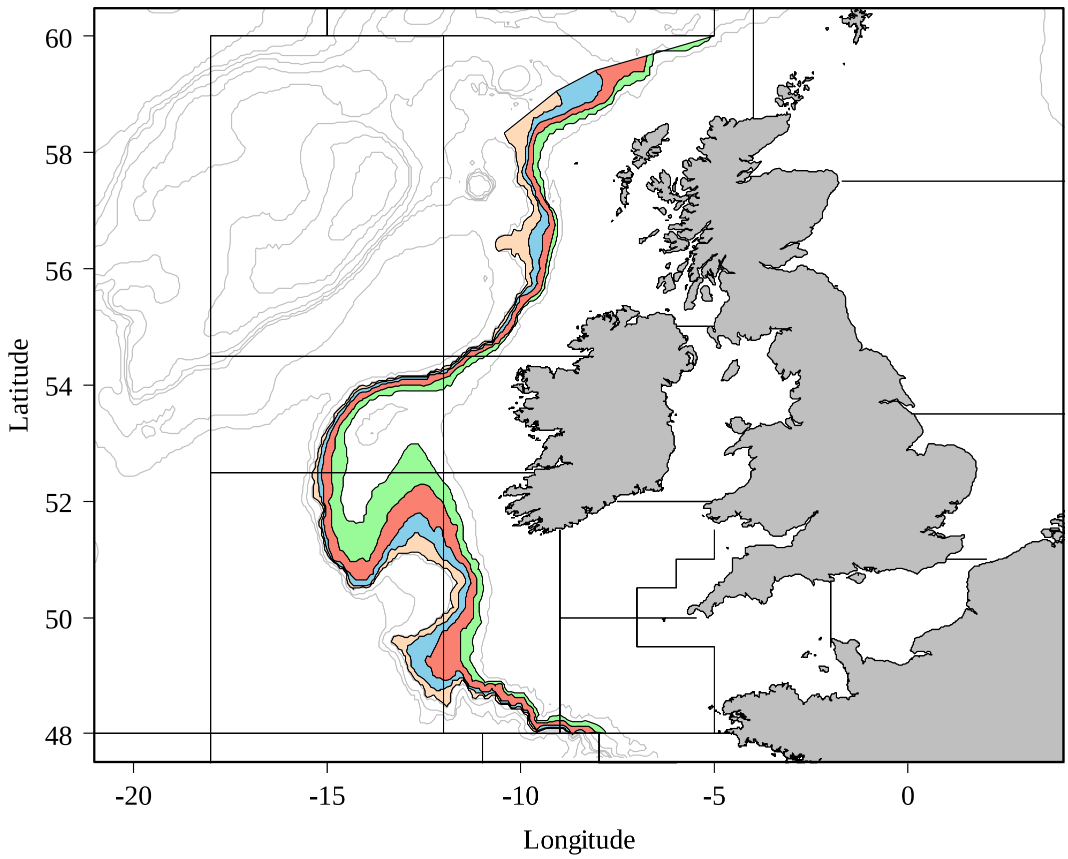


Figure 4. Extent of the continental shelf in ICES divisions VI and VII corresponding to the depth strata sampled by the Scottish survey design.

Examination of catch-per-unit-effort values for greater forkbeard, roundnosed grenadier, blue ling and black scabbardfish (Figure 5) shows that they generally follow steady trends which are adequately addressed by the current sampling strategy, and there would be limited gain from introducing extra hauls at intermediate depths. Figure 6 shows the contribution of individual strata to the total variance of estimates of blue ling, black scabbardfish, greater forkbeard and roundnosed grenadier, as well as the indicators of community composition; taxonomic diversity (Δ) and species richness, assuming the strata areas shown in Figure 3. Strata variance estimates are calculated as:

$$V_w = \frac{A_w^{\ 2} \frac{v}{n}}{\sum_1^w A_w^{\ 2} \frac{v}{n}}$$

Where V_w is the contribution to the total variance made by stratum w, of area A, which contains n hauls, of variance v.

