Common methodology for assessing the impact of fisheries on marine Natura 2000

**A proposal of methodology
for the Marine Expert Group**

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Prepared by:

THE **N2K** GROUP

European Economic Interest Group

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EXECUTIVE SUMMARY

The progress in establishing the marine Natura 2000 network is underlining the need of a common, harmonized methodology at EU level, to assess the impact of fisheries on marine sites, with a view to ensuring level-playing field and compliance with applicable provisions under the Habitats and Birds Directives and the CFP. A common methodology is also needed in order to help achieve an equal treatment of fishermen in relation to management of Natura 2000 sites, particularly where national and foreign vessels both fish within a site.

Being aware of the existing differences among fisheries activity in EU seas (e.g. North Sea versus Mediterranean Sea), this methodological proposal deals with the identification of tools, which should be, when applied, opportunely calibrated and set within the specific fisheries context.

This document is based on findings of a short and concise search effort into scientific literature and on the best available knowledge.

The assessment procedure must take into account the precautionary principle, according to which the absence of adequate scientific information should not be used as a reason for postponing necessary management measures. Only when information is not sufficient to adequately assess the potential impact on habitats/species in an area, should the precautionary principle be used.

1. Objective and scope of the document

This methodology is intended to be bound by and faithful to the articles of the Habitats and Birds directives and the wider principles underpinning EU environmental law and policy. It is not legislative in character, but provides non-binding guidance on the application of existing legal provisions in the context of fisheries in the Natura 2000 network.

It is consistent with the previous advice given by the Commission on the implementation of the Habitats and Birds directives, in particular with the document "Fisheries measures for marine Natura 2000 sites: A consistent approach to requests for fisheries management measures under the Common Fisheries Policy"[1]. The results of the impact evaluation would contribute to assess the need of specific fisheries management measures and to collate the scientific and technical information needed to request for fisheries management measures under the CFP.

The document intends to cover all marine Natura 2000 sites (inshore and offshore), including the entire geographical marine area to which the Habitats and Bird Directives apply, in order to define, when necessary, fisheries measures equally proportionate on the base of harmonized analyses.

The methodology focuses on habitats and species for which the sites have been designated, i.e. habitats in Annex I and species in Annex II of the Habitats Directive and Annex I of the Birds Directive plus migratory birds that justified designation of Natura 2000 sites. The methodology will not cover Annex IV species (Habitats Directive), even though the same approach used for mobile Annex II species could be also applied to mobile Annex IV species. This methodology could also be applied to species/habitats different from those listed in the Habitats and Birds Directives (e.g. table 1 of Annex III of the Marine Strategy Framework Directive).

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[1] http://ec.europa.eu/environment/nature/natura2000/marine/index_en.htm

The document intends to cover all professional fisheries under the Common Fishery Policy. The conceptual model developed for this methodology could also be applied to recreational fishery.

2. Conceptual model

The evaluation of impacts of commercial fisheries on Natura 2000 sites, including both SCIs, SACs and SPAs, is part of a larger process aimed at reducing the conflicts between fisheries activity and conservation of habitats/species of EU interest. This work was based on the general conceptual model in Figure 1. The methodology proposed refers only to the part inside the grey square, thus excluding the identification of fishery management measures.

Fig.1 General conceptual model. The methodology presented in this document refers to the part inside the grey square.
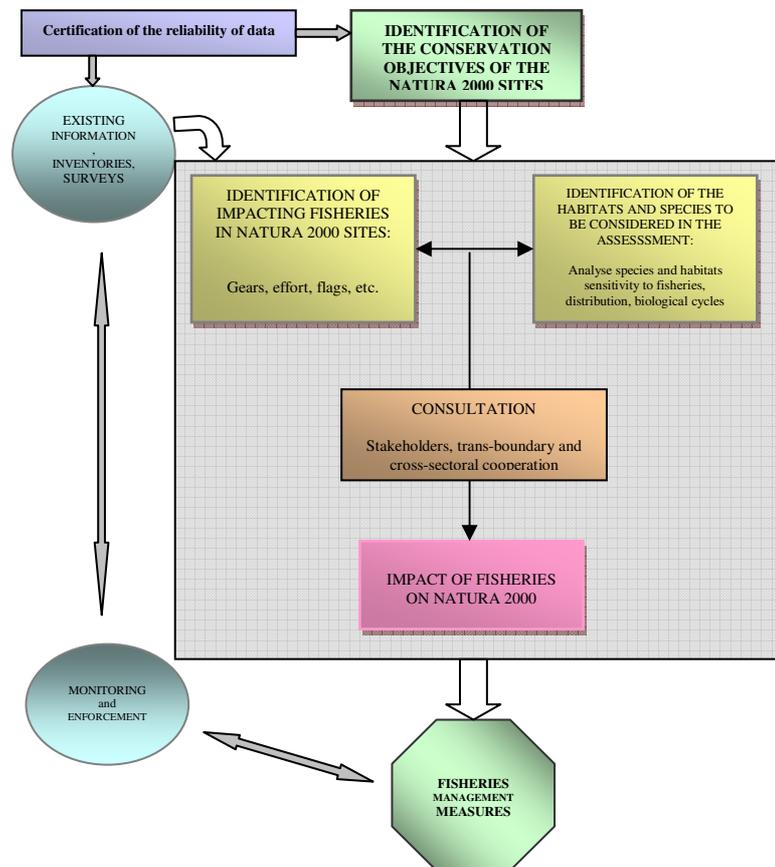
3. Methodology

The assessment of the impacts of commercial fisheries involves a hierarchical approach that moves from a comprehensive but largely qualitative analysis of impacts at Step 1, through a more focused and quantitative approach at Step 2 (Figure 2).

This approach allows site managers to prioritise and focus efforts on regulating the activities considered to have the greatest potential impact. This entails the review of available relevant information in order to categorize the potential impacts associated with development proposals and associated management options.

The evaluation of impact of fisheries on Natura 2000 must be based on best available sound scientific information on both the fishery and the sites in order to be able to analyse impacts. It should use the best available techniques (i.e. satellites, remote sensors, etc.), methods and approaches (i.e. GIS, predictive models, etc.) to estimate the extent of the effects.
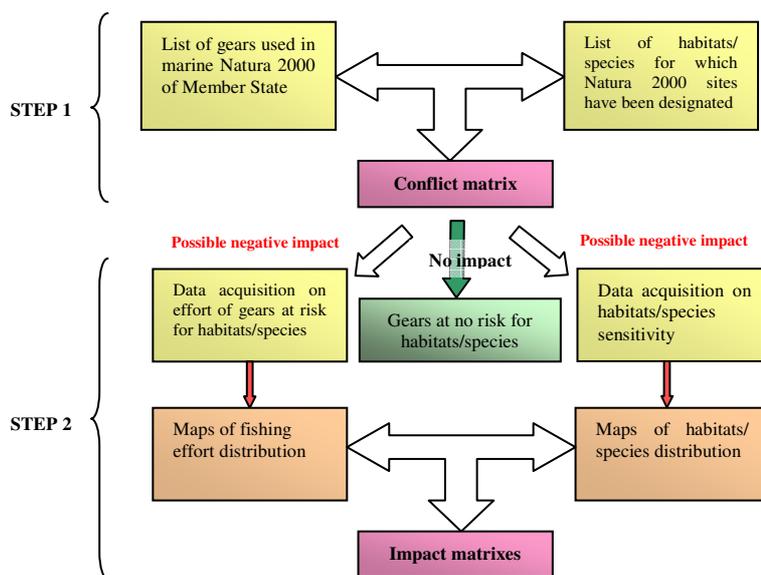
Fig.2 Methodology protocol (it covers the grey part of Figure 1).

The relevant stakeholders such as fishermen organisations, NGOs and CSOs should be consulted during the assessment process.

Step 1: qualitative assessment of impact

The analysis of the two main components of this assessment, fisheries and habitats/species of EU interest, should be carried out in parallel (Fig. 2), through a literature analysis. The minimal required information to start to assess the impacts of commercial fisheries on marine Natura 2000 sites is a list of:

 a) all habitats/species for which the marine Natura 2000 site is designated, i.e. habitats in Annex I and species in Annex II of the Habitats Directive and Annex I of the Birds Directive plus migratory birds that justified designation of N2000 sites. The list can be obtained from the Natura 2000 standard data forms. The relevant habitats and species should be identified taking into consideration the conservation objectives of the Natura 2000 sites;

 b) gears[2] used in the marine Natura 2000 sites and nearby them but having an impact therein should be compiled. Differences between gears and their environmental impacts need to be known.

Output

The two lists above will be used to compile the conflict matrixes, one for habitats and one for species. For each of the habitat/species for which the Natura 2000 site has been designated, the matrixes should report whether each of the gear could have a negative direct pressure on them, even though the matrixes do not indicate the magnitude of the impact or significance of the impact on habitats/species (presence/absence of conflict).

On the basis of the two matrixes, it will be possible to select the types of gears that could have negative impacts to specific habitats/species of EU interest in the Natura 2000 sites. Only these gears and these habitats/species have to be further investigated.

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[2] Level 4 of the classification of fishing activity reported in the Appendix IV of the Commission Decision 2010/93/EU of 18/12/2009 adopting a multiannual Community programme for the collection, management and use of data in the fisheries sector for the period 2011-2013.

Step 2: semi-quantitative assessment of impacts

The information to be taken into consideration is:

a) *Spatial and temporal distribution of habitats/species*

Information collected should as far as possible contain the following:

- ecology of habitats and species for which the site has been designated;
- specific conservation objectives for each of the features for which the site is designated;
- description of the spatial and temporal distribution of habitats and species for which the site has been designated;
- data on habitats/species, including condition and favourable conservation status;
- importance of the site at national and biogeographical region for the conservation of relevant habitats/species;
- data on species population and on usage of the site by species for activities such as foraging, breeding, etc.;
- intolerance, recoverability and subsequent sensitivity of habitats/species population to fishing disturbance.

On the base of the information collected, summary forms with the description of specific habitats/species or group of species and maps of the distribution of habitats sensitive to fishing pressure inside the marine Natura 2000 site and of the distribution of species population should be produced. If relevant, maps of the use of the site by species in different seasons should also be produced.

b) *Spatial and temporal distribution of fishing effort and fishing intensity*

For each type of gear identified in the previous phase, spatial and temporal data on fishing effort inside the Natura 2000 sites with vulnerable habitats/species should include data collected preferably at least for the previous three years. In practice this means the use of logbooks and for larger vessels automatic location communicators (e.g. VMS).

It needs to be emphasized that spatial and temporal distribution of the total fisheries occurring within the Natura 2000 sites should include all vessels, i.e. both with and without automatic location communicators (satellite-tracking devices), belonging to the national and to the international fleets operating in the areas.

On the base of the information collected, maps of the distribution of fishing intensity inside each marine Natura 2000 sites during the different seasons (winter, spring, summer, autumn) should be produced. Cumulative maps relative to the total fishing intensity during the four seasons should also be produced.

Output

Data on spatial and temporal distribution of fishing activities and associated pressures should be combined with spatial data on habitats and species distribution and with temporal data on the biological cycle of the species of EU interest. Overlay analyses will determine potential conflict/no-conflict zones in relation to the demarcated boundaries of the Natura 2000 sites (presence/absence of conflict).

The next phase will be to assess whether potential conflicts exist between conservation objectives and the use of the area.

c) *Sensitivity of habitats/species population to fishing pressure*

The sensitivity analysis of relevant habitats and species to the different aspects of fishing pressure should be carried out where potential conflicts exist between conservation objectives and the use of the area (i.e. fishing overlap in space and in time with the distribution areas of the relevant habitats and species).

Output

The link between the results of conflict analysis and of the sensitivity assessment of the habitat/species that could be impacted will allow to assess and rank habitats/species population sensitivity according to the actual fishing disturbance in each cell.

The ranking of the impact of fisheries on habitat/species should be carried out by expert judgement as a combination of fishing intensity and sensitivity, also taking into consideration the conservation status of the relevant habitats/species. Ad hoc expert workshops could be organised with this aim.

A comprehensive impact matrix (table 1), including the rank of the impact and the description of the type of impact, should be filled in for each Natura 2000 site for each habitat/species, which have a potential conflict with fisheries.

Tab.1 Example of impact matrix to be filled in.

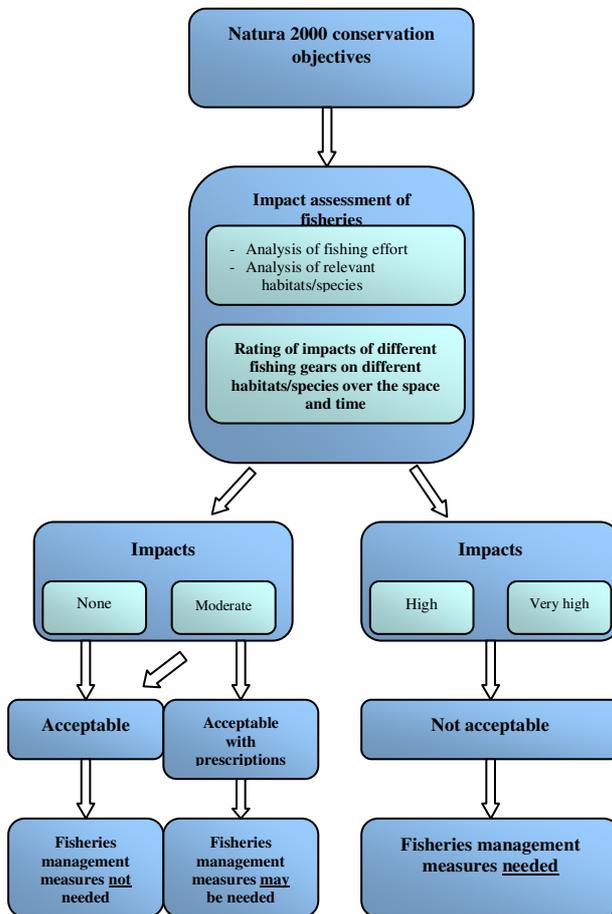| **Type of habitats** (Eunis level 3 or 4)	
Gear 1	
Type of impact	Eg scraping and ploughing of the substrate, sediment re-suspension, destruction of benthos
Scale of impact	According to the scale set up (e.g. Table 2.10)
Level of certainty	Depends mainly on the resolution of the habitat layer and the fishing pressure layer in GIS and the data available for the assessment
Gear 2	
….	
Species	
Gear 1	
Type of impact	Mortality, displacement
Scale of impact	
Level of certainty	
Gear 2	
….	

An integrated analysis of the cumulative effects of fisheries impacting habitats and species for which the site has been designated should be carried out. The analysis should take into consideration the conservation objectives of the Natura 2000 sites and the contribution of the site to the favourable conservation status of the relevant habitats/species. A map summarizing all the impacts of different types of gear on the conservation objectives of the marine Natura 2000 site should be produced.

4. Next step

The implication of the findings of the impact of fisheries on the Favourable Conservation Status of habitats and species for which the Natura 2000 sites have been designated should be clear and couched in the precautionary approach. In some cases it will be certain that long-term impacts will occur. In other cases no impact might be found but sufficient doubt may remain to warrant detailed monitoring and adaptative management. There is a gradation of findings that should be linked to a gradation of responses. An objective and science-based decision-making process

would help to link the impact matrix (Table 1) to a decision support matrix (Figure 3), which can be case specific.

Fig.3 Decision support tree.

The different ways in which to deal with a specific impact should be established. This may offer a choice in situations where a given impact may be acceptable. Acceptance could be passive in the event the impact is none or low, or active where the moderate impacts can be accepted with prescriptions. When the impacts are high or very high they are not acceptable.

In case impacts are not acceptable, specific fisheries management measures should be identified. When impacts are moderate the need of these measures is to be evaluated.

The judgment of experts is important when different gears have different effects (even positive effects) on habitats/species for which the Natura 2000 site has been designated.

