

ECOREGION BOOK 11**SUBJECT NEAFC Guidelines for Observers onboard fishing vessels authorised to fish in new bottom fishing areas****1. Background to request**

In 2008, NEAFC 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 NEAFC 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 to produce guidelines for observers onboard fishing vessels that might be authorised to fish in the so-called "new" bottom fishing areas.

1.1 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:

- Report of the Workshop on Vulnerable Ecosystems and Destructive Fishing in the Deep-Sea Fisheries (26–29 June 2007) (FAO, 2007a).
- Report of the Workshop on Data and knowledge in Deepsea Fisheries in the High Seas (Rome, 5–7 November 2007) (FAO, 2007b).
- Review of the code of conducts for scientific research in sensitive deepwater habitats (ICES, 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, 2008).
- Definition of Standard Data-Exchange Format for Sampling, Landings, and Effort Data from Commercial Fisheries (Jansen et al., 2009).
- International guidelines for the management of deep-sea fisheries in the high seas (FAO, 2009).

1.2 Scope of the request

ICES considers that these guidelines are aimed at an observer programme of scientific nature and that the data collected would form the scientific basis to provide the information that is required to assess fisheries in previously unfished areas. 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 seafloor during the normal course of fishing operations (NEAFC rec. XVI, 2008). With this in mind the guidelines focus on bottom trawling and bottom impacting gillnetting and longlining.

2. 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 characterise deep sea bottom fishing activities as stated in FAO, 2009:

- The catches include species that are characterised by low productivity and therefore can only sustain low exploitation rates;
- The fishing gear is likely to contact the seafloor during the normal course of fishing operations.
- With this in consideration, the observer programme has the following objectives:

Objective 1: Spatial (GPS) and temporal (hourly) information is collected on the vessel operation and effort to determine the fishing footprint and impact of this particular fishery.

Objective 2: Biological data on 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: Biological data is 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: Data is collected for the identification and mapping of vulnerable marine ecosystems (VMEs) and to contribute to the assessment of significant adverse effects.

Objective 5: Data is 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 function of scientific observers on board vessels engaged in scientific research or harvesting of marine living resources is to observe and report on the operation of fishing activities

Scientific observers should undertake the following tasks;

1. record details of the vessel's operation;
2. take samples of catches to determine biological characteristics;
3. record biological data by species caught;
4. record by-catches, their quantity and other biological data;
5. record the procedure by which declared catch weight is measured;
6. record entanglement and incidental mortality of birds and mammals;
7. prepare reports of their observations using standard data exchange formats;
8. submit copies of reports to NEAFC and captains of vessels.

The data collected by the observer programme should be formatted in a way that it makes it easily available to other bodies interested in the deep sea such as ICES and OSPAR. For efficiency, the observer programme should make use of existing standard data exchange formats. It is recommended to use ICES published standard format for sampling of commercial fisheries (Jansen *et al.*, 2009). The format includes records for trips, fishing stations, species caught, length distribution and biology (sex, maturity, age, weight, length). The headings for the data exchange formats according to Jansen *et al.* 2009 are as follows:

TR - Trip record

HH - Fishing station record

SL - Species list record

HL - Length record

CA- Sex Maturity Age Weight Length record

3. 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 organisations (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 VMEs. Where there is a high predicted likelihood of VME encounter this should be in the form of dedicated underwater camera and acoustic survey. Where there is a low likelihood of the occurrence of VMEs,, it should be sufficient to undertake short tows and assess any by-catch in line with move-on rules.

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.

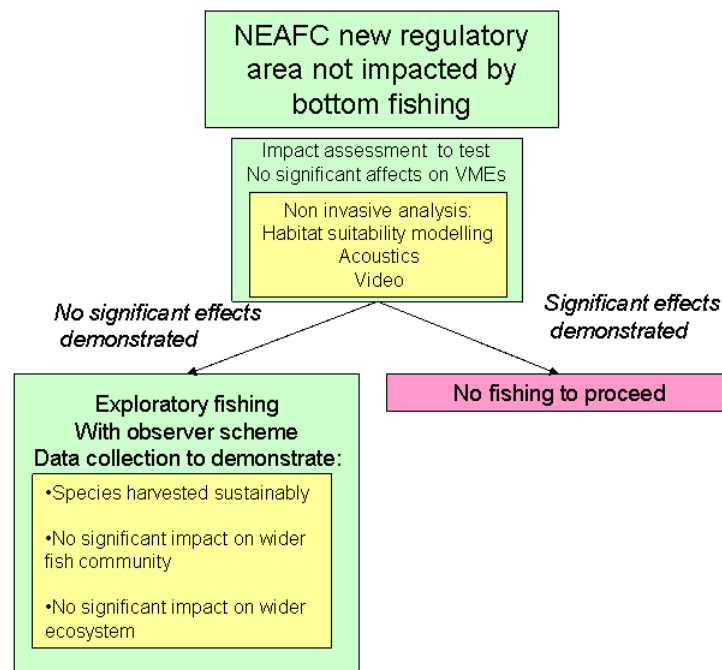


Figure 3.1 Schematic diagram of how the observer guidelines could be included in the NEAFC process for permitting bottom fishing in unimpacted bottom habitats.