The areas used in the calculation of strata variances for the Scottish data, corresponding to Figure 3, were:

500m	12620 km^2
1000m	14630 km^2
1500m	28370 km^2
1800m	24640 km^2

These figures suggest that the variance in the greater forkbeard data are roughly split between the 500m and 1000m depth strata, whilst source of the variance in the blue ling data are not consistently distributed at a particular depth over time. Black scabbardfish estimates would be improved by more shallow and deep hauls, and possibly by additional sampling at depths of 750m, which appears to be the depth of peak abundance, while roundnosed grenadier and indices of diversity and richness would be improved by more hauls in the deeper strata. These findings suggest there is no "magic formula" for improving this survey to generate indices. Species like blue ling will always remain problematic due to the clustered nature of their distribution and wide confidence intervals may be unavoidable.

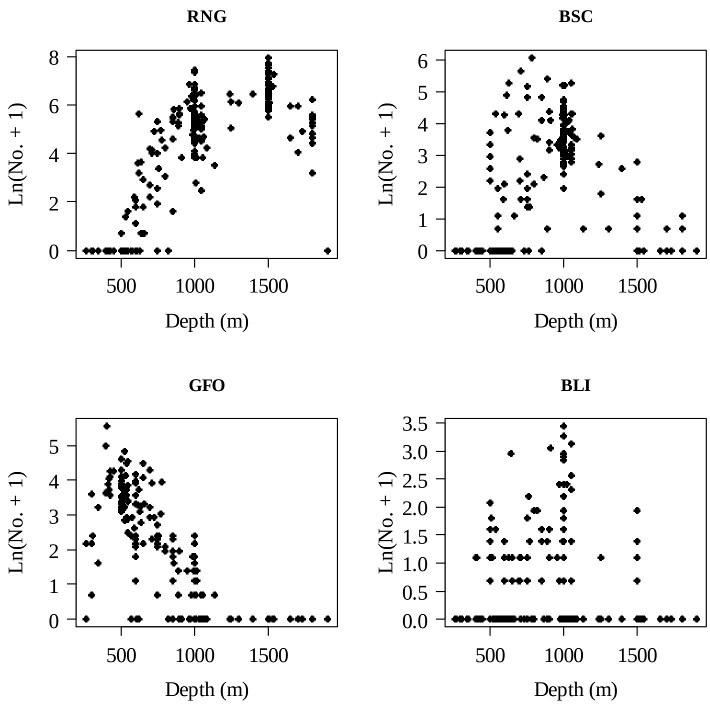


Figure 5. Logged catch per unit of effort at depth for the four species for which survey indices have been presented.