1 Introduction

Impacts of professional fisheries on marine ecosystems are a regular subject of debate among scientists, policy makers and those that exploit the sea's natural resources in particular in the Natura 2000 sites.

The Natura 2000 network has been established in the framework of the Habitats and Birds Directives, whose objective is to maintain or restore habitats and species of EU interest in a favourable conservation status. Marine professional fisheries are of exclusive competence of the EU in the framework of the Common Fishery Policy (CFP).

The progress in establishing the Natura 2000 network is now underlining the need of a common, harmonized methodology at EU level, to assess the impact of fisheries on marine sites, with a view to ensuring level-playing field and compliance with applicable provisions under the Habitats and Birds Directives and the CFP. This proposal for a methodology is the response to this need. A common methodology is also needed in order to help achieve an equal treatment of fishermen in relation to management of Natura 2000 sites, particularly where national and foreign vessels both fish within a site.

Being aware of the existing differences among fisheries activity in EU seas (e.g. North Sea versus Mediterranean Sea), this methodological proposal deals with the identification of tools, which should be, when applied, opportunely calibrated and set within the specific fisheries context.

This document is based on findings of a short and concise search effort into scientific literature and on the best available knowledge. It is mainly focussed on papers in international peer-reviewed journals and on research reports and conference publications when they originated from an internationally recognised scientific institution or EU public administration. However, there are still knowledge gaps in the fishery sector and regarding the evaluation of its impact at habitat/species levels. This methodology is also aimed at improving the knowledge on the issues treated and at promoting the exchange of information among Member States, which is now not sufficiently implemented and standardised.

The quality of an evaluation of the impacts of fisheries in Natura 2000 sites is limited by the availability of data, the lack of appropriate studies and knowledge and a number of other uncertainties regarding the assessment of impact. However, strategic use of fisheries information from VMS and logbooks can provide detailed information about fishing activities present in Natura 2000 areas and especially for towed gears detailed spatial information about the actual efforts in relation features of the Natura 2000 area such as habitats. The integration of such data with the assessment of habitats/species sensitivity (and their inherent biological traits and life cycles) in the framework of a assessment of impacts provides a common, harmonized methodology at EU level for the mapping of fishing pressures in N2K sites. Harmonising the mapping of fishing pressures for small scale coastal fisheries (<12m), which do not transmit VMS, is more problematic.

However, it is worth noting that no single descriptor or parameter can effectively or reliably explain the impact of fishing pressures on community structure and habitat response; a number of parameters are required to describe the nature of the activity, the nature of the impact or response, the potential rate of recovery and overall sensitivity of receiving habitats. In relation to characterising the conservation status and sensitivity of the receiving habitat the most used parameters include morphology and environmental position, their life history, the physical nature of the habitat itself (especially for soft sediments), and contribution to ecosystem function (e.g. biogenic habitats, biomass and productivity).

The assessment procedure must take into account the precautionary principle, according to which the absence of adequate scientific information should not be used as a reason for postponing necessary management measures. For this reason all information available coming from different sources, including the historical activity in the area, in connection with the conservation status of habitats and species, expert judgements, improving knowledge and monitoring parameters identified, should be taken into account. Only when information is not sufficient to adequately assess the potential impact on habitats/species in an area, should the precautionary principle be used.

1.1 Objective and scope of the document

This methodology is intended to be bound by and faithful to the articles of the Habitats and Birds directives and the wider principles underpinning EU environmental law and policy. It is not legislative in character, but provides non-binding guidance on the application of existing legal provisions in the context of fisheries in the Natura 2000 network.

It is consistent with the previous advice given by the Commission on the implementation of the Habitats and Birds directives, in particular with the document "Fisheries measures for marine Natura 2000 sites: A consistent approach to requests for fisheries management measures under the Common Fisheries Policy"[3]. The results of the impact evaluation would contribute to assess the need of specific fisheries management measures and to collate the scientific and technical information needed to request for fisheries management measures under the CFP.

The document "Fisheries measures for marine Natura 2000 sites" lists the following information to compile the formal request of Member States for fisheries management measures for Natura 2000 sites located outside their territorial waters (outside the 12 nautical miles of a Member States' coast):

1) Comprehensive description of the natural features including distribution within the site.
2) Scientific rationale for the sites selection in accordance with the information provided in the Natura 2000 data form. Intrinsic value of its features. Specific conservation objectives.

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[3] http://ec.europa.eu/environment/nature/natura2000/marine/index_en.htm

3) Basis for the spatial extent of the site boundary clearly justified in terms of conservation objectives.
4) Threats to habitats and species from different types of fishing gear. List of other human activities in the area that could damage the habitats.
5) Fleet activity in the area and in the region, distribution of fleets (by nation, gear and species), and information on target and by-catch species, all over the last 3 years.
6) Seasonal trends in fisheries over the last 3 years.
7) Proposed fisheries management measures to maintain the habitats features in favourable condition. Are they proportionate and enforceable? Other conservation measures that apply to the area.
8) Control measures envisaged by the Member State, possible ecological and control buffer zones to ensure site protection and/or effective control and monitoring measures.
9) Measures to monitor and assess the maintenance and/or recovery of the features within the site.
10) Coordination with neighbouring Member States as appropriate.
11) Evaluation of possible displacement of fishing effort and impact on new areas.

The methodology described here provides guidance on points 1-3 above (provision of spatial information on habitats and species at the appropriate spatial and biological resolution) and points 5-6 (guidance on mapping of fishing pressures), Other points such as identification of threats (4) or proposed management (7) and control measures (8) in response to an identified risk and monitoring of features (9) are not dealt with. Management and control measures are outside the scope of the document as the design of such measures is a matter for regulatory authorities/Ministries, stakeholders, control agencies and co-operating national administrations.

This document also aims to provide guidance that is:
- Based on well-founded ecological principles and scientific evidence;
- Practical and feasible within existing policy and legislation frameworks;
- Non-prescriptive, so that it can be improved and adapted as necessary by Members States according to their specific needs and circumstances;
- Flexible so that it can be refined in response to likely improvements in our understanding of the impacts of fisheries on biodiversity in the Natura 2000 network.

The document intends to cover all marine Natura 2000 sites (inshore and offshore), including the entire geographical marine area to which the Habitats and Bird Directives apply, in order to define, when necessary, fisheries measures equally proportionate on the base of harmonized analyses.

The methodology focuses on habitats and species for which the sites have been designated, i.e. habitats in Annex I and species in Annex II of the Habitats Directive and Annex I of the Birds Directive plus migratory birds that justified designation of Natura 2000 sites. Although the methodology for assessing the impacts of fisheries to habitats and species in a particular site can also be applied to mobile species, for which the site is designated, the relevance of doing so will depend on the proportion of the population of the designated species that occurs in the site. Nevertheless, at the site level, the impact to the individuals of the population within the site should be assessed. The methodology

will not cover Annex IV species (Habitats Directive), even though the same approach used for mobile Annex II species could be also applied to mobile Annex IV species. This methodology could also be applied to species/habitats different from those listed in the Habitats and Birds Directives (e.g. table 1 of Annex III of the Marine Strategy Framework Directive).

Even though the focus is on the Natura 2000 sites, if needed, the methodology could be also applied outside the sites to assess the impact of fisheries on mobile species that justified designation of Natura 2000 sites or in case an activity outside the site will affect the integrity of it. The possible need to extend the scope of assessments outside the Natura 2000 sites is to be established on a case-by-case basis, according to the conservation interests concerned (e.g. may be required for highly mobile species, protection of bird species from by-catch, harbour porpoise, etc.).

The document intends to cover all professional fisheries under the Common Fishery Policy (no fishing fleet segments or gears are scoped out of the process). The conceptual model developed for this methodology could also be applied to recreational fishery.

The methodology is a tool that should contribute to the implementation of art. 6 of the Habitats Directive, without any distinction between articles 6.1, 6.2 and 6.3, because all these provisions involve an evaluation of the impact of fisheries on marine Natura 2000 sites. The procedure for the definition of fisheries measures is not part of the methodology itself (cf Guidance on fisheries measures for marine Natura 2000 sites). The methodology is aimed at furnishing harmonized analyses of Natura 2000 sites and the technical information required to properly enact protection measures, when needed.

1.2 Conceptual model

The evaluation of impacts of commercial fisheries on Natura 2000 sites, including both SCIs, SACs and SPAs, is part of a larger process aimed at reducing the conflicts between fisheries activity and conservation of habitats/species of EU interest. In this context starting from the conservation objectives of the Natura 2000 sites, the assessment procedure will allow for the identification of impacts of fisheries and will represent the base to the formulation of specific measures to limit the impacts identified.

This work was based on the general conceptual model in Figure 1.1. The methodology proposed refers only to the part inside the grey square, thus excluding the identification of fishery management measures.

Fig.1.1 General conceptual model. The methodology presented in this document refers to part inside the grey square.
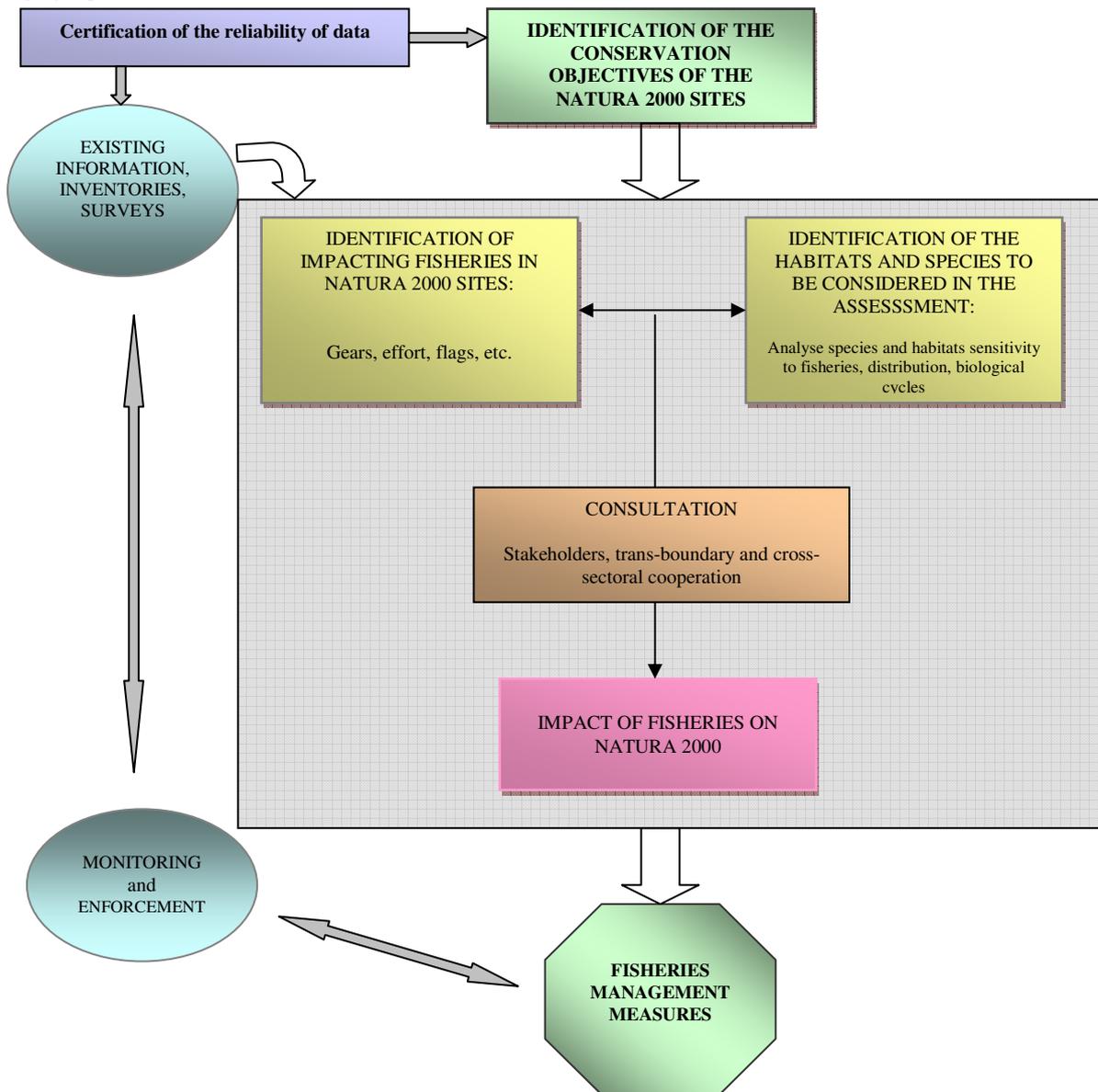
Assessments would benefit from the adoption of the DPSIR framework, according to which there is a chain of causal links starting with

'**driving forces**' (food demand and the interests of industry/fishermen), through
'**pressures'** (fishing activities), to
'**states'** (physical, chemical and biological conditions of habitats and species for which the Natura 2000 sites have been designated) and
'**impacts'** (opportunely ranked as low, moderate, high and very high) of fisheries on habitats/species eventually leading to
political '**responses'** (identification of fisheries management measures, outside the scope of this document).

Fig.1.2 DPSIR assessment framework
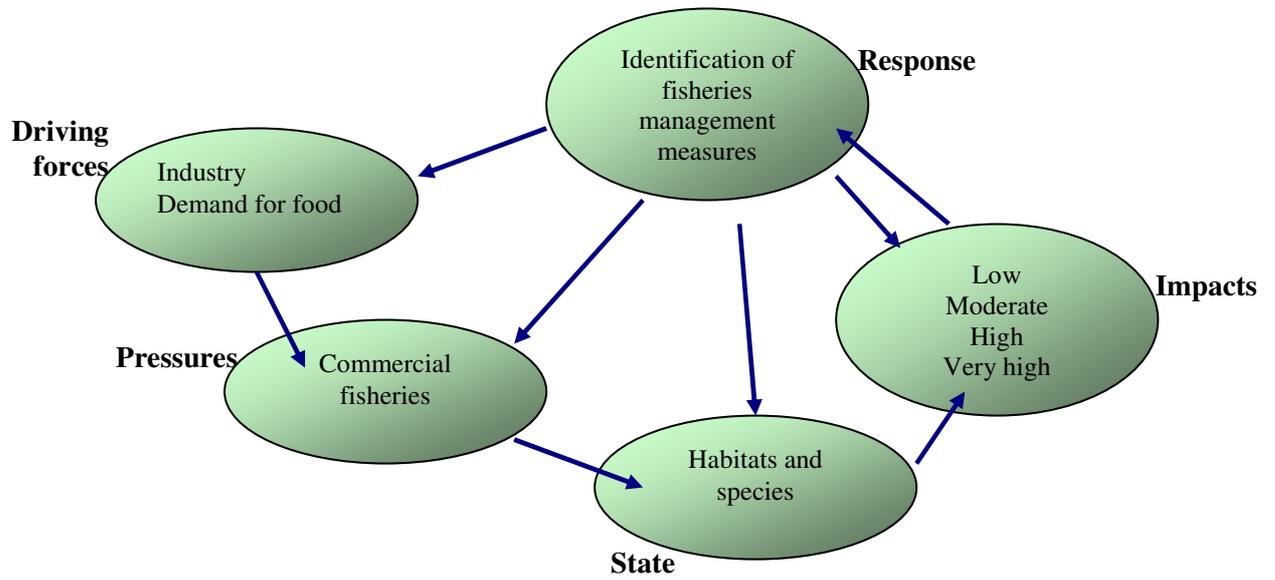
2 Methodology