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 pre-defined 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. 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.

4. Details on information that should be collected for each objective

Aim 1.) Spatial and temporal information is collected on the vessel operation and effort to determine the fishing footprint and link this in with other data sets 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 deepwater environment where serial depletion of deepwater 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. Spatial resolution should be at GPS level.

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 Trip record)
- Details on vessel capacity: (fields: vessel length, vessel power, vessel size, vessel type in Trip record)
- Details on gear and effort - i.e. number of hooks on long lines, 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". There should also be a record for a description of any technical measures that are being used to mitigate bottom impact.
- 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). In the case of static gears extra fields need to be included namely: initial and final positions when gear is set and initial and final position when gear is hauled)
- Total number of hauls (fields 13 in Trip records). Please see additional consideration.
- Example of standardised data records to log details on trip and station details (Jansen *et al.* (2009) are shown in Tables 3.1 and 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
11 Catch registration
12 Species registration
13 Date
14 Time
15 Fishing duration
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.) 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, see table 3.3),
- Length frequencies of total or subsampled catch (HL records, see table 3.4);
- Biological sampling on total catch or subsamples for weight measurements, sex ratios, maturity ratios, collection of samples for fecundity analysis (CA records, see table 3.5);
- Collection of hard structures for possible age determination (otoliths, spines scales) (fields 25–28 of CA records).

Biological samples should be taken by randomly sampling from the catch. Any sub sampling methods and raising procedures need to be fully described. 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 made. Special attention should be given to the identification of shark species.
4. collect length records 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, alfonsinos (*Beryx* spp.), sea bream, cardinal fish, orange roughy, deepwater sharks and could include other prioritised species and a representative sample of bycatch and discard species (see objective 4). When sampling a species for length, the number of individuals measured must ensure quality and accuracy of resultant length frequency. European DCF recommendations on sampling levels for length measurements are that “the number of length classes within a sample may be estimated from the approximate length range within it and, from this, the number of fish measured shall lie between $3 \times$ number of length classes and $5 \times$ number of length classes as a first approximation, in the absence of any statistical optimisation of the sampling design” (Commission decision 2008/949/EC). Due to the great variety of body shapes of deep-water fish species and the fragility of their tails and fins some species are not measured to total length. The ICES 2008 PGNEACS report gives details on which deepwater species should be measured to total length (TL), standard length (SL), Pre Anal Fin Length (PAFL), Pre Supra Caudal Fin Length (PSCFL) and Second Dorsal Fin (SDFL) (ICES, 2008b).
5. for the collection of biological parameters relating to weight measurements, sex, maturity and possible age determination, a priority and target list should be developed by NEAFC to guide the observer sampling protocols. For the determination of maturity stages, established maturity keys should be used for the species for which they are available. For species where agreed maturity scales are not available, categories can be reduced to spawning (hyaline eggs/running milt) and not spawning.
6. 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, 2009). Collecting CA record for blue ling may be priority in March–May over collecting HL record for other commercial species.
7. The overall sustainability of a fishery can be influenced 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 prioritisation 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. deepwater sharks, then this should take a high priority for biological data collection.

A priority list may be refined over time according to data missing, on-going scientific projects and general need for assessment and monitoring.

Objective 3.) Biological data is 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, to further aid the identification of VMEs.

Completion of SL record implies that landings and discards in weight of all species are recorded. A representative sample of bycatch and discarded catch should be sampled for length frequency.

Table 3.3 Headers for species list records (SL) from Jansen *et al.* 2009.

SL-(Species list record)
1 Record type
2 Sampling type
3 Landing country
4 Vessel flag
5 Year
6 Project
7 Trip number
8 Station number
9 Species
10 Catch category
11 Landing category
12 Commercial size category scale
13 Commercial size category
14 Subsampling category
15 Sex
16 Weight
17 Subsample weight
18 Length code

Table 3.4 Headers for length records from Jansen *et al.* 2009.

HL (Length record)
1 Record type
2 Sampling type
3 Landing country
4 Vessel flag
5 Year
6 Project
7 Trip number
8 Station number
9 Species
10 Catch category
11 Landing category
12 Commercial size category scale
13 Commercial size category
14 Subsampling category
15 Sex
16 Length Class
17 Number at length (not raised to whole catch)

Table 3.5Headers for sex, maturity, age, weight, length records from Jansen *et al.* 2009.

CA (Sex-Maturity-Age-Weight-Length record)
1 Record type
2 Sampling type
3 Landing country
4 Vessel flag country
5 Year
6 Project
7 Trip number
8 Station number
9 Quarter
10 Month
11 Species
12 Sex
13 Catch category
14 Landing category
15 Commercial size category scale
16 Commercial size category
17 Stock
18 Area
19 Statistical Rectangle
20 Subpolygon
21 Length class
22 Age
23 Single fish number
24 Length Code
25 Aging method
26 Age plus group
27 Otolith weight
28 Otolith side
29 Weight
30 Maturity staging method
31 Maturity scale
32 Maturity stage

Objective 4). Data is 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 and avoidance of VMEs. 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. 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 are also listed.