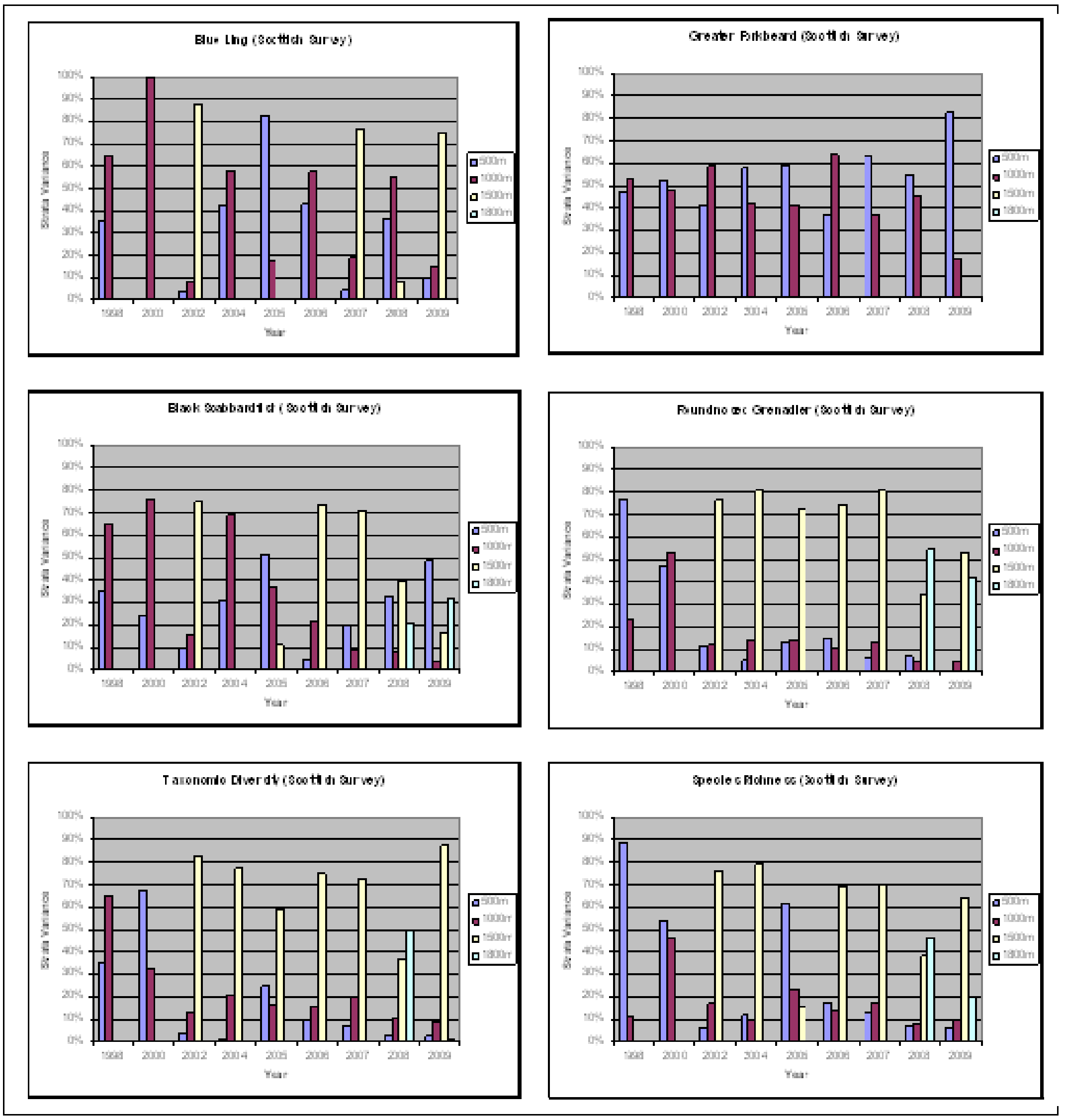
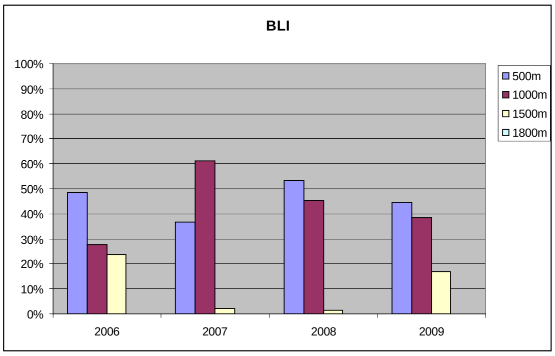


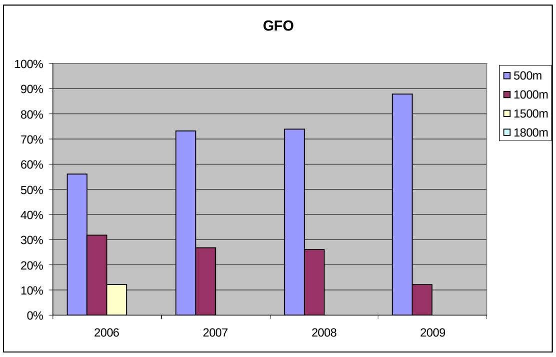
Figure 6. Contribution to total variance from individual strata variances, from Scottish data, for blue ling, greater forkbeard, black scabbardfish, roundnosed grenadier, taxonomic diversity (Δ) and species richness.