The methodology is intended to provide a step by step guide in collecting and analysing the main elements to take into consideration to assess the impact of fishing on marine Natura 2000 sites, identified in the protocol below covering the grey part of Figure 1.1.
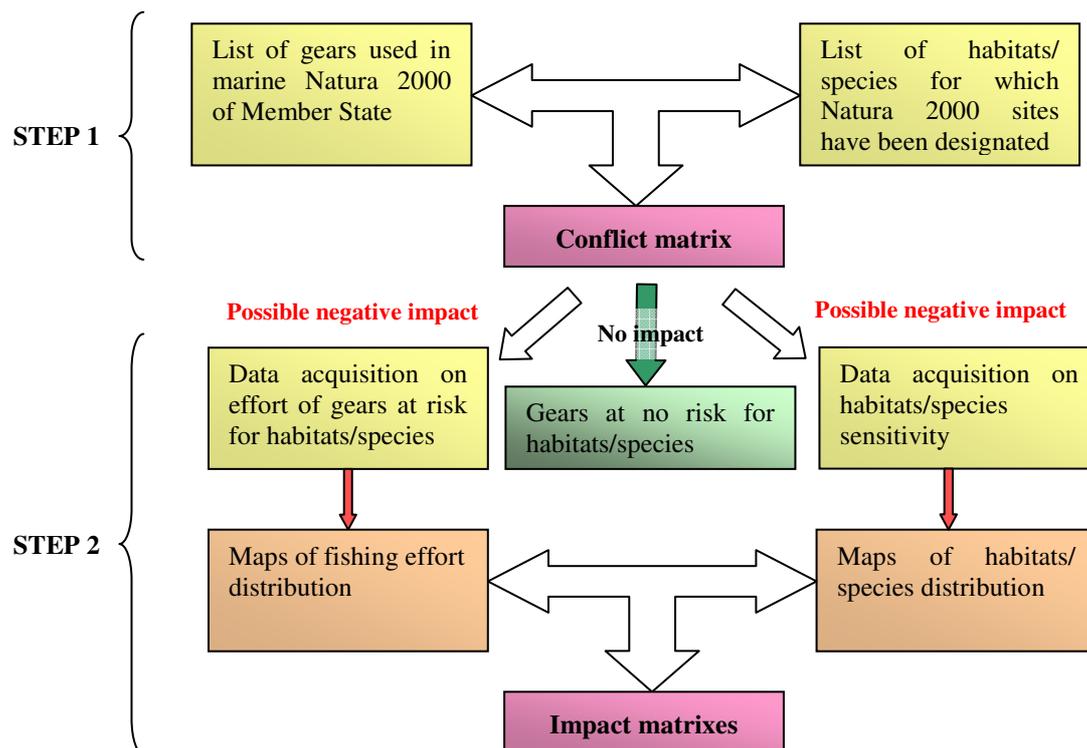
Fig.2.1 Methodology protocol.

The assessment of the impacts of commercial fisheries involves a hierarchical approach that moves from a comprehensive but largely qualitative analysis of impacts at Step 1, through a more focused and quantitative approach at Step 2 (Figure 2.1). This approach is efficient because many potential impacts are screened out at Step 1, so that the more intensive and quantitative analyses at Step 2 are limited to a subset of the higher potentially impacting activities associated with fishing. This approach is also precautionary, in the sense that possible impacts will be scored high in the absence of information, evidence or logical argument to the contrary, thus implying a bias towards false positives outcomes (fisheries are scored at higher risk of impact that would occur when assessed at a higher level with more data) rather than false negatives. The judgment of specific highly qualified experts will be important when relevant information is absent or insufficient.

This approach allows site managers to prioritise and focus efforts on regulating the activities considered to have the greatest potential impact. This entails the review of available relevant information in order to categorize the potential impacts associated with development proposals and associated management options. The evaluation of impacts

should be the base for the identification of the fisheries measures, a procedure which is outside the scope of this document.

The evaluation of impact of fisheries on Natura 2000 must be based on best available sound scientific information on both the fishery and the sites in order to be able to analyse impacts. It should use the best available techniques (i.e. satellites, remote sensors, etc.), methods and approaches (i.e. GIS, predictive models, etc.) to estimate the extent of the effects.

A crucial process in this assessment framework is to document the rationale behind assessments and decisions at each step in the analysis. The degree and type of uncertainty in each of the assessments has to be stipulated, based on the sources of evidence used. These could be accordingly classified as high, medium and low uncertainty, with appropriate sub-divisions. This is also necessary to make clear to the end-user the strength of evidence used. The categories are described in Annex B and Member States should guarantee the reliability/quality of data sources.

For each of the outputs the degree and type of certainty should be indicated. An explanatory table with indications on the reliability of data should be provided (Table 2.1).

Tab.2.1. Example of table to be filled in to stipulate evidences used and then certainty of the assessment. The relevant category of evidence should be crossed.

Evidence used			
Directly relevant site specific studies relative to the impacting fishery and peer reviewed literature	Directly relevant grey literature	Inference from peer reviewed or grey literature relating to a comparable habitat, gear or geographical area	Expert judgement
Reference list (if applicable)			
Comments			

2.1 Step 1: qualitative assessment of impact

The analysis of the two main components of this assessment, fisheries and habitats/species of EU interest, should be carried out in parallel (Fig. 2.1). The minimal required information to start to assess the impacts of commercial fisheries on marine Natura 2000 sites is:

  c) habitats and species of EU interest[4] for which the site is designated;
  d) gears used, or potentially being used in the site.

[4] Protected under the Habitats and Birds Directives.

2.1.1 Identification of habitats/species
The first need is a list of all habitats/species for which the marine Natura 2000 site is designated, i.e. habitats in Annex I and species in Annex II of the Habitats Directive and Annex I of the Birds Directive plus migratory birds that justified designation of N2000 sites. The list can be obtained from the Natura 2000 standard data forms. The relevant habitats and species should be identified taking into consideration the conservation objectives of the Natura 2000 sites.

2.1.2 Analysis of gears
A list of gears[5] (Annex C) used in the marine Natura 2000 sites and nearby them but having an impact therein should be compiled. Differences between gears and their environmental impacts need to be known[6].

Fig.2.2 A few example of fishing gears.
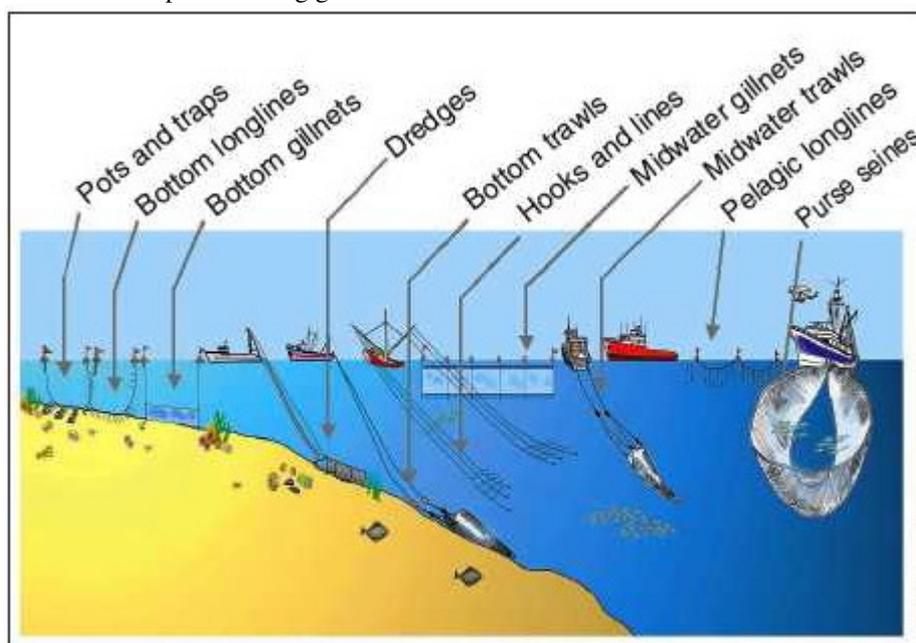
The determination of the typology of impact of each type of fishery to the various habitats/species of EU interest for which the site is designated can be carried out through a literature analysis and exchange of information among Member States. There is less information on less vulnerable habitats, so literature analysis can be useful more specifically for the more impacting types (e.g., heavy beam trawl, scallop dredge) on the most sensitive habitats (e.g. maerl beds, ross coral, etc.), but not for the less vulnerable habitats (e.g., mud, mixed sediments, mobile sand, etc). Little information is also available for the less impacting gears (e.g., static gears) and in some cases literature

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[5] Level 4 of the classification of fishing activity reported in the Appendix IV of the Commission Decision 2010/93/EU of 18/12/2009 adopting a multiannual Community programme for the collection, management and use of data in the fisheries sector for the period 2011-2013.

[6] At present, differences between gears in terms of their environmental impacts is unlikely to be reached, due to the paucity of data on their impacts on specific habitats, However, a qualitative correspondence can be established between gears and the habitat components (e.g. demersal, benthonic, pelagic, etc.) affected by their use.

doesn't differentiate between weight of different gears (e.g., light and heavy otter trawls). Literature is a source of information, but that whilst some gear/habitats interactions are relatively well understood (bottom trawls on coral reefs) many other are still poorly understood as have been studied much less (e.g. sandbanks).

The type of impacts on each specific habitats/species should be described for each of the gears (e.g. removal of species, destruction of sediments, bycatch, etc.), similar to the work carried out in France (le Fur, 2010), where 22 forms specific for each of the gears used in the country have been produced. This information would be useful when there is a need to identify specific fisheries management measures and in attempts in improving fishing gears.

Output

The two lists above will be used to compile the conflict matrixes (Tables 2.2 and 2.3). The matrixes will have varying degrees of confidence of the actual impacts depending on the literature information on the impacts of fishing gears on the specific habitats/species. These degrees of confidences will need to be described in any system. The matrixes should include both gear types for which reliable data exist confirming the impact and even gear types for which sufficient data excluding the impact do not exist.

Two conflict matrixes, one for habitats and one for species of EU interest, should be filled in. For each of the habitat/species for which the Natura 2000 site has been designated, the matrixes should report whether each of the gear could have a negative direct pressure on them, even though the matrixes do not indicate the magnitude of the impact or significance of the impact on habitats/species.

For the most heterogeneous habitats, e.g. 1160 large shallow inlets and bays, it will be necessary to break the habitats down to the sub-feature level at the finest scale possible (e.g., Eunis 3 or 4[7]). Table 2.2 is an example of the final output of this exercise.

Tab.2.2 A hypothetical example of a conflict matrix for habitats for which the site has been designated.

Habitats of EU interest	Fishing gears						
	Bottom trawl	Pelagic trawl	Beam trawl	Towed dredge	Gillnet	Longlines	Etc.
1110 Sandbanks which are slightly covered by sea water all the time	▓		▓				
1120 *Posidonia* beds	▓			▓			
1150 Coastal lagoons				▓			
Etc.							

Both the species listed in the Habitats and Birds Directive (inside or outside the marine Natura 2000 sites) should be taken into consideration. Table 2.3 provides an example of the final output of this exercise.

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[7] http://eunis.eea.europa.eu/about.jsp

Tab.2.3 A hypothetical example of a conflict matrix for species for which the site has been designated.

Species of EU interest	Bycatch by fishing gears							Other effects		
	Bottom trawl	Pelagic trawl	Beam trawl	Towed dredge	Gillnet	Longlines	Etc.	Food depletion	Disturbance	Discard
Caretta caretta	▬				▬	▬				
Tursiops truncatus	▬	▬			▬				▬	
Calonectris diomedea		▬				▬		▬		
Etc.										

Note that these matrixes are general and not definitive: many local factors may influence the actual impact of fishing activities on habitats/species for which the site has been designated, based on the actual practice of fishing activity on the site and of the local environmental conditions. It is therefore necessary to conduct a local analysis to evaluate the pressure and impact on these habitats/species.

On the basis of the two matrixes, it will be possible to select the types of gears that could have negative impacts to specific habitats/species of EU interest in the Natura 2000 sites. Only these gears and these habitats/species have to be further investigated.

2.2   Step 2: semi-quantitative assessment of impacts

The information to be taken into consideration is the geographic distribution of habitats and of fishing activity in the Natura 2000 sites and the area of distribution of the species for which the site has been designated. Information has to be reported on georeferenced maps, which include also the temporal extent.

2.2.1 Spatial and temporal distribution of habitats/species
Only for habitats/species that are sensitive to fishing pressures according to the conflict matrixes, supplementary information should be collected through literature, management plans, the report on the Conservation Status of Habitat Types and Species as required under Article 17 of the Habitats Directive and specific surveys.

Information collected should as far as possible contain the following:
- ecology of habitats and species for which the site has been designated;
- specific conservation objectives for each of the features for which the site is designated;
- description of the spatial and temporal distribution of habitats and species for which the site has been designated;
- data on habitats/species, including condition and favourable conservation status;
- importance of the site at national and biogeographical region for the conservation of relevant habitats/species;

- data on species population and on usage of the site by species for activities such as foraging, breeding, etc.;
- intolerance, recoverability and subsequent sensitivity of habitats/species population to fishing disturbance.

On the base of the information collected, summary forms with the description of specific habitats/species or group of species and maps of the distribution of habitats sensitive to fishing pressure inside the marine Natura 2000 site and of the distribution of species population should be produced. If relevant, maps of the use of the site by species in different seasons should also be produced.

2.2.2 Spatial and temporal distribution of fishing effort

For each type of gear identified in the previous phase, spatial and temporal data on fishing effort (expressed in fishing hours[8]) inside the Natura 2000 sites with vulnerable habitats/species should include data collected preferably at least for the previous three years. In practice this means the use of logbooks and for larger vessels automatic location communicators (e.g. VMS). Logbooks contain different levels of spatial information depending on Member state but should include at least information at a 30 x 30 nm scale.

It needs to be emphasized that spatial and temporal distribution of the total fisheries occurring within the Natura 2000 sites should include all vessels, i.e. both with and without automatic location communicators (satellite-tracking devices), belonging to the national and to the international fleets operating in the areas.

In case Member States have other fisheries observation programs, attempts should be made to use these data. For instance, some of the data can be extracted from national databases on the fishery sector set up in the framework of the Commission Regulation 404/2011, which gives Member States the opportunities to use data also for scientific purposes. Another possibility comes from the Council Regulation 2008/199/EU. The data collection program in this Regulation, started in 2009, is aimed at

    a) improving quality, completeness and broader access to fisheries data, more efficient support for provision of scientific advice;

    b) assessing the effects of fisheries on the marine ecosystem (and);

    c) promoting cooperation among Member States.

Data collection is mandatory, and the data stored in a national database are managed by the competent authority. In particular the national databases should include variables (Appendix VIII of the Commission Decision 2010/93/EU of 18/12/2009) and data on three important indicators[9]: Distribution of fishing activities (code 5), Aggregation of fishing activities (code 6) and Areas not impacted by mobile bottom gears (code 7).

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[8] On going discussion to assess systems of effort management may vary the fishing effort scheme used in the methodology. Recently, it was observed that more systematic and widespread data collection of fishing gear parameters would help refine effort metrics when dealing to how VMS and new monitoring systems could be useful in terms of providing better estimators of effort. For example instead of estimating effort in terms of time, trawl sensors could be used to quantify swept volume or area, while detailed description of activities including gear configurations, local variability in gear design and operations should be collected.

[9] Appendix XIII of the Commission Decision 2010/93/EU of 18/12/2009.

However particular attention should be paid in using VMS and other data collected under EU control and fisheries data collection regulations, because this could lead to legal issues related to confidentiality and the use of data for purposes other than those for which they are collected. Data Collection Framework foresees the sharing of information between scientific authorities, but that it is often challenging, notably for privacy reasons. Nonetheless, attempts should be made to share and use such data, between MS competent authorities.

2.2.2a Vessels equipped with automatic location communicators
One of the most reliable ways of obtaining fishing activity data is from the Vessels Monitoring System (VMS)[10].