Section three of these observer guidelines addresses the need to carry out non invasive impact assessments before any bottom impacting fisheries 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 and potential encounter avoidance of VMEs. Data required for the identification of VMEs is the identification and enumeration of the bycatch of benthic species.

For recording purposes, the species list (SL) records should include benthic invertebrates. Observers deployed should identify sessile benthic organisms such as reef forming corals, gorgonians, black corals, bamboo corals, sponges, possibly sea pens to the lowest possible taxonomical level, at a minimum this should be to genus level. It is stressed that scientific observers should be proficient in the identification of benthic invertebrates and high priority should be given to their training in these identification skills. Following the identification, the benthic invertebrate catch should be enumerated and weighted as indicated in the SL record. Observers should also record observations on the terrain, the occurrence of bathymetric features etc.

For species that cannot be identified at sea, a specimen or sample of the specimen should be collected and returned to shore. If adequate facilities are present, specimens should be frozen, otherwise they can be preserved in ethanol or 4% formaldehyde. Each sample to be frozen must be placed in a plastic bag and clearly labelled internally (resistant paper label) and externally (permanent marker) with the information described above

For preservation using formaldehyde or alcohol, preparation of fixatives should be carried out ashore before commencing the trip. Specimens need to be kept in plastic containers of adequate size and add the preservative solution until the specimens are completely submerged. A label including: vessel; gear, haul location (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).

When collecting specimens, it 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.) Data is 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 sea bird or protected, endangered or threatened species (PET species)
- Note on survival, death, injury etc,
- All live PET species shall be released after capture.

5 Other data that should be collected on observer trips:

Incorporation of fisher's knowledge - there should be scope in the observer data collection for fishermen's 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. this 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.

6 Other considerations

- Standard data collection procedures and protocols should be implemented, including standardised logbooks and recording sheets. The standard data exchange formats as published in Jansen et al., 2009 are recommended. All the data needs to be collected with the associated metadata.
- All coding should be standardised, 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;
- Scientific observers should be highly trained in species identification.
- In addition, there should be coordinated programmes on the standardisation of species identification including benthic invertebrates. The development of field guides to deepwater species identification should be considered. ICES WGNEACS has already initiated this process.
- During exploratory fishing, it is strongly advised that the observer samples all hauls, however if this is not possible other observation method should be explored such as recording catches on board with CCTV cameras.
- The mandatory reporting period should be brief in order to allow for rapid responses if management action is required.

7 Mitigation measures

The following are comments on measures that may mitigate the impact of fishing in sensitive habitats

7.1 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 limitations of the methods used in 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 worthy of mention 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.

7.1.1 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 deepsea fisheries is again dependent on target species and prevailing bottom conditions i.e. the drop chains may still damage large sessile structures.

7.1.2 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 relevant here but experiments have shown 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 thirty-one to nine. 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 have a reduced impact on the bottom. This was tested during a recent EU project entitled “Degree” and tested a standard rockhopper 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 rockhopper 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 rockhopper trawl path indicated that the rockhopper gear raised more sediments than the plate gear trawl (Anon., 2009). Neither of these modifications has been tested in VMEs.

7.1.3 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 from 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 seabed contact of sweeps (Goudey and Loverich, 1987). However, in some such riggings, depressor weight are sometimes attached to the bridles at a mid-point between the doors and the trawl. Thus while the doors are off the bottom there is still contact from these weights.

7.1.4 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 cas, disc clusters were placed on the bridles to raise the cable off the seabed and to reduce the cutting effect of the cable to sessile animals.

7.2 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 ground gear (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.

7.3 Gear Selectivity

Very little is known about the selectivity of towed gears in deepsea fisheries, although due to the morphology, generally sedentary behaviour and low light lives frequented by many deepsea 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 deepwater 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.

7.4 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 echo sounder 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.

8 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. *Fisheries Research*, 26: 225–237.
- 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 U.S. waters. *Frontiers in Ecology and the Environment*, 1: 517–524
- FAO. 2009. *International Guidelines for the Management of Deep-sea Fisheries in the High Seas*, Rome, ISBN 978-92-5-006258-7. 21pp.
- 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 Journal of Marine Science*, 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. Recovery 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 Fishing 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.
- ICES. 2008b. 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 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.
- Jansen, T., Degel, H., Vigneau, J., and 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. and 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 Fisheries Technical Paper 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, A.D., Clark, M.R., Hall-Spencer, J.M. and Gjerde, K.M. 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.
- 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 Vasconclo, P. 2002. Gill net and long-line catch comparisons in a hake fishery: the case of Southern Portugal. *Scienca Marina*, 66: 433–441.
- SEAFO guidelines for photographing, fixing and preserving corals and sponges in Conservation Measure 17/09: on Bottom Fishing Activities in the SEAFO Convention Area) Annex 3.
- Sundet, J.H. 1999. Bifangst av kongekrabbe i garn- og linefisket i 1999. *Fiskeriforskning*, p. 14.