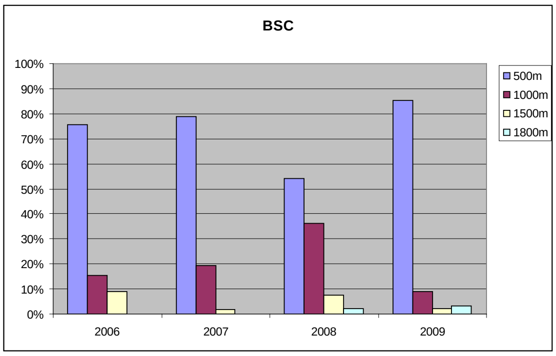
An analysis of combined Scottish and Irish survey data from 2006–2009, assuming the strata areas shown in Figure 4 reveals slightly different findings. In this case, variances have been raised to the total area of that depth strata which is contiguous with the shelf edge in ICES divisions VI and VII (Figure 4), and correspond roughly to:

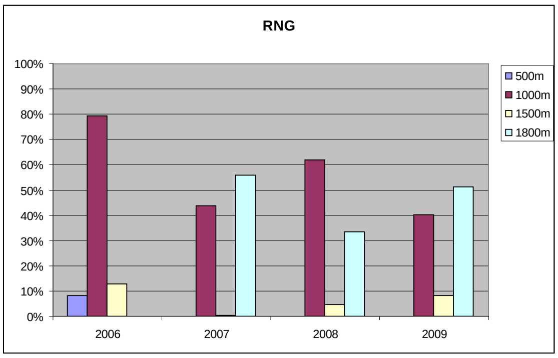
500m	39487 km^2
1000m	39465 km^2
1500m	25750 km^2
1800m	22262 km^2

Black scabbardfish and greater forkbeard estimates would both increase in precision through increased numbers of hauls at 500m, while roundnosed grenadiers would require increases in effort at 1000 and 1800m. These differences in interpretation highlight the importance of specifying the area to which survey data are applied









In conclusion, it is difficult to recommend any change in the stratification of the Scottish and Irish deep-water surveys on the basis of these findings. Whilst strata variances may bias the indices of abundance derived for these species, it is difficult to envisage how effort could be reallocated in a way which did not adversely affect the estimation of abundance of other species. Spatially, there are clear implications for the distribution of survey effort in terms of the extent of the depth strata to which these indices may be applied, and in terms of the correspondence between the distribution of survey effort and the distribution of the fishery.

WD2: AZOREAN SPRING DEMERSAL LONGLINE SURVEY (ICES XA2)

By Mário Rui Pinho

Introduction

The Azores is an archipelago located on the Mid Atlantic Ridge, around 1800km west of mainland Portugal. Divided by three island groups, distant about 350km each where a mean depth of ca. 4000m predominates, the archipelago is surrounded by an EEZ of approximately 1 million Km^2. However, only a small fraction of the area (about 2.5%) is less or equal to 1000 depth including coastal areas and seamounts. Seamounts are the predominant structures and are distributed around the EEZ.

The commercial demersal/deep-water fisheries operated on these areas using a demersal mixed hook and lines gears. The fishery effort is concentrated mainly off the coast of the islands and in some very well known banks and seamounts relatively near the islands coast (Pinho and Menezes, 2009). Other distant banks and seamounts (e.g. Voador, Monte alto, Sarda, Cavalo and Pico alto) on the limit of the Economic Exclusive Zone (EEZ) are also explored by some freezer longliners.

The commercial fishery operates mainly on the shallow (<250 m) and intermediate (250–600m) assemblages (Pinho and Menezes, *2009*; Menezes *et al.*, 2006), where the most important commercial species occurs.

Historical abundance information on demersal species consisted of statistics on catch per unit of effort (cpue) from the fishery. However, fishery catch rates (cpue) are often biased estimates of abundance and independent abundance estimate has been suggested for stock assessment and management purposes of these deep-water species (ICES, 2006).

Since 1995, a longline survey has been conducted annually by the Department of Oceanography and Fisheries at the University of the Azores (DOP/UAç), during spring, covering the main areas of distribution of demersal species (the coast of the islands, and the main fishing banks and seamounts), with the primary objective of estimating fish abundance for stock assessment (Silva and Menezes, 1995; Menezes *et al.*, 1998a,b; Pinho, 2003). The survey has supplied information needed to estimate the relative abundance of commercially important demersal species, based on the common assumption that catch rate (cpue) is proportional to species abundance.