Since 2000, the European Commission legislated that all European fishing vessels longer than 24 meters and since 2005[11] all vessels longer than 15 m should be equipped with a VMS. The Council Regulation 1224/2009[12] extended this rule also to vessels longer than 12 m. All these vessels operating in EU waters are required to transmit automatically their location at a minimum of two-hours intervals (which could be insufficient for the scope of this study), but also shorter intervals are applied. However some derogations on these intervals are possible. For instance, the frequency of data transmissions shall be of at least once every 30 minutes when a fishing vessel enters some fishing restricted areas.

For a given vessel, VMS continuously provides data on the location, course and speed, without further specific information about type (gear) and/or amount (distinction between fishing and steaming) of fisheries activity. VMS pings are generally provided about once every 2 hours, which is insufficient to represent fishing activity in detail. Thus, a sound use of this tool must take into account methods to
  I. interpolate VMS pings in order to obtain an amplification of the signal and a realistic representation of vessel behaviour;
  II. disentangling VMS data to the corresponding gear type; and
  III. identify fishing activity (e.g. active trawling or gear set positions) within each VMS track.

These processing steps have to be applied after disaggregating VMS data in tracks. A track is a single trip operated by a specific vessel. The track is the unit at which fishing activity is analysed. Tracks can be easily identified by splitting VMS dataset in subsets corresponding to single vessels and then testing each VMS signal for polygon inclusion into   European   harbours (http://ec.europa.eu/fisheries/cfp/control/technologies/ers/index_en.htm). A series of consecutive positions outside harbours constitutes a trip bounded by a departure and an arrival harbour.

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[10] Two other sources of data could be used (AIS, VDS).
[11] Mandatory reporting of speed information only came into force in 2006, therefore speed data are not available for all vessels fitted with VMS from 2000 to 2005.
12 Council Regulation (EC) No 1224/2009 of 20 November 2009, establishing a Community control system for ensuring compliance with the rules of the common fisheries policy and the relative Commission Implementing Regulation (EU) No 404/2011 of 8 April 2011, laying down detailed rules for the implementation of Council Regulation (EC) No 1224/2009.

I. *Interpolation*

According to the conclusion of the WKCPUEEFORT[13] meeting held in 2011, the 2 hours frequency of the transmission of VMS signal is too long and greater utility (precision) could be achieved with increased ping frequency. Frequency of signals is critical even when accounting for difference among gears. WKCPUEEFORT recommends that the ping interval should be at a maximum of 30 minutes. This limitation may be reduced by the application of a method to interpolate fishing tracks. A recently proposed approach, based on Hermite spline, provides a realistic reconstruction of fishing vessel behaviour for all gears. Although the use of such a method results in the addition of information to the original data (since position, speed and heading for interpolated points are not originally present in the dataset), it seems to be able to capture the often complex pattern of vessels course, with acceptable levels of error for the interpolated quantities. The method is free from assumptions and does not require calibration procedures. A short description is provided in Annex D.

II. *Gear assessment for each track*

The classification of fishing activity at a fine scale requires information about gear used and catches. The fishing gear used by vessels that are monitored with VMS can be established by linking the VMS data to national logbook data using the vessel identifier and time. Logbooks contain mandatory information about:
   a) vessel identification;
   b) gear type and mesh size used during trip;
   c) dates of operation;
   d) fishing time for each day at sea with location identified with respect to ICES statistical rectangle;
   e) quantities retained on board[14].

If the information provided by the logbook is available and reliable, a state-of-art approach exists in order to link this data to interpolated VMS tracks. This approach provides a robust method to allocate logbook catches to VMS positions, with focus on potential mismatch.

However, given that different problems (e.g. legal restriction or unavailability) could limit the use of data from logbooks, other strategies and data sources have to be identified. A possible way is the collection, from each Member State, of the lists of gears for which each vessel operating in the Natura 2000 sites is authorized. This, in combination with VMS data, would allow classifying the activity corresponding to each fishing tracks by using artificial intelligence technique (Annex E).

It has to be noticed that fishers may switch gear during a trip, so that a single track cannot always be assigned to a single gear. In these cases of multi-gear tracks, if track cannot be partitioned in mono-gear portion, a precautionary approach could be adopted by considering effort data for all the involved gear.

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[13] "Workshop on the utility of commercial CPUE and VMS data in assessment" (5-7 April 2011 - ICES HQ, Copenhagen, Denmark).

[14] Commission Regulation (EC) No 1077/2008 of 3 November 2008 laying down detailed rules for the implementation of Council Regulation (EC) No 1966/2006 on electronic recording and reporting of fishing activities and on means of remote sensing and repealing Regulation (EC) No 1566/2007.

III. *Identification of fishing set position*

At present, VMS data do not indicate when fishing is and is not taking place, and analytical tools must be applied to separate fishing and non-fishing activity. Therefore, the use of VMS data to estimate fishing effort depends on accurate differentiation between fishing and non-fishing activity.

A speed rule could provide a simple method for identifying and estimating fishing activity, but a speed rule alone is not recommended to support accurate quantification of fishing effort. The primary reason is the absence of speed records for many VMS positions. A further problem is in applying generic rules to differentiate between fishing and non-fishing locations, which can introduce errors and reduce accuracy when estimating the spatial extent of fishing: is it hard to define a common rule for towed and static gears, and the present procedure is actually based on speed filter for towed gears and rough position for static gears. Reasonably, this could determine non-homogeneous level of precision in the estimation of fishing pressure for different gear types and, as a consequence, unbalanced assessment of fishing impacts.

A criterion largely applied to divide fishing points from non-fishing points (or 'steaming') is based on the vessel speed profile. Trips with observers on-board have demonstrated that the speed-frequency histogram is usually bimodal for vessels using trawl, the commonest type of towed gear, where the first low speed peak corresponds to fishing activity, while the upper peak corresponds to faster movements, e.g., to steaming between fishing grounds and harbours. Different gears have different "fishing speed" and it should be stressed that fishing speed could be remarkably different in different fleets operating in different areas. Speed rule for identifying fishing activity should therefore be identified from speed histograms per gear and in the area of interest.

However, this approach does not work for all active and passive gears. As example, a study carried out in 2008 showed, for purse seine, that the use of a simple speed threshold on VMS data leads to a 182% overestimation of the number of fishing sets. The limits of VMS should also be identified and taken into account. Different approaches have been developed to overcome this problem e.g. the use Artificial Neural Network and a state-space model to pursue this aim. Given that these approaches are characterized by a certain degree of computational and statistical complexity and that other sources of information (e.g. on-board monitoring systems for tracking of soak time) are usually unavailable, it could be simpler to use a speed rule for towed gears and presence-absence for static (active and passive) gears.

The final methodological choice about how to identify fishing set position could be done after a preliminary analysis of the effort composition, in terms of relative importance of each gears group, for each Natura 2000 site. If the effort is exclusively represented by towed gears, the use of fleet-specific fishing speed ranges could be the simplest criterion.

Fig.2.3 Overview of VMS data processing.
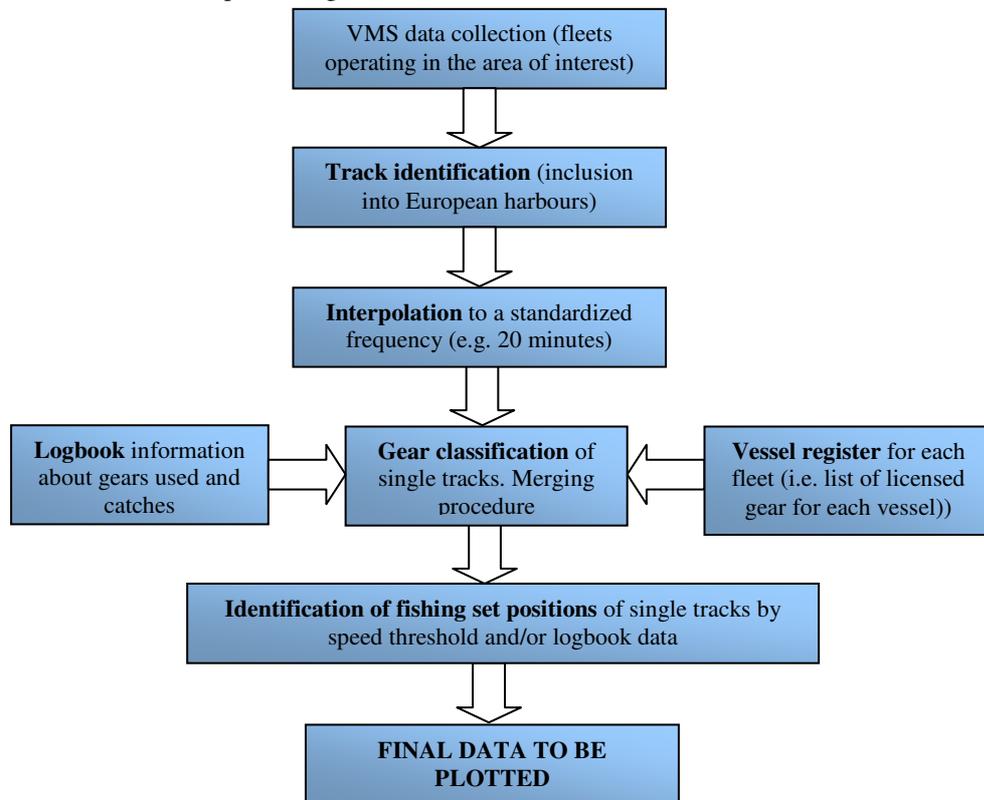
In this case, determination of fishing activity in VMS data could to be based on vessel-by-vessel speed profiles. Mean speed values will be calculated for all speed values comprised in the range of "fishing speed" for the specific gear used. All positions with a mean speed value in the range will be considered fishing-related positions and mapped. Conversely, when the role of active and/or passive gears is not marginal, an appropriate state-space model should be calibrated after collection of available data about fleet activity. The rationale flow for VMS data processing is shown in figure 2.3.

Data obtained at the end of the procedure will be represented by VMS pings accounting for fishing set positions at high temporal resolution and disaggregated to the finest scale of activity. These data will be mapped on a georeferenced grid for the area of study. Considering that data on habitats and species relevant to fishing activities are often distributed at small scales (about 1 km or less), processed VMS data should be plotted accordingly. The Working Group on the Ecosystem Effects of Fishing Activities strongly encouraged the use of a 3 km x 3 km grid, but in some cases the grid needs to be more detailed (for instance in coastal areas).

As the objective is not to simply describe activities but to determine geo-referenced pressures resulting from these activities, when acquiring fishing data every effort should be made to obtain quantitative information from which a fishing pressure footprint can be derived e.g. gear configuration, units of gear, fishing hours per day, number of fishing days. Such data complements VMS when this is available and can also be used to estimate pressures at 'some' spatial resolution when VMS is not available.

As recently recognized by ICES[15]:
1) there is a need for ensuring common data collection formats to allow that data from different sources are compatible and facilitate the production of global views of spatial activity and catches. The EU funded project "Development of tools for logbook and VMS data analysis" developed vmstools, a library which is an open source R package, available together with a wiki at http://code.google.com/p/vmstools. The package uses the common data formats (EFLALO2 for logbook data and TACSAT2 for VMS data) as input. The same input could be profitably selected in the Natura2000 framework;
2) the analytical approaches may differ between regions depending on the structure of the fishing sector, so that the development of "calibrated" approaches is welcomed.

<u>2.2.2b Data on vessels not equipped with automatic location communicators</u>
The majority of N2K sites are coastal and small in scale (e.g. habitats 1130, 1140) and fishing pressures in these sites largely arise from vessels <12m in length where there is no requirement to VMS until January 2012 and also vessels <10m in length where there is no uniform EU wide mandatory system of 'fishing activity' reporting. The principal characteristics of the small-scale fisheries are the high diversification of gears and techniques, the changing patterns of their use in time and space and the varying degree of fishermen's dependence on fishing. Data can be collected from the logbooks containing information about gear, total catch and the catch of specific species for every effort (set position) or for each trip, and in the case of vessels under 10m and if national authorities have not implemented logbook schemes for such vessels information can be obtained through interviews with fishermen. At least the fishing area and the days during which the different gears are used in each month should be obtained.

All interviews should be carried out by experienced interviewers with extensive knowledge of the fishing sector, on the base of a specific questionnaire covering the main fishing area/gear combinations. An example of questionnaire is reproduced in Annex F. Fishermen should be asked to report the location where most of their fishing effort occurs at least on a monthly basis (i.e. latitude and longitude) using maps as an aid and to answer questions regarding the quantity and size of gear used during a month, the set hauls per month or the number of days fishing per month, The monthly distribution of gear activity is relevant to assessing the persistence of pressure applied to a habitat and therefore the persistence of disturbance if the gear causes disturbance of habitat. At least the months where the gear is active and inactive should be identifiable.

Although some factors affecting the reliability of questionnaire data cannot be addressed (e.g., fishermen's memory accuracy), steps can be taken to assess and improve the reliability of response data to a large degree. In these cases scientific organisations can provide an important contribution. Questions and answer choices should be simple, straightforward, worded unambiguously, presented to fishermen in a standardized way, and pre-tested for clarity in all study areas. Non-response information (e.g., proportion of fishermen who refused to participate in the survey) should be collected and reported; this

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[15] "Workshop on the utility of commercial CPUE and VMS data in assessment" held at ICES HQ, Copenhagen, Denmark 5-7 April 2011.

can provide a measure of how representative the sample is of the target population. The number of interviews should be reliable from a statistical point of view to ensure the most accurate conclusions possible.

The information on fishing effort collected should be reported on maps, which should be validated by local fishing community through group validation meetings. The purpose of the validation meetings is to ensure that the amalgamated maps showing data from multiple interviews provide an accurate representation of the actual distribution of activity, given that it was not possible to interview every single fisherman in the area.

2.2.2c Determination of fishing intensity
The impact of fisheries on the Natura 2000 sites depends, among other factors, also on the fishing intensity (defined as fishing effort per unit area per unit time).

Depending on the requirements of the analysis with mapping of habitats or species, two different treatments could be applied to account for fisheries activities quantitatively.
Density mode: a quantitative per-area measure is derived. Each VMS position is considered as being representative of an area around the measured position as a result of movements of the vessels unaccounted for by VMS.
Point mode: fishing positions are mapped at high resolution to visualize small-scale distribution of activity in relation to habitat delineations.

Whatever the method the resolution of the fishing pressure data should be appropriate to identify pressures on potentially sensitive habitats/species and consistent with their spatial distribution. That is to say the resolution of fishing data should match the resolution of the habitat/species data.

On the base of the information collected, maps of the distribution of fishing intensity inside each marine Natura 2000 sites during the different seasons (winter, spring, summer, autumn) should be produced. This does not necessarily mean a ranking of the impact of fishing on habitat/species, which will be determined at a later stage by linking data on fishing intensity and data on habitats/species sensitivity. Cumulative maps relative to the total fishing intensity during the four seasons should also be produced.


Output
Data on spatial and temporal distribution of fishing activities (fishing intensity) and associated pressures should be combined with spatial data on habitats and species distribution and with temporal data on the biological cycle of the species of EU interest (results of sections 2.2.1 and 2.2.2). In particular with:
- spatial and seasonal distribution of species populations (abundance, or any consistent index of abundance);
- spatial and seasonal distribution of species according to particular stages of their life cycle (e.g. spawning, nursery areas, etc.);
- spatial distribution of habitats (presence/absence).

Spatial interactions between gear specific fishing intensity and species/habitats will be measured in GIS by analysing spatio-temporal overlaps between the core areas used for fishing and the core areas used by the species/habitats. Overlay analyses will determine potential conflict/no-conflict zones in relation to the demarcated boundaries of the Natura 2000 sites, similar to Figure 2.4 also including the ranking of conflict which is, however, not requested in this methodology (only presence/absence of conflict).