This paper has the objective to resume the Azorean demersal longline survey information needed for the WGNEACS.

Survey Objectives:

Survey objectives are: a) to provide fisheries independent estimates of abundance and size composition for commercially important demersal species; b) to collect information for biological studies on growth, reproduction, diet and migrations; and c) to obtain information for ecological studies, such as depth distribution, and community structure. The first objective has the highest priority, because the major cause of uncertainty in the assessment of demersal species is the lack of independent abundance estimates for population modelling.

Sampling protocols of Azorean survey

Survey design

Statistical areas

The Azorean longline survey was conducted annually each spring (usually from March/April to June) from 1995 to 2010. The survey followed a stratified design (Cochran, 1977) and covered the Azores archipelago around the islands, banks, and major seamounts as far as 70 nm from the islands. This area covered the entire island coastal and the main fishing seamounts, corresponding about 71% and 60% of the total EEZ area until 600m and 1000m depth. Some important fishing offshore seamounts are not covered by the survey, particularly the seamounts along the rift (between central and west group of islands).

The Azores archipelago was divided into six main statistical areas (I to VI), according to its geographical characteristics: I – banks of central group “Azores” and “Princesa Alice”; II – islands of central group “Faial / Pico”, “Graciosa”, “São Jorge”, and “Terceira”; III - islands of east group “Santa Maria” and “São Miguel”; IV – bank “Mar da

Prata"; V – banks "D. João de Castro", "Formigas" and other small seamounts; and VI – islands of west group "Flores / Corvo" (Figure 1). Each statistical area includes one or more subareas, corresponding to a more homogeneous statistical unit (individual area or seamount).

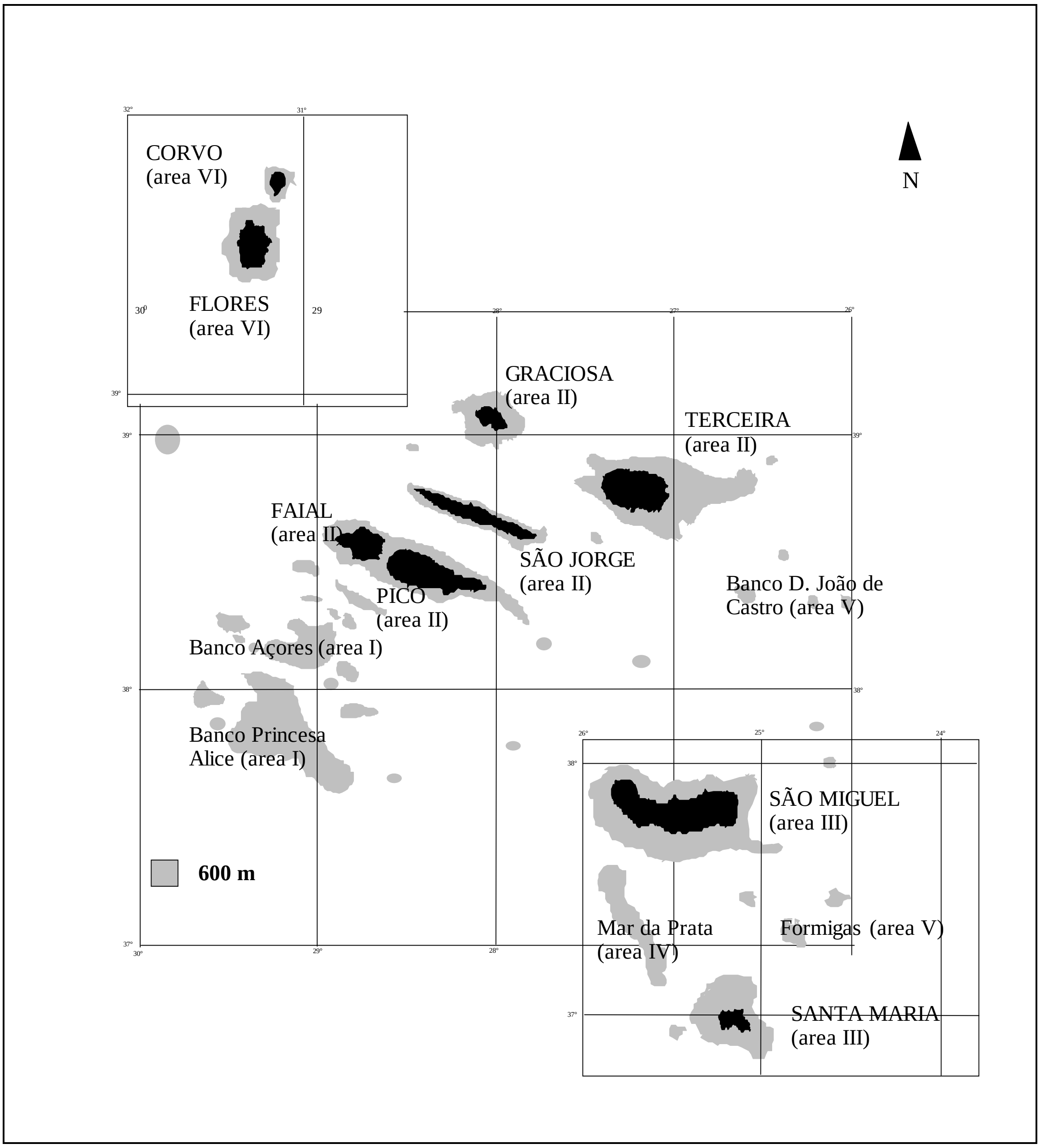


Figure 1. Statistical areas (I to VI) and subareas (names) defined for the Azorean longline survey. Shadowed areas represent the 600 m isobaths (From Pinho, 2003).

Stratification and effort allocation

Each area or subarea was further divided into 12 depth strata with 50 m intervals (i.e. the first strata represented 0–50 m, the second 51–100 m, etc. up to 600 m depth) for abundance estimation purposes. However, one random station within each subarea was always extended to deeper strata (601–1200 m depth) for exploratory and ecological purposes. An exception to this 50 m depth interval occurred in 1995, where strata interval below 200 m depth was 100 m, according the survey design adopted. After 2004 the 600 m depth limit for abundance estimation was extended to 800 m (Melo *et al.*, 2004).

Planar area size by depth strata was estimated from contour maps using the MapViewer vs. 4.00 software (Thematic Mapping System, Golden Software, Inc.). Contour maps were first produced using the bathymetric data from Smith and Sandwell (1997) and the kringing method from SURFER vs. 7.0 (Surface Mapping System, Golden Software, Inc.).

The number of sets was allocated proportional to the area and subarea sizes. A minimum of two sets was allocated to each subarea. A maximum limit of 60 days (corresponding approximately to 30 sets) was imposed, due to ship time availability and cost limitations.

Set locations within a subarea were selected by choosing a central point and a random direction within a 360º from the point. Each set was laid across depth. So, each set is a vertical transept from the surface to the bottom, covering whenever possible 24 depth strata (stations). On average 517 stations were covered annually by the survey since 2004.

Gear and regime of operation

The survey gear was very similar to the one used by the commercial fishery (Figure 2). This gear 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 soak time, between setting and retrieval, varied from about two and six hours. Highest catch rates of the most important target species occurred during and after sunrise, and were associated with the period of feeding activity (Silva and Menezes, 1995). The bait was chopped salted sardine (*Sardina pilchardus*).