Fig.2.4 Results of conflicts analysis in the Pomeranian Bay relative to marine birds species (EMPAS project). The maps were developed by relating bird distribution and fisheries distribution data. The scale of ranking was developed by expert judgment.
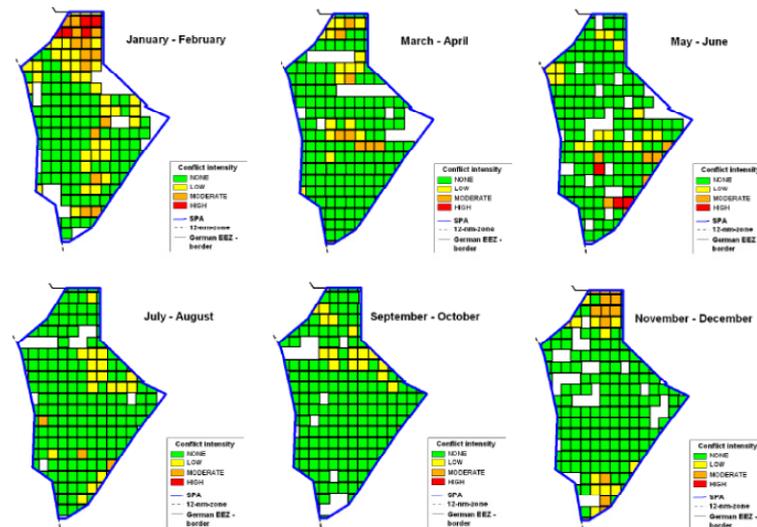
The main purpose of mapping the use of the area is to collate and present a common knowledge base for further work focussed on potential areas of conflicts where impacts of the fisheries on nature conservation objectives/targets are more likely. The information needed is spatial and temporal data on the conservation features and, similarly, spatial and temporal data on the use of the area where the features occur. Having these data at hand the next step will be to assess whether potential conflicts exist between conservation objectives and the use of the area.

2.2.3 Sensitivity of habitats/species population to fishing pressure

The assessment of the sensitivity, and hence vulnerability, of marine species, habitats or landscapes has long been held as a potentially powerful tool in marine environmental management and planning at local, regional and national scales.

In general, assessments have considered that sensitivity is a measure of the degree to which a receptor is affected by an impact and the ability of the receptor to recover from this (although studies may only focus on one aspect). Other studies have used the terms 'resistance' and 'resilience' to encompass similar concepts. The variety of studies and the differing purposes of these, and hence their approaches, have meant that alternative definitions and measures of sensitivity have been used in marine habitat assessment and other fields.

However there is still not an agreement on a common approach to assess the sensitivity of species populations/habitats and research activities are still ongoing on this subject.

Fig.2.5 Diagrammatic representation of Favourable Conservation Status (FCS) in relation to changes to habitats and species brought about by fisheries. The red line represents FCS for attributes of species and habitats.
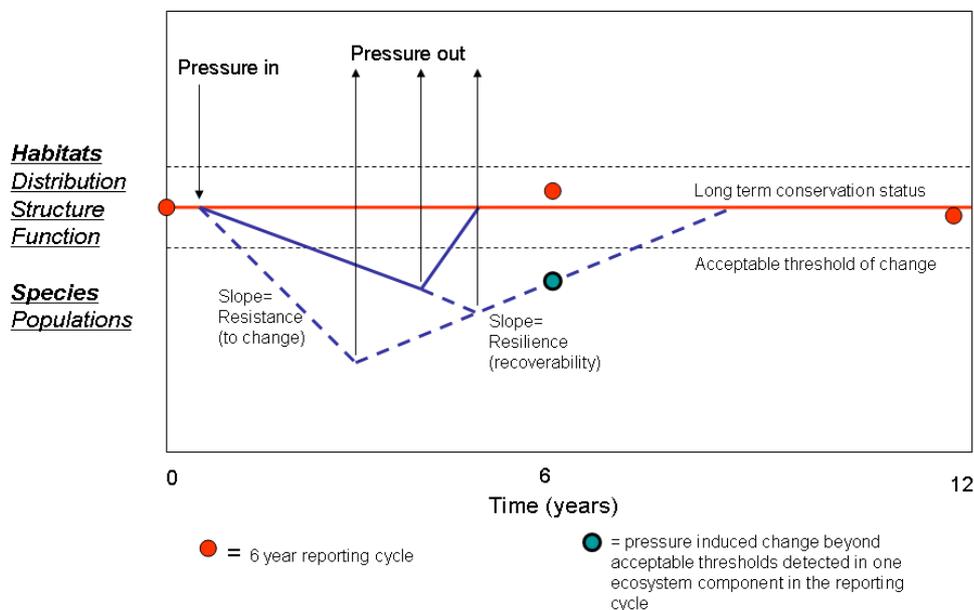
Given that natural systems are variable and dynamic there are acceptable thresholds of change from their favourable conservation status, especially when considering medium-term period dynamics as in the case of the six-year reporting cycles, foreseen by Article 17 of the Habitats Directive.

The complexity of this process in the context of Natura 2000 sites is summarized in Figure 2.5. The application of a pressure for different periods leads to change in the level of an attribute. However, attributes vary in their resistance to change (the rate of change in an attribute following application of a given level of pressure) and in their capacity to recover from change. This change is followed by recovery when the pressure is removed. Attributes (of habitats and species) have variable resistance and recovery capacity. The degree of change in the attribute may also affect recoverability. This could be due, for example, to reductions in productivity of the environment or the population. Resistance and recoverability are not necessarily linear processes over time or in relation to applied pressure but can take many different trajectories depending on the pressure applied, life-history traits and ecological properties of the habitat in question. Predicting the rate of change and recovery and their trajectories in relation to intensity and nature of applied pressures is a major challenge for assessing impacts of fishing on marine habitats.

The sensitivity analysis of relevant habitats and species to the different aspects of fishing pressure should be carried out where potential conflicts exist between conservation objectives and the use of the area (i.e. fishing overlap in space and in time with the distribution areas of the relevant habitats and species). Each species and habitat type has its own conservation requirements. Also, the impacts on a particular species or habitat

type may vary from one site to another depending on condition, the intensity and timing of disturbance and the ecological conditions.

The Marine Life Information Network (MarLIN) has developed a methodology for the assessment of the sensitivity of several habitats/species population to different environmental factors[16].

According to the MarLIN approach, biotopes (i.e. habitats[17])/species population sensitivity '*depends on the intolerance of a species or habitat to damage from an external factor and the time taken for its subsequent recovery*'. Thus, two main features must be assessed when estimating habitat/species population's sensitivity:
- intolerance: *the susceptibility of a habitat, community, or species, to damage or death, from an external factor*;
- recoverability: *the ability of a habitat, community, or species to return to a state close to that which existed before the activity or event caused change*.

Since the response of an habitat/species population to a change in an environmental factor depends on the magnitude, extent and duration of that change, MarLIN developed a suite of standard levels of magnitude and duration of change (benchmarks) for 24 different environmental factors, against which the level of response of species and biotopes has been assessed. These environmental factors are those components of the physical, chemical, ecological or human environment that may be influenced by natural events or anthropogenic activity:
-   Physical factors: substratum loss, suspended sediment; desiccation, changes in emergence regime, changes in water flow rate, changes in temperature, changes in turbidity, changes in wave exposure, noise disturbance, visual presence, physical disturbance and abrasion, displacement;
-   Chemical factors: synthetic compound contamination, heavy metals contamination, hydrocarbon contamination, radionuclide contamination, changes in nutrient levels, changes in salinity, changes in oxygenation;
-   Biological factors: introduction of microbial pathogens/parasites, introduction of non-native species, selective extraction of this species, selective extraction of other species.

In agreement with the benchmarks definitions, six "environmental factors" may be directly related to fishing impact, i.e. substratum loss, changes in suspended sediment, physical disturbance and abrasion, displacement, selective extraction of species.

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[16] For more detailed information, it is recommended to consider the full reports and peer-reviewed publications describing the methodology at the MarLIN web site (www.marlin.ac.uk).
[17] In the MarLIN approach the term habitat refers to the physical environment, i.e. the place in which a plant or animal lives, and it is defined for the marine environment according to geographical location, physiographic features and the physical and chemical environment (including salinity, wave exposure, strength of tidal streams, geology, biological zone, substratum), 'features' (such as crevices, overhangs, or rockpools) and 'modifiers' (for example sand-scour, wave-surge, or substratum mobility).
On the opposite biotopes are defined as the physical habitat with its biological community; thus, this term refers to the combination of physical environment and its distinctive assemblage of conspicuous species.
For practical reasons of interpretation of terms used in directives, statutes and conventions, in some documents, 'biotope' is sometimes synonymized with 'habitat' therefore for the purpose of this document, in relation to the Habitats and Birds Directives, the term biotope can be considered as synonymous of habitat.

<u>2.2.3a Sensitivity assessment of species</u>
The assessment rationale involves judging the intolerance of a species to change in an external factor arising from human activities or natural events. The rationale then assesses the likely recoverability of the species following cessation on the human activity or natural event. Intolerance and recoverability are then combined to provide a meaningful assessment of their overall sensitivity to environmental change.

After the collection of key information on the species listed in the Birds and Habitats directives for which the Natura 2000 sites have been designated from the best available scientific literature and the expertise of marine biologist, with assurance of reliability of data, the rationale used to prepare a review of the biology and sensitivity key information for a species is given below.

1. Assess the **intolerance** of the species to change in environmental factors with respect to a specified magnitude and duration of change (benchmarks; (www.marlin.ac.uk/sensitivitybenchmarks.php) for the aforementioned list of 24 separate environmental factors. The assessment of intolerance is then made according to an intolerance scale (Table 2.4) by reference to the reported change in environmental factors and their impact, relative to the magnitude and duration of the standard benchmarks and other relevant key information.

Tab.2.4 Ranks of species intolerance. Intolerance is assessed relative to change in a specific factor.

Rank	Definition
High	The species population is likely to be killed/destroyed by the factor under consideration.
Intermediate	Some individuals of the species may be killed/destroyed by the factor under consideration and the viability of a species population may be reduced.
Low	The species population will not be killed/destroyed by the factor under consideration. However, the viability of a species population will be reduced.
Tolerant	The factor does not have a detectable effect on survival or viability of a species.
Tolerant*	Population of a species may increase in abundance or biomass as a result of the factor.
Not relevant	This rating applies to species where the factor is not relevant because they are protected from the factor (for instance, through a burrowing habit), or can move away from the factor.
Insufficient information	Insufficient information

2. Assess the **recoverability** of the species from disturbance or damage. This feature is dependent on the ability to regenerate, re-grow, recruit or re-colonize, depending on the extent of damage incurred and hence its intolerance. The recoverability of a species is assessed against the recoverability scale (Table 2.5) by reference to direct evidence of recruitment, re-colonization or recovery (e.g. after environmental impact or experimental manipulation in the field) and/or key information on the reproductive biology, habitat preferences and distribution of the species.

Tab.2.5 Ranks of recoverability. Recoverability is only applicable if and when the impacting factor has been removed or has stopped. Ranks also only refer to the recoverability potential of a species, based on their reproductive biology etc..

Rank	Definition
None	Recovery is not possible
Very low / none	Partial recovery is only likely to occur after about 10 years and full recovery may take over 25 years or never occur.
Low	Only partial recovery is likely within 10 years and full recovery is likely to take up to 25 years.
Moderate	Only partial recovery is likely within 5 years and full recovery is likely to take up to 10 years.
High	Full recovery will occur but will take many months (or more likely years) but should be complete within about five years.
Very high	Full recovery is likely within a few weeks or at most 6 months.
Immediate	Recovery immediate or within a few days.
Not relevant	For when intolerance is not relevant or cannot be assessed. Recoverability cannot have a value if there is no intolerance and is thus 'Not relevant'.
Insufficient information	Insufficient information

3. Assess the **sensitivity** of the species[18]. The overall sensitivity rank is derived from the combination of intolerance and recoverability using different scenarios (Table 2.6) according to a scale that is intuitively weighted towards recoverability. However, where recovery is likely to occur in a short period of time, intolerance has been given a greater weight rather than under-estimate the potential sensitivity of marine species (Table 2.7). The decision matrix is not symmetrical because the scale represents scenarios in which the potential damage to the species or habitat matters. The scale is weighted towards recoverability, although in a few cases intolerances has been given a greater weight rather than under-estimate the potential sensitivity of marine habitats and species.

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[18] Data for the assessment of habitat/species intolerance and recoverability (and, thus, sensitivity) are not available for all taxa at site and regional levels for all the environmental factors, therefore for some species uncertainty in the sensitivity assessment might be high.

Tab.2.6 Ranks of species 'sensitivity' combining assessments of intolerance and recoverability. (**) 'Reduced viability' includes physiological stress, reduced fecundity, reduced growth, and partial death of a colonial animal or plant. NB: Where there is insufficient information to assess the recoverability of a habitat or species the precautionary principle will be used and the recovery will be assumed to take a very long time i.e. low recoverability in the derivation of a sensitivity rank.

Rank	Definition
Very high	- The habitat or species is very adversely affected by an external factor arising from human activities or natural events (either killed/destroyed, "high" intolerance) and is expected to recover only over a prolonged period of time, i.e. >25 years or not at all (recoverability is "very low" or "none"). - The habitat or species is adversely affected by an external factor arising from human activities or natural events (damaged, "intermediate" intolerance) but is not expected to recover at all (recoverability is "none").
High	- The habitat or species is very adversely affected by an external factor arising from human activities or natural events (killed/destroyed, "high" intolerance) and is expected to recover over a very long period of time, i.e. >10 or up to 25 years ("low" recoverability). - The habitat or species is adversely affected by an external factor arising from human activities or natural events (damaged, "intermediate" intolerance) and is expected to recover over a very long period of time, i.e. >10 years (recoverability is "low", or "very low"). - The habitat or species is affected by an external factor arising from human activities or natural events (reduced viability **, "low" intolerance) but is not expected to recover at all (recoverability is "none"), so that the habitat or species may be vulnerable to subsequent damage.
Moderate	- The habitat or species is very adversely affected by an external factor arising from human activities or natural events (killed/destroyed, "high" intolerance) but is expected to take more than 1 year or up to 10 years to recover ("moderate" or "high" recoverability). - The habitat or species is adversely affected by an external factor arising from human activities or natural events (damaged, "intermediate" intolerance) and is expected to recover over a long period of time, i.e. >5 or up to 10 years ("moderate" recoverability). - The habitat or species is affected by an external factor arising from human activities or natural events (reduced viability **, "low" intolerance) but is expected to recover over a very long period of time, i.e. >10 years (recoverability is "low", "very low"), during which time the habitat or species may be vulnerable to subsequent damage.
Low	- The habitat or species is very adversely affected by an external factor arising from human activities or natural events (killed/destroyed, "high" intolerance) but is expected to recover rapidly, i.e. within 1 year ("very high" recoverability). - The habitat or species is adversely affected by an external factor arising from human activities or natural events (damaged, "intermediate" intolerance) but is expected to recover in a short period of time, i.e. within 1 year or up to 5 years ("very high" or "high" recoverability). - The habitat or species is affected by an external factor arising from human activities or natural events (reduced viability **, "low" intolerance) but is expected to take more than 1 year or up to 10 years to recover ("moderate" or "high" recoverability).
Very low	- The habitat or species is very adversely affected by an external factor arising from human activities or natural events (killed/destroyed, "high" intolerance) but is expected to recover rapidly i.e. within a week ("immediate" recoverability). - The habitat or species is adversely affected by an external factor arising from human activities or natural events (damaged, "intermediate" intolerance) but is expected to recover rapidly, i.e. within a week ("immediate" recoverability). - The habitat or species is affected by an external factor arising from human activities or natural events (reduced viability **, "low" intolerance) but is expected to recover within a year ("very high" recoverability).
Not sensitive	- The habitat or species is affected by an external factor arising from human activities or natural events (reduced viability **, "low" intolerance) but is expected to recover rapidly, i.e. within a week ("immediate" recoverability). - The habitat or species is tolerant of changes in the external factor. - The habitat or species may benefit from the change in an external factor (intolerance has been assessed as "tolerant").
Not relevant	The habitat or species is protected from changes in an external factor (i.e. through a burrowing habit or depth), or is able to avoid the external factor.
Insufficient information	

Tab.2.7 Combining 'intolerance' and 'recoverability' assessments to determine 'sensitivity'. NS = not sensitive, NR = not relevant. Please note that the intolerance, recoverability and sensitivity ranks should be read in conjunction with the MarLIN on-line explanatory rationale for each assessment, which outline the evidence and key information used and any judgements made in the assessment. The information used and evidence collated is fully referenced throughout.