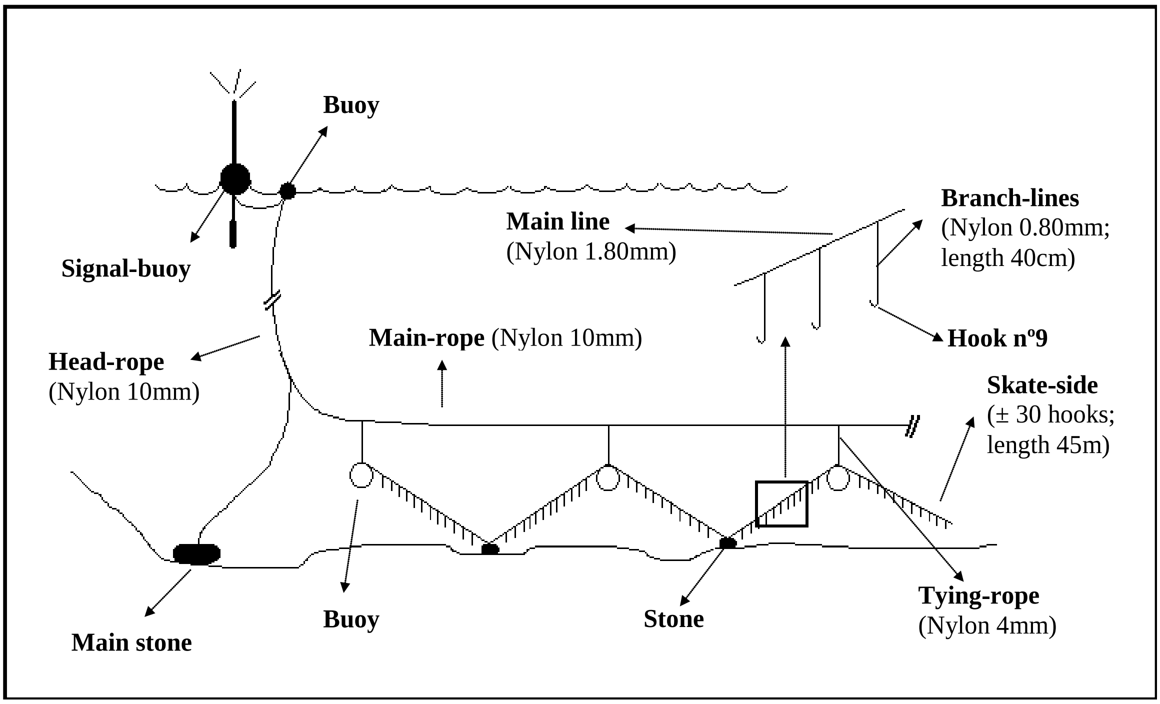


Figure 2. Bottom longline gear used in the Azorean surveys (From Pinho, 2003).

Statistical and biological data recorded

Time, position (GPS) and depth (echosounder) were recorded for every quarter-skate (every 30 hooks) during gear deployment. Fish species and hook condition was recorded while the sampling gear was retrieved. Hook condition was classified as baited, unbaited, with fish, or ineffective (i.e. missing, broken or tangled). All fish were tallied by species and strata, measured and weighed and some were tagged and released. So, total catch and catch by species are measured directly. The weight of tagged fish is converted using length-weight relationships estimated for the species (Rosa, 2006).

Biological sampling by species and strata was made based on subsample of the total catch and information on length and weight, sex, otoliths, maturation stage, gonad and liver weight, were recorded. Some fish also were sampled for genetics and heavy metals measurements.

Abundance index computation

Total effort was estimated by set and strata, sampling the quarter skates during the retrieval. About half the quarter skates that were deployed were sampled. The effort was inflated based on the proportion of skates that was sampled to compute the total number of effective hooks. Ineffective hooks were excluded from analysis.

The catch per hook value (cpue) was calculated for each species, area, and station stratum, and an index of relative abundance in number was obtained by multiplying each of these cpue values by the corresponding area size. The average relative abundance value for each area and stratum was then calculated. The annual abundance values for each area and for the Azores were computed by summing the abundance values across strata and across areas, respectively. Finally, the bootstrap method

(Efron and Tibshirani, 1993) was applied to calculate confidence intervals and check statistical differences for the annual estimated abundance values.

Not all depth strata were sampled at each station as a consequence of bottom topography (i.e. stratum non-existent), lost gear or ship operation difficulties. Hence, missing values are not considered for the abundance computations.