		Recoverability						
		None	Very low (>25 yr.)	Low (>10/25 yr.)	Moderate (>5 -10 yr.)	High (1 -5 yr.)	Very high (<1 yr.)	Immediate (< 1 week)
Intolerance	High	Very high	Very high	High	Moderate	Moderate	Low	Very low
	Intermediate	Very high	High	High	Moderate	Low	Low	Very Low
	Low	High	Moderate	Moderate	Low	Low	Very Low	NS
	Tolerant	NS	NS	NS	NS	NS	NS	NS
	Not relevant	NR	NR	NR	NR	NR	NR	NR

2.2.3b Sensitivity assessment of habitats

The MarLIN approach to the assessment of the sensitivity of habitats[11] assumes that the sensitivity of a community within a habitat is dependent upon and, therefore, is indicated by the sensitivity of the species within that community[19]. The species that indicate the sensitivity of a habitat are identified as those species that significantly influence the ecology of that component community according to criteria that subdivide species into key and important based on the likely magnitude of the resultant change. The loss of one or more of these species would result in changes in the population(s) of associated species and their relationship.

The first steps consist in a) characterising the structural and functional role of key species for each of the habitats listed in the Habitats Directive present in the Natura 2000 sites (Table 2.8) and b) the preparation of a review of the biology and sensitivity of these species and the habitat based in the aforementioned process for species sensitivity assessment.

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[19] Further developments of the MARLIN method for the sensitivity assessment of off-shore sedimentary communities to fishing activities have been proposed by Tyler-Walters et al. (2009). While being based on the same approach for the species sensitivity assessment, this method adopts slightly different intolerance, recoverability and sensitivity classifications (see related paper). Moreover, for the assessment at community level (i.e. habitat), the authors suggest to consider the five species that contribute the most to similarity and the ten species with the greatest abundance or biomass.

Tab.2.8 Species indicative of habitat sensitivity: selection criteria - the following criteria are used to decide which species best represent the sensitivity of a habitat or community as a whole.

Rank	Criteria
Key structural	The species provides a distinct habitat that supports an associated community. Loss/degradation of this species population would result in loss/degradation of the associated community.
Key functional	The species maintains community structure and function through interactions with other members of that community (for example, predation, grazing, competition). Loss/degradation of this species population would result in rapid, cascading changes in the community.
Important characterizing	The species is/are characteristic of the habitat (dominant, highly faithful and frequent) and are important for the classification of that habitat. Loss/degradation of these species populations could result in loss of that habitat.
Important structural	The species positively interacts with the key or characterizing species and is important for their viability. Loss/degradation of these species would likely reduce the viability of the key or characterizing species. For example, these species may prey on parasites, epiphytes or disease organisms of the key or characterizing species.
Important functional	The species is/are the dominant source of organic matter or primary production within the ecosystem. Loss/ degradation of these species could result in changes in the community function and structure.
Important other	Additional species that do not fall under the above criteria but where present knowledge of the ecology of the community suggests they may affect the sensitivity of the community.

After this first assessment of species intolerance and recoverability has been accomplished, the following rationale should be applied:
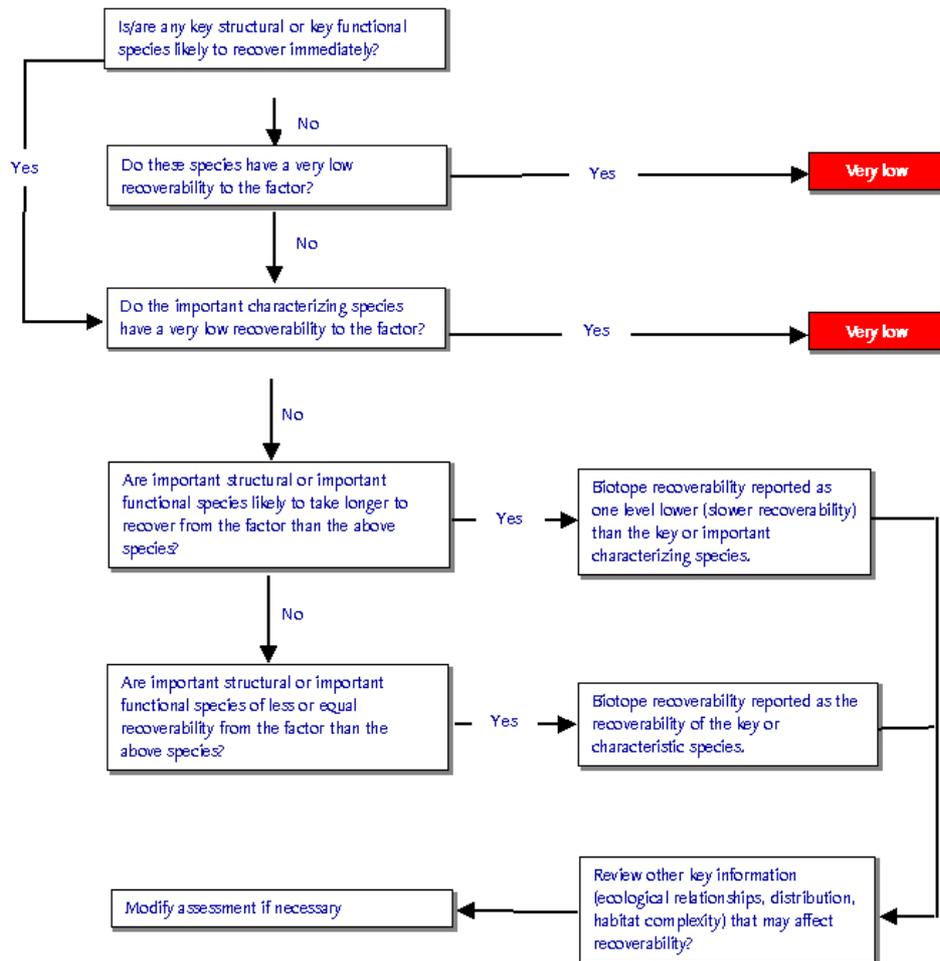1. Assess the overall intolerance of the habitat derived from the intolerance of the key species using the procedure shown in Figure 2.6.

Fig.2.6 Rationale for habitat intolerance assessment.
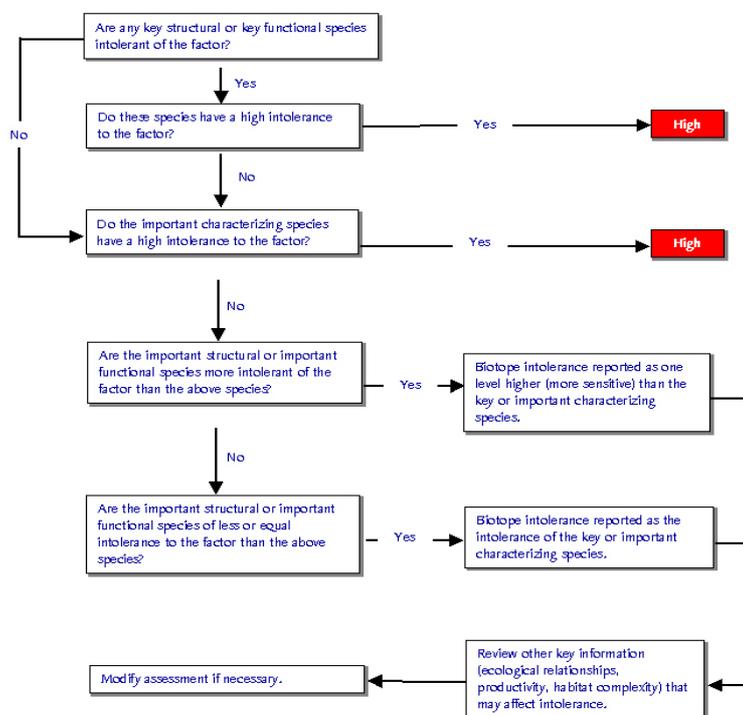
2. Assess the overall recoverability of the habitat derived from the recovery capacity of the key species identified using the procedure shown in Figure 2.7.

Fig.2.7 Rationale for habitat recoverability assessment.

3. Assess the overall sensitivity rank for habitats from the combination of intolerance and recoverability of key species using the rationale already shown in Tables 2.6 and 2.7.
4. Assess the likely effect of the environmental factors on species richness. Indeed, change in an environmental factor may not significantly damage key or important species but may still degrade the integrity of the habitat due to loss of species richness. Therefore, the likely effect of the factor on species richness in the habitat should be assessed according to ranking scale (Table 2.8). Where there is insufficient information to assess the intolerance and recoverability of a habitat the precautionary principle will be used and the intolerance will be assumed to be high and recovery will be assumed to take a very long time. In this case an important input can be obtained by expert consultation.

Tab.2.8 Ranking of response of species richness (the number of species in a given habitat, habitat, community or assemblage) to an external factor.

Rank	Definition
Major decline	The number of species in the community is likely to decrease significantly (>75% of species) in response to the factor, probably because of mortality and loss of habitat. For example, a change from very rich to very poor on the NHAP scale (Hiscock 1996).
Decline	The community is likely to loose some (25-75%) of its species in response to the factor by either direct mortality or emigration. N
Minor decline	The community is likely to loose few species (<25% of species) in response to the factor. For example, a decrease of one level on the NHAP scale (Hiscock 1996).
No change	The factor is unlikely to change the species richness of the community
Rise	The number of species in the community may increase in response to the factor. (Note the invasion of the community by aggressive or non-native species may degrade the community).
Not relevant	It is extremely unlikely for a factor to occur (e.g. emergence of a deep water community) or the community is protected from the factor.
Insufficient information	

Output

The link between the results of conflict analysis and of the sensitivity assessment of the habitat/species that could be impacted will allow to assess and rank habitats/species population sensitivity according to the actual fishing disturbance in each cell, thanks to the benchmarks used in the MarLIN approach.

Current knowledge does not allow understanding in all cases the relationship between fishing intensity and impacts on the favourable status since acceptable, comparable and quantified thresholds are not yet defined for this purpose. Moreover, fishing effort intensity might vary sharply in absolute values between different Natura 2000 sites and no agreed general quantitative relationships between fishing intensity and the effects on habitats/species population is available (the concept is outlined Fig 2.5 but the figure is 'unscaled'). A clear, direct and linear link between fishing effort and impacts on habitats/species is known only for a few gears (e.g. trawl on Posidonia beds), for which higher fishing intensity corresponds to higher impacts. Therefore the ranking of the impact of fisheries on habitat/species (defined as in Table 2.9) should be carried out by expert judgement as a combination of fishing intensity and sensitivity, also taking into consideration the conservation status of the relevant habitats/species. *Ad hoc* expert workshops could be organised with this aim.

For the purpose of this methodology, when considering the outcomes of the sensitivity analysis of species population/habitats (Table 2.7), a functional link between sensitivity ranking and the scale for measuring their conservations status[20] can be established (Figure 2.8). The link is not immediate and direct as, for instance, high sensitivity does not imply unfavourable status, but only a potential unfavourable status if the impacting pressure occurs.

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[20] Assessment, monitoring and reporting of conservation status – Preparing the 2001-2007 report under Article 17 of the Habitats Directive (European Commission - DocHab-04-03/03 rev.3).

The Art.17 report guide proposes three different scores to assess the habitats/species conservation status: Favourable, Unfavourable inadequate and Unfavourable bad. It also includes the category Unknown, when insufficient information is available to make an assessment. The scores of sensitivity could be related to the scores of the conservation status, for instance the ranks "high" and "very high" sensitivity can be related to "unfavourable bad" conservation status (Figure 2.8).

Fig.2.8 Relationship between the results of the sensitivity assessment and the potential Favourable Conservation Status if the impacting pressure occurs.
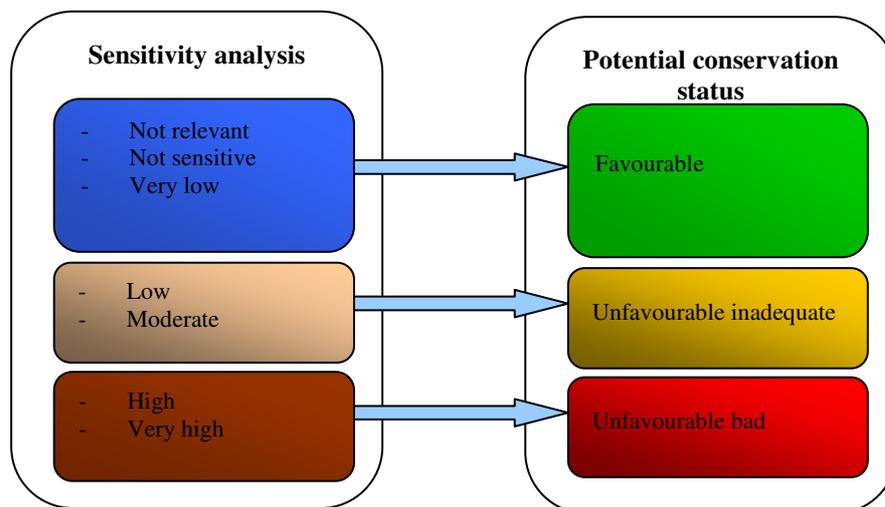
The Swedish Environmental Protection Agency developed in 2010 a scale for the assessment based on potential impacts of fisheries on the favourable conservation status of habitats/species, taking into consideration their sensitivitiy. The assessment of impacts is based on the impact of fishing on habitat function, structure or characteristic species. For the assessment of species the scale is based on the impact on populations. The aim is to assess, with the support of the matrix, the potential impact of fisheries based on the conservation objectives for the identified species and habitats in the site and available information on current fisheries in the area (Table 2.9). The scale can also be used when sensitivity of habitats/species is evaluated.

Tab.2.9 Scale for measuring the impact of fisheries on habitat/species.

None or low effect	Favourable conservation status is not depending on the intensity of the fishing, timescale or geographic scale; not for area or characteristic species nor for structure or function. No regulation needed.
Moderate effect	Favourable conservation status is moderately affected. The criteria are affected depending on the intensity of the fishing, timescale or geographic scale. Recovery small. Regulations might be needed.
High effect	Favourable conservation status is highly affected by one of the criteria areal, characteristic species, structure or function. Recovery is small or poor if no action is taken. Regulations should be implemented.
Very high effect	Favourable conservation status is very largely affected. Irreversible effects. Regulations must be implemented to reach the conservation objectives.

A comprehensive impact matrix (Table 2.10), including the rank of the impact[21] and the description of the type of impact, should be filled in for each Natura 2000 site for each habitat/species, which have a potential conflict with fisheries. Table 2.11 is an example of such impact matrixes relative to habitats.

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[21] Given that data on by-catch, sediment disturbance, etc, are generally not available, it will be hard to assess impacts of fishing effort on ecosystem components with high detail.

Tab.2.10 Example of impact matrix to be filled in.

Type of habitats (Eunis level 3 or 4)	
Gear 1	
Type of impact	Eg scraping and ploughing of the substrate, sediment re-suspension, destruction of benthos
Scale of impact	According to the scale set up (e.g. Table 2.10)
Level of certainty	Depends mainly on the resolution of the habitat layer and the fishing pressure layer in GIS and the data available for the assessment
Gear 2	
Type of impact	
Scale of impact	
Level of certainty	
Gear 3	
….	
Species	
Gear 1	
Type of impact	Mortality, displacement
Scale of impact	
Level of certainty	
Gear 2	
Type of impact	
Scale of impact	
Level of certainty	
Gear 3	
….	

Tab.2.11 Example of an impact matrix relative to habitats, relative to the Swedish marine Natura 2000 sites, developed using the scale of Table 2.9.

The development of a common conflict matrix at European level could be considered based on the work of various Member States.

An integrated analysis of the cumulative effects of fisheries impacting habitats and species for which the site has been designated should be carried out. The analysis should take into consideration the conservation objectives of the Natura 2000 sites and the contribution of the site to the favourable conservation status of the relevant habitats/species. The analysis of cumulative human impacts in the marine environment is at the beginning, but it is developing rapidly. A meta-analytical approach can be used to quantify overall effects of various gears on the different habitats/species and to compare the relative importance of different impacts across the various habitats/species of EU interest. However, in most cases only a qualitative assessment is possible and the expert judgment acquires a strategic importance in particular when there are contrary effects of one gear on different habitats/species. A map summarizing all the impacts of different types of gear on the conservation objectives of the marine Natura 2000 site should be produced.

2.3 Stakeholders involvement and international cooperation

The relevant stakeholders such as fishermen organisations, NGOs and CSOs should be consulted during the assessment process. Consultation could be carried out in three separate steps:

a) In an initial, analytic phase of the work, the role of stakeholders should be limited to provision of data and factual correction of information. The involvement of stakeholders depends on the available information: where strong scientific data are available then stakeholder involvement should be minimised or at least weighted according to the level of expertise and data that such a consultation would bring to the table. Where data are scarce, the involvement of specific experts and of stakeholders will facilitate the collection of reliable information about the site, the species/habitats present. Questionnaire and interviews have already been used successfully in this framework.

b) Later, the involvement of stakeholders in assessing the potential impacts of the fisheries and other human activities on these, can guarantee the correctness of the impact evaluation. The organisation of thematic workshops for experts of the different matters of the assessment have already been used successfully. In particular, where expert judgement is relied on then a broader set of views, including stakeholders, should be included.

c) If the assessment of impacts is agreed between stakeholders and evaluators then consultation with stakeholders and policy makers is required to design the appropriate mitigation measures

During the consultation process, the Regional Advisory Councils (RACs) should be consulted formally and in writing, in accordance with the Commission's minimum standards[22]. RACs can also be involved in the collection and mapping of fisheries information and in designing mitigation measures as appropriate.

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[22] Communication from the Commission "Towards a reinforced culture of consultation and dialogue - General principles and minimum standards for consultation of interested parties by the Commission" n. COM(2002) 704 final of 11/12/2002.

In the fishery sector, there are problems among Member States for the communication of data from vessels fishing in a Member State different from its own. International cooperation is essential:

1. when different national fleets operate in the Natura 2000 sites concerned;
2. to improve and broaden the quality of the assessment in cases where Natura 2000 features span over the territories of several Member States or when fisheries from more than one States are carried out in a given site;
3. to agree on the assessment methodology and to work towards achieving the same approach to fisheries management in transboundary N2K sites;
4. to help ensure that no Member State fishing vessels are discriminated against.

3 Next step

The implication of the findings of the impact of fisheries on the Favourable Conservation Status of habitats and species for which the Natura 2000 sites have been designated should be clear and couched in the precautionary approach. In some cases it will be certain that long-term impacts will occur. In other cases no impact might be found but sufficient doubt may remain to warrant detailed monitoring and adaptative management. There is a gradation of findings that should be linked to a gradation of responses. An objective and science-based decision-making process would help to link the impact matrix (Table 2.11) to a decision support matrix (Figure 3.1), which can be case specific.

Fig.3.1 Decision support tree.
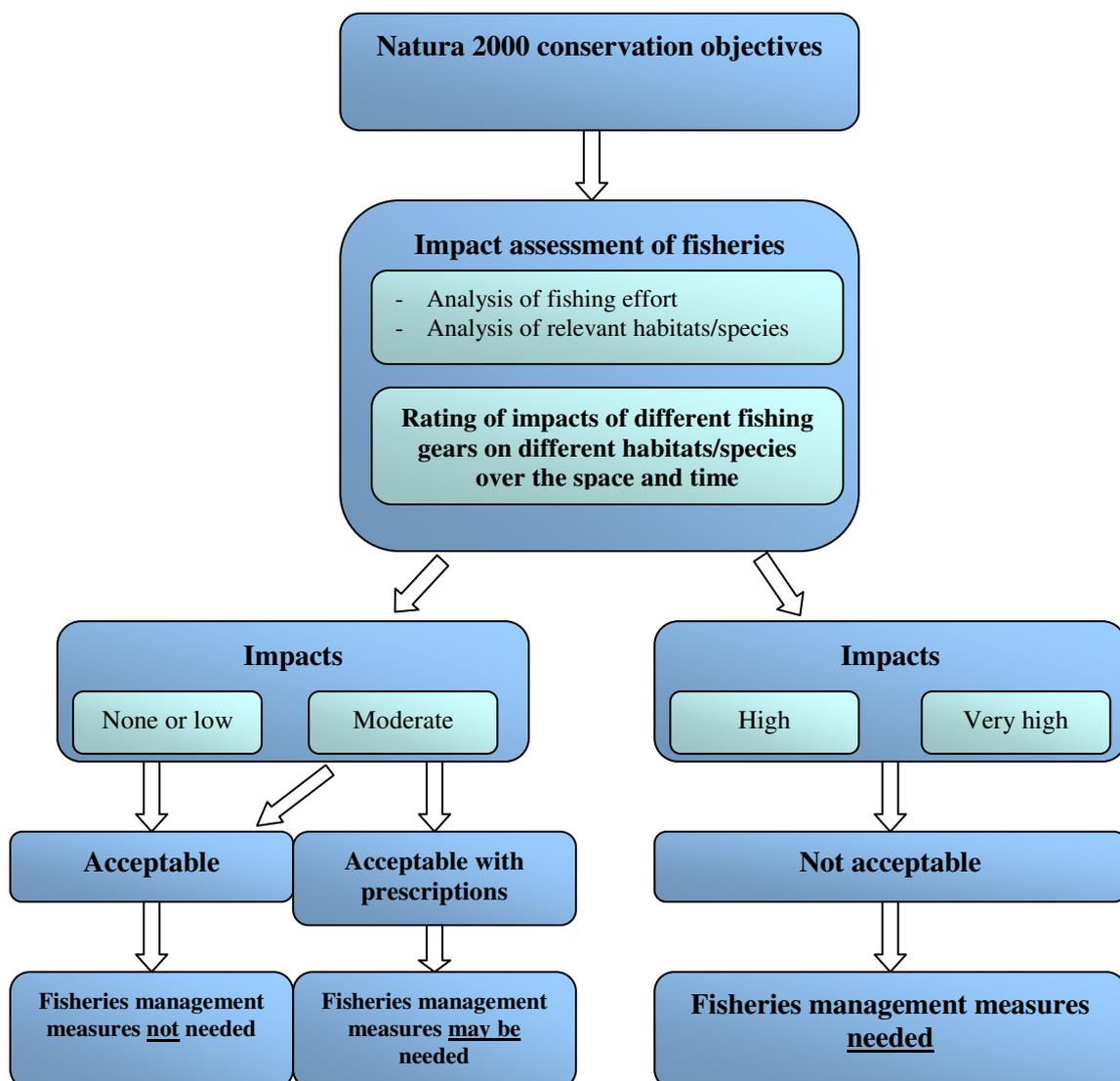
The different ways in which to deal with a specific impact should be established. This may offer a choice in situations where a given impact may be acceptable. Acceptance

could be passive in the event the impact is none or low, or active where the moderate impacts can be accepted with prescriptions. When the impacts are high or very high they are not acceptable.

In case impacts are not acceptable, specific fisheries management measures (Annex G) should be identified. When impacts are moderate the need of these measures is to be evaluated.

The judgment of experts is important when different gears have different effects (even positive effects) on habitats/species for which the Natura 2000 site has been designated.

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Useful links

EMPAS project: www.ices.dk/projects/empas.asp
FIMPAS project: http://noordzee.wordpress.com/2009/11/01/project-fimpas-official-summary
Marlin sensitivity assessment methodology: http://www.marlin.ac.uk/sensitivityrationale.php
WAKO II project: http://www.ilvo.vlaanderen.be/wako/Background/tabid/3006/Default.aspx
UK MPAs: http://jncc.defra.gov.uk/page-4524

Annex A. Definition of the main terms used

Term	Definition	Reference
Conservation objective	It is the specification of the overall target for the species and/or habitat types with a view to maintaining or reaching favourable conservation status at the national, the biogeographical or the European level.	"Draft commission note on the setting conservation objectives for natura 2000 sites" of 18/11/2011
Favourable Conservation Status	*Of a natural habitat:* means the sum of the influences acting on a natural habitat and its typical species that may affect its long-term natural distribution, structure and functions as well as the long-term survival of its typical species within the territory referred to in Article 2. The conservation status of a natural habitat will be taken as 'favourable' when: • its natural range and areas it covers within that range are stable or increasing, and • the specific structure and functions which are necessary for its long-term maintenance exist and are likely to continue to exist for the foreseeable future, and • the conservation status of its typical species is favourable as defined in (i); *Of a species* means the sum of the influences acting on the species concerned that may affect the long-term distribution and abundance of its populations within the territory referred to in Article 2; The *conservation status* will be taken as 'favourable' when: • population dynamics data on the species concerned indicate that it is maintaining itself on a long-term basis as a viable component of its natural habitats, and • the natural range of the species is neither being reduced nor is likely to be reduced for the foreseeable future, and • there is, and will probably continue to be, a sufficiently large habitat to maintain its populations on a long-term basis.	Articles 1e and 1i of the Habitats Directive
Fishing effort	The amount of fishing gear of a specific type used on the fishing grounds over a given unit of time e.g. hours trawled per day, number of hooks set per day or number of hauls of a beach seine per day. When two or more kinds of gear are used, the respective efforts must be adjusted to some standard type before being added.	FAO (1997)
Gear type	Level 4 of the classification of fishing activity reported in the Commission Decision 2010/93/EU.	Appendix IV of the Commission Decision 2010/93/EU of 18/12/2009
Intolerance	The susceptibility of a habitat, community, or species, to damage or death, from an external factor	Hiscock and Tyler-Walters, 2006

Term	Definition	Reference
Recoverability	The ability of a habitat, community, or species (i.e. the components of a habitat) to return to a state close to that which existed before the activity or event caused change.	Hiscock and Tyler-Walters, 2006
Sensitivity	Sensitivity depends on the intolerance of a species or habitat to damage from an external factor and the time taken for its subsequent recovery.	Defra, 2004
VMS	Satellite-based Vessel Monitoring System trough specific satellite-tracking devices installed on board Community fishing vessels	Regulation N° 404/2011

Annex B. Determination of reliability of data

All literature used should be cited along with a brief description of its relevance to the specific assessment (fishery+Natura 2000 habitats/species). An indication of the quality of the evidence could be:
- Directly relevant peer-reviewed studies;
- Directly relevant "grey literature" studies;
- Inference from peer-reviewed or grey literature relating to a comparable habitat/species, gear or geographical area;
- Expert judgement.

The degree and type of uncertainty in each of the assessments must be stipulated, based on the sources of evidence used. These are to be classified as high, medium and low uncertainty, with appropriate sub-divisions. This is necessary to make clear to the end-user the strength/weakness of evidence used. The categories are described below.

Low certainty
- There is no direct evidence (peer-reviewed scientific, grey literature or non-scientific). It has been necessary to rely on analogy with other habitats/species for which evidence does exist. Evidence to support this assumption may be limited (i.e. the relative sensitivity of the habitats is not clear).
- The Natura 2000 habitat may encompass a number of sub-types, which vary in their sensitivity to fishing pressure. There is no direct evidence for any of the subtypes so it has been necessary to rely on analogy with several other habitats for which evidence does exist.
- Conclusions have been based on sensitivity assessments, which may rely on significant assumptions or generalisations. It has not been possible to validate these assumptions.
- The evidence base is conflicting, as a result it is not possible to reach accurate conclusions on the effect of activities on the Natura 2000 site.

Medium certainty
- There is no direct evidence. It has been necessary to make an analogy with other habitats for which evidence exists. There is good reason to believe that the analogy is justified (e.g. occurrence of species with similar characteristics).
- The habitat may encompass a number of sub-types, which vary in their sensitivity to fishing pressure. The available evidence does not cover the full range of the variation so some cases may not be well supported by evidence.
- There is directly relevant scientific information to support the conclusion but it comes from "grey literature" sources.
- There is relevant non-scientific information that directly supports the conclusion on impacts.

High certainty
- There is good quality, highly relevant site-specific studies, scientific and non-scientific information to directly support the conclusion.
- There may not be direct evidence to support the conclusions, but they are inevitable conclusions based on the application of common sense.

Annex C. Gears used in the European Union

Gears are commonly classified in three categories:

1. Towed gears that are towed across the seabed;
2. Passive gears that are placed on the seabed and do not move until lifted by the fishing vessel
3. Active (or mobile) gears that involve movement of the fishing vessel during deployment but are not actively towed.

The tracks belonging to different categories are generally characterized by important differences in terms of course and operation speed during fisheries operations. Furthermore, each gear group is characterized by different significant adverse impacts on marine habitats and species.

The table includes the list of the gears used in the EU, reported in Appendix IV of the Commission Decision 2010/93/EU of 18/12/2009. Level 4 of the classification of fishing activity has been considered in this methodology.

	Gears	Baltic Sea	North Sea	North Atlantic	Mediterranean Sea and Black Sea
Towed	Boat dredge	No	Yes	Yes	Yes
	Mechanised/Suction dredge	No	Yes	Yes	No
	Bottom otter trawl	Yes	Yes	Yes	Yes
	Multi-rig otter trawl	Yes	Yes	Yes	Yes
	Bottom pair trawl	Yes	Yes	Yes	Yes
	Beam trawl	No	Yes	Yes	Yes
	Midwater otter trawl	Yes	Yes	Yes	Yes
	Pelagic pair trawl	No	No	No	Yes
	Midwater pair trawl	Yes	Yes	Yes	No
Passive	Hand and Pole lines	Yes	Yes	Yes	Yes
	Trolling lines	No	No	Yes	Yes
	Drifting longlines	Yes	No	Yes	Yes
	Set longlines	Yes	Yes	Yes	Yes
	Pots and Traps	Yes	Yes	Yes	Yes

	Gears	Baltic Sea	North Sea	North Atlantic	Mediterranean Sea and Black Sea
	Fyke nets	Yes	Yes	Yes	Yes
	Stationary uncovered pound nets	Yes	No	Yes	Yes
	Trammel net	Yes	Yes	Yes	Yes
	Set gillnet	Yes	Yes	Yes	Yes
	Drifnet	No	Yes	Yes	Yes
Active	Purse seine	Yes	Yes	Yes	Yes
	Lampara nets	No	No	No	Yes
	Fly shooting seine	Yes	Yes	Yes	Yes
	Anchored seine	Yes	Yes	Yes	Yes
	Pair seine	Yes	Yes	Yes	Yes
	Beach and boat seine	Yes	Yes	Yes	Yes
	Glass eel fishing	No	Yes	Yes	Yes

Annex D. Interpolation of VMS tracks by splines

RATIONALE OF THE APPROACH

Given a sequence of sequential positions in a two-dimensional space $\{(t_i, \mathbf{P_i}, \mathbf{T_i^I}, \mathbf{T_i^O})\}_{i=0}^{n-1}$ where t_i is the sample time, $\mathbf{P}_i$ is the sample position, $\mathbf{T_i^I}$ is the incoming tangent vector, and $\mathbf{T_i^O}$ is the outgoing tangent vector. A spline specifies a cubic polynomial interpolation between each pair of key frames by choosing the incoming and outgoing tangents in a special way. The tangents at $\mathbf{P}_i$ are chosen based on neighboring positions and on three parameters that have some visual appeal. The parameters are ***tension*** which controls how sharply the curve bends at a control point, ***continuity*** which controls the continuity (or discontinuity) at a position, and ***bias*** which controls the direction of the path at $\mathbf{P}_i$ by taking weighted combination of one-sided derivatives at that position. Figure shows a typical position, tangent vectors, and the curve segments passing through the position.
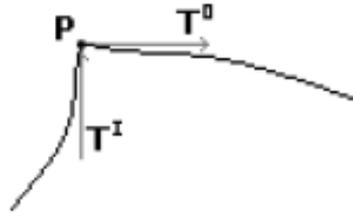

Figure 1. A cubic spline curve passing through point **P** with incoming tangent $\mathbf{T^I}$ and outgoing tangent $\mathbf{T^O}$.