Species

Approximately 135 different species, belonging to about 85 families, were caught and identified until now on the Azorean bottom longline survey, including crustaceans, elasmobranchs, molluscs and teleosts (www.int-res.com/articles/suppl/m324p241_app.pdf). These species are structured by depth assemblages usually resumed as shallow (≤250m), intermediate [250–800m] and deep (≥800m; Menezes *et al.*, 2006; Pinho and Menezes, 2005). The dominant species are *Mora moro* (deep strata), *Helicolenus dactylopterus* (intermedian strata) and *Pagellus bogaraveo* (shallow/intermedian strata), that represents about 50% of total survey abundance (Table 1).

Table 1. Mean relative abundance index by species from the Azorean spring demersal longline survey for the period 1995–2007.

Species	Mean 95-07
	2.654
	2.236
	1.030
	0.482
	0.371
	0.325
	0.311
	0.302
	0.262
	0.229
	0.213
	0.189
	0.171
	0.142
	0.137
	0.125
	0.122
	0.119
	0.117
	0.101
	2.424
	12.064

References

Cochran, W. G. 1977. Sampling techniques, 3rd Ed. New York. John Wiley and Sons. 428 pp.

Efron, B., and Tibshirani, R. 1993. An introduction to the bootstrap. Monographs on statistics and applied probability, 57. Chapman & Hall. 436 pp.

ICES. 2006. Report of the Working Group on the Biology and Assessment of Deep-Sea Fisheries Resources. ICES CM 2006/ACFM:28.

Meneses, G. M., Sigler, M. F., Silva, H. M., and Pinho, M. R. 2006. Structure and zonation of demersal and deep-water fish assemblages off the Azores Archipelago (mid-Atlantic). Marine Ecology Progress Series, 324:241–260.

Melo, O., Menezes, G., Pinho, M. R., Rosa, A., and Isidro, E. 2004. Relatório do Cruzeiro de Monitorização de Demersais realizado durante a Primavera de 2004 nos Açores (ARQDAÇO-21-P04).

Pinho, M. R., and Menezes, G. 2009. Pescaria de demersais dos Açores. Boletim do Núcleo Cultural da Horta 2009:85–102. ISSN 1646–0022.

Pinho, M.R., and Menezes, G. 2005. Azorean Deepwater Fishery: Ecosystem, Species, Fisheries and Management Approach Aspects. Deep Sea 2003: Conference on the Governance and Management of Deep-sea Fisheries, Conference Poster and Dunedin Workshop Papers. FAO Fish. Proc. 3/2.

Menezes, G., Silva, H., Krug, H., Bulguerias, E., Delgado, J., Pérez, J., Soldevilla, I., Nespereira, J., Carvalho, D., and Morales, J. 1998a. Design optimization and implementation of Demersal Survey Cruises in the Macaronesian Archipelagos. Final report, Commission of the European Communities (DG XIV/C/1- Study contract 94/034). *Arquivos do DOP*, Série Relatórios Internos, No. 3/98, 162 pp.

Menezes, G, Delgado, J., Krug, H., Pinho, M. R., Silva, H., and Carvalho, D. 1998b. Design optimization and implementation of Demersal Survey Cruises in the Macaronesian Archipelagos - II. Final report, Commission of the European Communities (DG XIV-Study contract 95/095). 160 pp.

Pinho, M. R. 2003. Abundance estimation and management of Azorean demersal species. PhD thesis. Department of Oceanography and Fisheries, University of the Azores, Horta, Portugal, 163 pp.

Rosa, A., Menezes, G. Melo, O., and Pinho, M. R. 2006. Weight-Length Relationships of 33 Demersal Fish Species from Azores Archipelago. *Fisheries Research,80, 329–332.*

Silva, H. M., and Menezes, G. M. 1995b. Relatório do Cruzeiro de Demersais realizado durante a Primavera de 1994 nos Açores (ARQDAÇO-02-P94). Arquivos do DOP, Série Cruzeiros, No. 2/95. 42 pp.

Smith, W. H. F., and Sandwell, D. T. 1997. Global seafloor topography from satellite altimetry and ship depth soundings, Science, v. 277, p. 1957–1962, 26 September, 1997.