INPUT DATA

VMS dataset in which each point contained information about position, vessel speed, and prow heading.

DATA PROCESSING

A cubic Hermite spline is a third-degree spline with each polynomial of the spline in the Hermite form. Using the data about times (t_i), positions (X_i) and tangent vectors (T_i), is possible to use cubic Hermite splines to obtain an intepolation $S(t)$ of the points. Splines satisfy the requirements:

$$S_i(t_i) = X_i, \qquad S_i(t_{i+1}) = X_{i+1}, \qquad S'_i(t_i) = Ti$$

Hence, the spline will pass exactly on the control points X (that are the points into the input dataset) and the spline derivatives in those points will match the vectors T. The interpolation procedure is composed by two steps: (1) computing tangents at control points and (2) computing interpolated positions. When VMS tracks are interpolated, tangents should be computed in order to take into account for the different forces acting during fishing vessel navigation. In this way, it is possible to assume that the real heading of a vessel between two recorded positions is the vectorial sum of two components: the one actively determined by boat rudder and engine (H^p) and the one represented by the combined actions of sea current and of wind eventually present (H^{drift}). This is particularly true when static gears are deployed. While H^p is under the human control, H^{drift} is an environmental factor that could be indirectly evaluated via the VMS data. In fact, VMS data do not contain any measurement about the drift, but they provide the data about H^p. If we assume that H^{Est} is a good estimate of the real direction, for each control point, we can decompose H^{Est} in its two components H^p and H^{drift}:

$$H^{Est} = H^p + H^{drift}$$

An estimate of the drift effect will be given by the median ˆH drift computed on the values of Hdrift. In this way, our method is devised to obtain an estimate of the drift without using external (oceanographic) data. This estimate will be used to correct the direction of tangent vectors. Taking the median $\hat{H}^{drift}$ as an estimate of the drift step implies that the behavior of the current at the microscale (that is a squared area of 10kmside) containing the fishing track is considered stable. The real heading H^{CRm} of the vessel at each point is finally estimated as the vectorial sum of prow heading and median sea current heading:
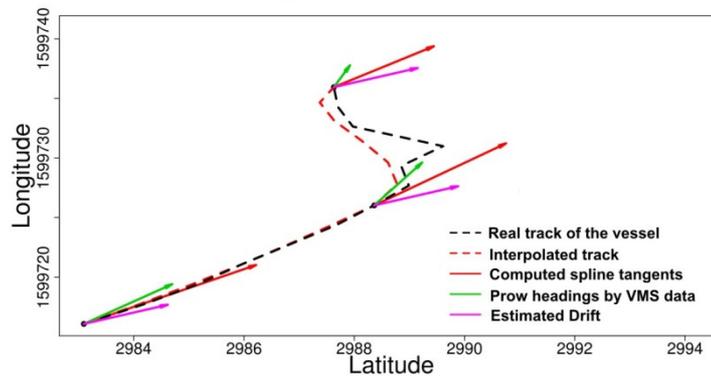
$$H^{CRm} = \hat{H}^{drift} + H^p$$

Figure 2. Schematic representation of the comparison between real and interpolated track for three succeeding VMS records towards an estimated one. Spline tangents and vectors are shown.

As example, the application of this method on a large VMS dataset for the activity of the Italian professional fishing fleet is reported in the following figure. The dataset comprises VMS track for vessels using three different types of gears. The method present here corresponds to red line, while another similar method (used for performance comparison) corresponds to blue line. The real track, obtained from a high frequency VMS dataset (with pings at 20 minutes rate) corresponds to black line. It seems that the method presented in Russo et al., 2011 provides the best performance for all the gears.

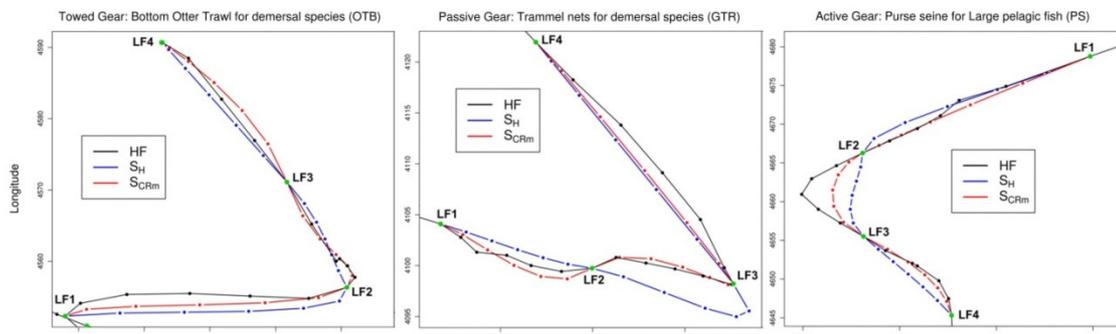**Figure 3.** Comparisons between the real high frequency track (black points and black solid line HF) and those estimated by means of the method proposed by Hintzen *et al*., 2010 (blue points and blue solid line SH), and the CRm method proposed by Russo *et al*., 2011 (red points and line SCRm) for each gear type: OTB, GTR and PS. Green points represent VMS signals at low frequency (LF) (control points).

Annex E. Assigning fishing effort to métiers based on VMS data using artificial neural networks

RATIONALE OF THE APPROACH

Although robust procedures are available to assess métiers associated with VMS tracks through the use of logbook data, these are still affected by the variable quality of information recorded in logbooks. In addition, logbooks may not reflect fine-scale tactical features (the so-called skipper effect), which can significantly contribute to the fishing strategy. When logbooks are not available for all VMS tracks and/or quality of information is poor, a possible alternative could be represented by the training of an artificial neural network (ANN) on a subsample of tracks and then the assignment of the rest of the tracks by the trained ANN. The basic idea of this approach is that the real behavioural pattern expressed by a fishing vessel is captured by VMS, and then it could be used to reconstruct and classify activity. In fact, the tracks belonging to different categories are generally characterized by important differences in terms of course and operation speed during fisheries operations. This is reflected, in turn, by the spatial trajectories of vessels. Given that VMS data provide information about vessel position, speed, and heading, while sea depth can be inferred by vessel position, these quantities can be used to identify the fishing activity associated with a given track of a particular fishing vessel.

INPUT DATA
(1) VMS dataset in which each point contained information about position, vessel speed, and prow heading. Sea depth can be reconstructed, for each position of the VMS dataset, by space coordinates. These descriptors should be converted in classes of frequency. Number of classes for each descriptor (e.g speed) could be tuned for each case of study
(2) Vessel Register reporting list of authorized gears for each fishing vessel in the VMS dataset. Each gear should be converted in a binary (0,1) variable describing if a given vessel is licensed to use it.
(3) Logbook (only for a part of the VMS dataset) in order to train and validate ANN.

DATA PROCESSING

Extensive of ANN are reported in literature. Here we used a particular kind of ANN, called Multilayer Perceptron Network (MPN). An MPN (see the following figure) consists of at least three layers of neurons (also called units or nodes). The input layer contains as many neurons as independent variables or descriptors used to predict the dependent variables, which in turn constitute the output layer. The hidden layer neurons compute a weighted sum of the input variables through a first activation function; then they send a result to the output neurons through a second activation function. The output produced for each track can be regarded as a series of probabilities to belong to each one of the 15 level 6 métiers. The application of MPN consists of a training phase and a test phase. The training is based on the use of two datasets (the "training" and "validation" datasets, respectively) to adjust the weights of the hidden layer neurons to minimize the error function between the observed and predicted values. In the test phase,the MPN

should be able to show high performances (i.e. >80%) in classifying patterns from a "test dataset", which is different from both the training and the validation dataset.
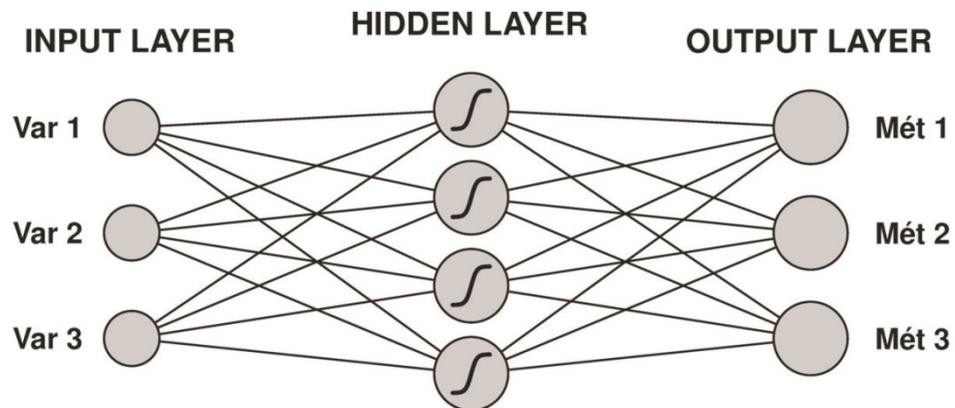
Russo et al., 2011 report an extensive calibration and application of this approach on a large dataset consisting of 15,000 tracks belonging to 15 different métier of level 6. Trained MPN evidenced a very satisfying performance on the test dataset (more than 90% of the tracks correctly classified).

Annex F. Example of questionnaire

The questionnaire should cover issues about fishing activities, ecological knowledge, and suggestions for areas that might benefit from protection. Therefore it could address two main issues:
- a set of questions aimed at determining the spatial and seasonal distribution of different types of fishing activities in the Natura 2000 sites;
- a set of questions about the vessel.

The first of the two sets of questions is the most important, and it takes up the largest part of the questionnaire. Interviewees should be asked what areas they fished, what types of gear they used, which species they targeted, and the months of the year during which these activities are carried out. A georeferenced map should be used to precisely locate the fishing area. Moreover a description of the type of interaction (accidental capture, sighting, etc.), if any, with species of EU interest should be compiled.

The second set of questions is shorter. In includes basic details about the size and power of vessel used, and the port they operated from for most of the year.

In addition, the questionnaire should also collect basic personal details (name, contact) on voluntary basis. To ensure anonymity of individual responses, only the officer who carried out the interview can retain these personal details, and before being passed on to the main GIS, databases should be cleared of these personal details.

Questionnaire
Agree to be interviewed? Y / N / Later / Other*
* if other, indicate what :
Date:

Table 1: Individual details (only on voluntary basis)	
Name	
Address	
Telephone number(s)	
Skipper? Other (specify)?	

Table 2: Fishing range and navigation	
ICES sub area(s) you work (map in annex)	
Min distance from coast (NM)	
Max distance from coast (NM)	

Table 3: Vessel and crew	
Home port	
Vessel registration number	
Vessel type (open, half deck, decked etc)	
Vessel Length	
Vessel GTs and KWs	
Plotter installed ?	
Sounder installed ?	
In what year was the vessel built?	
Crew number (inclusive of the skipper)	
Nationality of crew	
Are you a member of a PO or other representative organisation ?	
Main target species (in order of importance)	

Table 4: Gear: specify <u>amount</u> in each month													
Gear	**Target species**	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Continued …													

Note: The monthly distribution of gear activity is relevant to the persistence of pressure applied to a habitat and therefore the persistence of disturbance if the gear causes disturbance of habitat. At least the months where the gear is active and inactive should be identifiable. For months where the gear is active be categorical (low, medium or high relatively other months) or ideally quantitative (pots used, miles of nets, number of nets).

Table 5: Gear: Specify <u>days during which gear is in the water</u> in each month													
Gear	**Target species**	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Continued …													

Note: The fishing pressure for a gear in any month is the product of the amount of gear and number of days the gear is in the water during that month. For months where the gear is used get an estimate of the number of days the gear is in the water, which for static gear is higher than the number of fishing days.

Table 6: Interaction with species of EU interest														
Gear	**Species**	**Type of interaction**	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Continued …														

Note: This kind of questionnaire could also be used for habitat types when the habitat types are well identifiable and known to fishermen.

Annex G. Standard list of fishery management measures

Several management measures can be adopted in order to limit the negative effects of fishing in Natura 2000 sites. The following list is intended to show possible management measures examples divided into input and output controls as well as technical measures. Management measures should be set when negative impact in the Natura 2000 sites are identified according to the framework proposed in this document. The severity of such measures should be decided according to fisheries inherent features in the assessed site with the aim of achieving the favourable conservation status.

Input controls or fishing effort management
Input controls are restrictions put on the intensity of use of gear that fishers use to catch fish. Most commonly these refer to restrictions on the number and size of fishing vessels (fishing capacity controls), the amount of time fishing vessels are allowed to fish (vessel usage controls) or the product of capacity and usage (fishing effort controls).
Examples of input controls are:
- licence limitation (e.g. number of fishing vessels allowed to carry out fishing activities);
- fishing vessels capacity limitations (e.g. tonnage or engine power limitations for fishing vessels):
- fishing gear limitation (e.g. number of type of fishing gear that can be used in a given area);
- fishing effort limitation (e.g. days/hors of fishing allowed per year/season);
- fishing grounds limitations (e.g. areas where the use of specific fishing gear is interdicted);

Output controls or catch management
Output controls are direct limits on the amount of fish coming out of a fishery (fish is used here to include shellfish and other harvested living aquatic animals). Obvious forms of output control are limits placed upon the tonnage of fish or the number of fish that may be caught from a fishery in a period of time. Another form of output control is the bag limits (restrictions of the number of fish that may be landed in a day) used in many recreational fisheries. Limiting by-catch might also be seen as an output control. It is worth immediately noting that to limit fishing intensity it is necessary to limit fishing intensity it is essential to limit the catch (the amount taken from the sea) rather than the landing (which may contain only a selection of the catch). The unwanted catches (the discards) may be a substantial proportion of the total catch, and thus undermine the efforts to manage fishing activities. The Proposal for a new Regulation on the Common Fisheries Policy aims at eliminating unwanted catches of commercial stocks and at ending the practice of discards. The Proposal introduces the obligation to land all catches of specified stocks, with a precise timeline for implementation.

Examples of output controls are:
- Total Allowable Catch (e.g. the total quantity of a given species that can be landed);

- Minimum landing size (e.g. the minimum size of individuals that can be sold; it is defined according to species inherent biological features).
- By-catch limitations.

Technical measures

Technical measures includes a range of limitations and tools that can be effectively adopted to reduce fishing mortality, by-catch production and the direct/indirect effect of fishing on marine species populations/habitats:
- mesh size/shape regulations (e.g. minimum cod-end size; adoption of squared meshes instead of diamond meshes);
- by-catch reduction devices (e.g. benthos release panels; turtle exclusion devices);
- fishing gear size/weight limitations (e.g. adoption of light beam trawl).